SMU | ANNETTE CALDWELL SIMMONS SCHOOL OF EDUCATION & HUMAN DEVELOPMENT

RESEARCH IN MATHEMATICS EDUCATION

Teacher Advisory Panel: Teacher Resource Development

Technical Report 21-06

Teacher Advisory Panel: Teacher Resource Development

Jennifer McMurrer • Tina Barton • Cassandra Hatfield • Leanne R. Ketterlin-Geller

Southern Methodist University

Spring 2021

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

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

Abstract

In this technical report, the Research in Mathematics (RME) team documents the research process and findings from our engagement with the Measuring Early Mathematics Reasoning Skills (MMaRS) Teacher Advisory Panel (TAP) work sessions held in November 2020. These teachers' experiences and perspectives provide important insights for the MMaRS research project, from which researchers will create a formative assessment suite for numeric relational reasoning and spatial reasoning. We followed a Human-Centered Design approach to collaborate with the TAP and qualitative research methods to analyze the resulting data. The RME research team will use the findings from this report—as well as multiple other sources of data—to build the instructional tools and formative assessment items for the MMaRS project.

Table of Contents

Teacher Advisory Panel: Teacher Resource Development

Introduction

The primary goal of the Measuring Early Mathematical Reasoning Skills (MMaRS) project is to create a formative assessment suite for numeric relational reasoning (NRR) and spatial reasoning (SR) for students in grades K-2. Teachers may use results of these assessments to guide their instructional decision making to support student learning of these constructs. But before teachers can administer the classroom assessments, they will need informational resources that provide guidance about how to choose and use the MMaRS formative assessments that best fit their student and classroom needs.

An important component of the MMaRS research project is to engage teachers to serve as a voice for practitioners. To this end, RME researchers work with the Teacher Advisory Panel (TAP) to solicit their input and guidance from a practitioners' perspective about the use case of the formative assessments and accompanying resources, including perspectives about the usability, feasibility, and desirability of the outcomes from these tools. RME researchers gleaned important insights from the TAP sessions held in 2018-19 and the summer of 2020, which we built upon through continued, meaningful engagement with the TAP in the fall of 2020.

Specifically, the November 2020 collaboration with the TAP focused on desirability testing and a co-design exercise to test a prototype of the pre-assessment resource that teachers will use to select from the suite of MMaRS formative assessments for students in their classrooms. The purpose of this technical report is to outline our research design, data collection process, analysis methods, and findings from this meeting. We also include copies of the selection guide iterations in the Appendix.

Research Goals and Questions

The goal of the November meeting with the TAP was to solicit input about the prototype resources that may accompany the MMaRS assessments to support teachers in determining which assessment tool they want to give to students. We also worked with the TAP to co-design the next iteration of these resources. Therefore, the primary research question guiding the research design of the November meeting was as follows:

> *How might the TAP inform the design of the informational resources to support teachers' selection from the MMaRS assessment portfolio for students in their K-2 classrooms?*

The 2020-21 TAP included ten public and private kindergarten, first- and second-grade teachers with four to 20 years of classroom teaching experience. Six of these ten teachers were available to participate in the November 2020 meeting session. Due to the global pandemic and restrictions around gathering in person, the 2020 TAP meeting sessions were conducted remotely via an online video conferencing platform called Zoom. This allowed the research team and

participants to engage in the TAP sessions safely in a socially-distanced way. For more details about the TAP recruitment and selection process, see the Teacher Advisory Panel: Summer 2020 technical report (Tech. Rep. No. 20-22).

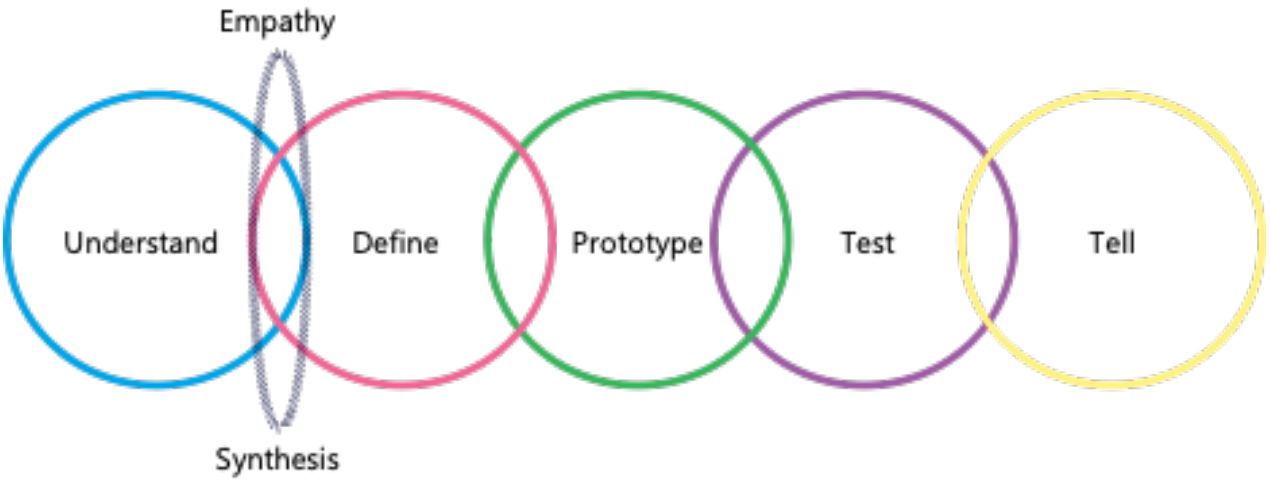
Method

Research Design

RME researchers structured earlier TAP inquiries within a Human-Centered Design (HCD) methodology. Faculty from the Master of Arts in Design and Innovation (MADI) program at SMU define HCD as a creative approach to problem-solving that designs with the end-user in mind. Baker and Moukhliss (2019) define design thinking (or Human-Centered Design) "as a problem-solving approach which reduces a number of broad design methods into a simple replicable framework, and is utilized in an ever-increasing number of settings to address a growing variety of challenges" (p. 307). Drawing from the MADI course description, HCD is a "well-established process and set of methods aimed at devising solutions based on people's needs" (SMU, 2020). HCD is a methodology employed by different groups and fields and most companies generate their own process to follow (J. Burnham, personal communication, May 7, 2020). The process taught by co-founders of the MADI program at SMU, Kate Canales and Gray Garmon, is shown in the adapted figure 1.

Figure 1

Human-Centered Design Process



Data collected from earlier TAP sessions followed the HCD process figure, encompassing components of the understand, define, and early prototyping phases through participatory design principles (Sanders, Brandt, & Binder, 2010). One of the key tenets of Human-Centered Design is keeping the end-users central to the process and maintaining a continuous feedback loop throughout each phase. "By engaging the client in participatory design…designers are able to obtain client feedback on the design solution throughout the process" (Baker & Moukhliss 2019,

p. 307). Drawing from the goal of the fall 2020 engagement, we continued within the prototype phase with three activities:

1. Parallel prototyping
2. Desirability testing
3. Participatory Co-design exercise

Parallel prototyping

Martin and Hanington (2012) explain that parallel prototyping "is the process of considering a range of potential design ideas simultaneously before selecting and refining one specific design approach" (p. 122). Two members of the research team simultaneously designed sample pre-assessment resource prototypes, which we presented to the other members of the MMaRS research team during weekly meetings over the course of one month. (The first iteration of the prototype is shown in Appendix A.) This collaboration on parallel designs promoted teamwork and facilitated the refinement of one another's work into subsequent designs. Building on the parallel prototype work from within the research team, we moved forward with the TAP by engaging in desirability testing and co-design, which are both participatory design activities within the HCD framework.

To continue documenting the reflections and theories of the research team, the four lead facilitators drafted memos immediately after the November meeting session with the TAP. These memos provided supplemental data sources and insight during the analysis phase of the study. According to Miles and Huberman (1994) and Maxwell (2005), this exercise is an essential procedure for qualitative analysis.

Data Collection with TAP

Meeting Activities

Upon completion of the parallel design activities with the research team, we created a sample prototype of the assessment selection guide to share with the TAP (shown in Appendix B). Building on the parallel design processes to develop this prototype, we followed the below high-level agenda of activities for a 90-minute meeting with the TAP in November:

I. Welcome Back! (15 minutes)
   a. Brief review of Learning Progressions
   b. Goals of the MMaRS portfolio of assessments
   c. Purpose of the teacher resource/assessment selection guide

II. Desirability Testing Activity (20-30 minutes)

III. Participatory Design through Co-Design Activity (40-50 minutes)

Four RME researchers co-facilitated the November meeting. We started with a brief review of Learning Progressions (LP) and explained that the goal of the MMaRS classroom assessments will be to identify their students' placement along the LP to help guide their classroom instructional practices. This review provided an important connection point between the summer TAP sessions and our re-engagement in November. Then we introduced and shared the purpose of the assessment selection guide with the TAP.

