

Opening access to numeracy: Public goods to support mathematics teacher professional development

Presented by:

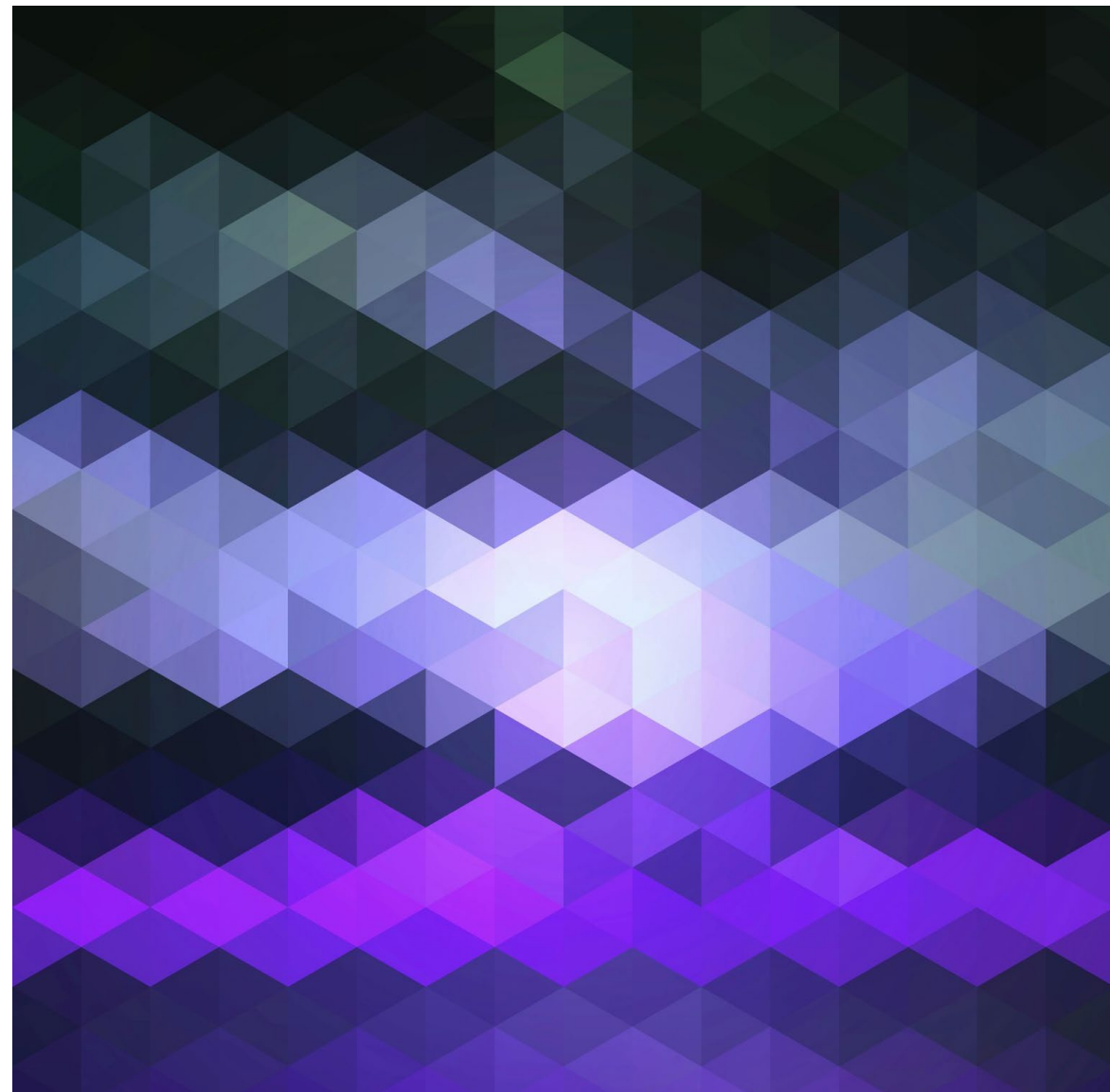
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Science of Teaching

CIES Conference Miami

Thursday, March 14, 2024



Outline of the presentation

1. Introduction to Science of Teaching (SoT)
2. SoT numeracy activities
3. Timeline of public good development
4. Process and content of the numeracy public goods:
 - a. Teacher training modules
 - b. Materials guidance for numeracy programs
5. Field Testing
6. Accessing the public goods



Introduction to Science of Teaching

Science of Teaching (SoT) is a four-year (August 2020-December 2024) grant funded by the Gates Foundation and implemented by RTI International.

