

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

**Presented by:**

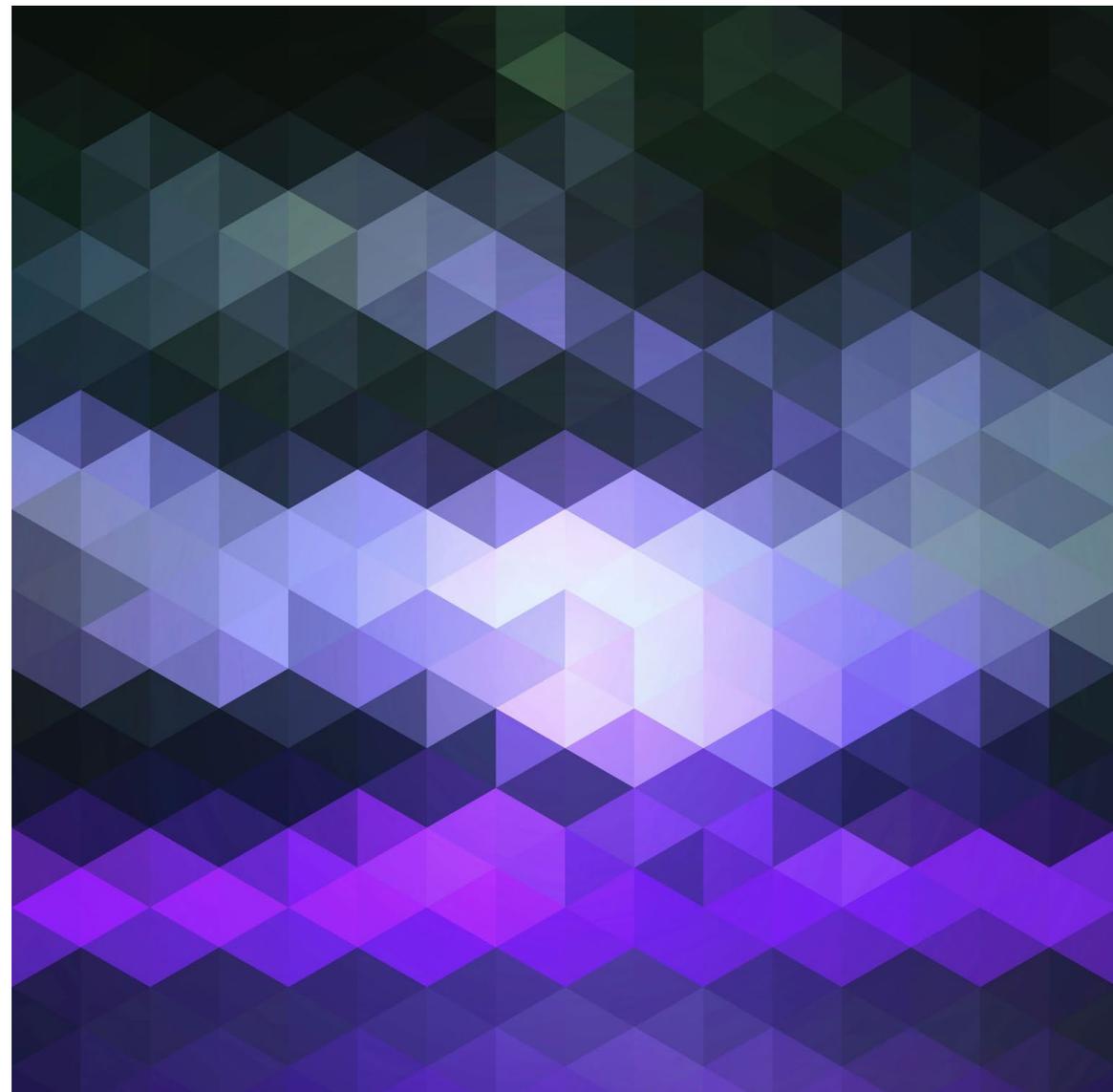
Brittany Meredith, Ed.M.

