Math Intervention

TRAINEE'S HANDBOOK

KEY MESSAGES AND HANDOUTS
FOR SHLS LEADERS AND FACILITATORS

SAFE HEALING AND
LEARNING SPACES TOOLKIT

USAID
FROM THE AMERICAN PEOPLE

INTERNATIONAL RESCUE COMMITTEE

International Rescue Committee
Agency Headquarters
122 East 42nd Street
New York, NY 10168
USA
+212 551 3000

Rescue.org

For more information about the Safe Healing and Learning Spaces Toolkit, please contact the IRC at children@rescue.org. To download the resources in the SHLS Toolkit, please go to SHLS.rescue.org.

DISCLAIMER

The content and conclusions in the Safe Healing and Learning Spaces Toolkit are those of the authors and do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

Contents

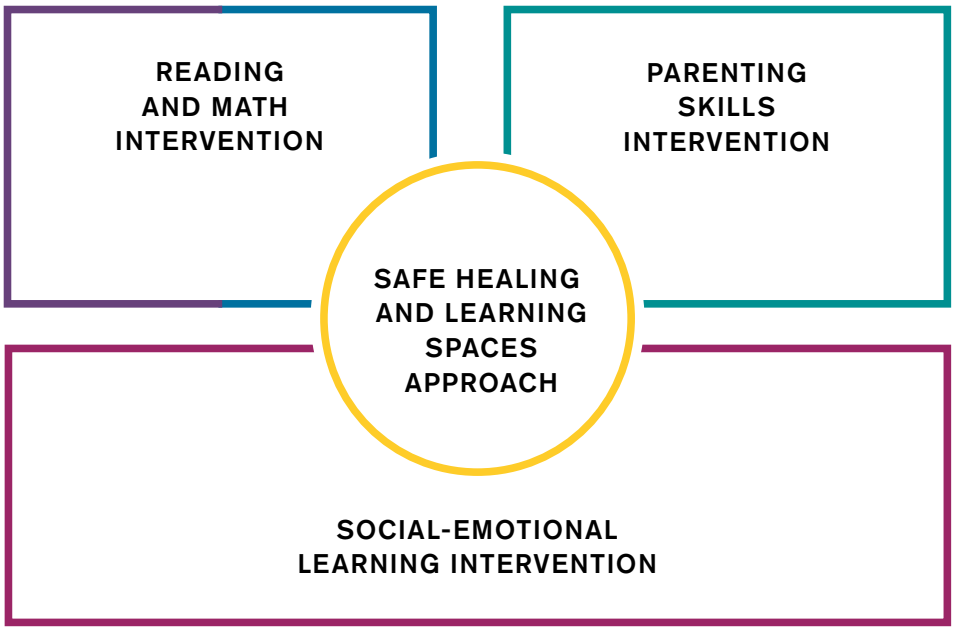
Introduction

Welcome to the Safe Healing and Learning Spaces Math Trainee's Handbook! This resource is to be used by trainees in the Math Training. It contains key messages and best practices in how to teach math, instructions for activities, and general recommendations on how to conduct daily lessons. Trainees can also use it as a reference tool when implementing the Math Intervention in a Safe Healing and Learning Space (SHLS).

This handbook contains 2 parts:

- Part 1: Information for Math Training – Phase 1
- Part 2: Information for Math Training – Phase 2

The Reading and Math Intervention is one of the 5 components of the SHLS Toolkit. As illustrated in the diagram below, the SHLS Approach, the Social-Emotional Learning Intervention, the Parenting Skills Intervention, and the Reading and Math Intervention are complementary and contribute to the overarching goal, that **children are safe, well and learning in emergencies**.



PART 1

Math Training

Phase 1

Upon completing Math Training – Phase 1, trainees will be able to:

1. Understand the importance of introducing young students to math.
2. Use the math resources effectively.
3. Design active and fun learning activities to teach math.
4. Use teaching aids in daily lessons.
5. Develop problem-solving skills in students.

Math Training Session 2: What is Math?

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Identify 5 key reasons for introducing young students to math.
- Name the 4 competencies of math.

KEY MESSAGES

- It is important for students to learn math for the following 5 reasons: 1) It predicts students' later success in school; 2) It makes students more intelligent; 3) It builds students' self-confidence; 4) It develops mathematical thinking and problem-solving skills; and 5) It is useful for everyday living.
- There are 4 Math Competencies in this: 1) Number Sense; 2) Operations; 3) Measurement and Data; and 4) Geometry.

Why learn math?

The Math Intervention of the SHLS toolkit develops students' ability to master numbers and the application of numbers using operations, understand measurement, develop spatial sense and explore basic geometric figures. The primary goal of the math component is to enable students to develop problem-solving skills through analysis and reasoning.

It predicts students' later success in school.
Students' early knowledge of math strongly predicts their later success in math and science subjects, in high school and beyond. More surprising is that it predicts later success in reading. That is because doing more math increases oral language skills such as vocabulary and grammar.

It builds students' self-confidence.
Students who can accurately calculate and find answers feel capable and smart. They feel proud of themselves. Students must feel good about learning and the future. Students who have confidence in themselves are then able to apply abstract mathematical concepts in everyday life.

It develops mathematical thinking and problem-solving skills.
Students who develop mathematical thinking can communicate, reason, organize, classify, sort, and prioritize to solve a problem. Mathematical thinking is a form of critical thinking – the student finds a problem, plans the steps to solve the problem, solves the problem and then checks if the answer is correct. This process is used in many other areas of life as well. Also remember that mathematical ability is not determined by gender. Both girls and boys can do math equally well. All students can learn and grow their math ability by working hard and practicing.

It makes students more intelligent.
The brain is like a muscle. The more it is used and does the work, the more it grows. All students, girls included, are able to increase their intelligence when they work the muscles of their brain.

It is useful for everyday living.
Students who can calculate quickly and accurately do better in their daily life tasks ,such as going to buy goods at the market. They are also able to solve problems in everyday life by using their mathematical knowledge. And, as they become adults, they have more opportunities for employment.

What are the competencies of math?

Competencies are knowledge, skills and attitude developed progressively over a long period of time from early childhood, through primary school into high school and beyond formal schooling. There are 4 math competencies that form the foundation of early math learning – namely Number Sense, Operations, Measurement and Data, and Geometry.

SOLVE PROBLEMS

NUMBER SENSE
Students develop the ability to recognize numbers, identify their relative values, count, order, measure and estimate.

OPERATIONS
Students learn to manipulate numbers using mathematical processes such as addition, subtraction, multiplication and division.

MEASUREMENT AND DATA
Students explore concepts of length, distance, weight and volume and learn to collect, sort and represent data and make decisions.

GEOMETRY
Students learn to identify characteristics, measurements, orientation, size and relationships of objects and shapes in space.

The SHLS Math Intervention covers 4 competencies – Number Sense, Operations, Measurement and Data and Geometry.

1. **Number Sense** – This competency develops the verbal counting sequence. Number words are tied to objects as students mentally connect each number word in one-to-one correspondence with an object. Other important aspects of counting include knowing the next number in a sequence and comparing quantities.

2. **Operations** – This competency involves the manipulation of objects to join them together (addition) or to take them apart (subtraction). For example: "We have 3 girls and 4 boys in our group. How many students do we have altogether?" Subtraction for young students is a separation activity. For example: "If you have 5 blocks and you give me 2, how many will you have left?" It also includes multiplication and division.

3. **Measurement and Data** – This competency introduces students to using non-standard measurement tools to understand length, height, weight and volume. Later, they can use standard tools such as rulers and scales to measure precisely.

4. **Geometry** – This competency includes shape recognition and naming. For example: "That's a triangle." Spatial sense involves knowing location, distance and direction using terms such as 'over', 'under', 'above', 'below' and so on.

Math Training Session 3: Examine the Math Resources

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

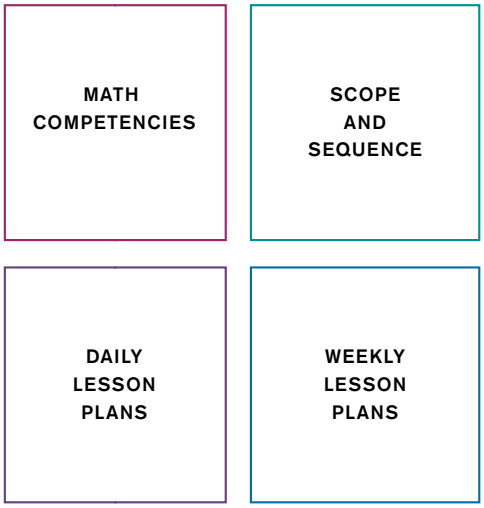
- Use the Math Trainee's Handbook and Math Lesson Plan Bank to conduct daily lessons.

KEY MESSAGES

- The Math Trainee's Handbook contains key messages, best practices in teaching math, examples of teaching aids and general recommendations on how to facilitate daily lessons.
- The Math Lesson Plan Bank contains Math Competencies, Scope and Sequence, daily lesson plans, and weekly lesson plans.
- These resources can be adapted and contextualized to your needs.

What are the components of the Math Lesson Plan Bank?

The Math Lesson Plan Bank comprises 4 components – Math Competencies, Scope and Sequence, daily lesson plans and weekly lesson plans.



Math Competencies

The Math Competencies are broken down into level-specific skills that students should learn for each competency. In the SHLS Reading and Math Intervention, there are 2 learning levels based on students' prior knowledge – 'emerging' and 'developing'. The levels are loosely based on international standards for primary level grades 1 and 2 but do not correspond exactly. Math Competencies can be assessed at the end of a lesson, at the end of the week or at the end of the 36 weeks.

Learning Levels for Math	
Emerging	Students with little to no Number Sense or knowledge of Operations learn Number Sense (up to 100) and Operations (addition and subtraction within 100 and multiply within 10) and are introduced to concepts of Measurement and Data, and basic spatial reasoning.
Developing	Students with some Number Sense and knowledge of Operations develop their skill and fluency with Number Sense (up to 1,000) and Operations (addition and subtraction within 1,000, multiply and divide within 10) and expand their Measurement and Data and Geometry knowledge.

Scope and Sequence

The Scope and Sequence determines the math competencies for each lesson and the order in which they can be covered over the period of 36 weeks with 5 lessons per week. It outlines what to teach, how to teach it and when to teach it.

The SHLS program provides a Scope and Sequence for both the emerging and developing levels of math.

Daily Lesson Plans

The daily lesson plans provide guidance on activities to be completed during a 30-minute lesson. Learning objectives for each lesson come from the Scope and Sequence. The SHLS Toolkit provides a Scope and Sequence for both the emerging and developing levels, but lesson plans for only the emerging level. Daily lesson plans have been provided for the first 12 weeks. For the remainder of the weeks, use the weekly plans as a guide to deliver the daily lessons. Daily lessons use games, songs, art activities, role-playing, working in small groups or in pairs and teaching aids to create an inclusive, safe, predictable and enjoyable learning experience.

How to read a lesson plan

The first page of every lesson contains the **Lesson summary** which includes the **competency being taught, level of students, topic, week number, lesson number, duration, learning objectives, resources required, preparation required, sensitivity notes** and the **lesson overview**.

The following pages include the **Steps to follow**, detailing how to carry out each activity. Each lesson is divided into 4 sections – **Warm-up, Present, Practice, Apply**.

Section	
Warm-up	Students participate in an activity that prepares them to learn the objective of the day. This activity can be a review of a previous learned skill or one that is fun and enjoyable to set the tone of the lesson such as a song or a story.
Present	Facilitator introduces the learning objective of the lesson.
Practice	Students practice the skill either individually, in pairs, or in small groups.
Apply	Students present their work, individually answer a question, or solve a problem to show what they have learned during the lesson.