Desirability testing activity

As our first activity, we conducted desirability testing with the TAP using the sample prototype created by the research team shown in Appendix B. We shared a PDF copy of this prototype with the TAP in advance of the meeting and asked participants to have a printed, color-copy handy for the activities during the meeting session. Martin and Hanington (2012) explain desirability testing may be done with low-fidelity prototypes to explore the "effective response that different designs elicit from people, so that the team can focus design efforts on shaping the emotional response they want people to have…it provides people a way to identify and articulate how a design makes them feel" (p. 64). We planned to use the feedback from the desirability testing activity to inform the design decisions that would be made in the iterations of the prototype in the future phases. The prototype resource components and principles that the TAP found helpful would guide next steps while the elements that were considered "time consuming" or "confusing" could be reimagined based on feedback related to the desired emotional outcome. "Using the prototypes in this way allows designers [and researchers] to construct a better understanding of the potential viability of the proposed solution in a more concrete way" (Baker & Moukhliss 2019, p. 307). The activity also provides a quick snapshot of the prototype's effect on participants' emotions by capturing their immediate response to the visual stimuli and information. This can help drive decisions related to the visual layout and information that teachers need to make decisions related to the suite of LP assessments.

One at a time, we presented a PDF image of each page of the assessment selection guide prototype. We provided teachers with a list of words to consider for the desirability test and instructed them to select three to five words that best reflect their immediate feeling or response toward each of the five steps shown in the prototype. Our word bank was adapted from the work of Benedek and Miner (2018) and Rohrer (2008) and is shown in Figure 2. Teachers responded individually within their paper or electronic copies of the desirability worksheet that we emailed in advance of the meeting. Then teachers were given the opportunity to share and discuss their rationale for their word choices with the research team and the TAP as a whole group. All six participants emailed an electronic copy or picture of their completed worksheets to the RME researchers after the meeting.

Figure 2

Word Bank Worksheet for Desirability Testing

Worksheet | Desirability Testing

Word Bank		
Clear	Intuitive	Complex
Organized	Time-consuming	Easy to use
Confusing	Understandable	Hard to Use
Reliable	Not Valuable	Accessible
Too Technical	Useful	Other (please explain)

Directions: Please select 3 to 5 words from the bank that characterize your feeling(s) for each page of the five-step process. You may select the same word multiple times or add a word not listed within the choices.

Step 1	Step 2	Step 3	Step 4	Step 5

Participatory design through a co-design activity

We spent the final portion of the meeting session on a participatory design activity. More specifically, we asked the TAP to build on the desirability testing activity by co-designing components of the prototype that they recommended changing in real-time as a group. According to McKercher (2020) "co-design is an approach to designing with, not for, people" (p. 14) that provides an opportunity to value and give voice to the lived experiences of participants. This fits the model outlined by Martin and Hanington (2012) who write that the participatory design approach "encompasses several methods, with the unifying philosophy that they all involve active consultation with users, clients, and other stakeholders in the design process, ideally through face-to-face contact in activity-based co-design engagements" (p. 128).

We presented the TAP with each two-page step of the assessment selection guide and asked them to reconfigure the components however they saw fit. The TAP could also "mark up" the content within the components and across the pages. As previously noted, we emailed a PDF file of the prototype to the TAP in advance so that participants could print paper copies of the file to annotate with paper and pencil as well as physically cut into pieces during this co-design activity. RME researchers facilitated the process with the TAP groups using a Miro board. (Miro is an online whiteboard that people may use to collaborate and work in real-time.) We pre-loaded the prototype pieces to the board. We instructed the TAP to move and annotate the pieces

themselves or provide instructions to the RME researchers on how they would like the prototype assembled and edited. Some participants marked up and cut their own paper copies while others verbally shared their feedback while the facilitators captured their thoughts on the Miro board.

The ideal size for focus groups is generally between five to eight participants, depending on the subject matter and extent of the participants' expertise about the research topic (Krueger and Casey, 2009). Six TAP members attended the November session, so for this activity we split the TAP into two separate groups using the breakout room feature in Zoom. This allowed for all participants to actively engage in the co-design process. Two RME researchers helped facilitate each group. Based on the Miro board experience with the TAP in the summer 2020 sessions, teachers appeared more comfortable with the RME team adding to the Miro board, following the TAP's instructions during the Zoom meeting.

Analysis

The November TAP session was digitally recorded using the Zoom record feature by all four RME researchers for backup coverage. These recordings included the main session as well as the separate breakout rooms where two smaller groups of TAP members participated in the participatory co-design activity. RME researchers sent the recorded audio files to a third-party vendor (Rev.com) for transcription. Upon receipt we de-identified participant information. Then, we loaded the following data into a shared NVivo project file:

- all of the transcripts
- Miro whiteboard notes from the co-design activity
- individual reflections from the desirability testing
- photos from the TAP participants documenting the co-design
- memos from the four RME researchers who designed and facilitated the meeting session.

NVivo is a software program used to organize and facilitate coding and analysis of data—especially in qualitative studies—on research teams.

Analytic Strategies

Two researchers—one meeting facilitator from each breakout group—reviewed the session videos, transcripts, desirability testing submissions from the TAP and other meeting artifacts such as the Miro boards and TAP photo submissions from the co-design activity. We conducted this review independently and noted key words and concepts from the data files as preliminary ideas for organizational categories and possible substantive categories (Maxwell, 2005). Researchers approached the preliminary analysis as follows:

- One researcher catalogued this process within an analysis memo in NVivo organized first by activity (desirability testing or co-design) and then the five steps within the assessment selection guide.

- The other researcher noted the TAP key words and concepts from the data on sticky notes then categorized these notes across five common themes. A photograph from this process is shown in figure 3.

Figure 3

Sorting and Theming Sticky Notes

Next, the two researchers met to discuss and compare our preliminary organizational themes and the analytic processes we used to draft our respective analysis memos. Many of the data points from both of our memos overlapped even though some of our processes and organization of the data differed. We decided one researcher would continue iterating on the design of the assessment selection guide and the other would draft the written narrative about the analysis processes and findings based on the TAP data. We reviewed one another's products and provided critique and feedback about the outcomes. A copy of the third iteration of the assessment selection guide is included in Appendix C (with annotations) and Appendix D (clean version).

The two researchers used the data, as coded in memos and on the sticky notes, to consider themes and develop substantive categorizations across the multiple data sources and write the findings for this technical report. Maxwell (2005) explains substantive categories "are primarily

descriptive, in a broad sense that includes a description of participants' concepts and beliefs; they stay close to the data categorized and don't inherently imply a more abstract theory" (p. 97). Corbin and Straus (2015) note that substantive categories may be inductively developed through open coding, the approach we followed.

Methodological Integrity

The varied data sources allowed the team to triangulate and review the themes across multiple sources of evidence. The research team also accounted for reflexivity through the following processes:

- conducting the parallel prototyping activity with the research team prior to the TAP meeting and incorporating outcomes from this process in the study design
- writing memos throughout the data collection and analysis process
- discussion and consensus meetings with the researchers during analysis.

Member checks (Lincoln and Guba, 1985) were not formally conducted with the TAP after the meeting, however, the emailed submissions from the desirability testing exercise and the pictures from the co-design activity gave the TAP an opportunity to contribute their individual thoughts. Additionally, to encourage frank responses and preserve anonymity, the RME researchers promised the TAP participants that they and their schools and districts would not be named in our reporting.

Findings

The TAP participants offered a variety of perspectives from K-2 classrooms that encompass urban, suburban, and rural locales. The research question we explored for this aspect of the study was:

> *How might the TAP inform the design of the informational resources to support teachers' selection from the MMaRS assessment portfolio for students in their K-2 classrooms?*

To answer this question, findings from the TAP data centered around the following five areas

1. Information architecture
2. Level of detail and information
3. Clear directions and pathways
4. Missing information and confusion about next steps
5. Design elements and features

We outline more details and subcategories within these five areas in the sections below. Data from the desirability testing and co-design exercises are integrated within these five sections.