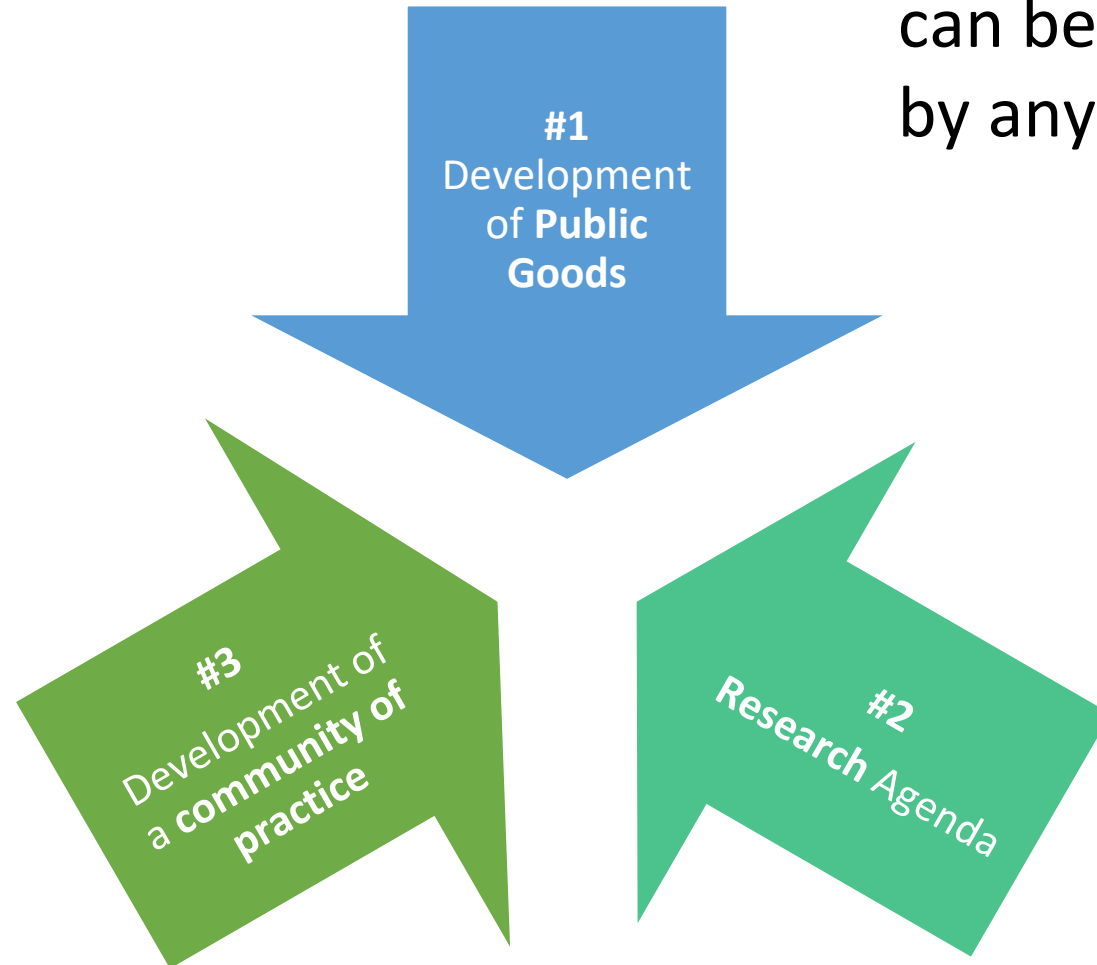
Objective : to provide data, evidence, and innovation in order to improve foundational literacy and numeracy (FLN) outcomes in Sub-Saharan Africa and South Asia.