How to present a lesson

1. Before each daily lesson, read and practice the steps of the activities recommended in the lesson plan.
2. Before delivering each lesson, read through the plan, ensure you are ready for each activity, and do any preparations listed in the lesson.
3. Throughout lesson activities, observe students and adapt the lesson accordingly.
4. Make note of skills your class struggled with so that you can review them another day.
5. Also make note of students who may need additional help.

Daily lesson plan

Week ....., Lesson .....

Topic .....

Competency: ..... | **Level:** ..... | **Duration:** ..... 30 minutes

LEARNING OBJECTIVES

By the end of the lesson, pupils should be able to:

- .....
- .....
- .....

PREPARATION REQUIRED

- .....
- .....
- .....

RESOURCES REQUIRED

- .....
- .....
- .....

LESSON OVERVIEW

.....

.....

.....

.....

Math
LESSON PLAN BANK

SHLS TOOLKIT
Week ...., Lesson ....

1

Steps to follow

Warm-up

Activity: .... | **Time:** .... | **Classroom Arrangement:** ....

1. .....
2. .....

Present

Activity: | **Time:** | **Classroom Arrangement:**

1. .....
2. .....

Practice

Activity: | **Time:** | **Classroom Arrangement:**

1. .....
2. .....

Apply

Activity: | **Time:** | **Classroom Arrangement:**

1. .....
2. .....

Math
LESSON PLAN BANK

SHLS TOOLKIT
Week ...., Lesson ....

2

Weekly Lesson Plans

The weekly lesson plans for weeks 13 to 36 outline the lesson objectives and classroom activities for each week. They identify the **competency**, **topic**, **level** and **week** at the top of each page, and use the Scope and Sequence as a guide to determine the topics to cover each day. The weekly plans follow the same 4-part structure – Warm-up, Present, Practice, Apply. Use this as a guide to write daily lessons for weeks 13 to 36.

Weekly lesson plan

Lesson 3

LEARNING OBJECTIVES

- Add within 100 without regrouping, using number bonds.
- Solve 1-step word problems using addition.

WARM-UP (5 MINUTES)

- Present a short story that requires adding within 100 without regrouping.
- Draw the scene on the board.

PRESENT (5 MINUTES)

Demonstrate how to add using the number bonds.

PRACTICE (15 MINUTES)

- Students work in small groups to find the result of adding numbers within 100 without regrouping, using the same short story as the problem to solve.
- Each group should draw a number bond to solve the problem.

APPLY (5 MINUTES)

- Students take turns to write the results on a piece of paper.
- Walk around and check the work of each group, providing support.

Lesson 4

LEARNING OBJECTIVES

- Add within 100 with regrouping, using number bonds.
- Solve 1-step word problems using addition.

WARM-UP (5 MINUTES)

- Present a short story that requires adding within 100, with regrouping.
- Draw the scene on the board.

PRESENT (5 MINUTES)

Demonstrate how to add using number bonds.

PRACTICE (15 MINUTES)

- Students work in small groups to find the result of adding numbers within 100 with regrouping, using the same short story as the problem to solve.
- Each group should draw a number bond to solve the problem.

APPLY (5 MINUTES)

- Students take turns to write the results on a piece of paper.
- Walk around and check the work of each group, providing support.

Activity 2.1 – Understand my Resources

Complete the following questions using the Math Lesson Plan Bank.

1. What is the title of the topic covered in Week 6 of the emerging level?

   .....

   Source: .....

2. What is the title of the topic covered in Week 6 of the developing level?

   .....

   Source: .....

3. What learning objectives are covered during Lesson 4 of Week 5 of the emerging level?

   .....

   Source: .....

4. What resources are required during Lesson 1 of Week 8 of the emerging level?

   .....

   Source: .....

5. What learning objectives are covered during Lesson 4 of Week 25?

   .....

   Source: .....

6. How many weeks will you teach Number Sense in the emerging level?

   .....

7. How many weeks will you teach Operations in the emerging level?

   .....

8. How many weeks will you teach Measurement and Data in the emerging level?

   .....

9. How many weeks will you teach Geometry in the emerging level?

   .....

10. How many weeks are identified for Review, Build Fluency and Assess in the emerging level?

    .....

Activity 2.1 – Answer Key

1. What is the title of the topic covered in Week 6 of the emerging level?

   Add and subtract within 10

   Source: Scope and Sequence for the emerging level

2. What is the title of the topic covered in Week 6 of the developing level?

   Understand concepts of multiply

   Source: Scope and Sequence for the developing level

3. What learning objectives are covered during Lesson 4 of Week 5 of the emerging level?

   Add within 10 using concrete objects or images

   Source: Lesson plan for Week 5, Lesson 4

4. What resources are required during Lesson 1 of Week 8 of the emerging level?

   Counters, 2 bands of 10

   Source: Lesson plan for Week 8, Lesson 1

5. What learning objectives are covered during Lesson 4 of Week 25?

   Subtract within 100 without regrouping using concrete objects or images

   Solve one-step word problems using subtraction

   Source: Weekly plan for week 25

6. How many weeks will you teach Number Sense in the emerging level?

   7

7. How many weeks will you teach Operations in the emerging level?

   15

8. How many weeks will you teach Measurement and Data in the emerging level?

   6

9. How many weeks will you teach Geometry in the emerging level?

   3

10. How many weeks are identified for Review, Build Fluency and Assess in the emerging level?

    4

Math Training Session 4: Teaching Aids for Number Sense

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Incorporate teaching aids to teach students Number Sense and Operations.
- Collect counters and make number cards and the band of 10 using locally available materials.

KEY MESSAGES

- Teaching aids are any objects or tools that allow students to explore a concept and learn math in an active, hands-on way.
- Lessons that use different teaching methods and aids create a stimulating environment, help build relationships between students, and give students a sense of control over their own math understanding.
- A good lesson has activities that combine student's listening, seeing and manipulating skills.

How do students learn math?

The daily lesson plans use different teaching aids to help students learn. Learning occurs when students actively develop their own understanding. Different teaching methods help with this: some students learn by listening, others like to see things written down, and some students learn by working with their hands, using objects to manipulate, organize, or play. A good lesson has activities that combine a student's listening, seeing and manipulating skills. Some examples of teaching methods for each type of learning style are provided below. We will explore some of these examples in depth during the training.

Here are some examples of teaching methods for each type of learning style:

1. Listening

- Number rhymes
- Songs
- Demonstration
- Presentation
- True/false
- Who am I?
- Simon says

2. Seeing

- Number cards
- Number charts
- Fill in the blank
- Associate
- Categorize

3. Doing

- Manipulatives or counters (e.g. rocks, sticks, beans, seeds)
- Cutouts of shapes (e.g. square, rectangle, triangle, circle)
- Measuring tools
- Band of 10
- Show me

Different teaching methods and aids create a learning environment that:

- Draws students' attention.
- Makes learning interesting and fun.
- Builds friendships between students.
- Improves students' self-confidence and sense of control over their own learning.
- Increases student participation.
- Makes the lessons more concrete.
- Helps teachers to assess learning.

What are math teaching aids for Number Sense and Operations?

Teaching aids are physical objects that are used to engage students in the hands-on and visual learning of mathematics. They can be brought from home, or made by Facilitators and students. Here we discuss some teaching aids used for learning Number Sense and Operations.

Counters

What is a counter?

Counters are objects that students can manipulate with their hands. Examples of objects that can be used as counters are buttons, stones, pebbles, bottle caps and so on.

Why use counters?

Counters help students visualize abstract math concepts while building students' motor skills such as hand–eye coordination. Students can touch, feel, play with and count with the counters. They can then begin to associate the number of counters with the numeral representation of the quantity.

- Counters are useful to teach one-on-one correspondence by placing the objects in a neat pattern for counting.
- Counters are useful for basic addition and subtraction where pupils can add or remove counters to calculate the result.
- Counters can be used with the band of 10 to link numbers with place value (units, tens, hundreds).

When to use counters

Counters can be used to teach a variety of concepts. They are most practical for counting, addition and subtraction within 20. They can still be used for calculations and counting beyond 20 but there are other teaching aids that can also be used for that level. Here are examples useful for teaching Number Sense, addition and subtraction:

- Form a collection of objects to show a number.
- Count objects one at a time.
- Estimate the number of objects in a group.
- Identify the relative value of numbers using objects.
- Compare the size of different groups of objects.
- Order a set of objects.
- Represent addition with objects.
- Represent subtraction with objects.
- Use with the band of 10 for counting, adding and subtracting.

How to collect counters

- Calculate the number of counters needed for your class based on the total number of students working in groups of 3 to 5, with up to 20 counters per group. At least 100 counters are needed for group activities.
- Go outdoors and collect any object that is easily found in your environment such as seeds, stones or bottle caps. Only use one type of object.
  For example, do not mix stones and seeds.
- Carefully store the counters in a bag or box.

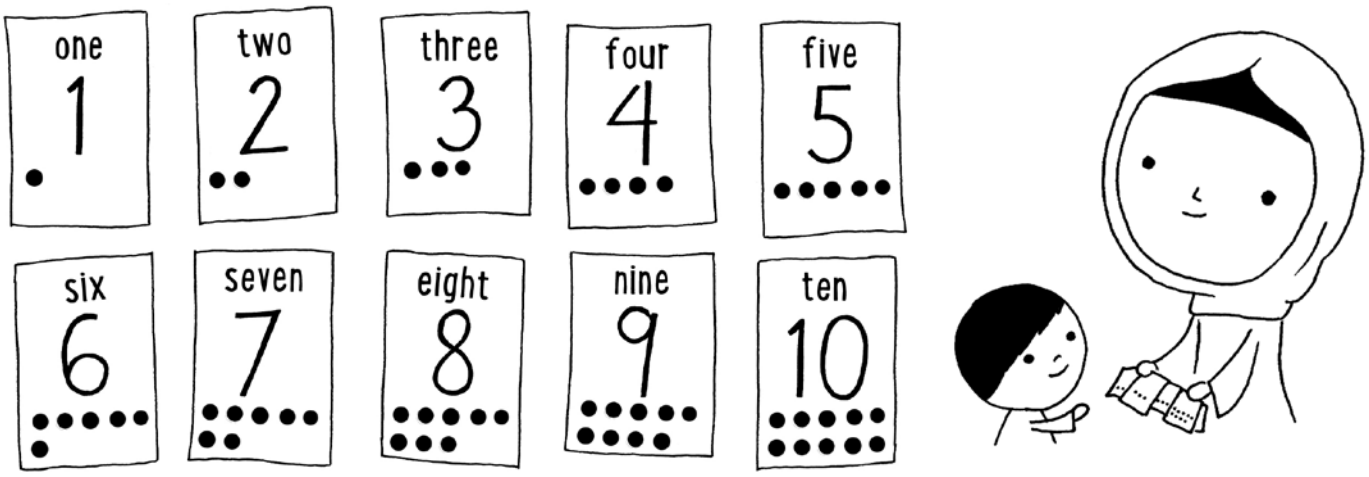
Number Cards

What are number cards?

Number cards are visual aids that a Facilitator can use at anytime during a lesson. Each number card has 3 parts:

1. Word representation of the number.
2. Numeral representation of the number.
3. Visual representation of the number using dots or some easily recognized picture like fish.

Each card should be large enough for all students to see when the Facilitator holds it up in the front of the class. It should also be made out of a strong cardboard so that it is not damaged easily.



Why use number cards?

Number cards associate the symbolic or numeral representation of a number with the quantity it represents, as described by the dots or the pictures. It reinforces the symbol with its quantitative value.