Annie Savard, Ph.D.

**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.**

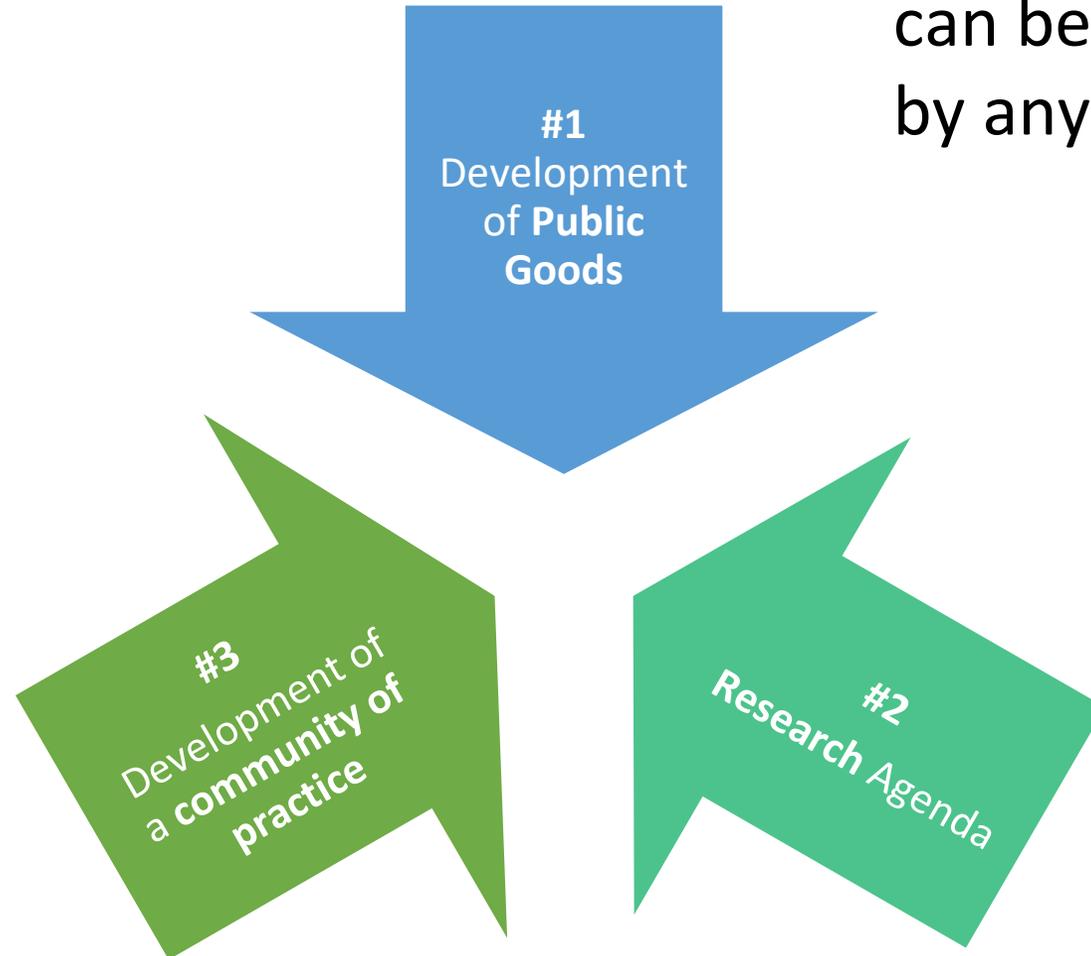
**Objective** : to provide data, evidence, and innovation in order to improve foundational literacy and numeracy (FLN) outcomes in Sub-Saharan Africa and South Asia.