Main Areas of Focus :

1. Synthesis of the body of evidence on effectively implementing FLN programs at scale.
2. Generation of new evidence on how to effectively implement FLN programs in LMICs.
3. Dissemination of synthesis products developed and new research generated.

SoT Numeracy Activities

Public goods are resources in the public domain that can be accessed and used by anyone.



Timeline of the development of public goods

Feb-Apr 2023

Listening sessions with experts

Three listening sessions with mathematics education researchers and practitioners.

Aug-Oct 2023

Public Goods Developed

Teacher training modules and numeracy materials guidance developed.

Dec-Feb 2024

Public Goods Revised

Training modules and materials guidance revised based on feedback.

May-July 2023

Priority Areas Determined

Nature of the public goods determined.; Collaborators identified

Nov 2023

Numeracy Workshop

Experts consulted to provide feedback on the public goods.

Feb 2024

Field testing begins

Numeracy Public Goods

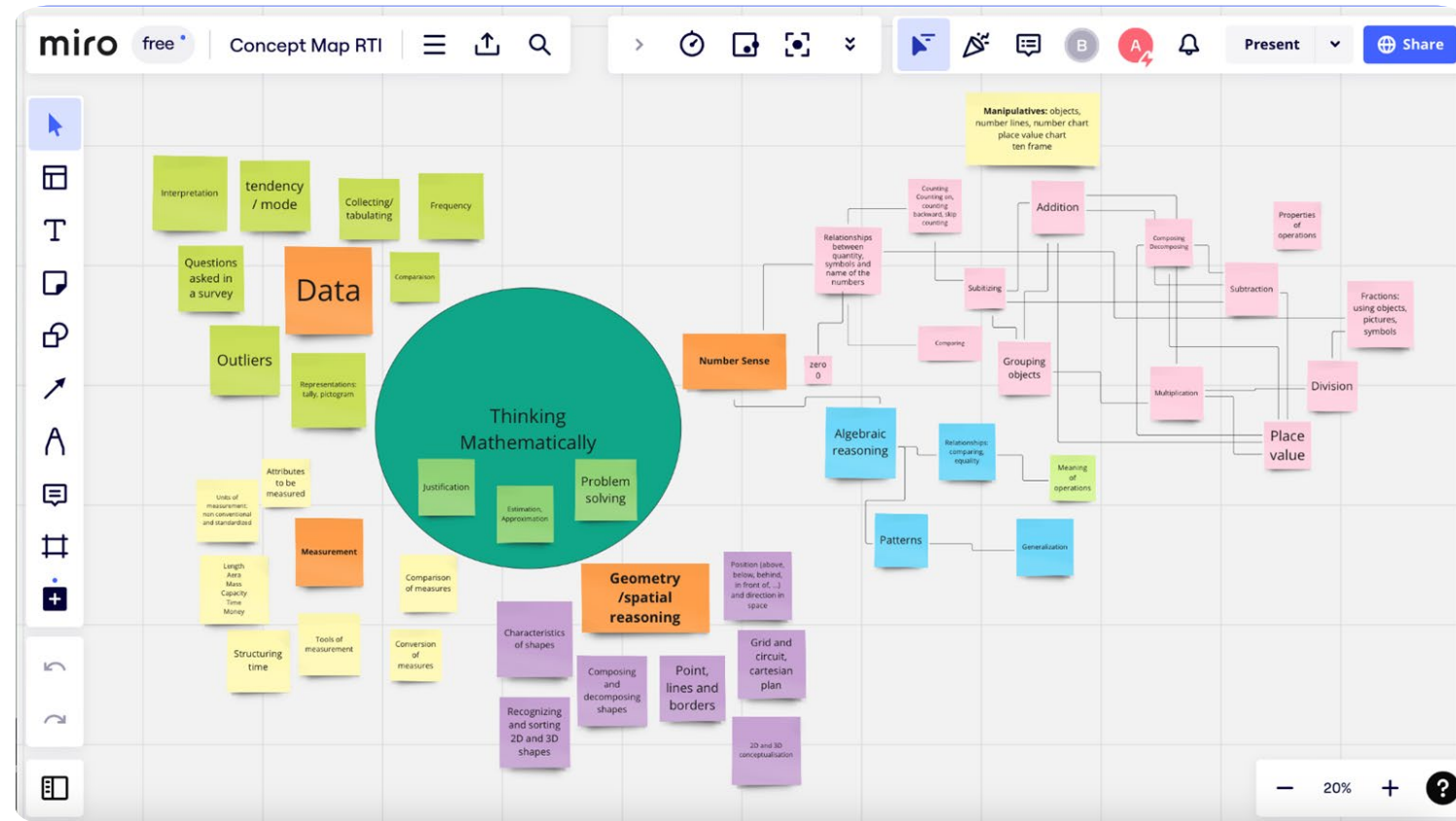
Priority Areas for Building Public Goods.