When to use number cards

Number cards can be used to teach a new concept, reinforce a concept, or for assessment. They can be used at any time during a lesson. Number cards can be made for numbers beyond 10 as well. Number cards can be used to:

- Identify numbers or show how to construct a number.
- Compare numbers.
- Put cards in ascending or descending order.
- Find and indicate the relative values of numbers.
- Add numbers.
- Subtract numbers.

How to make number cards

- Draw 11 rectangles (dimensions 15cm x 21cm) on a piece of cardboard using a ruler and pencil.
- Neatly write the word name, the numeral and draw the dots on each card using a marker.
- Cut along the lines of the rectangle to make a set of cards from 0 to 10.
- Alternatively, you can cut out the following pages from this handbook and glue them on cardboard and cut along the lines.
- You can also make number cards up to 100 if resources are available.

one

1

two

2

three

3

four

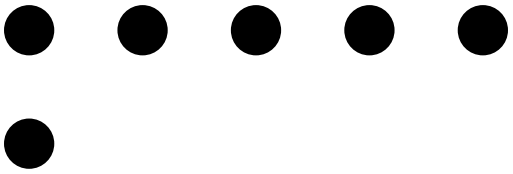
4

five

5

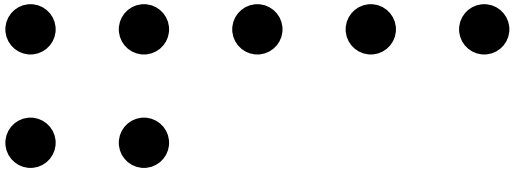
six

6



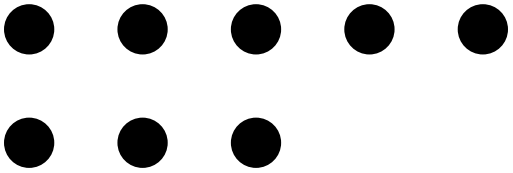
seven

7



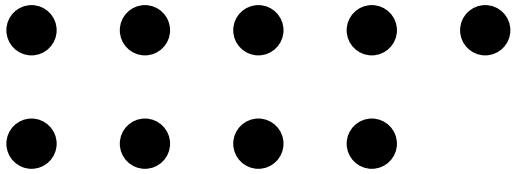
eight

8



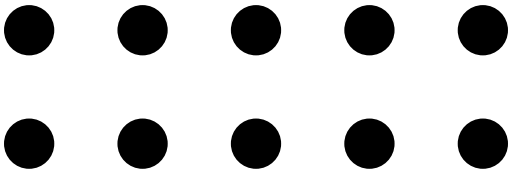
nine

9



ten

10

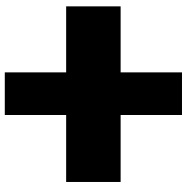
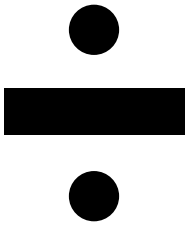


zero

0

equal

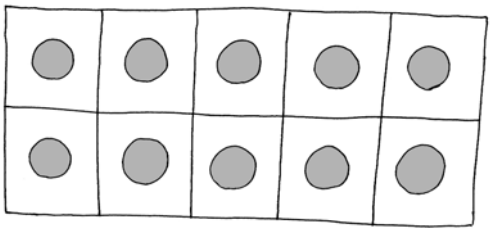
=

add 	**subtract** 
multiply 	**divide** 

Band of 10

What is the band of 10?

The band of 10 is a visual teaching aid. It is a table with 2 rows and 5 columns. Each cell can be filled with 1 counter or 1 drawing in a circle.



Why use the band of 10?

The band of 10 is used to develop Number Sense and Operations by illustrating the various properties of 10 visually. It is a means of developing links between numbers with units, tens, hundreds and thousands.

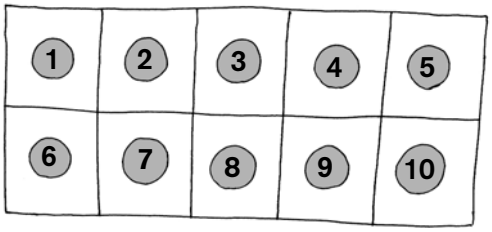
When to use the band of 10

The band of 10 is most suitable for learning Number Sense at least up to 50 and for adding and subtracting within 50. It can still be used for calculations and counting beyond 50 but there are other teaching aids that can also be used for larger numbers. The band of 10 can be used to:

- Identify numbers of objects.
- Recognize overall amounts.
- Recognize 0 (when the bands are empty).
- Compare numbers (13 is 10 with 3 more, 17 is 10 with 7 more).
- Reinforce basic operations (addition, subtraction).

How to use a band of 10

A band of 10 can be drawn on the board by the Facilitator and the cells filled out using a circle. It can also be drawn on students' notebooks or slate, and used in group work or pair activities. To read the band of 10, start from the top row, from left to right, and then the second row. When counters are placed in the cells of the table, it is placed from the top row left to right and then the second row left to right. The order of placing the counters or filling in the cells with a circle from left to right starting from the top row is very important because it illustrates the adding on principle, develops pattern recognition and improves estimation skills in students. When removing counters or erasing the circles, do so from the bottom right to left and then the top row, right to left again.



Math Training Session 5: Add and Subtract within 20

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Use band of 10 and number bonds in daily lessons to teach addition and subtraction within 20.

KEY MESSAGES

- It is important for students to develop basic mental skills **before** learning the standard way of adding or subtracting (using vertical columns).
- Addition and subtraction is taught first with numbers within 10, then by increasing to numbers within 20 and eventually onto larger numbers.
- Band of 10 and number bonds are teaching methods for addition and subtraction.

How to teach addition and subtraction

Of the 4 operations on numbers – addition, subtraction, multiplication and division, addition is the most natural. Subtraction and addition are opposite operations.

For example, 6 = 4 + 2 is the same as 6 – 4 = 2 and also 6 – 2 = 4.

Students can add numbers mentally when they play, while watching sports like football and while buying items at the shops. The standard way of adding or subtracting vertically is taught for larger numbers when mental calculation is difficult.

There are many ways to add and subtract. But, it is important for students to develop some basic mental strategies before they are taught the standard way of adding or subtracting vertically.

First, we teach adding up to 10. Then, numbers within 20 can be introduced. Then, we teach to add 2-digit numbers that does not require regrouping. Then, we teach adding 2-digit numbers that requires regrouping.

We teach subtraction using the same approach. First, we teach how to subtract 2-digit numbers without regrouping, and then how to subtract 2-digit numbers that require regrouping.

Adding and subtracting should be presented in this order. The Scope and Sequence reflects this learning progression.

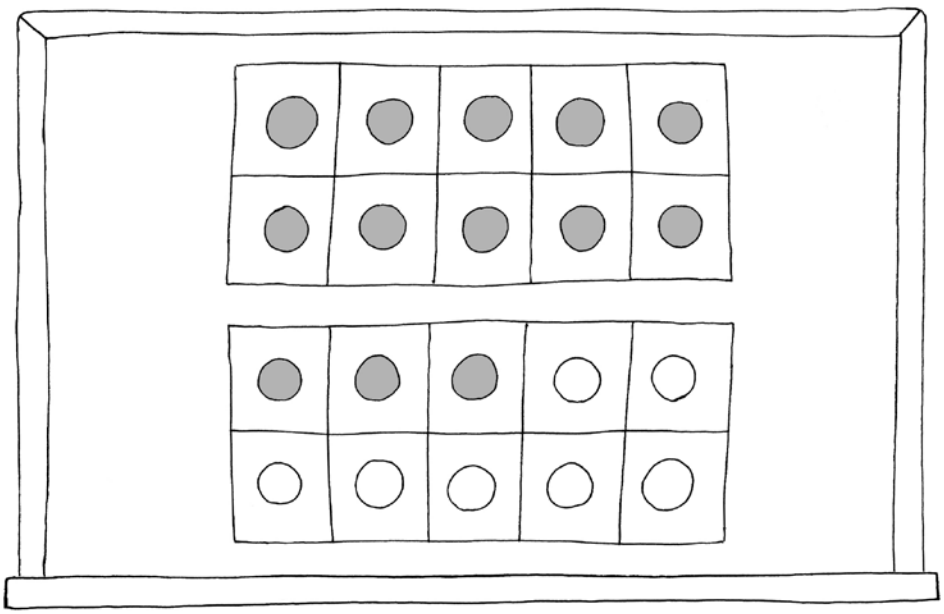
How to use the band of 10

The band of 10 visually shows the properties of ten. It is most suitable for learning Number Sense, at least up to 50 and for adding and subtracting within 50. It can still be used for calculations and counting beyond 50 but there are other teaching methods that can also be used for larger numbers.

Here are examples of how to use the band of 10:

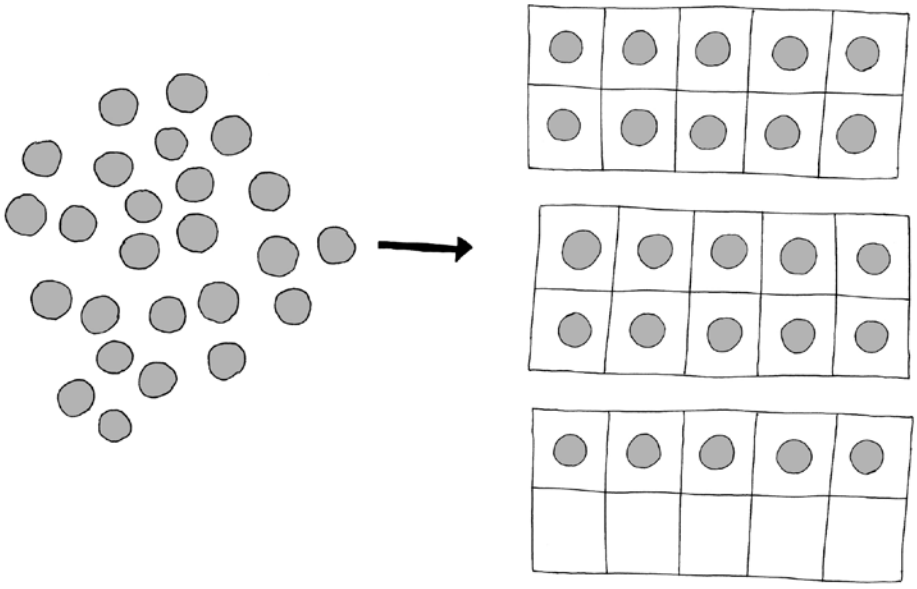
Example 1: Identify numbers of objects

- Show different amounts on the bands of 10 and ask the following questions:
  - How many stones do you see?
  - How do you know?
  - Is there another way to count and get to 13?
  - What are the ways to make 13?



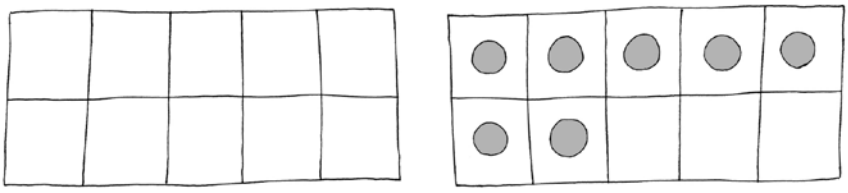
Example 2: Recognize overall amounts

- After exploring the bands of 10 with students, show them a collection of objects.
- Count the objects with the students (e.g. 25 objects).
- Then, ask them to predict how many bands 25 objects would fill.
- Ask them to discuss with a partner.
- Ask them to share their predictions and their justifications.
- Check by filling the bands' 10 cells and compare student predictions with the results: 2 full bands, plus one with 5 cells filled.