Information Architecture

In the field of design, information architecture characterizes how we organize information. "Information architecture (IA) is a design discipline that is focused on making information findable and understandable." (Rosenfeld, L., Morville, P., & Arango, J., 2015, p. 2) IA provides an important perspective of information products and services for us to draw from as we analyze the data provided by the TAP. Not only is it important to include pertinent and useful information in resources developed, it also matters how usable and accessible that content is. IA encompasses how information is arranged and organized as an environment of information for users to navigate. Drawing from the results of the desirability testing exercise, teachers reported the guide was "organized" six times across the five-step process. Similarly, they selected the term "clear" seven times and "accessible" four times. Conversely, the TAP wrote the guide was "confusing" in nine instances and "complex" in three instances.

Feedback from the TAP about the assessment selection guide during the co-design activity frequently centered around this concept of information architecture. More specifically, several of the teachers' questions and comments referred to the language and the structure of the guide. These are both areas of opportunities to inform the next iteration of the prototype.

Language

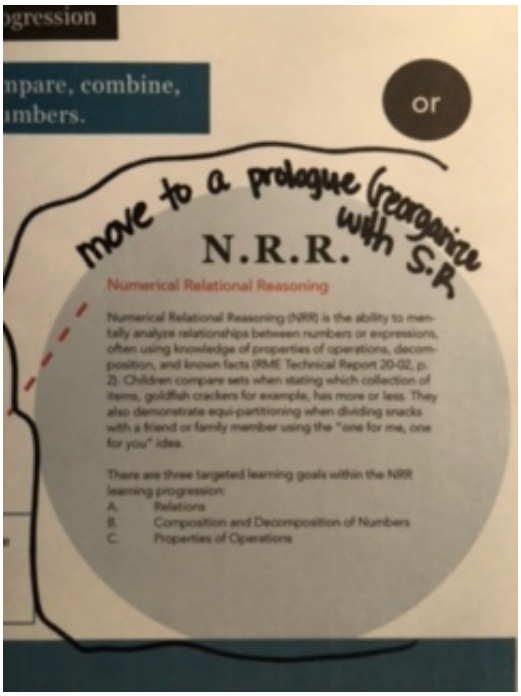
The TAP emphasized the importance of using concise language that is understandable and accessible to teachers in the assessment selection guide. Two teachers, one from each of the groups, commented they were confused by the term "equipartitioning." Others explained they do not understand the term "transitivity." The TAP suggested using language that mirrors the state standards so that the content aligns with the vernacular that teachers use and are familiar with. One teacher explained "… when you throw out a different language to us, we get confused."

Structure

Several of the TAP members commented they liked the structure of the bulleted lists and preferred a vertical orientation for both the flowcharts and the guide's content. They explained these lists and several of the prompts (e.g. "I want to know how my students compare…") were understandable, easy to use, and clear. The TAP suggested adding a prologue that outlines the purpose of the selection guide as well as a glossary of terms for teachers to access either at the beginning or the end of the assessment selection guide. In figure 4, we extracted notes from one of the TAP during the co-design session related to this suggestion.

Figure 4

Sample TAP Co-Design for Step 1



Level of Detail and Information

Some teachers selected the "other" response option during the desirability testing activity and wrote that some steps in the assessment selection guide were "overwhelming" and "too wordy." Other teachers who selected the "other" response option wrote "detailed" and "lots of words" but neither teacher was sure if these were positive or negative attributes. Then three teachers chose "too technical" as their initial reaction from the word bank for two steps in the guide.

Drawing from the data shared during the co-design activities, the TAP want "just enough" detail to make decisions about their selection, however, the information should be concise. One teacher shared "sometimes less is more" and at first glance, some of the pages were overly complex. Other pages, for example, the bullet points about the targeted learning goals on page 3 (shown in Appendix B) and the text boxes on page 4, were the TAP's favorite pages. Teachers commented that the narrative clearly defines what teachers want their students to know. One teacher explained, "I like knowing what I'm supposed to know [as the teacher on page 3] and I like knowing what my students are supposed to know [on page 4] but maybe streamline some of the excess words." Figure 5 shows a snapshot of the sticky note sorting for this theme.

Figure 5

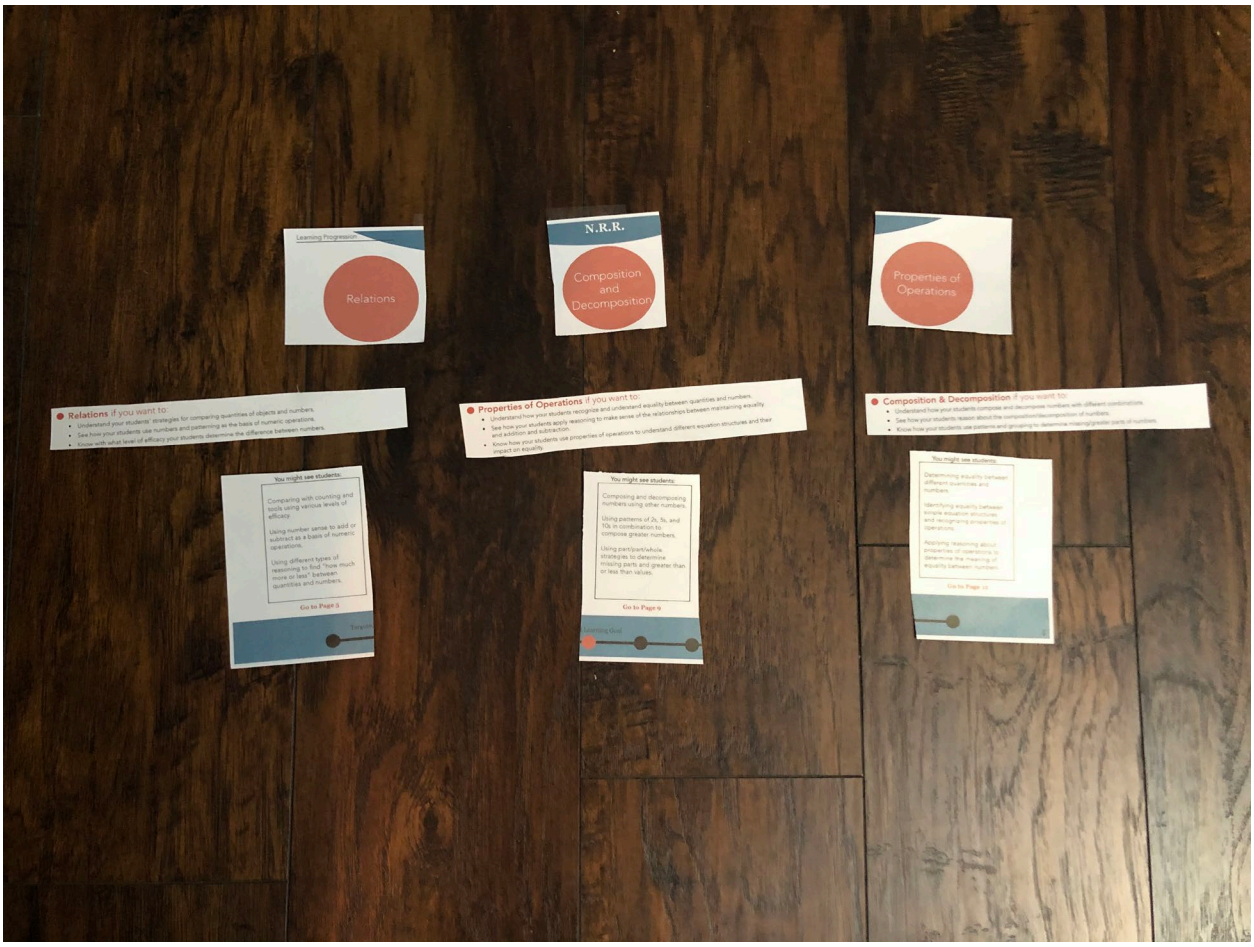
Sorting for Level of Detail Theme

Clear Directions and Pathways

The TAP emphasized several positive aspects of the prototype guide, including the clear directions and pathways outlined in the flow charts. Drawing from the desirability testing submission, teachers selected the terms “useful” in nine instances and “easy to use” in seven instances. The TAP liked the simplicity of the choices (for example, “yes,” “no,” and “don’t know” on page 1) as well as they clear lines that pointed them where to go next. One teacher commented “I like a good flow chart!” Another pointed to the utility of the statements “you might see students” and the layout on page 4 (shown in Appendix B). A third teacher agreed and suggested adding the bullets on the targeted learning goals from page 3 above the text boxes on page 4 (which she submitted as figure 6) as a more succinct pathway.