- 1) Teacher Professional Development modules
- 2) Guidance on teaching and learning materials
- 3) Assessment-Informed instruction – practical application



Concept Map

- A mapping of the topics and skills relevant for teaching mathematics to grades 1-3 students.
- The basis for developing teacher training modules.



Draft Teacher Training Modules

Module Topics

1. Teaching Numbers and Quantities
2. Teaching Foundations of Addition and Subtraction
3. Teaching Place Value

Module Structure

Part 1: Independent Study & Practice

- Illustration of teaching
- What do children learn about the topic?
- How do you teach the topic?
- Teaching practice and reflection

Part 2: Facilitated Teacher Discussion

- Guidance for facilitator
- Overview
- Meeting activities

Numeracy Workshop

Invited numeracy experts reviewed public goods, provided feedback, and made key decisions.

Key takeaways:

- Structure and format of modules is not practical for teachers in LMICs
- Content is technically sound
- Decided to have off-line modules for low-resource contexts + elearning modules for contexts with access.



Mini-Module Redesign

Chapters	Mini-Modules
Chapter 1: Numbers and Quantities	A. Count
	B. Compose, Decompose and Subitize
	C. Understand, Read and Write Numbers
	D. Compare
Chapter 2: Foundations of Addition and Subtraction	A. Understand Addition
	B. Understand Subtraction
	C. Apply Addition and Subtraction
Chapter 3: Place Value	A. Group Units and Tens
	B. Understand the Digits of Numbers
	C. Compare 2- and 3-Digit Numbers

- Each chapter has an introduction
- Existing content is revised into digestible mini-modules
- Text and module length are reduced
- No more independent practice, teachers are guided through content
- Focus on both pedagogy and subject knowledge is maintained

Mini-Module Structure

Chapter Introduction:

1. Mini-modules in this chapter
2. Goals of the chapter
3. List of key terms
4. Guidance on using materials
5. Connections with other math concepts

Each Mini-Module:

1. Objectives
2. Recommended materials
3. Illustration of teaching
4. Activity for teachers
5. What do children learn about the topic?
6. Reflection
7. Teaching practice activity

Example Mini-Module

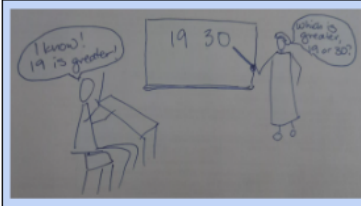
Chapter 3: Place Value Mini-Module C: Compare 2- and 3-digit numbers

Objectives

- This mini-module aims to support teachers to:
- Build students' understanding of how to use place value to compare 2-digit and 3-digit numbers.
 - Identify how some place value materials are used to compare numbers.
 - Practice a new teaching activity.



Illustration of Teaching



Reflect

What does this mistake tell you about the student's knowledge of numbers?

How can you support this student?

