Using Think Aloud Data to Understand Spatial Reasoning

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Context

Measuring Early Mathematical Reasoning Skills (MMaRS)

Goal: to create formative assessment resources focused on Numeric Relational Reasoning (NRR) and Spatial Reasoning (SR) for students in grades K-2. Teachers may use the results of these assessments to guide their instructional decisions to support student learning.

MMaRS researchers conducted think aloud interviews with children in grades K-2 to collect information that may be used to refine the draft assessment items. This poster follows the evolution of items aligned to one subcomponent.

Research Questions

1. Do the items and activities elicit intended content knowledge and reasoning strategies in students' responses?
2. How should the items be refined to elicit students' reasoning?

Method

Participants: Three phases of Think Aloud Interviews (October 2021, February 2022, and March 2023.) A total of 18 students across grades K-2 participated in interviews specific to the SR construct.

DRAFT Item Development
Analyze literature, develop inventory, draft items aligned with subcomponents within learning progression

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Conduct Think Aloud Interviews - Models A & B
Ask students concurrent & retrospective questions, analyze responses & actions in real-time & across-cases

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ITERATE & REVISE

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Conduct Think Aloud Interviews - Model C
Ask questions, analyze in real-time, iterate, revise, & refine

The think aloud process "is a psychological method used to collect data about human information processing….[it] can be a useful tool in determining whether test items or tasks elicit problem-solving processes" (Padilla & Leighton, 2017, p. 220).

Iterations & Analysis

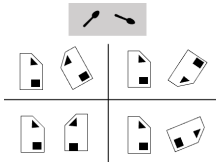
This example focuses on the iteration of a single item aligned to one subcomponent, designed and tested with students who were in second grade that asked students **to recognize congruent two-dimensional shapes or figures after a rotation.**

Model A

Scaffold:

These two hearts are the same. How can you make this heart (*point to left heart*) look like this heart (*point to right heart*)?

Content Question:



These two spoons are the same.

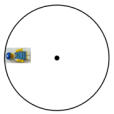
Which of these sets of shapes shows the same relationship ?

Reasoning Question:
How do you know these show the same relationship?

Model A Analysis: Evidence of students matching the placement of the object in the gray box to the placement of the answer choice rather than focusing on rotation.

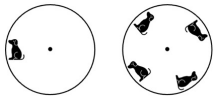
Model B

Scaffold:



I am going to rotate this card around the point in the middle. What happens to the figure?

Content Question:



Imagine I rotate this picture around the point in the middle (like the spinner).

Which picture would you NOT see??

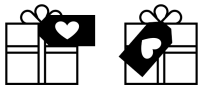
Reasoning Question:
How do you know you WOULD see this one?
(*Point to one of the correct answers.*)

Model B Analysis: Even with the spinner scaffold, students did not understand the concept of rotation within this item.

Revisions

Model C

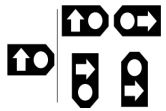
Scaffold:



These two gift tags are the same. How can you make this gift tag (*point to left tag*) look like this gift tag (*point to right tag*)?

Content Question:

Here are two shapes on a gift tag.



Which of these gift tags has turned but is the same?

Reasoning Question:
(*Point to the gift tag they chose.*) How has this gift tag turned?

Model C Analysis: The familiarity of the gift tag as the scaffold allowed students to focus on the rotation of the shape. **As intended, students responded by accurately showing the rotation with their gestures, selecting the correct response choice, and explaining the changed direction of the heart and arrow shapes as well as the top portion of the gift tag.** Drawing from the interview evidence from the model C reasoning question, we also suggest adding flexibility for teachers to ask follow-up questions about non-selected responses to allow students the opportunity to demonstrate their full reasoning. (Interviewers went off-script and asked students about their non-selected responses while testing model C for the think aloud interviews.)

Conclusions:

1. Evidence from the think aloud interviews showed items and activities from models A and B did not elicit intended content knowledge and reasoning strategies in students' responses. Model C functioned well.
2. We revised the items by adding a familiar object—a gift tag—to the scaffold and using this same gift tag shape for the content and reasoning questions. We also refined the wording of the questions based on the students' feedback while testing models A and B, as shown in model C.

Contributions to the Field

Think aloud interview data offer important insight—directly from students—about the alignment of an intended construct and how the drafted item elicits reasoning strategies based on the verbal and action-based responses of students.
These data inform item iteration, which ultimately helps researchers and teachers understand students spatial reasoning.

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