Figure 6

TAP Co-Design for Pathway



Missing Information or Confusion about Next Steps

The order of the information within the assessment selection guide was important to the TAP. Seeing the layout of the decisions that need to be made in one figure or tree seemed equally helpful to the TAP as the glossary of terms or detailed narrative about each step. The TAP liked the "start here" and "next" language within the tool but suggested we provide information about the step first then provide guidance about the corresponding action. Along this same vein, the TAP asked for clarification about some of the directions. For example, the prompt on page 4 (Appendix B) reads "You might see students…" but does that mean teachers might currently see students exhibiting these skills or are these skills that teachers may want to develop or reinforce with their students? Some teachers noted they liked the layout and detail of the core concept menu on page 6 (Appendix B). Two teachers suggested collapsing the icon and core concept name column into one and adding a column for teachers to take notes about students.

Design Elements and Features

In design, each page and its features should have a function. The assessment selection guide prototype that we shared with the TAP used a hierarchy to concisely organize information. The TAP commented that a vertical theme throughout with a visual system that is cohesive and functional would be ideal. Teachers reacted positively to many of the design features, including the use of circles and bolding for important terms alongside the squared text boxes with columns of narrative. One teacher commented that the overall length, which was 8 pages, was "quite okay" but another felt it could be consolidated to a slightly shorter length in some areas. We provided an excerpt from the data sorting process for this theme in figure 7.

Figure 7

Sorting for Design Elements and Features Theme

Discussion

We analyzed and synthesized the data from the November TAP meeting which revealed both high level, conceptual themes related to the content and amount of information that is useful and usable to teachers with varying degrees of experience, as well as the practical details that comprise the functionality of the teacher resource in how it is arranged on the paper and organized in sections. Drawing from Lidwell, Holden, and Butler (2010), a technique referred to as "chunking" is defined as "combining many units of information into a limited number of units or chunks, so that the information is easier to process and remember" (p. 40). The feedback from the TAP confirms that this technique is preferable, especially in the context of a working manual for regular use in the classroom.

The MMaRS research team applied the themes that surfaced in the iteration process of the prototype for the third-round of development. We considered principles of aesthetic-usability and accessibility throughout the development of the prototype and specific interpretations of those design principles that were either reinforced or clarified with the data that we collected. Drawing from the themes that emerged from the TAP data synthesis, we found evidence that the teachers' perspectives were invaluable to the process of designing tools and resources that will achieve the desired outcome of scaffolding the use of the suite of Learning Progression-based assessments.

Study Strengths and Limitations

The HCD methodology puts the end user of a program or product at the center of the development process with designers, which is an important strength of the research design. For the MMaRS project, the TAP participants served as the voice of K-2 teachers—who will be the end users of the MMaRS assessments and instructional tools. Six TAP members participated in the co-design and desirability testing activities and offered unique insights about how the prototype resources, designed to accompany the MMaRS assessments, might help teachers determine which assessment tool they want to give to students. Even more impactful, the TAP co-designed the next iteration of the prototype resources. The study design incorporated multiple data sources, including data from the researchers' parallel design session and TAP desirability testing.

All of the TAP participants are teachers within the Dallas-Fort Worth metroplex in the state of Texas. These teachers' experiences and contexts may or may not be representative of K-2 educators who work outside this geographic area. This limitation does not mean that our findings may not be applicable more generally. The feedback and input from the TAP contribute to theory about the use of the teacher resources that may be extended to other cases (Maxwell, 2005; Becker, 1991; Yin, 1994). Nevertheless, future studies may consider engagement with teachers who work in other states.

Considerations for Future Research

Our collaboration with the TAP informed the design of the informational resources that will support teachers' selection from the MMaRS assessment suite for students in their K-2 classrooms. As stated in the introduction, the pre-assessment resource is what teachers will use to select from the suite of MMaRS formative assessments for their students in their classrooms. We propose using the findings from this study and continuing our engagement with end-users to advance our refinement of these resources to include additional components such as guidance on the materials that will be needed to administer specific subtests. This continuation of the process may fall within the "test" ring of the HCD process shown in figure 1.

References

Baker, M. & Moukhliss, S. (2019). Concretising design thinking: A content analysis of systematic and extended literature reviews on design thinking and Human-Centred Design. *Review of Education (Oxford)*, *8*(1), 305–333. DOI: https://doi.org/10.1002/rev3.3186

Becker, H.S. (1991). Generalizing from case studies. In E. Eisner & A. Peshkin (Eds.), *Qualitative inquiry in education: The continuing debate* (pp. 233-242). New York: Teachers College Press.

Benedek, J. & Miner, T. (2018) "Measuring Desirability: New Methods for Evaluating Desirability in a Usability Lab Setting." *Proceedings of UPA 2002 Conference*, Orlando, FL, July 8-12, 2002. Retrieved from https://nanopdf.com/download/measuring-desirability-new-methods-for-evaluating_pdf# .

Corbin, J. & Strauss, A. (2015). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (4th edition). Thousand Oaks, CA: Sage Publications, Inc.

Krueger, R.A. & Casey, M.A. (2009). *Focus groups: A practical guide for applied research* (4th edition). Thousand Oaks, CA: Sage Publications, Inc.

Lidwell, W., Holden, K., Butler, J., & Elam, K. (2010). *Universal principles of design: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design* (2nd edition). Beverly, MA: Rockport Publishers.

Lincoln, Y., & Guba, E. (1985). *Naturalist inquiry*. Beverly Hills, CA: Sage Publications, Inc.

Martin, B. & Hanington, B. (2012). *Universal methods of design: 100 ways to explore complex problems, develop innovative strategies, and deliver effective design solutions.* Osceola: Quarto Publishing Group USA. Retrieved from http://ebookcentral.proquest.com/lib/southernmethodist/detail.action?docID=3399583

Maxwell, J.A. (2005). *Qualitative research design: An interactive approach* (2nd edition). Thousand Oaks, CA: Sage Publications, Inc.

McKercher, K.A. (2020). *Beyond sticky notes. Doing co-design for real: Mindsets, methods and movements.* Sydney, Australia: Beyond Sticky Notes.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd edition). Thousand Oaks, CA: Sage Publications, Inc.

Rohrer, C.P. (2008, October 28). Desirability studies: Measuring aesthetic response to visual designs. *XD Strategy*. Retrieved from https://www.xdstrategy.com/desirability-studies/

Rosenfeld, L., Morville, P., & Arango, J. (2015). *Information architecture: For the web and beyond* (4th edition). Sebastopol, CA: O'Reilly Media, Inc.

Sanders, E. B.-N., Brandt, E., & Binder, T. (2010). A framework for organizing the tools and techniques of participatory design. In *Proceedings of the 11th Biennial Participatory Design Conference (PDC '10)*. Association for Computing Machinery, New York, NY, USA, 195–198. DOI: https://doi.org/10.1145/1900441.1900476

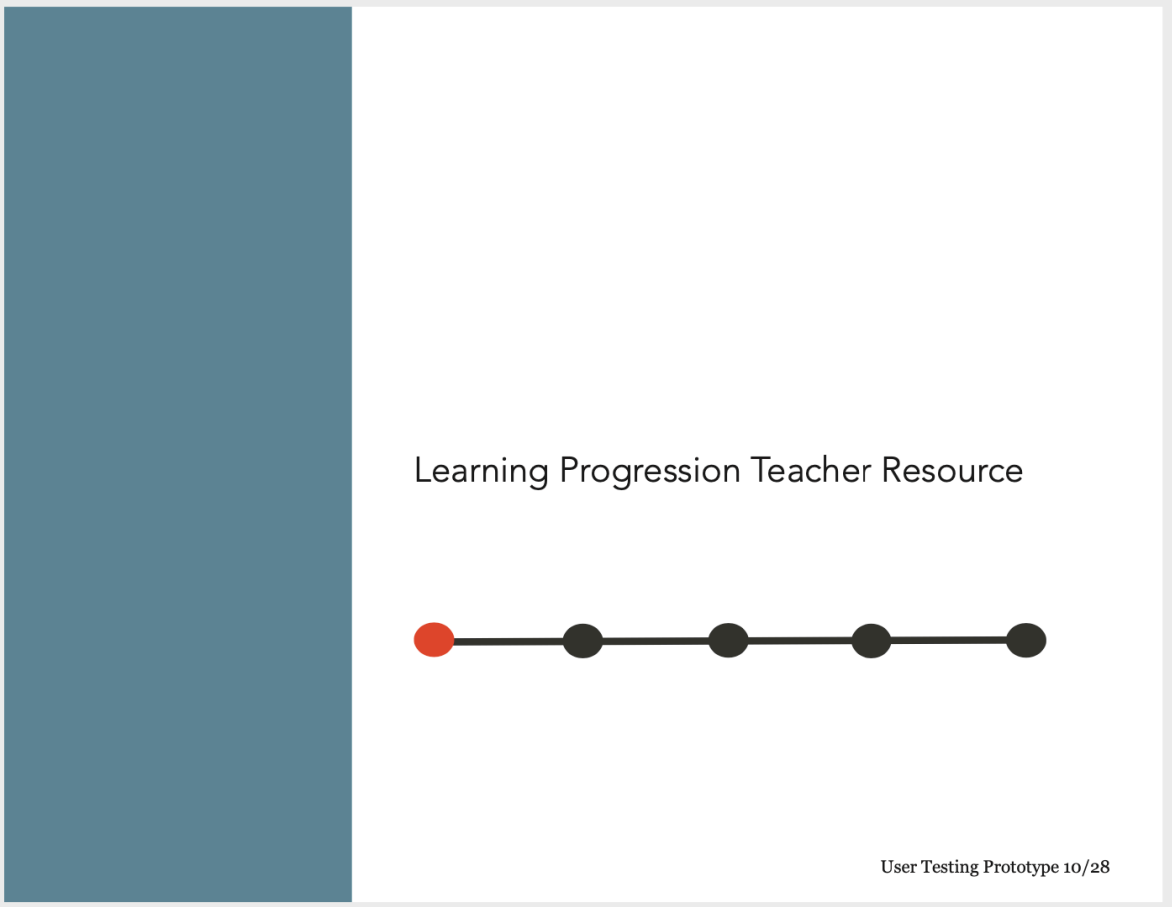
Southern Methodist University (SMU). (2020). DSIN 7303 – Human-Centered Design. 2019-2020 Graduate Catalog. Retrieved from https://catalog.smu.edu/search_advanced.php?cur_cat_oid=41&search_database=Search&search_db=Search&cpage=1&ecpage=1&ppage=1&spage=1&tpage=1&location=33&filter%5Bkeyword%5D=human-centered+design&filter%5Bexact_match%5D=1