Ideas to consider:

The student thinks that 19 is more than 30. They might think this because 19 has the biggest digit, 9. They might also think that 30 is only 3 because the other digit is zero. It seems like the student does not have a good understanding of place value. Students with a good understanding of place value should be able to identify that 30 is more than 19 because it has more tens. Students build a good understanding of place value by using materials such as sticks, base 10 blocks, and the 100 chart to count and compare numbers.

As teachers, we should try to understand why students make mistakes so that we can support them. In this mini-module you will learn how to support children to compare numbers by building their understanding of place value.

Activity: Compare two numbers

This activity can be completed alone, in pairs, or with a group of teachers. If you have colleagues to work with, take turns choosing numbers and representing them with place value materials. Discuss your responses to the questions.

Purpose: Compare two numbers using the place value of their digits.

Materials Needed: Place value manipulatives (e.g. sticks with rubber bands or strings to group them; base 10 blocks).

Instructions

- Write down a pair of 2-digit numbers. For example: 24 17
- Count out each number using place value materials.

- Compare the materials. *How can you tell which number is greater?*
- Repeat with a pair of numbers with the same tens' digit. For example, 21 and 25.
- Compare the materials. *How can you tell which number is greater?*
- Repeat with a pair of numbers with the same ones' digit. For example, 23 and 13.
- Compare the materials. *How can you tell which number is greater?*
- Repeat with different pairs of numbers. Use examples with the same digit and different digits in the tens' place and ones' place.

What do children learn about comparing 2- and 3-digit numbers?

You used your knowledge of place value to compare numbers during the activity. Children build their understanding of place value during the early grades. Teachers can lead many different activities, and use different materials, to teach and practice the skills in the table below. Children first learn about place value by using place value materials to compare numbers. Then, they learn to compare numbers using the place value of the digits.

Children should be able to ...	What is it?	Example
Compare quantities using materials	Identify the relative size of two numbers (greater than / less than) using materials to represent the digits.	21 is greater than 15 because it has more tens.
Compare numbers	Identify the relative size of two numbers (greater than / less than) using the place value of their digits.	21 is greater than 15 because the tens' digit is greater.
Identify 10 more / 10 less / 100 more / 100 less	Identify the number that is 10 more / 10 less / 100 more / 100 less than a given number using the place value of digits.	33 is 10 more than 23 because it has 1 more group of 10. 23 is 10 less than 33 because it has 1 fewer group of 10.

Reflection

Write your responses down and/or discuss your ideas with your colleagues:

- What are some mistakes that your students make when comparing numbers?
- What can you do to help the students realize their mistake and correct it?
- How do you know if a student has a good understanding of place value?

Teaching Practice

This practice activity may be completed by teachers with their own class, or with a smaller group of students.

Compare two numbers

Learning Objective: Students will be able to compare two numbers using place value.

Materials Needed: Place value manipulatives (e.g. sticks with rubber bands or strings to group them).

Note: This activity may be changed based on students' knowledge and available materials. For example, you may use a place value chart with hundreds or use base 10 blocks instead of sticks.

Instructions

- Ask students to work with a partner (or for larger classes, students can work in groups).
- Write two numbers on the board (e.g. 23 and 15). Assign each partner to make one of the numbers with their sticks.

- **Ask:** Compare your number with your partner's number. Which number is greater, 23 or 15? How do you know?

23 is greater because it has 2 groups of sticks, and 15 only has 1 group.	15 is greater than 23 because 5 is more than 3. (Tip: The child may not understand the place value of digits. Emphasize that the first digit of the number (tens) has a greater value than the second digit (units), so a number with more tens is greater.)

- **Say:** 23 is greater than 15 because it has more tens. This means that there are more sticks in the number 23.
- Repeat with a pair of numbers with the same tens' digit. For example, 21 and 25.

- **Ask:** Compare your number with your partner's number. Which number is greater, 21 or 25? How do you know?
- Allow students to answer.
- **Say:** 21 and 25 both have 2 tens. We must compare their units. 25 is greater than 21 because it has more units. This means that there are more sticks in the number 25.
- Repeat many times with different pairs of numbers. Use examples with the same digit in the tens' place and different digits in the tens' place.

