Capturing Teacher’s Mathematical Knowledge for Teaching

CIES 2023

Wendi Ralaingita, RTI International
Aizada Mamytova, RTI International
Yasmin Sitabkhan, RTI International
Outline

- Introduction to MKT
- Instrument development and Field test
- Pilot-Kyrgyz Republic
- Discussion and next steps
Mathematical Knowledge for Teaching – an Introduction

- Essential question: What do math teachers need to know and be able to do in order to teach effectively?
- From foundation of Shulman’s Content Knowledge/Pedagogical Content Knowledge
- MKT Unpacks CK and PCK

Developing the MKT Survey

- Can we develop a tool with core items that can be easily adapted for valid use in different contexts?
- Based on existing tools, developed matrix of domains and problem types
- Adapted and generated problems according to matrix (refined over time)
- Cognitive interviews
- Problem refinement/finalization

<table>
<thead>
<tr>
<th>Developmental progressions</th>
<th>Scaffold</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometry and Spatial Sense</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Students in your class are asked to measure the length of the classroom in steps. Ruslan says the classroom is 10 steps long. Ayana says the classroom is 12 steps long. Both think they are right. How can you help them explain this difference?

- a. Ask them to measure the length of the classroom with a ruler.
- b. Ask them to measure the classroom again in steps.
- c. Ask them to compare the length of their step.
- d. I have difficulties answering.
Tools Adaptation Process

1. Review questionnaire with local math education experts
2. Use of local context and terminology
3. Field-test with cognitive interview
23. Which of the following is the approximate diameter of a mature tree found in Kathmandu valley and its surrounding?

a. 0.5 millimeters  
b. 0.5 meters  
c. 10 meters  
d. I have difficulties answering

- Option C - I think trees are bigger. So, I chose the highest diameter.
- Option D - it can be not said since there is no numeric value. It can be anything.

Overall Observations:
1) Teachers appear to understand questions
2) Teachers are less aware with the progression of mathematical knowledge.
3) Teachers are more focused on algorithmic problem solving rather than conceptual learning.
Pilot- Kyrgyz Republic
USAID Okuu Keremet! (Learning is awesome!) project

- 5-year project to improve reading and math instruction in primary schools benefiting more than 450,000 children in 1,682 public schools

- 10 training modules on improved math instruction developed covering key math domains

- Mathematics program piloted in 30 schools in 2021 before large-scale intervention

- Over 13,000 teachers joined the training in 2022
Methods

- MKT survey administered during a teacher training in 30 math pilot schools

- 323 teachers took part in pre-test in February 2021 (Module 2). 280 teachers took part in post-test in November 2021 (Module 10)

- Teachers were sent a link with the survey; answered questions during the training using their phones

- Survey was adapted in country to align with curriculum

- 23 items across number, operations, geometry, and measurement included in survey
Illustrative Findings

- At the baseline, teachers answered, on average, 56% of items correctly.

- At endline, the average score was 63% correct. This represented about two more problems solved correctly at endline out of 23.

- Areas in which teachers showed growth were directly related to content provided in the modules
  - Ex: developing mathematical models for word problems

- Individual problems within each domain best illustrated how teachers shifted in knowledge during the pilot intervention.
Teacher performance on **Measurement** items was strong given the centrality of measurement in both current textbooks as well as the modules.

Which word problem would be the easiest for a child to solve during the initial stage of learning?

a. Rima was reading a book. She started reading at 13:12 and finished at 16:12. For how many hours did she read?

b. Aknur was reading a book. He started reading at 13:30 and finished at 14:15. For how many minutes did he read?

c. Zina was reading a book. She started reading at 13:16 and finished at 13:32. For how many minutes did she read?

d. I have difficulties answering

---

**Which problem is the easiest for a child to solve?**

<table>
<thead>
<tr>
<th>Problem Description</th>
<th>Baseline</th>
<th>Endline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading from 13:12 to 16:12</td>
<td>70%</td>
<td>53%</td>
</tr>
<tr>
<td>Reading from 13:30 to 14:15</td>
<td>11%</td>
<td>19%</td>
</tr>
<tr>
<td>Reading from 13:16 to 13:32</td>
<td>24%</td>
<td>19%</td>
</tr>
<tr>
<td>Difficulties answering</td>
<td>5%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Teacher performance on Early Mathematics items went down from baseline to endline.

Revised modules on numbers and operations to include more early mathematics concepts.
Conclusion and Next Steps
Conclusion and Next Steps

The survey has many uses:

- **Before:** Inform development of teacher trainings to better target teacher needs
- **During:** Be a tool to for professional development during teacher trainings
- **Before and After:** A subset of the items can be used as a pre-post survey to understand how teacher knowledge changes over time (confirmed via IRT analysis)
Conclusion and Next Steps

- Share the tool with the larger education community (will be shared on https://shared.rti.org/ soon!), with guidelines for adaptation and use.

- Utilize MKT survey in multiple contexts (e.g., Numeracy at Scale)

- Collaborate with larger community to create tools and resources to improve teachers’ MKT in early grades.
Key References and Resources


Thank You!

Dr. Wendi Ralaingita | wralaingita@rti.org
Aizada Mamytova | amamytova@rti.org
Dr. Yasmin Sitabkhan | ysitabkhan@rti.org

Learn more about RTI’s work in International Education:

www.rti.org/idg_education