Example 3: Recognition of 0 (when bands are empty)

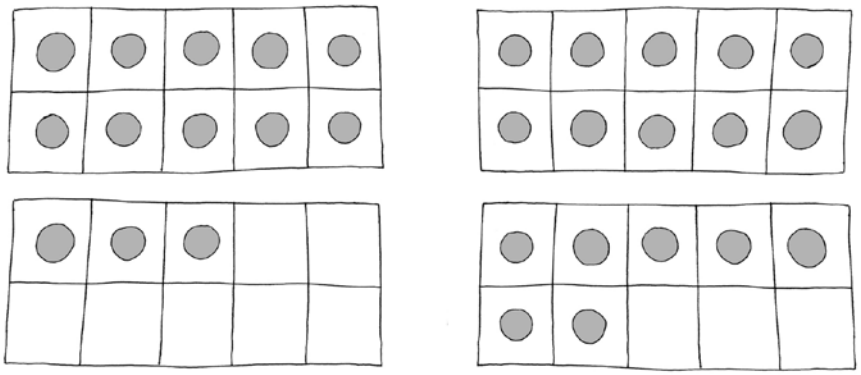
- To explain the concept of the number 0, show a band of 10 that is empty. Ask students to indicate how many objects are on the band of 10. It should be compared with a band of 10 that is filled with objects.



0 **7**

Example 4: Compare numbers
(13 is 10 with 3 more, 17 is 10 with 7 more)

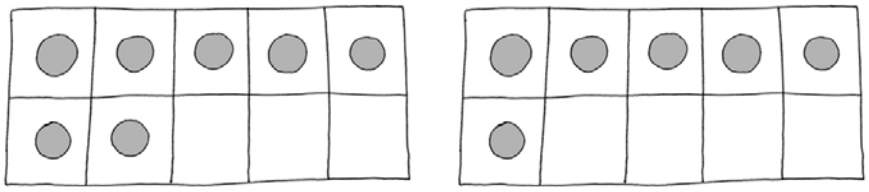
- Show the difference between 13 and 17.



13 **17**

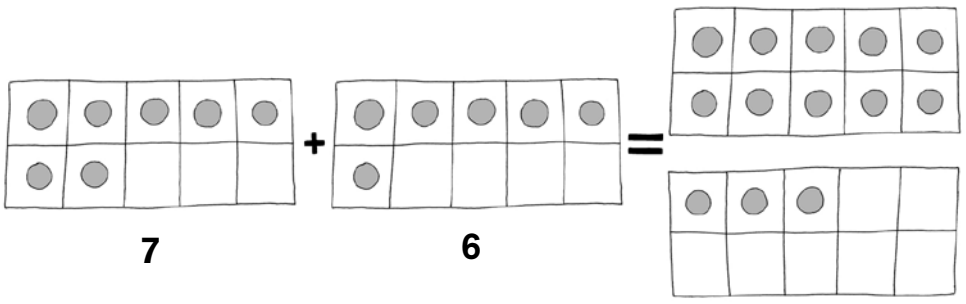
Example 5: Addition

- Use the band of 10 for adding sets of numbers.
- Show a band of 10 with 7 stones and another band with 6 stones.



7 stones **6 stones**

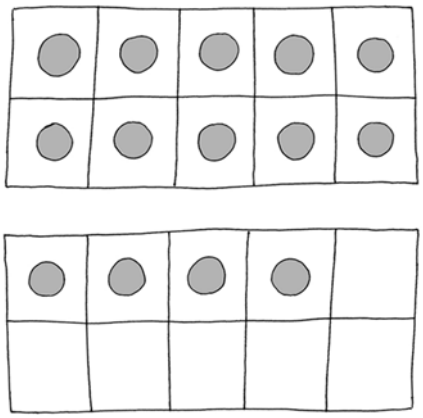
- Ask how many stones will we have if we add 7 stones and 6 stones.



7 **6** **13**

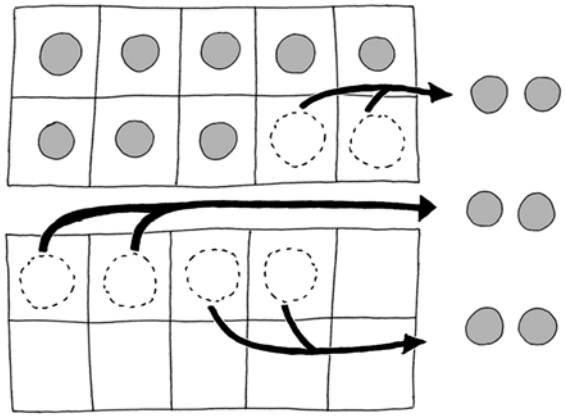
Example 6: Subtraction

- Use bands of 10 for subtracting.
- Show the bands of 10 with 14 stones.



14 stones

- Remove 6 stones, and ask how many are left.



14 – 6 = 8

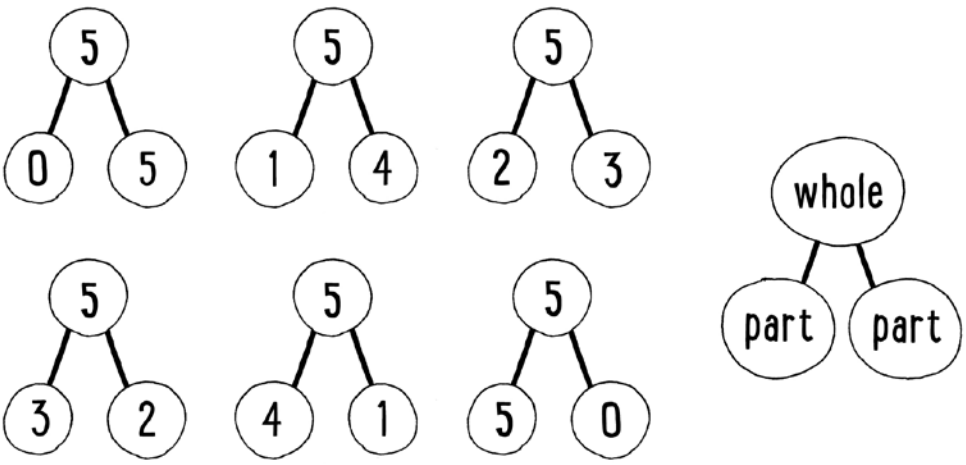
How to use number bonds

Another visual approach to teaching Number Sense is called the **number bond**. A number bond is a picture using circles and lines to show the link between a number and the parts that combine to make it. A whole thing is made up of parts. If you know the parts, you can put them together (add) to find the whole. If you know the whole and one of the parts, you take away the part you know (subtract) to find the other part.

Number bonds let students see the link between addition and subtraction. Students should be able to quickly recall addition facts at least up to 20 for the emerging level, and number bonds help teach this skill. Knowing these number facts will help improve students' speed and accuracy when adding and subtracting. You can draw number bonds on paper, using circles. This visual is important to understand before introducing the math symbols '+', '–' and '='.

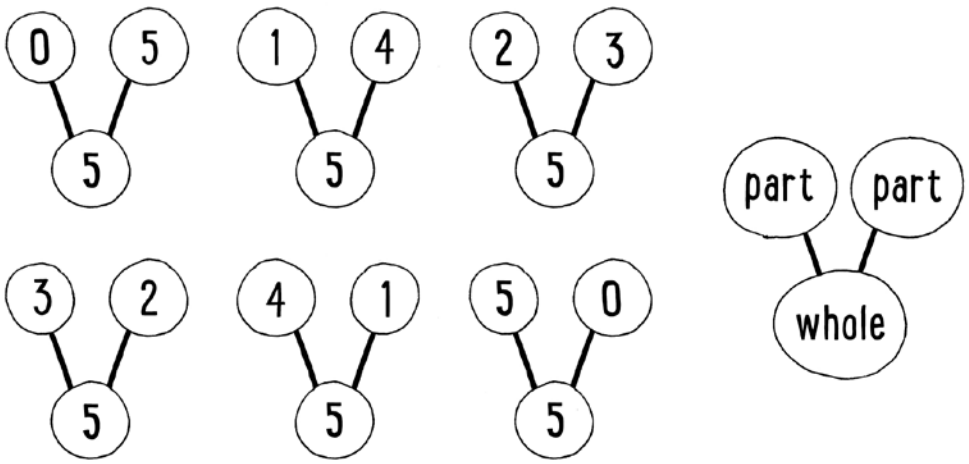
Example 1: Represent a whole as a sum of 2 parts

This is an example of all the number bonds for 5. Here the number bonds are written in a way that represents 'decomposition'.



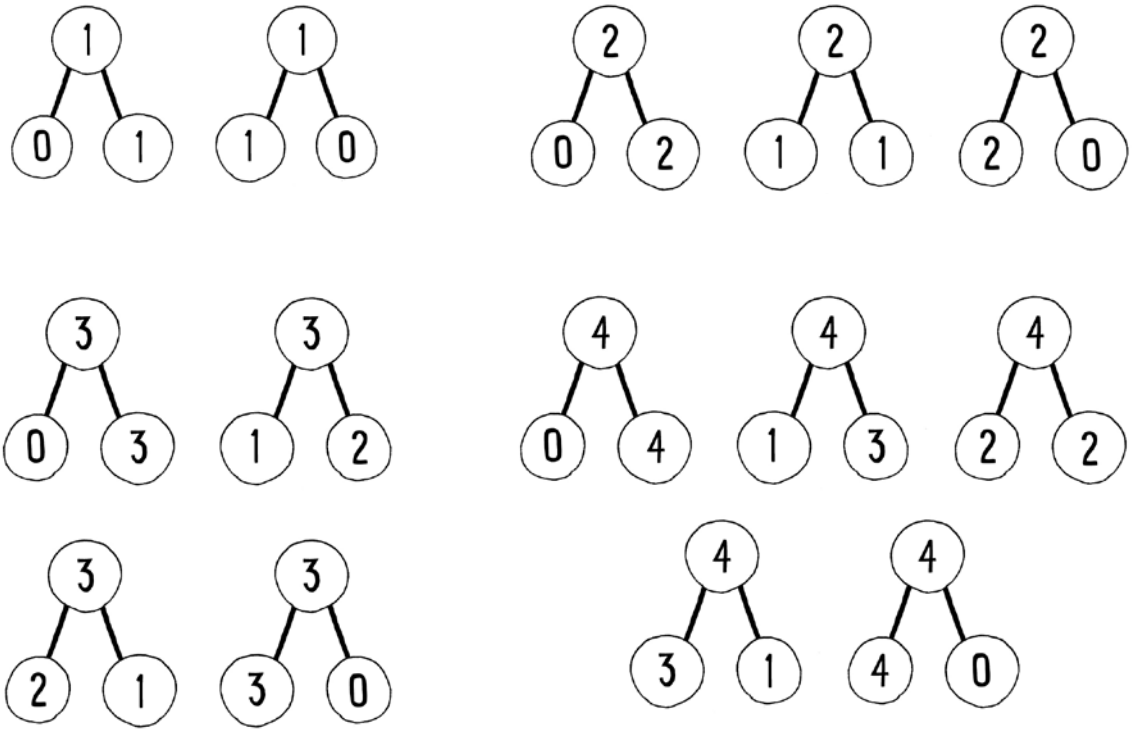
Example 2: Represent the sum of 2 parts is a whole

Here the number bonds are written in a way that represents 'association'.