Objectives
Recommended materials
Illustration of teaching

Activity for teachers

What do children learn?
Reflection

Teaching practice

Field Testing Mini-Modules

The 3 Place Value mini-modules were tested with 19 elementary school teachers in rural Malawi.

Findings:

- Well understood by teachers.
- Teachers liked the tables of what children learn.
- Teachers found the activities and reflection questions worthwhile.
- Illustrations of teaching sometimes unclear.

Next steps:

- Design tools for more structured field testing.
- Conduct more rigorous field tests in ~3 countries.
- Test all mini-modules.



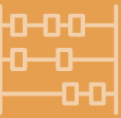
Materials Guidance for Numeracy Programs

Part 1: Selecting and Using Materials

1. Introduction
2. Design and adoption of teacher and student books
3. The importance of different forms: concrete, pictorial, and abstract
4. Selecting appropriate materials
5. Providing or obtaining materials
6. Teacher training on materials
7. Educational technology and online resources
8. Common manipulatives and models

High-Impact Teaching Strategies (HITS)
for Foundational Literacy and Numeracy

Materials Guidance for Numeracy Programs



PART 1: Selecting and Using Materials – The Basics

INTRODUCTION

As described in the Science of Teaching structured pedagogy how-to series, teaching and learning materials play an important role in supporting children's learning. At the same time, materials can represent a significant resource investment, so making decisions about what materials to use and how to ensure that they are used appropriately is an important part of designing a numeracy program.

This guidance is intended to help decision-makers understand and make decisions about adopting and incorporating materials for early grade math programs. It also provides information for curriculum and materials developers and teacher trainers, who play a role in ensuring that materials are used appropriately to support children's learning.

In keeping with this dual purpose, the guidance is presented in two parts. This first part provides general information on the selection and use of materials, including print materials and math manipulatives. The second part provides more in-depth information about manipulatives and pictorial models that are commonly used in math programs.

Part I begins by presenting key considerations for using written materials—including teacher's guides and student books—in the math classroom. It then focuses attention on manipulatives and other models that help children understand math concepts, explaining the importance of these manipulatives and models and providing recommendations on the essential ones to include in a math classroom toolkit. Considerations around acquiring or developing materials, as well as preparing teachers to use them appropriately, are discussed. Finally, it ends with a table listing common manipulatives and models and the math domains or topics for which they can be used.

Definitions

Abstract

A mathematical concept represented through symbols (e.g., the addition sentence $4 + 2 = 6$)

Competency

A statement that describes the desired knowledge or skill for a student to gain

Concrete

A mathematical concept represented using physical objects (e.g., counters)

Domain

An area of study in a curriculum (e.g., number sense, operations, measurement)

Manipulatives

Physical materials that can be moved and touched, such as counters

Pictorial

A mathematical concept represented through a picture, drawing, or figure

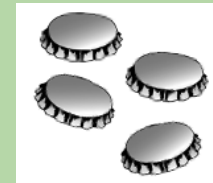
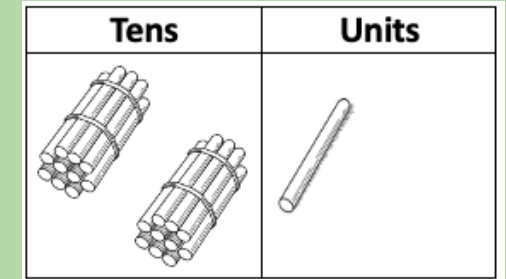
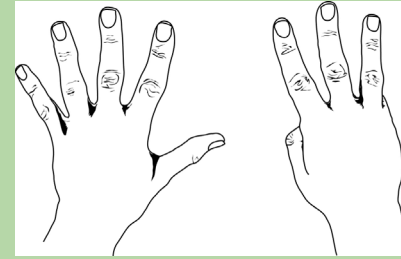
Representation

Showing a mathematical concept or idea through symbols (abstract), drawings (pictorial), or objects (concrete)