Texas Education Agency (n.d). *TEA ESTAR/MSTAR Learning Progressions.* Retrieved from http://jukebox.esc13.net/learningprogressions/HTML_materials/lp_03_06_reflection_slides.pdf

Yin, R.K. (1994). *Case study research: Design and methods* (2nd edition). Thousand Oaks, CA: Sage Publications, Inc.

Appendix A – Sample 1 Prototype of the Assessment Selection Guide

Below are screenshots from the first selection guide developed during the parallel prototyping phase with RME researchers.



Start here

1. Choose which Learning Progression

I want to know how my students compare values and understand equality between numbers.

Yes

Select the **N.R.R. (Numerical Relational Reasoning)** Learning Progression to start with.

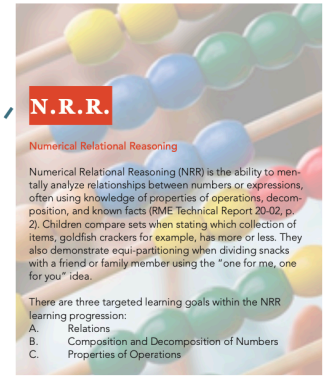
Go to page 3 to determine which Targeted Learning Goal to start with.

No

Consider whether the S.R. Learning Progression is more appropriate.

I don't know

Learn more about what NRR or the Numerical Relational Reasoning Learning Progression can tell you about your students.



Learning Progression

1

or

I want to know how my students understand shapes and their relationship to space and movement.

Yes

Select the **S.R. (Spatial Reasoning)** Learning Progression to start with.

Go to page 3 to determine which Targeted Learning Goal to start with.

No

Consider whether the N.R.R. Learning Progression is more appropriate.

I don't know

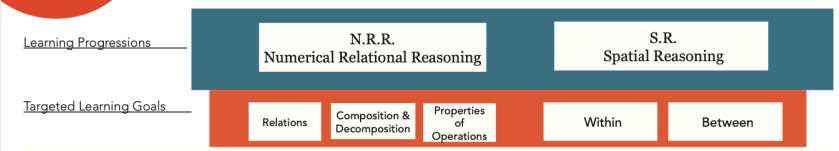
Learn more about what S.R. or the Spatial Reasoning Learning Progression can tell you about your students.

Learning Progression

2

Next...

2. Choose your Targeted Learning Goal



- **Relations** if you want to:
  - Understand how your students use comparison to find more/less and least to greatest.
  - See how your students reason about the relationships between different values and numbers.
  - Know how your students apply tools and strategies to determine less than and greater than.
- **Composition & Decomposition** if you want to:
  - Understand how your students compose and decompose numbers with different combinations.
  - See how your students reason about the composition/decomposition of numbers.
  - Know how your students use patterns and grouping to determine missing/greater parts of numbers.
- **Properties of Operations** if you want to:
  - Understand how your students recognize and understand equality between quantities and numbers.
  - See how your students apply reasoning to make sense of the relationships between maintaining equality and addition and subtraction.
  - Know how your students use properties of operations to understand different equation structures and their impact on equality.

N.R.R.

Relations

You might see students:

Comparing quantities and numbers to find more or less.

Using counting and grouping strategies to find which values or numbers are greatest and least.

Using numberlines and hundreds charts to determine how many more or less between numbers.

Go to Page 5

Composition and Decomposition

You might see students:

Composing and decomposing numbers using other numbers.

Using patterns of 2s, 5s, and 10s in combination to compose greater numbers.

Using part/part/whole strategies to determine missing parts and greater than or less than values.

Go to Page 9

Properties of Operations

You might see students:

Determining equality between different quantities and numbers.

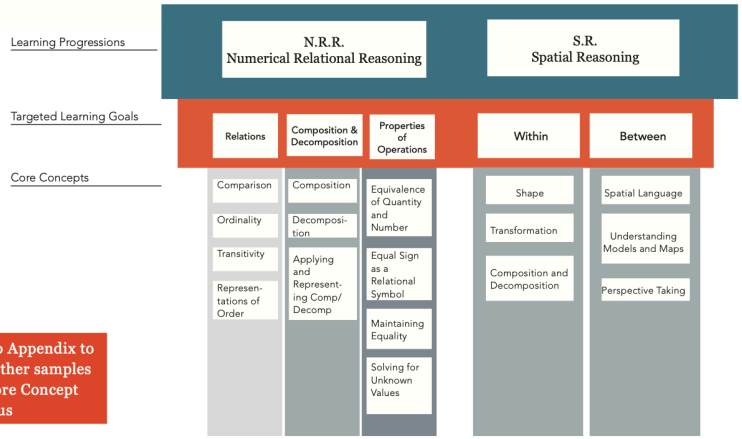
Identifying equality between simple equation structures and recognizing properties of operations.

Applying reasoning about properties of operations to determine the meaning of equality between numbers.

Go to Page 12

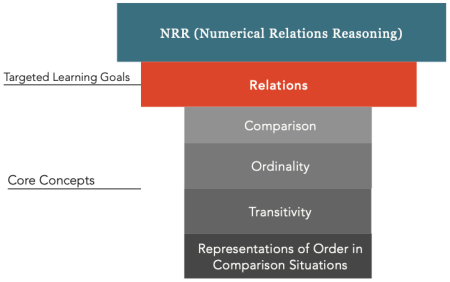
3. Choose your Core Concept

Use a Core Concept Menu to choose the best starting place for your students. The Assessment Tool will provide data that positions each of your students on the learning progression and will help inform how to group them into instructional groups for next steps.



Go to Appendix to see other samples of Core Concept Menus

Relations Core Concepts

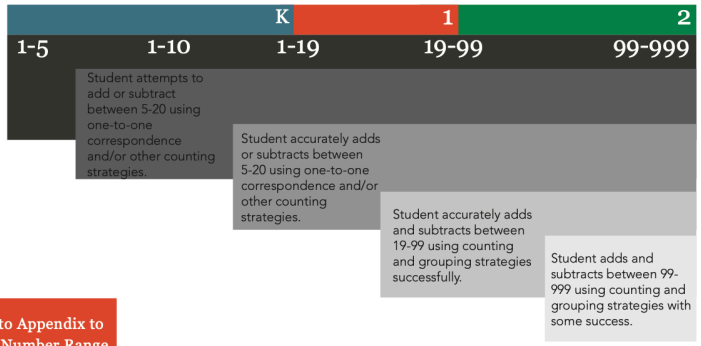


Sample Core Concept Menu
N.R.R. Relations

1.	Compare two quantities and determine which is more/less using a. matching and counting strategies?* b. a balance to find which weighs more/less? c. mental images?		Comparison *Number range determines F/B/T in grades K-1*
2.	Compare two numbers and determine which is more/less using a. Mental number lines? b. Written number lines? c. Open number lines? d. Using symbols: >, < ?**		Comparison **Number range (19-99)*
3.	Find a unit more/less than a given number a. using tools but without counting? b. using grouping strategies but without counting? c. mentally without calculating?		Ordinality
4.	Compare and order more than two objects with unspecified lengths, weights, quantities, and numeric values? a. How does the student use tools to order numbers? b. What mental strategies does the student use to order numbers?		Transitivity
5.	Do you want to know how your student... a. makes sense of finding how much more or how much less? b. finds how much more/less using tools? c. finds how much more/less between two numbers in a word problem? d. compares two numbers to find which is closest/furthest from a benchmark with or without tools?		Representation of Order in Comparison Situations

4. Choose Number Range

- Use prior knowledge and student observation data to determine best number range for your student(s) to start with. Depending on time of year, you may choose the lowest range for your grade band to start and the Assessment Tool will help place your student appropriately.