## **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

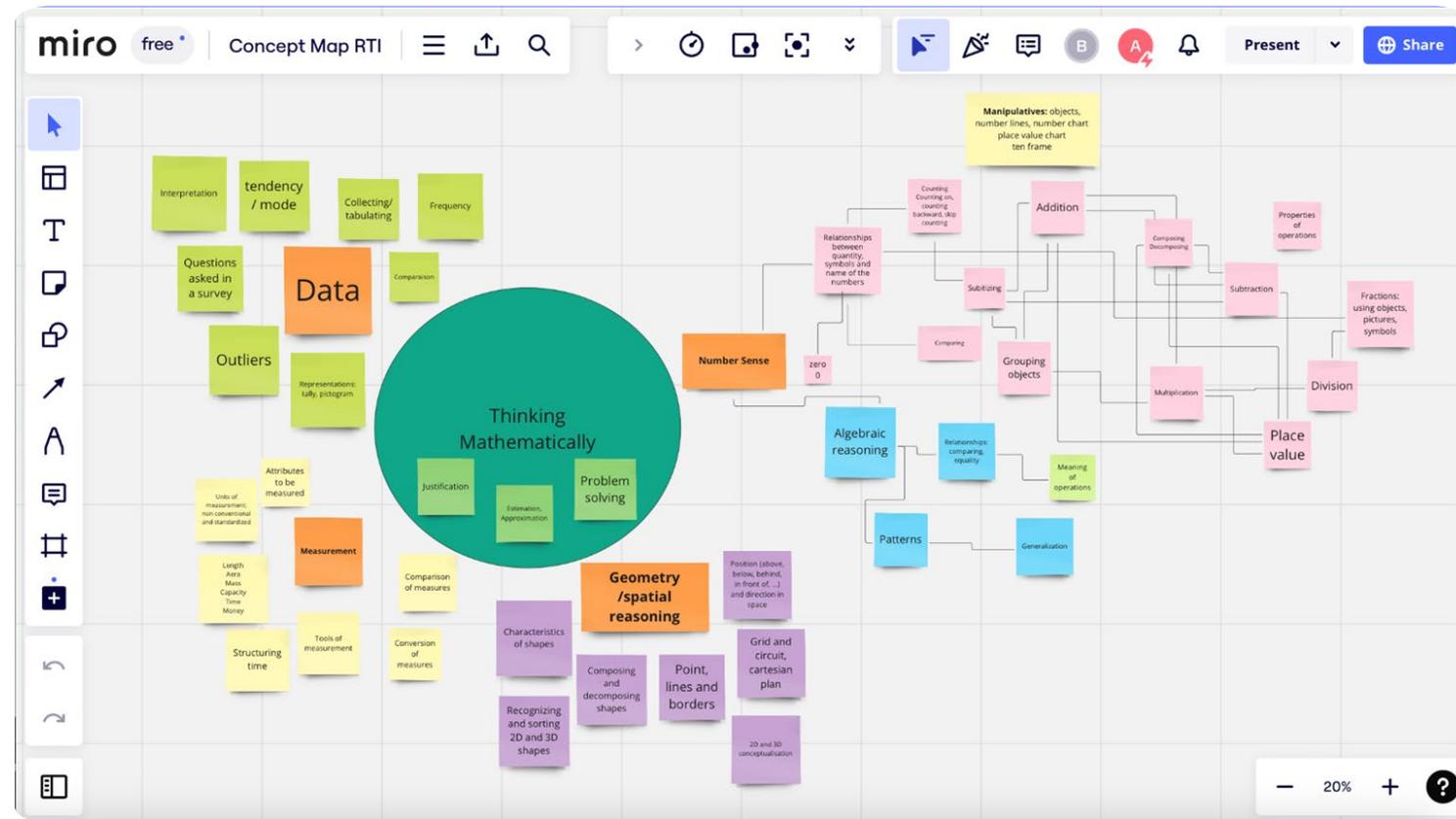
## **Priority Areas for Building Public Goods.**

- 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
<b>Chapter 1:</b> Numbers and Quantities	A. Count
	B. Compose, Decompose and Subitize
	C. Understand, Read and Write Numbers
	D. Compare
<b>Chapter 2:</b> Foundations of Addition and Subtraction	A. Understand Addition
	B. Understand Subtraction
	C. Apply Addition and Subtraction
<b>Chapter 3:</b> 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

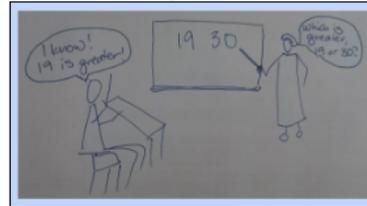
### Objectives

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.