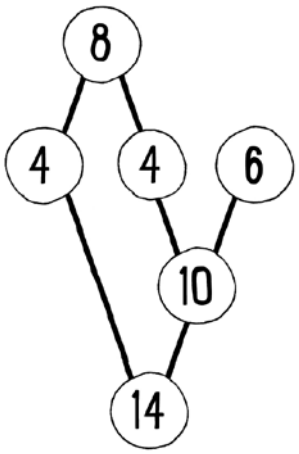


Example 3: Number bonds for 1 to 10

Students should master all the number bonds from 1 to 10.



Example 4: Use number bonds for addition



When using number bonds for addition, there may be more than one way to decompose and associate numbers using basic addition facts.

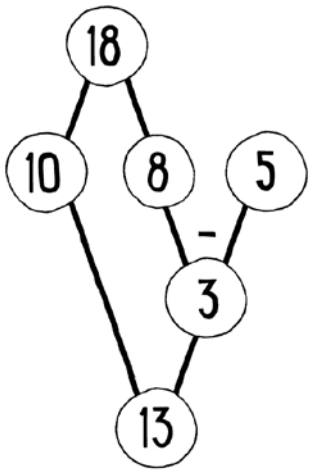
In this example, the numbers are decomposed in a way that uses addition facts for 10.

6 + 4 = 10

Students should master the number bonds for 10. Then the most efficient way to add 8 + 6 is to decompose 8 as 4 + 4 in order to add 4 to 6.

8 + 6 = (4 + 4) + 6 = 4 + (4 + 6) = 4 + 10 = 14

Example 5: Use number bonds for subtraction



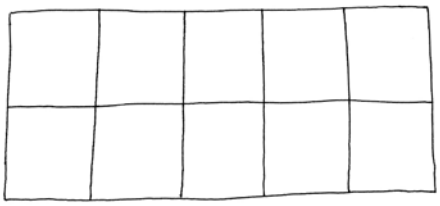
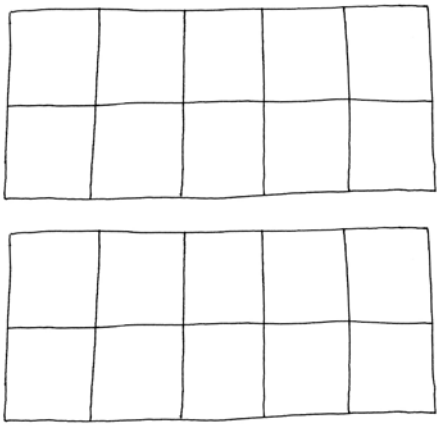
When using number bonds for subtraction, there may be more than one way to decompose and associate numbers. Always remember to write the subtraction sign in the bond. When there is no sign, we can assume that it is an addition. In this example, the numbers are decomposed in a way that uses place value.

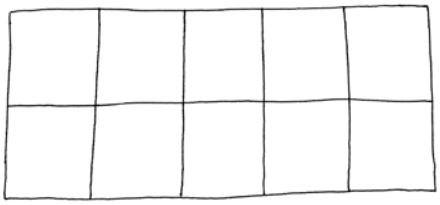
18 = 10 + 8

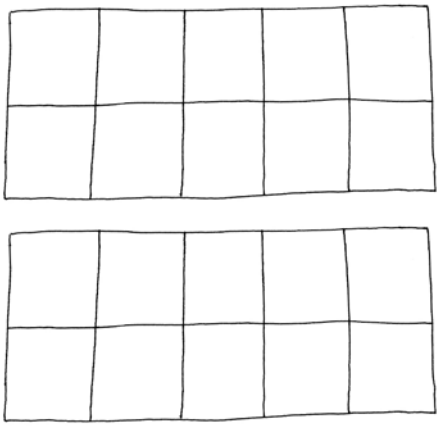
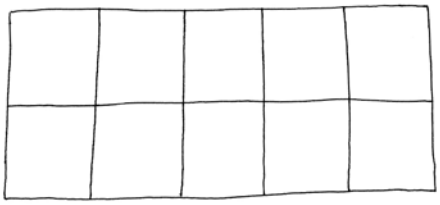
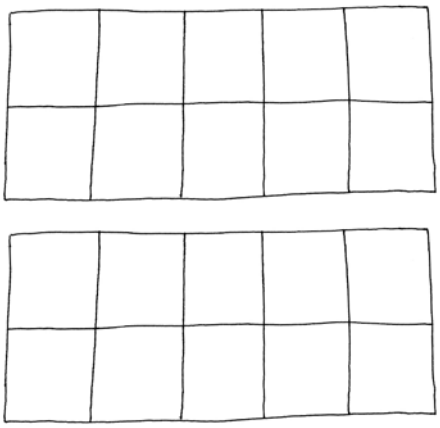
Then the most efficient way to subtract.

18 – 5 = (10 + 8) – 5 = 10 + (8 – 5) = 10 + 3 = 13

Activity 4.1 – Practice Exercises for Adding and Subtracting within 20

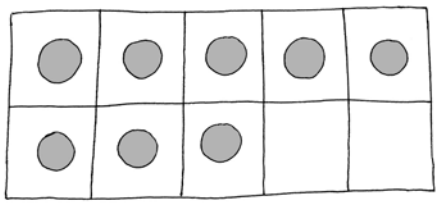
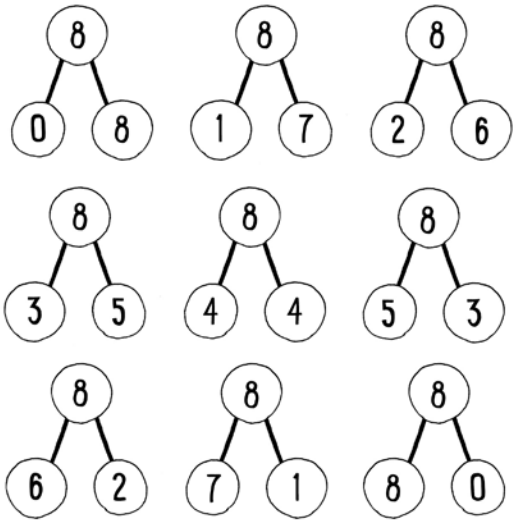
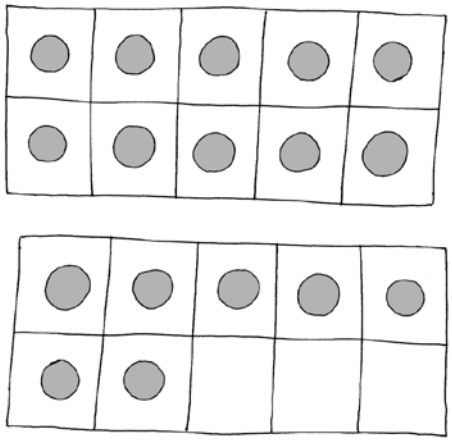
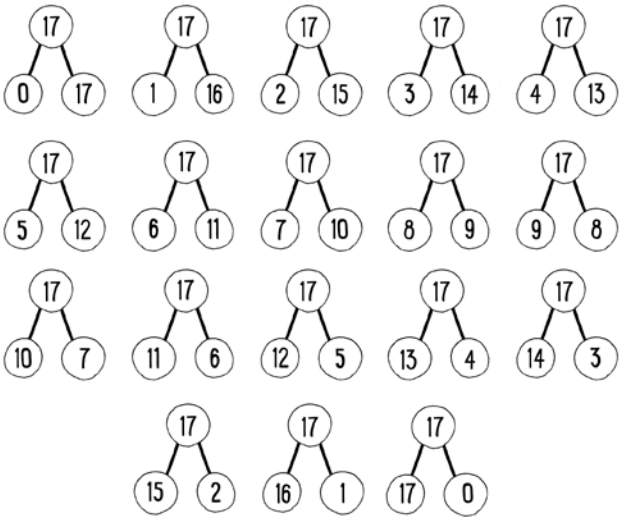
Question	Fill the band of 10	Draw 2 different number bonds
8?		
17?		

Question	Solve using band of 10	Solve using possible number bonds
3 + 5?		

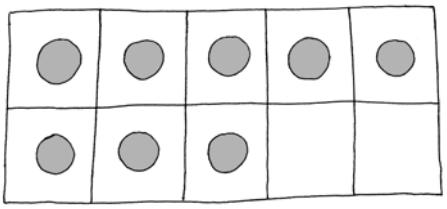
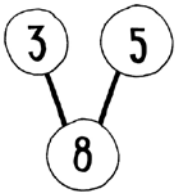
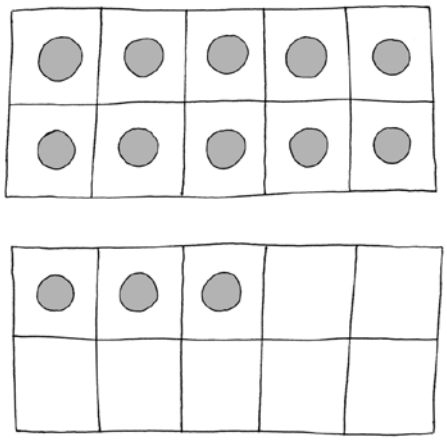
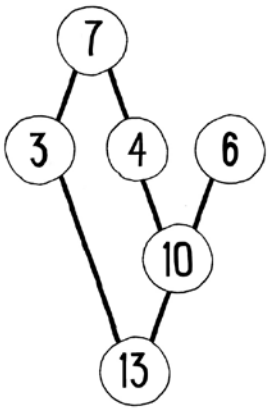
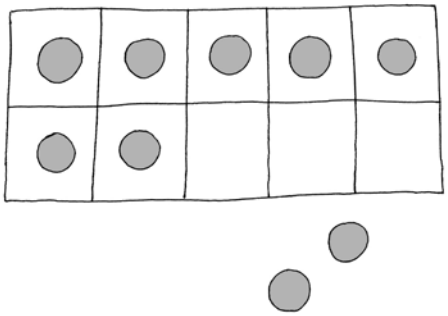
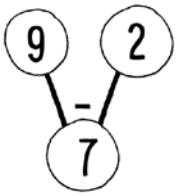
Question	Solve using band of 10	Solve using possible number bonds
7 + 6?		
9 – 2?		
17 – 5?		

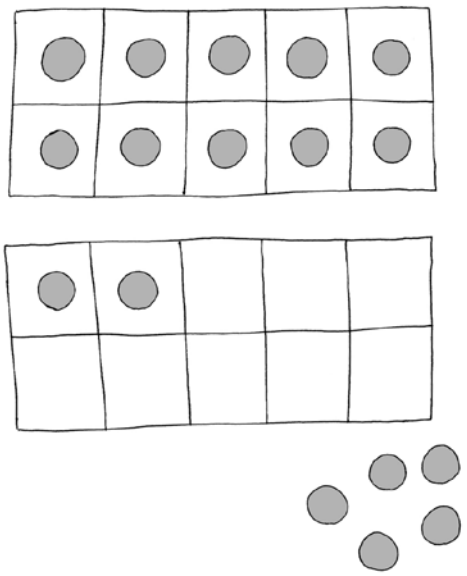
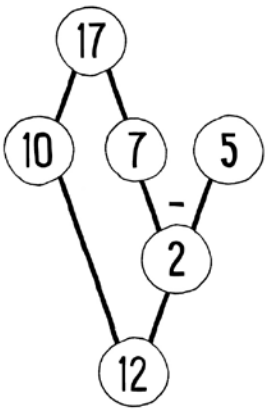
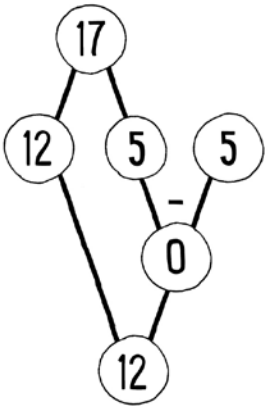
Activity 4.1 – Answer Key

Note that the number bonds are only possible answers as there are many other ways to work out a problem using number bonds.