Go to Appendix to see Number Range Locator Tool.

Sample Learning Progression

1. Comparison

Code	Kindergarten			Grade 1			Grade 2		
	F	B	T	F	B	T	F	B	T
NRR.A.1.a.	Compare two quantities to find which is more/less using **matching and counting strategies**.								
NRR.A.1.b.	Compare two **unspecified weights** using balances to find which weighs more/less.								
NRR.A.1.c			Compare two quantities to find which is more/less using **mental images.**						
NRR.A.1.d.		Compare two numbers using **mental number lines** to determine which is more/less.							
NRR.A.1.e.				Compare two numbers using **written number lines** to determine which is more/less.					
NRR.A.1.f.				Compare two numbers using **open number lines** to determine which is more/less.					
NRR.A.1.g.						Compare two numbers using symbols: >, <.			

F=Foundational B=Bridging T=Target

Number Range

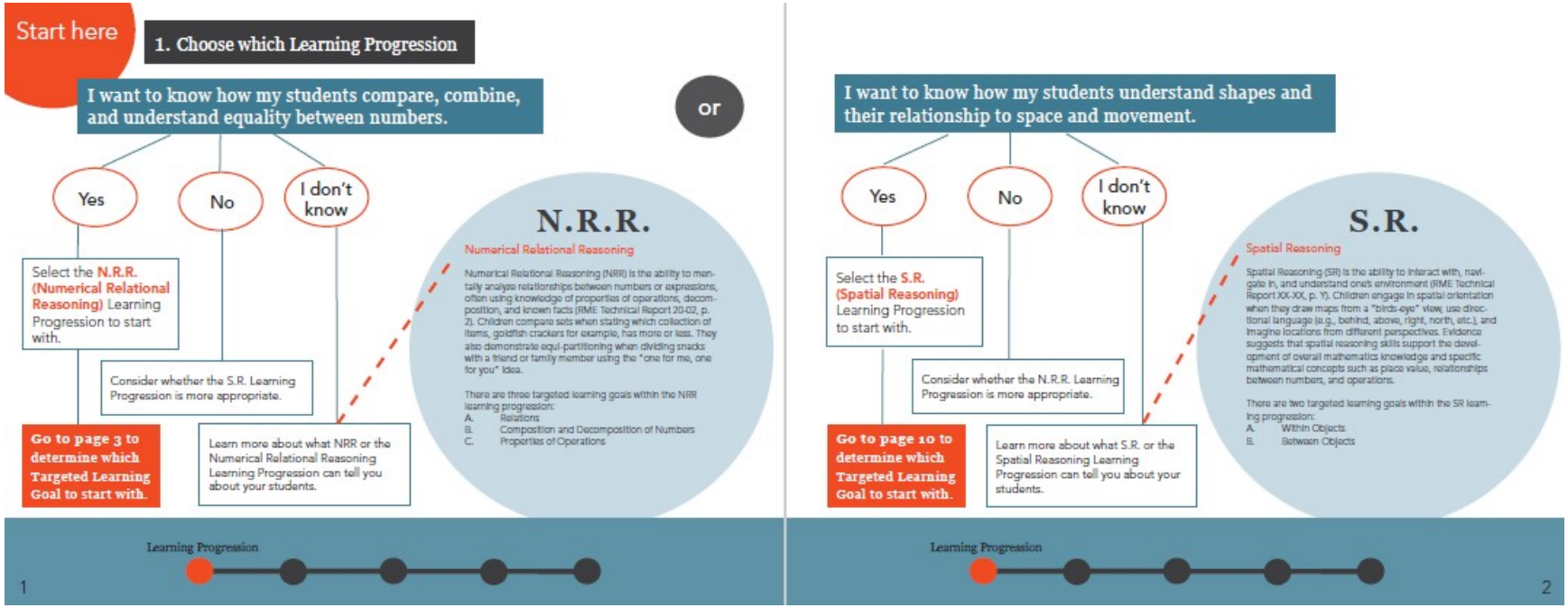
Assessment Tool

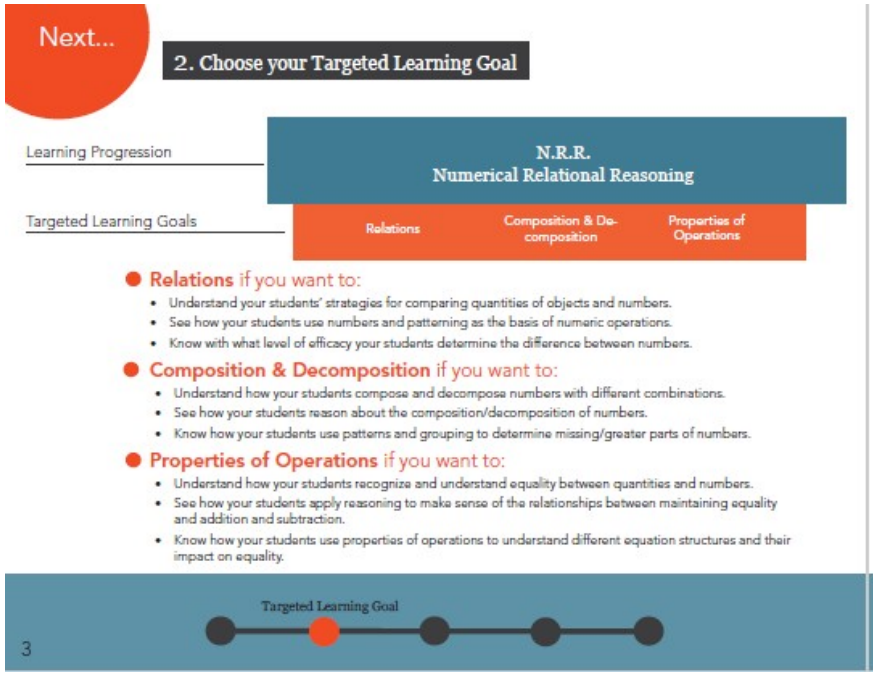
7

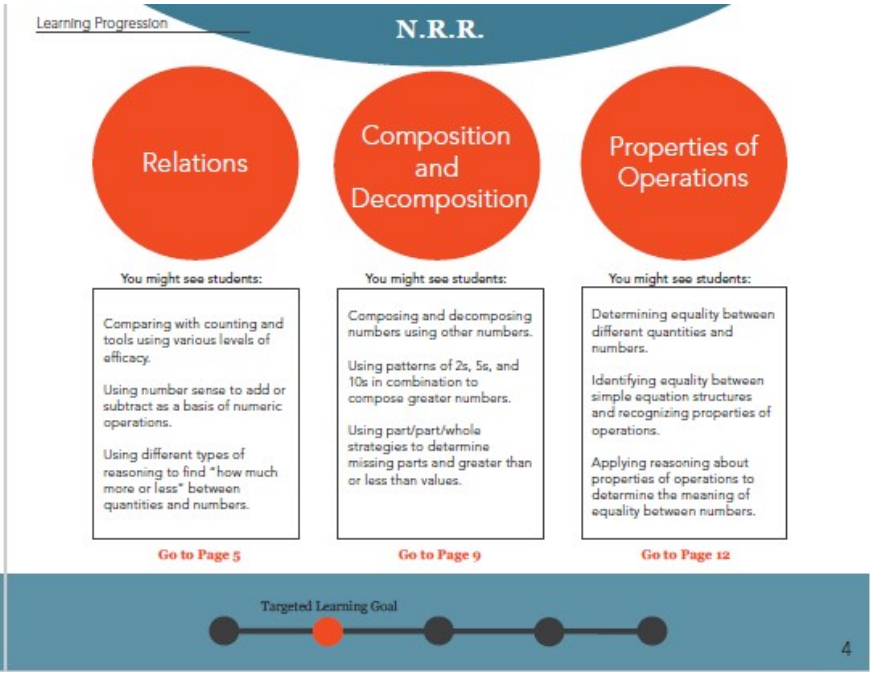
8

Appendix B – Sample 2 Prototype of the Assessment Selection Guide

Below are screenshots from the second iteration of selection guide developed by the RME researchers to share with the TAP for the desirability testing activity.