**Recommended materials**

### 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.



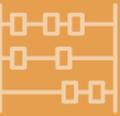
# Materials Guidance for Numeracy Programs

## 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

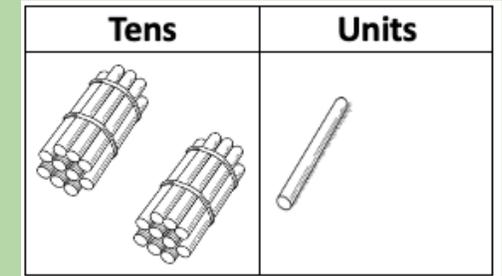
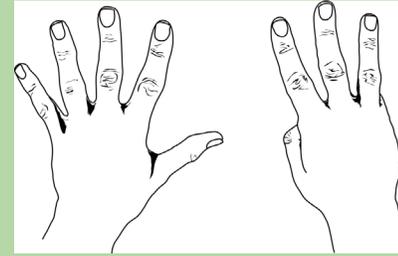
##### **Representation**

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

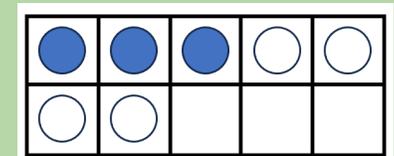
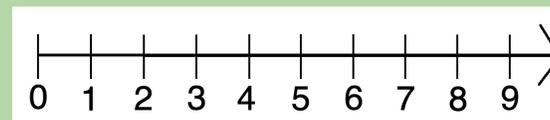
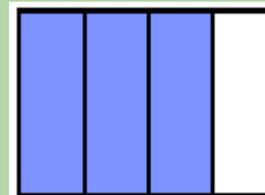
# Part 2: Selecting and Using Materials

