



**SMU** | ANNETTE CALDWELL SIMMONS  
SCHOOL OF EDUCATION & HUMAN DEVELOPMENT

RESEARCH IN MATHEMATICS EDUCATION

# **Numeric Relational Reasoning: Locator Test Development and Implementation**

Internal Report

RESEARCH IN  
MATHEMATICS  
EDUCATION

# Numeric Relational Reasoning: Locator Test Development and Implementation

Muhammad Qadeer Haider, Lindsey Perry, Cassandra Hatfield, & Leanne Ketterlin Geller

Southern Methodist University

**Semester Year**

Published by

Southern Methodist University  
Department of Education Policy & Leadership  
Simmons School of Education & Human Development  
PO Box 750114  
Dallas, TX 75275-0114  
Contact information: [rme@smu.edu](mailto:rme@smu.edu)

This research was supported by The National Science Foundation (Grant #1721100). Opinions expressed herein do not necessarily reflect those of The National Science Foundation or individuals within.

Copyright © 2020. Southern Methodist University. All rights reserved. This publication, or parts thereof, may not be used or reproduced in any manner without written permission.

SMU will not discriminate in any employment practice, education program or educational activity on the basis of race, color, religion, national origin, sex, age, disability or veteran status. This document is available in alternative formats upon request.

## Abstract

---

The purpose of this technical report is to describe the locator test and how it was used during the Numerical Relational Reasoning (NRR) cognitive interviews (CIs) that were conducted as part of the Measuring Early Mathematics Reasoning Skills (MMaRS) project aimed at grades K-2. The locator test was comprised of three sets of problems: comparison questions, find the missing number questions, and addition problems. The locator test was used to determine students' baseline skills and knowledge in concepts related to numerical relational reasoning so the interviewer can start the interview at a suitable number range for each student.

## Table of Contents

---

Introduction	1
Locator Test	1
Test Development	1
Test Implementation	1
Data Entry and Analysis	2
Test Results	2
Conclusion	3
References	4
Appendix A – Locator Test	5

# Numeric Relational Reasoning: Locator Test Development and Implementation

## Introduction

We developed a short assessment called a Locator Test to determine students' baseline skills and knowledge in numerical relational reasoning concepts. We administered the locator test to all students who participated in the cognitive interviews at the beginning of the first interview. More details about the cognitive interviews process and related items are available in a separate technical report (Sparks et al., 2020). The locator test's purpose was to start the cognitive interview at an appropriate number range level for every participant. Interviewers started every interview at a specific number range based on students' current grade level and performance on the locator test.

## Locator Test

In this section, we describe the locator test development and implementation during the cognitive interviews.

### Test Development

---

One of the senior researchers developed the locator test based on prior experience working in the area of early mathematics. The primary source of locator test items was based on the report titled Early Grade Mathematics Assessment (EGMA): A Conceptual Framework Based on Mathematics Skills Development in Children (EdData II, 2009). Locator test items were adjusted according to the number ranges we determined for different grade levels. The test carried three sets of problems: comparison questions, find the missing number questions, and addition problems. Each set of questions includes various levels of difficulty appropriate for students at their grade level.

For the set of comparison questions, students were given three pairs of numbers, one by one, and students were asked to circle the greater number in each pair. For the set of missing number questions, students were given three sequences of numbers, one by one, with a missing number. Students were asked to determine and write the missing number in the given space. For the set of addition problems, students were given three addition problems, one by one, and students were asked to compute and write the answer in the given space. A copy of the locator test is available in appendix A.

### Test Implementation

---

We used the locator test to determine the starting number range for every participating student at the beginning of cognitive interviews. Each student was given one question at a time on a paper, and the student circled the correct answer or wrote the answer in the given space. After the

student answered a problem, interviewers copied the student's response in the interviewer's copy of the locator test.