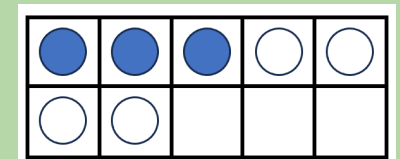
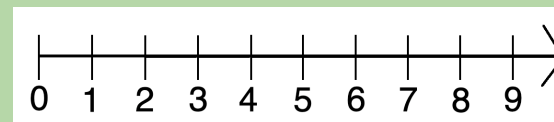
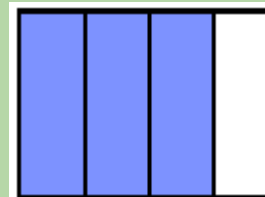
Part 2: Selecting and Using Materials

Introduction and guidance on specific materials:

- Counters
- Fingers
- Ten frame
- Number line
- Bead strings
- Sticks, base 10 blocks and place value chart
- Number cards
- 100 chart
- Fraction strips
- Fraction shapes
- Geometric shapes
- Ruler
- Model clock
- Calendar
- Model money
- Everyday objects for measurement



1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

















Part 2: Selecting and Using Materials

Guidance on each material:

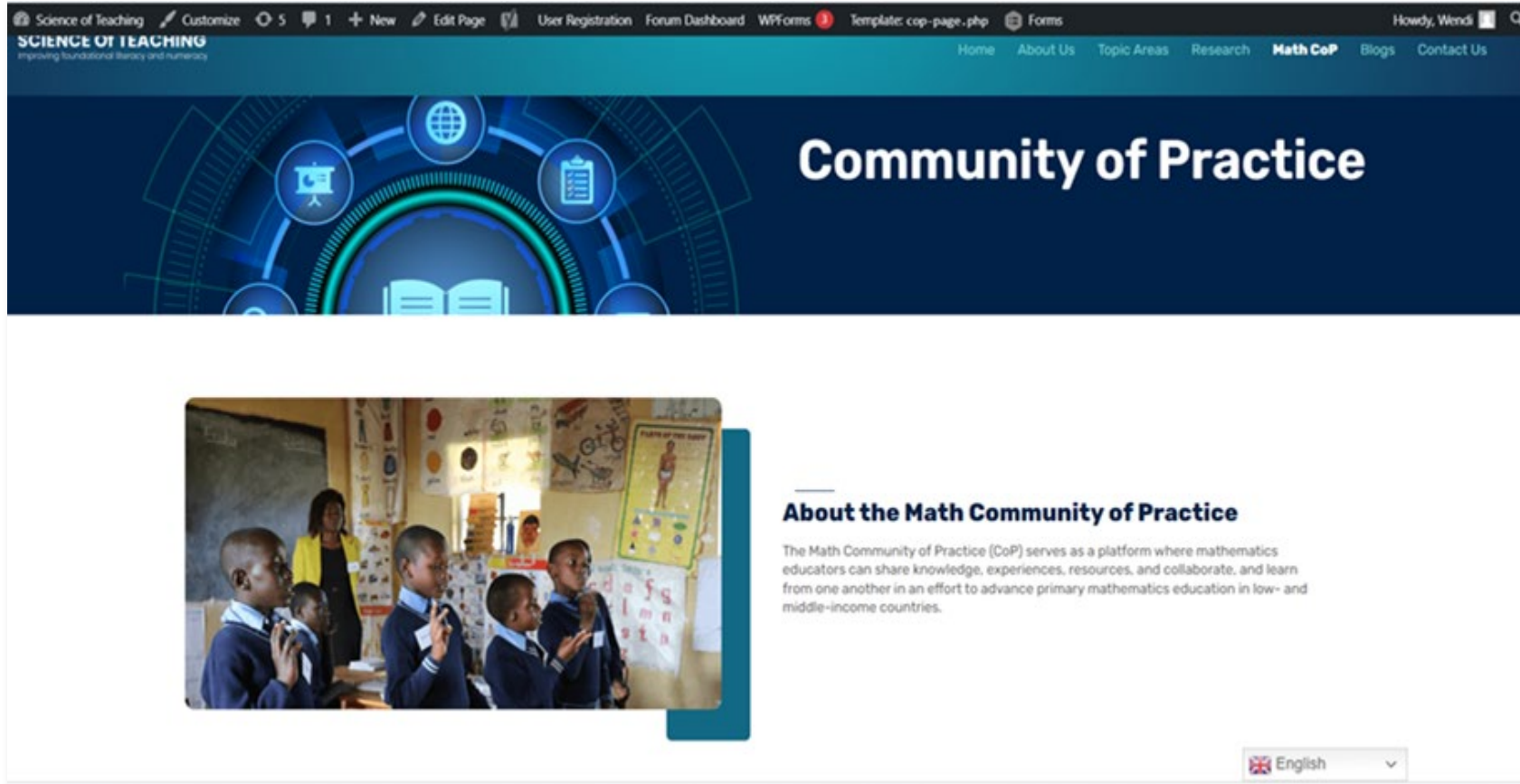
1. What it is
2. Why it is used
3. How to obtain or make it
4. What it is used for (links to specific math skills in modules)