Question	Fill the band of 10	Possible number bonds
8?		
17?		

Tip: Highlight that 17 is 3 less than 20

Question	Solve using band of 10	Solve using number bonds
3 + 5?		
	Tip: Highlight that 8 is 2 less than 10	
7 + 6?		
	Tip: Highlight that 13 is 3 more than 10	Here we use the number bonds for 10 and for 7 to decide to decompose 7 as 3 and 4 in order to make 10 with the 6. Students can be encouraged to use any decomposition that they like, but making 10 is a strategy that is the fastest.
9 – 2?		

Question	Solve using band of 10	Solve using number bonds
17 – 5?		 

Here are 2 examples of how to get the same answer. In the first example, we decompose 17 using place value. Then subtracting the 1s and adding the remainder. Remember to always write the minus sign when subtracting. If there is no sign, you can assume that it is an addition. In the second example, we decompose using a different number bond for 17, made up of 12 and 5, so that we can use the fact 5 – 5 = 0.

Math Training Session 6: Add and Subtract beyond 20

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Use number bonds in daily lessons to teach addition and subtraction beyond 20.

KEY MESSAGES

- Place value is the value of a digit which depends on its place or position in the number.
- Number bonds can be used in different ways to add or subtract – by decomposing or breaking down numbers according to place value or by using the 'make 10' strategy.

What is place value?

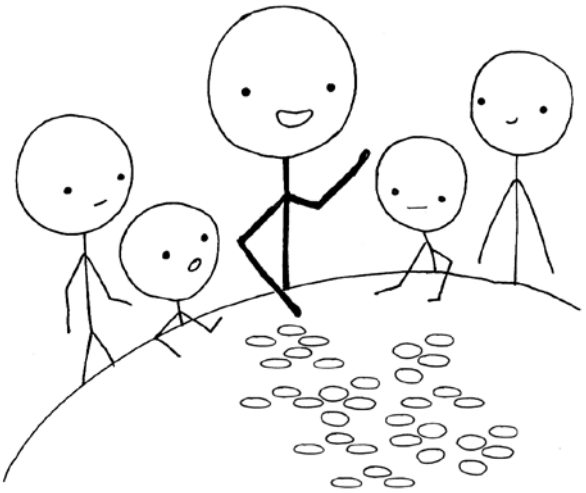
In our number system, the value of a digit depends on its place or position in the number. Each place has a value of 10 times the place to its right. A numeral or digit is one of the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8 or 9. All numbers are made up of one or more digits. For example, the number 2 has one digit; the number 89 has two digits and the number 450 has three digits. The position of each digit in a number tells its value, or **place value**. For example, the number 'five million, two hundred ten thousand, nine hundred sixty three' is made up of 7 digits and is written as and shown by the place value table below.

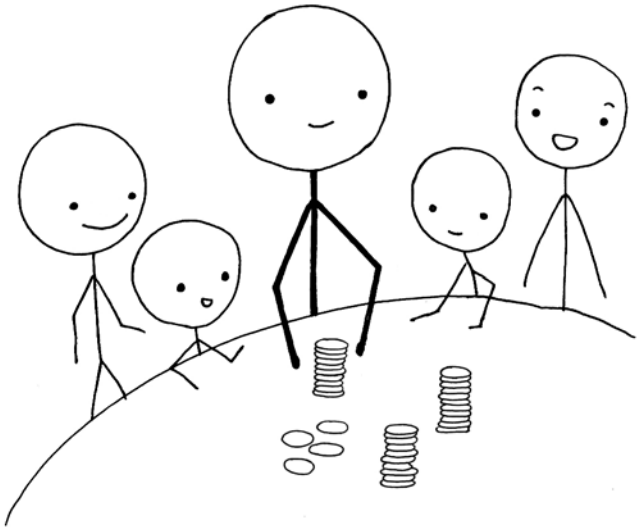
Millions	Hundred thousands	Ten thousands	Thousands	Hundreds	Tens	Ones
5	2	1	0	9	6	3

The emerging level students should learn the place value for ones, tens and hundreds. The developing level students should learn up to thousands.

Understanding the importance of ten is very important so activities should focus on that. Using the band of 10 teaching properties of 10. Skip counting by 10 by counting 10, 20, 30, 40, 50 etc. also does that. By the time they come to school they may know 5, 20 and 50 and 100 from using money at home. Students should be able to think of numbers as 10 and 1, 10 and 2, 10 and 3 and so on.

It is important to teach students to organize items into '10s' as a fast way of counting. For example, a collection of 34 counters can be organized for easy counting in 10s where the 10s are counted first followed by the 1s: "10, 20, 30, 31, 32, 33, 34." There are 34 counters.





Number Bonds for Addition and Subtraction Beyond 20

We use number bonds to teach addition and subtraction before teaching how to add or subtract vertically in columns. This is because when adding and subtracting vertically in columns, the concept of regrouping is difficult for students. Therefore, we use the number bonds approach first to build students' ability to do quick mental arithmetic. After they master that, you can teach them to add or subtract vertically in columns.

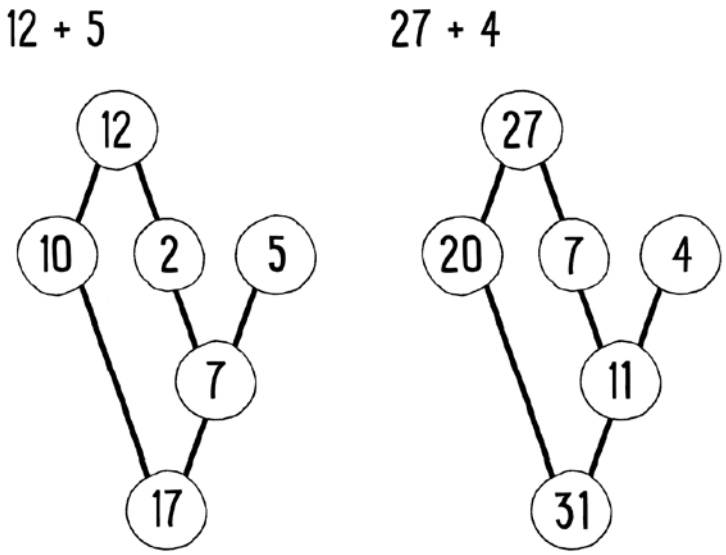
When using number bonds to add or subtract, there are many ways of breaking down the first number. Here we look at 2 ways:

1. By their place value.
2. By 'making 10' or a multiple of 10 when adding to the second number.

Students can break down numbers in other ways as well, depending on how they see and understand them. This should be encouraged and you should support it to build their self-confidence and knowledge of number bonds. Working with number bonds should be a fun activity. Make sure that you create an environment where students feel free to try different combinations to form their number bonds.

Example 1: Add using number bonds

In these examples, the numbers are broken down according to their place value.



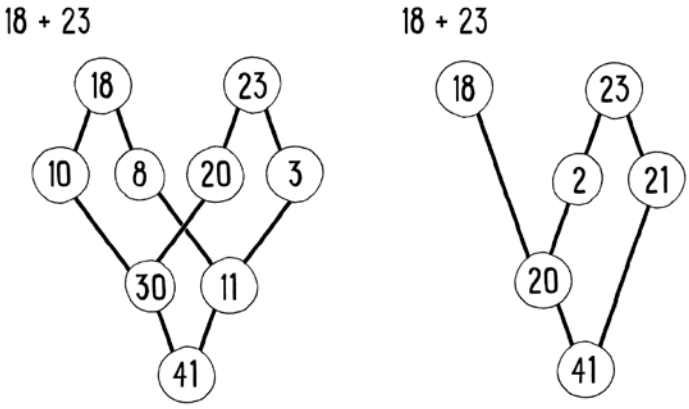
Example 2: Add using number bonds

In this example, numbers are decomposed according to their place value.

18 + 23 = (10 + 8) + (20 + 3) = (10 + 20) + (8 + 3) = 30 + 11 = 41

Alternatively, numbers can be decomposed in order to make a multiple of 10

18 + 23 = 18 + 2 + 21 = (18 + 2) + 21 = 20 + 21 = 41



Example 3: Add using number bonds

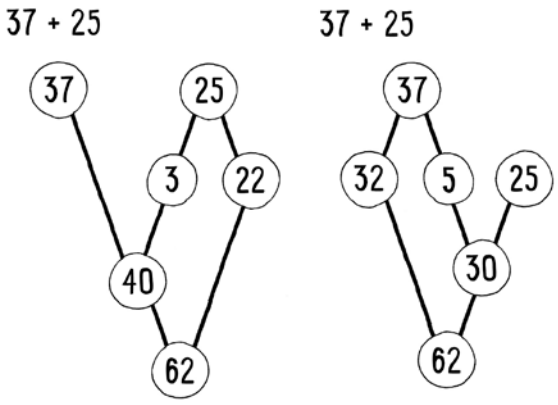
In this example, numbers can be decomposed in order to make a multiple of 10.

37 + 25 = 37 + (3 + 22) = (37 + 3) + 22 = 40 + 22 = 62

Here we use the addition fact that 37 + 3 = 40, which should be a quick recall extended from understanding that 7 + 3 = 10.

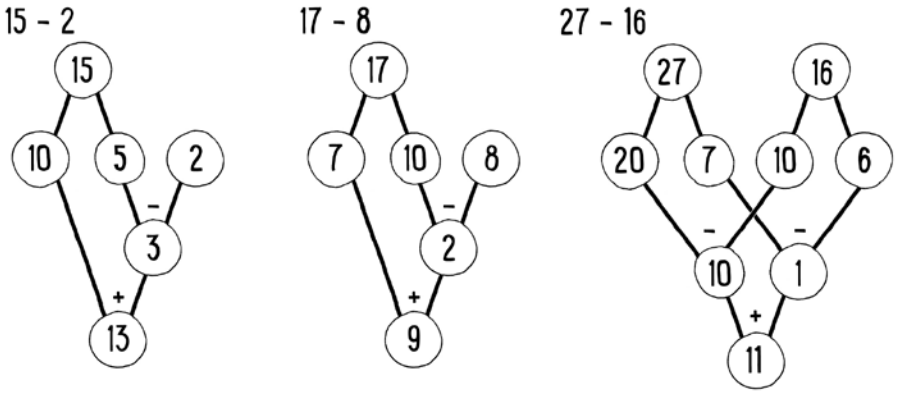
Alternatively, we can make a multiple of 10 using the addition fact that 25 + 5 = 30 and decompose 37 into 32 and 5.

37 + 25 = (32 + 5) + 25 = 32 + (5 + 25) = 32 + 30 = 62



Example 4: Use number bonds for subtraction

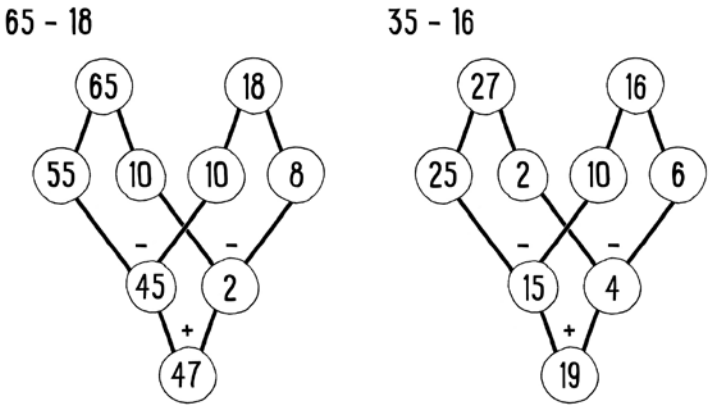
In the following 3 examples, the first number is decomposed by place value.