If a student gave correct answers to most of the questions on the locator test, the interviewer started the interview at the highest number range available for that grade level. However, if a student did not perform well on the locator test, the interviewer started the interview at a lower number range for that grade level. There were no set criteria for the correct number of items, but it was subjective for the interviewers' judgment. Based on students' responses, interviewers decided on the starting number range for each student. For students who were placed at a higher number range based on the locator test, interviewers also judged students' performance during the interview to ensure that students were not wrongly placed at a higher number range. If the interviewer noticed that a student is struggling at a higher number range (e.g., if a student consistently gave three incorrect answers), then the interviewer lowers the number range. The performance judgment process was repeated for every core concept in the protocol to ensure students can provide a response and reasoning up to their best ability. Therefore, one student may have answered questions from two different number ranges during cognitive interviews.

## **Data Entry and Analysis**

---

All locator test paper data were scanned and securely stored on the Box drive along with other cognitive interview documents. A team member prepared a spreadsheet to enter locator test data. The spreadsheet includes a student identification number, grade level, cognitive interview protocol, and response to each item. One team member entered the locator test data into the spreadsheet from the scanned copies, and another team member verified the accuracy of data transfer by cross-checking 20% of entered data. If the student's response to the item was correct, it was coded as 1, incorrect as 0, and -8 for cases where nothing was entered as a response by interviewers. The datasheet is available here: <https://smu.app.box.com/folder/119552266510>

A team member computed the overall score of the locator test for each student and entered the starting number range for every interview in the datasheet. The goal was to identify a pattern of starting number range based on the locator test performance. The updated data sheet with scores is available here: <https://smu.app.box.com/file/715515902125>

## **Test Results**

---

To identify a specific pattern that interviewers adopted with starting number range at the beginning of the interviews with performance on the locator test, we tried to identify a pattern based on the grade level and overall locator test score. A random selection of two students per grade level revealed that interviewers did not follow any specific rule to pick a starting number range based on a grade level and based on the locator test score. Analyses show inconsistencies among starting number ranges based on the grade level and locator test score; tables are available here: <https://smu.app.box.com/file/715515902125>

## Conclusion

The locator test's purpose was to assess students' baseline skills and knowledge in concepts related to numerical relational reasoning. The locator test was carried three sets of problems: comparison questions, find the missing number questions, and addition problems in the locator test. The interviewers used students' performance on the locator test to pick a starting number range for cognitive interviews. We did not set specific criteria to pick the starting number range based on the number of the correct answer on the locator test. We noted for all future work to set specific criteria for every decision.



---

## References

---

- Sparks, A., Perry, L., Geller, J., Haider, M. Q., & Ketterlin-Geller, L. R. (2020). *Numeric relational reasoning (NRR): Teacher survey administration* (Tech. Rep. No. 20-01). Dallas, TX: Southern Methodist University, Research in Mathematics Education.
- EdData, I. I. (2009). *Early Grade Mathematics Assessment (EGMA): A Conceptual Framework Based on Mathematics Skills Development in Children*.

Internal Report

## Appendix A – Locator Test

Locator Test			Notes
<i>Before we work with the math puzzles, there are a few problems for you to solve. We'll do one at a time.</i>			
<i>Circle which is greater:</i>			
<b>K</b>	<b>1</b>	<b>2</b>	
4 3	7 5	39 23	
9 5	11 24	65 67	
11 16	58 49	146 153	
<i>Fill in the missing number:</i>			
<b>K</b>	<b>1</b>	<b>2</b>	
5 6 7 <u>   </u>	20 <u>   </u> 40 50	348 349 <u>   </u> 351	
14 15 <u>   </u> 17	2 4 6 <u>   </u>	28 <u>   </u> 24 22	
20 <u>   </u> 40 50	28 <u>   </u> 24 22	30 35 <u>   </u> 45	
<i>Solve:</i>			
<b>K</b>	<b>1</b>	<b>2</b>	
1+3=	3+2=	4+5=	
3+3=	8+1=	2+7=	
8+1=	5+5=	9+8=	
7+3=	7+8=	10+2=	

Internia