Selected materials:

- are effective
- require few resources
- can be easily maintained
- can be used repeatedly for different topics

Domain	Competency	Description	Example							
Place value	Identify 10 as a group of ten units	Form the quantity 10 by a group of ten units.	Count ten sticks ("1, 2, 3, 4, 5, 6, 7, 8, 9, 10") and tie them together to make a bundle of 10. 							
	Count tens	Count by 10s using bundles.	Count bundles of ten sticks: "10" "20" "30" 							
	Decompose a number using place value	Decompose a number based on the place value of its digits.	Show me 23. "10" "20" "21, 22, 23" 							
	Compare numbers	Identify the relative size of two numbers (more than/less than) using the place value of their digits.	21 is greater than 15 because it has more tens. <table border="1" data-bbox="2127 978 2331 1099"> <thead> <tr> <th>Tens</th> <th>Units</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table> <table border="1" data-bbox="2127 1106 2331 1228"> <thead> <tr> <th>Tens</th> <th>Units</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table>	Tens	Units			Tens	Units	
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Accessing the Public Goods




The screenshot shows the top navigation bar of the Science of Teaching website. The main header features a dark blue background with a futuristic, glowing blue and green circular graphic on the left. The text "Community of Practice" is prominently displayed in white. Below the header, there is a photograph of a classroom with students and a teacher. To the right of the photo, the heading "About the Math Community of Practice" is followed by a paragraph describing the platform's purpose. A language dropdown menu is visible in the bottom right corner of the page.

Science of Teaching | Customize | 5 | 1 | + New | Edit Page | User Registration | Forum Dashboard | WPForms | Template: cop-page.php | Forms | Howdy, Wendi | Search

SCIENCE OF TEACHING
Improving foundational literacy and numeracy

Home | About Us | Topic Areas | Research | **Math CoP** | Blogs | Contact Us

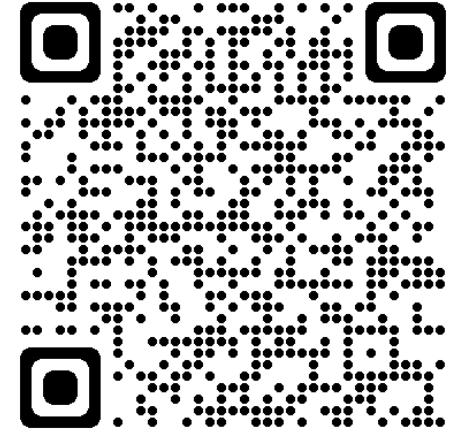
Community of Practice



About the Math Community of Practice

The Math Community of Practice (CoP) serves as a platform where mathematics educators can share knowledge, experiences, resources, and collaborate, and learn from one another in an effort to advance primary mathematics education in low- and middle-income countries.

English



Public Goods will be available through the Science of Teaching website - through the Numeracy Topic Area OR the Math Community of Practice page.
<https://scienceofteaching.site/community-of-practice/>



Thank you!