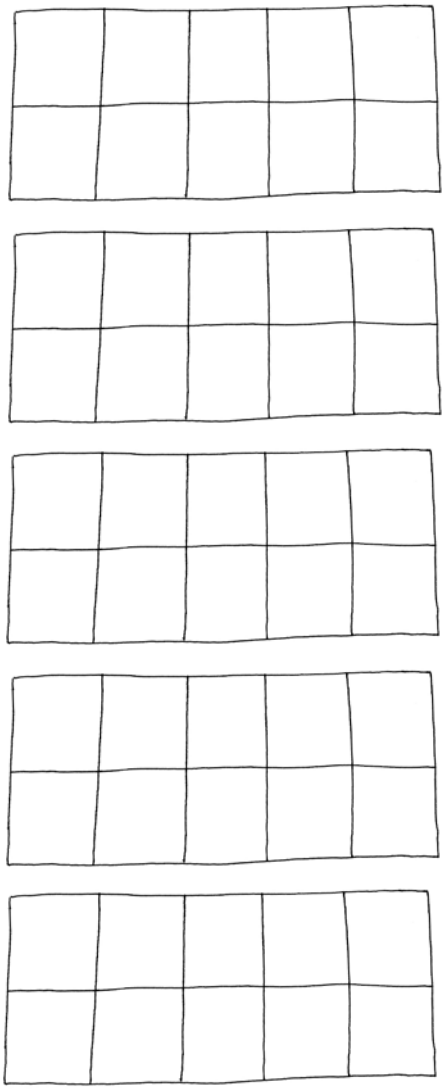
Example 5: Use number bonds for subtraction

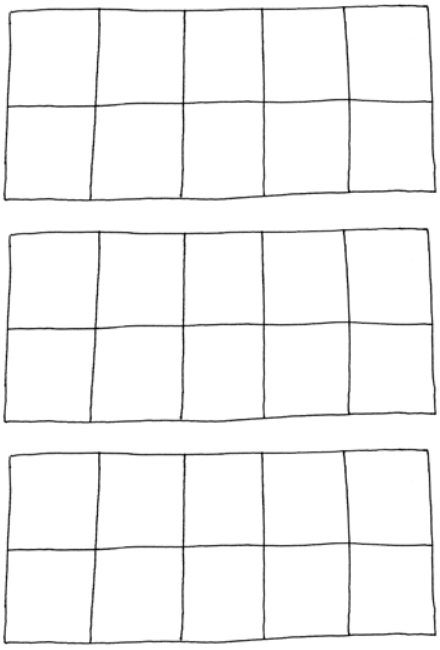
In these 2 examples, because the subtraction requires regrouping, the first number is decomposed using the addition facts for 10. In other words, 65 is 55 and 10, or 35 is 25 and 10. For examples with regrouping, this is the best approach. Then there will be 2 subtractions – one for the 10s place and another for the 1s place.

Always remember to write the subtraction sign in the number bond.



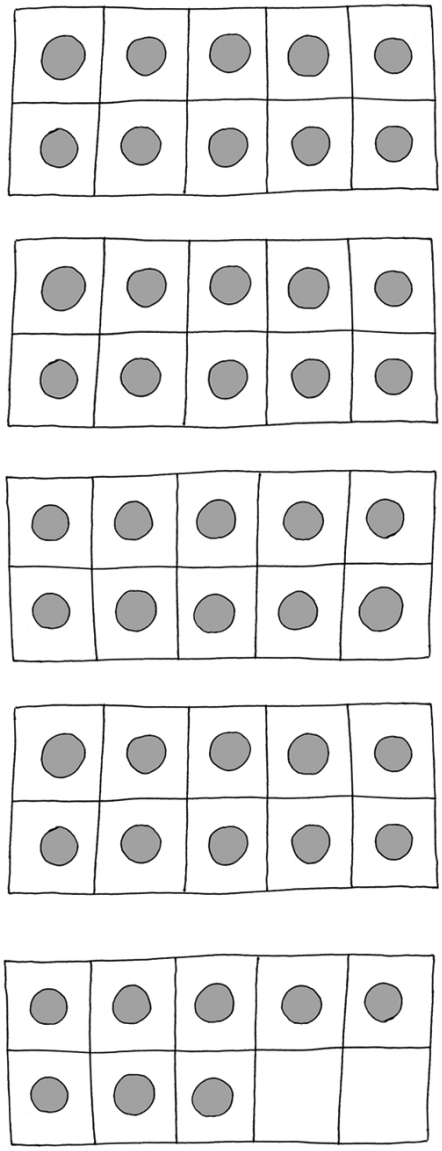
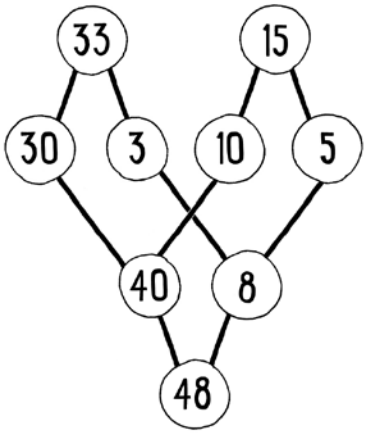
Activity 5.1 – Practice Exercises for Adding and Subtracting Beyond 20

Question	Solve using band of 10	Solve using number bonds
33 + 15?		

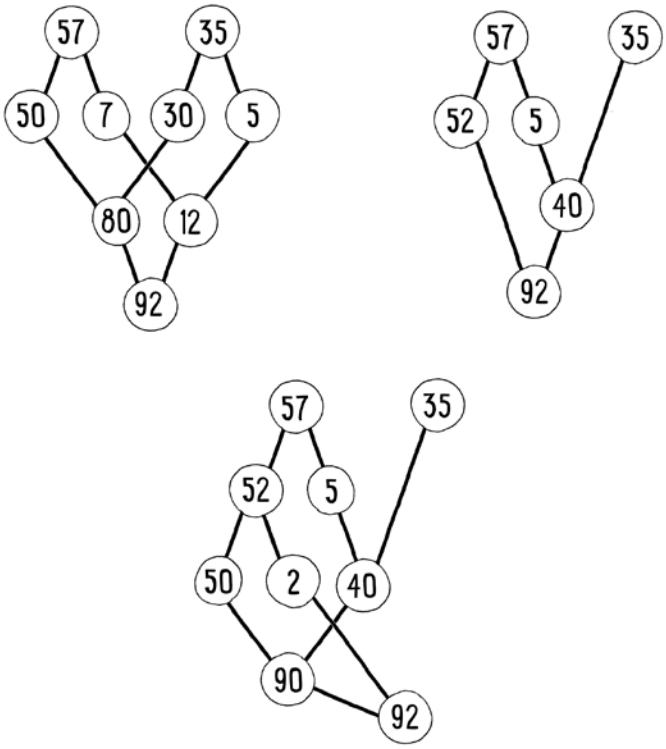
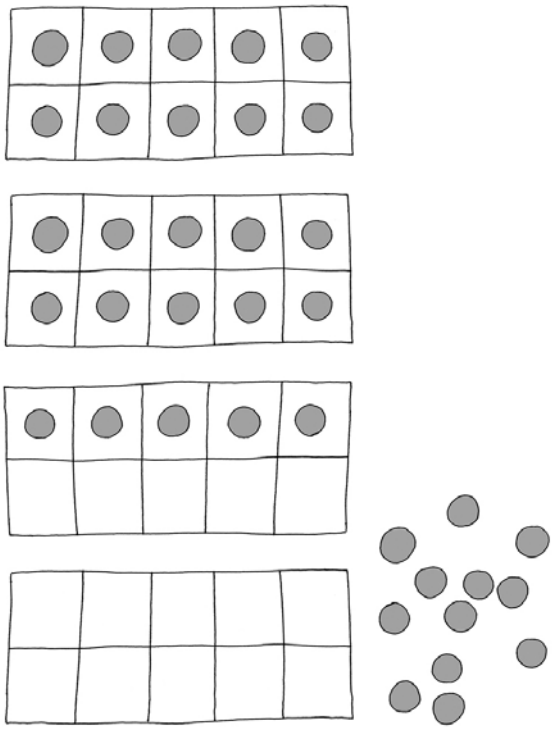
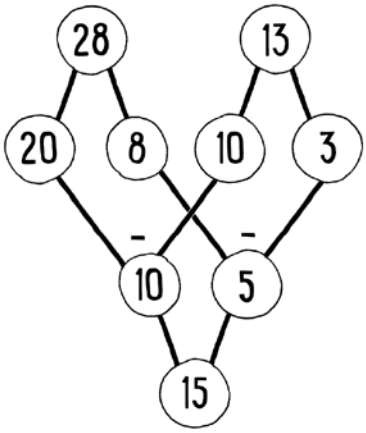
Question	Solve using band of 10	Solve using number bonds
57 + 35?	Band of 10 is not suitable for large calculations so only represent this calculation as a number bond.	
28 – 13?		
60 – 22?	Band of 10 is not suitable for large calculations so only represent this calculation as a number bond.	

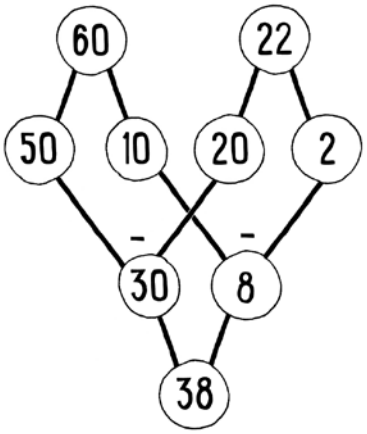
Activity 5.1 – Answer Key

Note that the number bonds are only possible answers as there are many other ways to work out a problem using number bonds.

Question	Solve using band of 10	Solve using number bonds
33 + 15?		

Tip: Highlight that 48 is 2 less than 50

Question	Solve using band of 10	Solve using number bonds
57 + 35?	Band of 10 is not suitable for large calculations so only represent this calculation as a number bond.	
28 – 13?		

Question	Solve using band of 10	Solve using number bonds
60 – 22?	Band of 10 is not suitable for large calculations so only represent this calculation as a number bond.	

Math Training Session 7: Make Math Fun

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Use games and songs to build fluency in Number Sense and Operations.

KEY MESSAGES

- Games and songs create an atmosphere where students enjoy learning math. It creates a sense of belonging, develops confidence and helps the brain to store knowledge.
- Fluency refers to an automatic recall of basic number facts such as number bonds, adding and subtracting within 10, adding and subtracting within 100 and doubling numbers. Being fluent frees up the short-term memory, which we need for everyday tasks, to learn new things. Building fluency is not the same as memorizing. You can memorize and not understand, but when you develop fluency you recall facts quickly and also understand them.
- When counting forward and backward students know the forward number sequence up to 100, using words and symbols for 0, 1, 2, 3, 4 and so on; and the backward sequence from 100 to 0. It helps their ability to name the number before and after a given number thereby introducing the concept of addition and subtraction.
- Skip counting is counting by a number that is greater than 1, such as by 2s, 5s or 10s. It is an introduction to the concept of multiplication.

Fluency in Math

What does fluency in math mean?

Fluency refers to the automatic recall of basic number facts such as number bonds, adding and subtracting within 10, adding and subtracting within 100 and doubling numbers. Being fluent frees up the short-term memory when tackling a more interesting and engaging piece of math. Counting forward and backward, and skip counting are examples of strategies that build fluency.