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



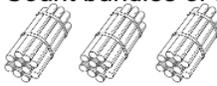
# Part 2: Selecting and Using Materials

## Guidance on each material:

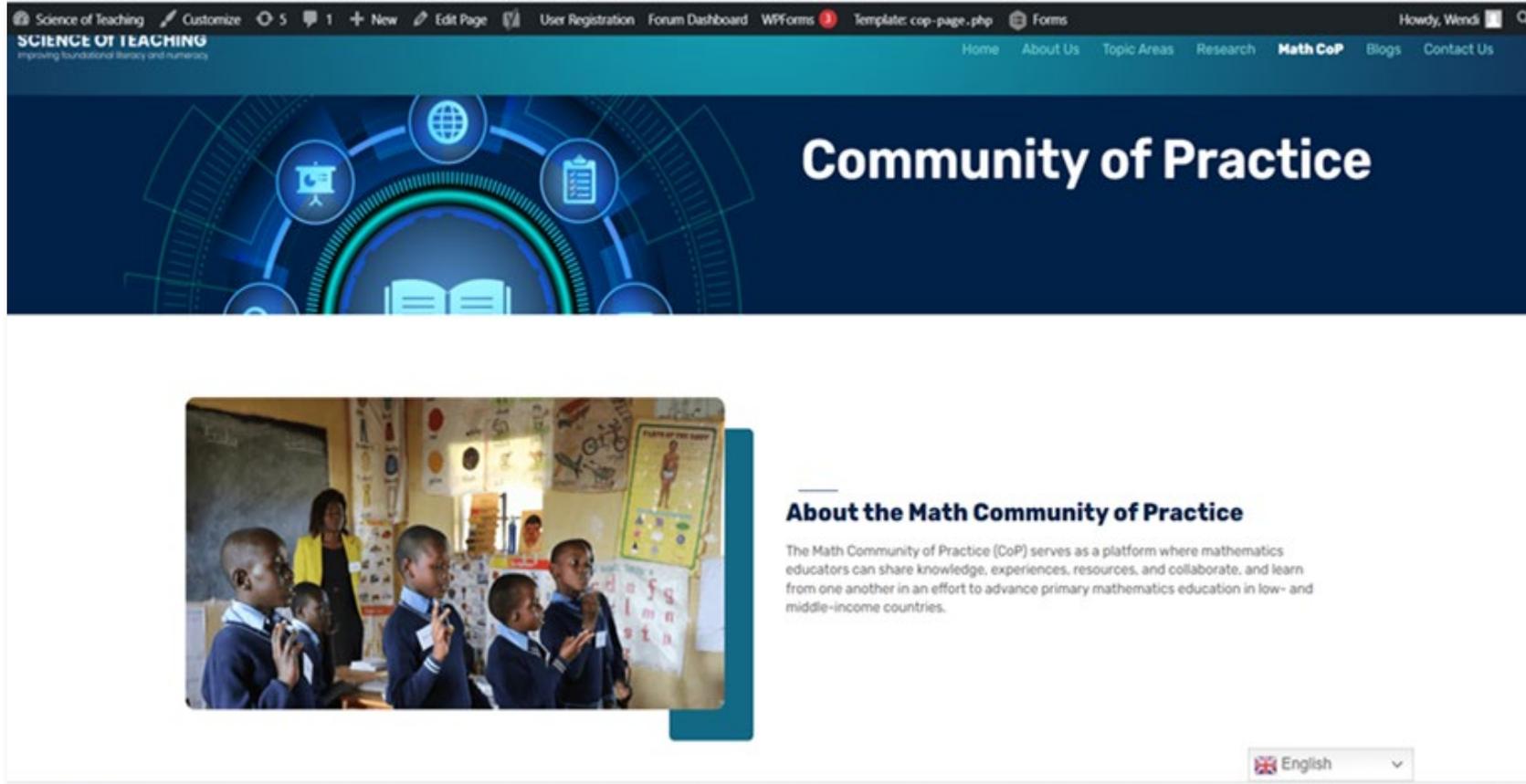
1. What it is
2. Why it is used
3. How to obtain or make it
4. What it is used for (links to specific math skills in modules)

## Selected materials:

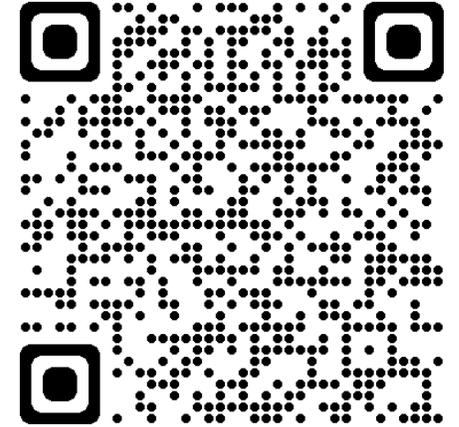
- are effective
- require few resources
- can be easily maintained
- can be used repeatedly for different topics

Domain	Competency	Description	Example							
Place value	<b>Identify 10 as a group of ten units</b>	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. 							
	<b>Count tens</b>	Count by 10s using bundles.	Count bundles of ten sticks:  "10" "20" "30"							
	<b>Decompose a number using place value</b>	Decompose a number based on the place value of its digits.	Show me 23.  "10" "20" "21, 22, 23"							
	<b>Compare numbers</b>	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	
Tens	Units									
										
Tens	Units									
										

# Accessing the Public Goods



The screenshot shows the top navigation bar of the Science of Teaching website. The main header features a blue background with a circular graphic containing icons for a globe, a person, and a document. 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 text reads: 'About the Math Community of Practice' followed by a paragraph: '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.' A language dropdown menu is visible at the bottom right, set to '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!**