Next...
2. Choose your Targeted Learning Goal
Learning Progression
N.R.R.
Numerical Relational Reasoning
Targeted Learning Goals
Relations
Composition & De-composition
Properties of Operations
Relations if you want to:
Understand your students' strategies for comparing quantities of objects and numbers.
See how your students use numbers and patterning as the basis of numeric operations.
Know with what level of efficacy your students determine the difference between numbers.
Composition & Decomposition if you want to:
Understand how your students compose and decompose numbers with different combinations.
See how your students reason about the composition/decomposition of numbers.
Know how your students use patterns and grouping to determine missing/greater parts of numbers.
Properties of Operations if you want to:
Understand how your students recognize and understand equality between quantities and numbers.
See how your students apply reasoning to make sense of the relationships between maintaining equality and addition and subtraction.
Know how your students use properties of operations to understand different equation structures and their impact on equality.
Targeted Learning Goal
3


Learning Progression
N.R.R.
Relations
Composition and Decomposition
Properties of Operations
You might see students:
Comparing with counting and tools using various levels of efficacy.
Using number sense to add or subtract as a basis of numeric operations.
Using different types of reasoning to find "how much more or less" between quantities and numbers.
Go to Page 5
You might see students:
Composing and decomposing numbers using other numbers.
Using patterns of 2s, 5s, and 10s in combination to compose greater numbers.
Using part/part/whole strategies to determine missing parts and greater than or less than values.
Go to Page 9
You might see students:
Determining equality between different quantities and numbers.
Identifying equality between simple equation structures and recognizing properties of operations.
Applying reasoning about properties of operations to determine the meaning of equality between numbers.
Go to Page 12
Targeted Learning Goal
4

3. Choose your Core Concept

Use a Core Concept Menu to choose the best starting place for your students. The Assessment Tool will provide data that positions each of your students on the learning progression and will help inform how to group them into instructional groups for next steps.

Learning Progressions

Targeted Learning Goals

Core Concepts

N.R.R.
Numerical Relational Reasoning

Relations	Composition & Decomposition	Properties of Operations
Comparison	Composition	Equivalence of Quantity and Number
Foundations of Operations	Decomposition	Equal Sign as a Relational Symbol
Transitivity	Applying and Representing Decomposition	Maintaining Equality
Representations of Order in Comparison Situations		Solving for Unknown Values

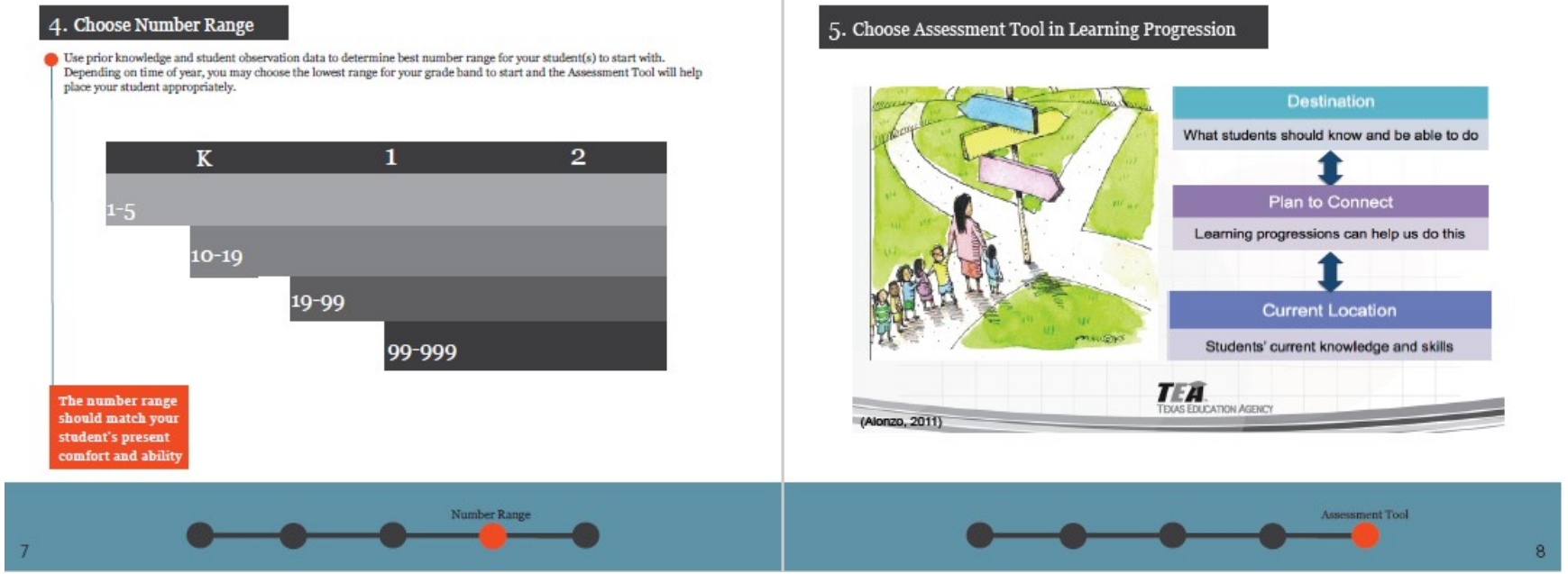
Go to Appendix to see other samples of Core Concept Menus

Targeted Learning Goal

Relations

SAMPLE CORE CONCEPT MENU: Relations

1. 	Compare two quantities to determine which is more/less when a. quantities are in no apparent order b. quantities are presented in an arrangement c. given representations of place value? Compare two numbers and determine which is more/less when a. using the number sequence? b. using number lines? c. using symbols: >, < ?	**Comparison**
2. 	Find a number a. 1 or 2 more/less than a given number b. 10 more/less than a given number c. multiples of 10 more/less than a given umber d. 100 more/less than a given number e. multiples of 100 more/less than a given number	**Foundations of Operations**
3. 	Compare and order more than two objects with unspecified lengths, weights, quantities, and numeric values? a. How does the student use tools to order numbers? b. What mental strategies does the student use to order numbers?	**Transitivity**
4. 	Find how much more/less between two quantities a. pre-place value b. with place value representations Find how much more/less between two numbers	**Representation of Order in Comparison Situations**



Source: Texas Education Agency (n.d.). TEA ESTAR/MSTAR Learning Progressions. Retrieved from http://jukebox.esc13.net/learningprogressions/HTML_materials/lp_03_06_reflection_slides.pdf

Appendix C – Sample 3 Prototype of the Assessment Selection Guide with Annotations

Below are screenshots from the third iteration of selection guide developed by the RME researchers with annotations that outline our rationale for some of the changes.

Sample Teacher Resource Design Decisions (Annotated)

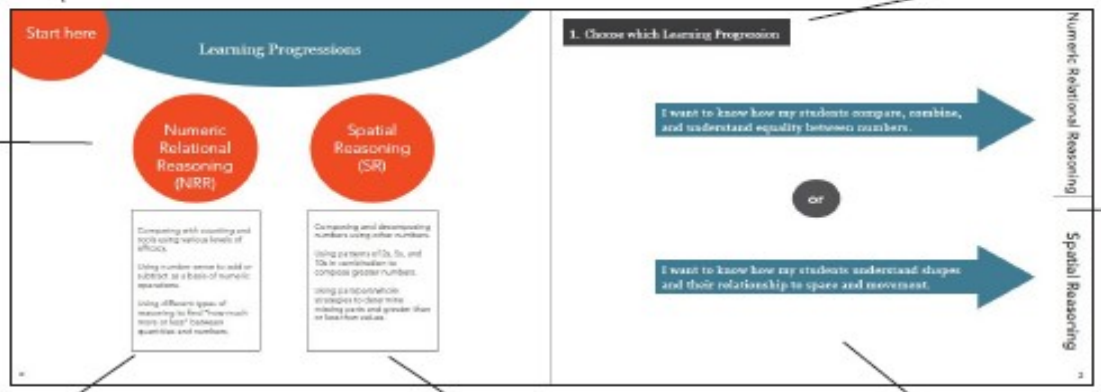
"Start Here, it's simple, but I like it."

TAP participants noted that the vertical layout of information and quick, simple signals like "start here" created accessibility.

"This is what I need to know and this is where I need to go."

TAP participants asked for actionable and **concise directions. TAP liked the flow chart of** decision-making that told them what their next steps would be.

TAP participants wanted the acronymns spelled out for clarification.



"A quick, short decision making thing"

Intentional design elements, like arrows and tabs, included to facilitate quick and easy decision-making.

TAP participants suggested that bulleted lists and streamlined content would be more easily accessible for both new and veteran teachers.

"Easier to look at and I understand..."

TAP participants indicated that the layout of content and the text boxes made information aided comprehension.

TAP participants specifically mentioned the importance of concise, **"teacher language"** for conveying purpose and function of each step.

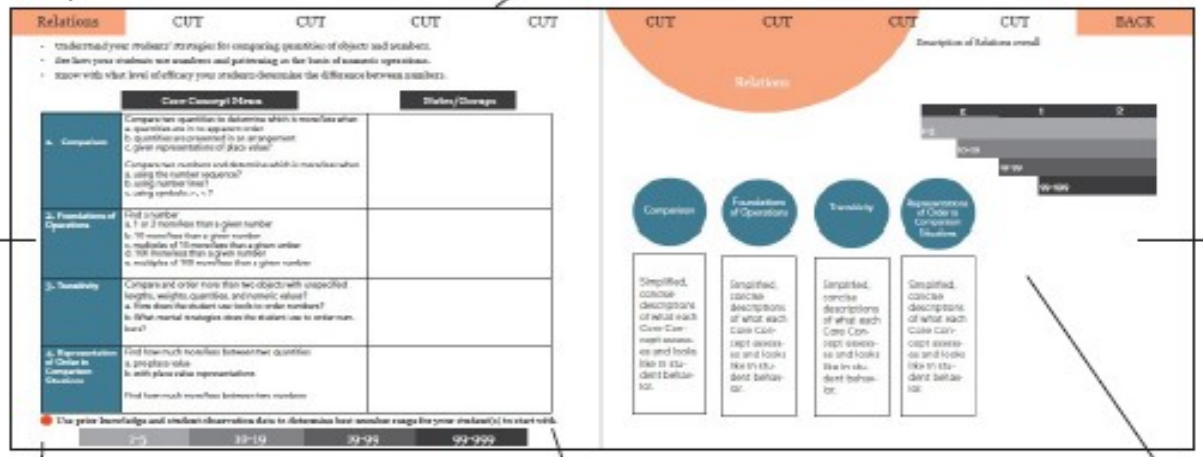
Teacher Resource Step One

TAP participants suggested separating **"what you need to know" from "what you need to do"** for teachers to have easy access to using the Core Concept Menus.

"A table of student behaviors to reference for PLCs."

TAP referred to using this tool in other contexts to make data collected more actionable.

We ideated a double-sided "recipe" card that combines the "just enough" information the TAP might need to make decisions and the CC Menu that provides actionable next steps.



"The images don't add much."

The TAP indicated that they would like more "detailed description" under-neath the name of each Core Concept.

"a book, a manual or a one-pager"

The back of the recipe card is an iteration of a "one-pager" of information for making decisions.

Including a quick reference to the Number Range at the bottom of the card will help prompt teachers to recall where they will start with each student.

"It might make small group work more intentional to have the menu to reference."

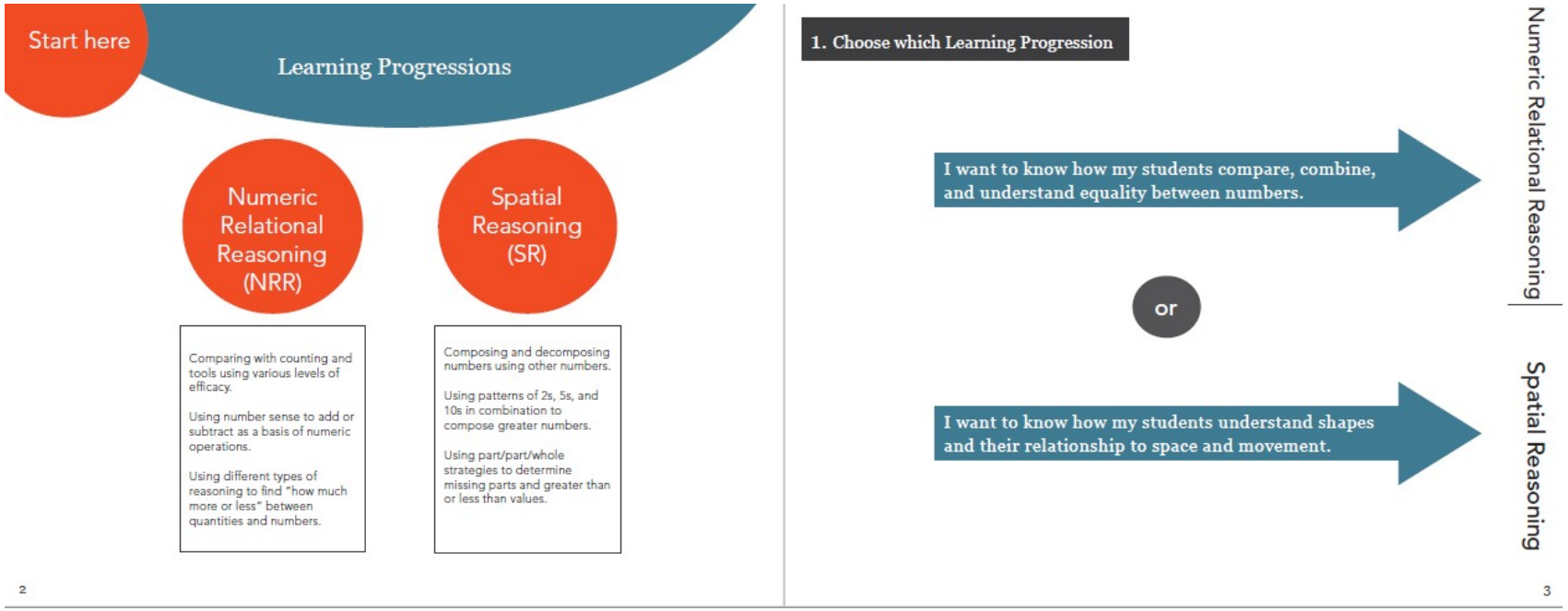
Teachers asked for workspace on CC Menu to include student names to make it more of a tool for action.

"Just a little bit more information, so I can make a decision."

The back of the recipe card has more information to reference while using the CC Menu to find your students' starting point.

Teacher Resource Recipe Card

Appendix D – Sample 3 Prototype of the Assessment Selection Guide without Annotations



Relations CUT CUT CUT CUT

- Understand your students' strategies for comparing quantities of objects and numbers.
- See how your students use numbers and patterning as the basis of numeric operations.
- Know with what level of efficacy your students determine the difference between numbers.

	Core Concept Menu	Notes/Groups
1. Comparison	Compare two quantities to determine which is more/less when a. quantities are in no apparent order b. quantities are presented in an arrangement c. given representations of place value? Compare two numbers and determine which is more/less when a. using the number sequence? b. using number lines? c. using symbols: >, < ?	
2. Foundations of Operations	Find a number a. 1 or 2 more/less than a given number b. 10 more/less than a given number c. multiples of 10 more/less than a given umber d. 100 more/less than a given number e. multiples of 100 more/less than a given number	
3. Transitivity	Compare and order more than two objects with unspecified lengths, weights, quantities, and numeric values? a. How does the student use tools to order numbers? b. What mental strategies does the student use to order numbers?	
4. Representation of Order in Comparison Situations	Find how much more/less between two quantities a. pre-place value b. with place value representations Find how much more/less between two numbers	

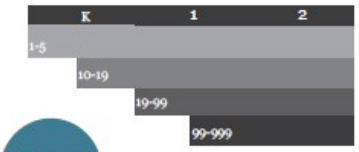
Use prior knowledge and student observation data to determine best number range for your student(s) to start with.

1-5 | 10-19 | 19-99 | 99-999

CUT CUT CUT CUT BACK

Description of Relations overall

Relations



Comparison	Foundations of Operations	Transitivity	Representations of Order is Comparison Situations
Simplified, concise descriptions of what each Core Concept assesses and looks like in student behavior.	Simplified, concise descriptions of what each Core Concept assesses and looks like in student behavior.	Simplified, concise descriptions of what each Core Concept assesses and looks like in student behavior.	Simplified, concise descriptions of what each Core Concept assesses and looks like in student behavior.