What is counting forward and backward?

Counting forward and backward helps to develop an understanding of the number sequence to 100 (or 1,000) using words and symbols for 0, 1, 2, 3, and 4 onwards. Counting forward also introduces the idea of addition or 'one more'. Counting backward from 100, 99, 98, and 97 down to 1 is a more challenging skill to develop but important as it introduces the concept of subtraction or 'one less'. Developing mastery of counting forward and backward sets the foundation for developing number Operations and other mathematical concepts.

What is skip counting?

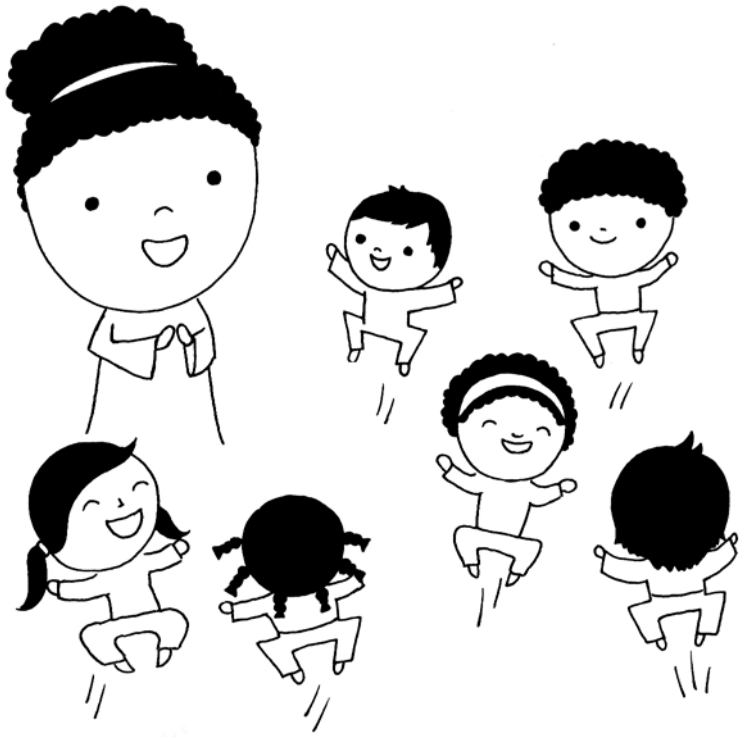
Skip counting is counting by a number that is not 1. In other words, it is counting by skipping numbers by a number greater than 1, such as by 2s or 5s or 10s. For example, to skip count by 2s is to count as follows: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20 and so on. To skip count by 5s is to count as follows: 5, 10, 15, 20, 25, 30, 35, 40 and so on. To skip count by 10s is to count as follows: 10, 20, 30, 40, 50, 60 and so on. Building fluency in skip counting lays the foundation for success with multiplication. It emphasizes pattern recognition in counting for students. For example, when skip counting by 2, we begin at 0 and skip every other number. When skip counting by 5s the numbers always end in either 5 or 0. When skip counting by 10s, the number always ends only in 0.

Counting forward and backward and skipping can be practiced using a variety of counting experiences such as counting songs or rhymes, finger play, games and working with counters. The number chart can be used to point at as students sing a song or play other games, such as asking them to count while skipping with a skipping rope, or forming a circle and throwing a ball around

the circle while skipping the number of pupils you are skip counting by. These strategies develop the students' comprehension of Number Sense, ability to see patterns, build fluency and improve memory capacity.

Why use games and songs to build fluency?

Games and song create an atmosphere where students enjoy learning math. It creates a sense of belonging, develops confidence and stimulates the brain to retain knowledge. Games and song can be used to build fluency in Number Sense and Operations. Some games used in the math lessons are 'Simon says' and 'Who am I?' Today we will practice singing and play 'Simon says'.



Game: Simon Says

'Simon says' is a fun, engaging activity that allows students to practice new skills and show what they understand.

Steps

1. Tell students that they will have 5–10 minutes for this activity.
2. Ask students to stand.
3. Tell students that:
    - If you say "Simon says" before an instruction, they should act out what you say.
    - If you do not say "Simon says" before the instruction, they should stay still and do nothing.
4. Those who make a mistake and do the action are no longer in the game.
5. Begin with an example like, "Simon says jump up and down." All students should jump up and down. Then say "Clap your hands." Students who clap their hands are disqualified from the game because you didn't say "Simon says" before the instruction.
6. Make sure you adapt the instructions if the class has students with disabilities.
7. Continue the game with instructions specific to the lesson. For example:
    - "Simon says … count backward from 10 to 1."
    - "Skip count by 2 up to 10."
    - "Simon says … jump up and down 5 times."
    - "Go around in circles 3 times."

Game: Who am I?

'Who am I?' is a particularly useful technique for students to guess the correct answer to questions and clues that the Facilitator poses to the class.

Steps

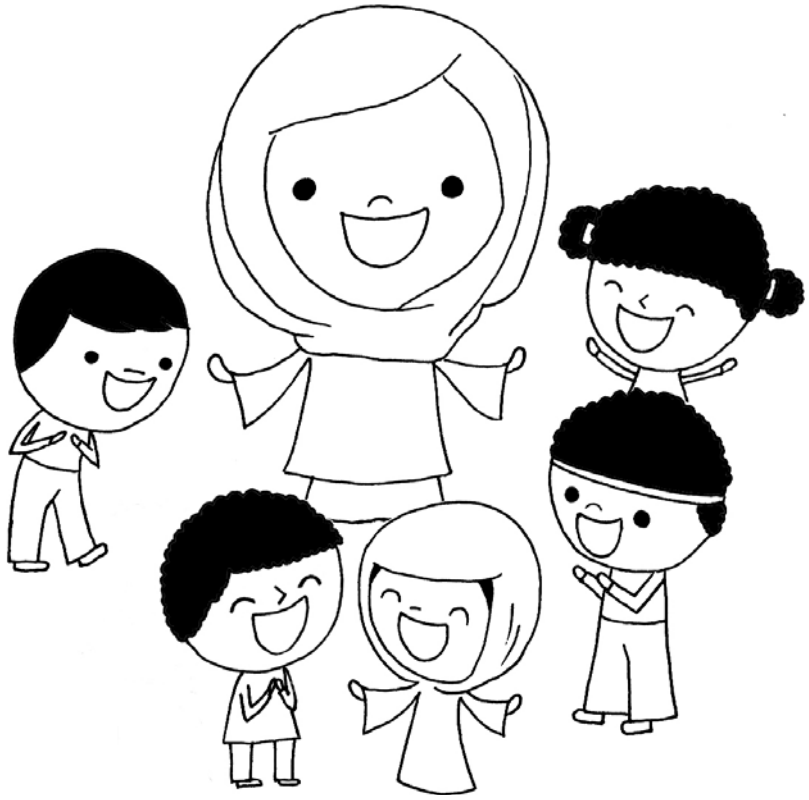
1. Tell students that they are going to play a game called 'Who am I?'
2. They can give their answer by raising their hands and when you call on a student, she or he should say "I am a ....."
3. Call out the clue. For example, "I have 3 sides and 3 angles, who am I?"
4. Students should raise their hand to respond "I am a triangle!"

Songs and Storytelling

Singing songs is a fun way of capturing students' attention. In math you can sing counting songs or make up songs about shapes and their properties. You can write your own songs about any concept to help students learn.

Steps

1. Gather students in a circle.
2. Sing the song once as a demonstration.
3. Ask students to repeat with you.
4. You can clap or introduce an instrument as well.



Storytelling is a creative and enjoyable way of checking for understanding. Students can create their own story or you can narrate a story and pose questions about it to check understanding. Storytelling in math can take the form of problem-solving where an addition or subtraction problem is presented in the context of a story.

Math Training Session 8: Solve Word Problems

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Use real-life or imaginary scenarios and storytelling to present counting, addition and subtraction problems.

KEY MESSAGES

- Problem-solving is one of the most important teaching strategies in math.
- Problem-solving provides a context in which learning math becomes meaningful and enjoyable to students.
- Problem-solving builds students' ability to reason logically, and to persevere and manage their emotions.
- The primary goal of problem-solving is the thinking process that leads to the solution.
- Understanding how students think about a problem will give us insight into how they understand or misunderstand math concepts.
- Problem-solving is best taught by allowing students to work in small groups or pairs.

Why is it important to teach students problem-solving?

In the previous sessions, we practiced 3 different teaching strategies useful for teaching addition and subtraction, before teaching the standard way of adding vertically using place value:

1. Band of 10
2. Number bonds
3. Using games and songs

Visual images of addition or subtraction such as band of 10 and number bonds rely on students' ability to decompose and associate numbers. Remember that it is important to use these different methods **before** introducing students to the standard way of adding vertically in columns.

In the 2 sample lessons we just reviewed, the lesson objective is being introduced to the students in the context of a story or a problem. **Problem-solving is one of the most important teaching strategies in learning math. It is important to introduce problem-solving at an early age because it provides a context in which learning math becomes meaningful and enjoyable to students**. A math problem presented in the form of a story captures the students' imagination because it relates to real life or is humorous.

Problem-solving also builds students' ability to reason logically, persevere and manage their emotions. When students struggle to solve a problem by themselves, we should not show them how to solve it right away. Instead, try the following techniques:

- Slowly and clearly read aloud the word problem.
- Repeat it in local language to ensure that the problem is understood.
- Invite students who speak other languages to help translate the problem into the different languages spoken in class.
- Allow students sufficient time to think about the problem.
- Draw a picture to represent the story.
- Ask students open questions.

- Instruct students to work in small groups or in pairs.
- Ask students to explain how they are thinking about the problem.
- Encourage each group of students to use a technique they understand such as band of 10 or number bonds or using the standard method to find the solution.

Although finding the right answer to a problem is important, it is not the primary goal of using problem-solving as a teaching strategy. **The primary goal of problem-solving is the thinking process that leads to the solution.**

Therefore, when a student provides the incorrect answer, it is important **not** to point out that it is incorrect. It is also important **not** to say that the answer was good or correct. Instead, ask a question such as "Can you explain how you got this answer?" Ask other questions that help the student explain their reasoning such as "Why do you think the problem is done that way?"

Understanding how students think about a problem will give us insight into how they understand or misunderstand math concepts. When a student provides an incorrect answer to a math problem, it is not because they are not intelligent or cannot do math.

Mathematical ability is not an in born trait. It is not determined by gender. It is developed through dedication and hard work. Mathematical ability is affected by social expectations and gender roles that students grow up with. All students can learn and grow their math capacity through perseverance and practice.

Why should students work in small groups or in pairs?

Problem-solving is best taught by allowing students to work in small groups or in pairs. Small group work or working in pairs is important because it helps students to:

- Create important relationships with their classmates.
- Learn to work together.
- Learn from each other.
- Learn to be empathetic.
- Develop leadership skills.

- Help each other in their own language away from the pressure of the whole class.

Some important strategies for small group work or pair work are listed below:

How many students should be in a small group?

The ideal size for small group work is 3–5 students. If class sizes are larger, forming larger groups of 6–10 students is acceptable but not ideal. Also, classroom activities can be done in pairs.

How do we form small groups in class?

Groups can be formed using the rows of desks students are already seated in. Groups can also be formed by asking students to pick one object out of a container of mixed objects such as leaves, flowers and sticks, then grouping them by matching objects – students who picked a leaf form one group, students who picked a flower form another group, and so on.

How do I make sure that small group work is a success?

It is important to prepare the activity in advance. Know how many groups you intend to form and what the goal of the activity is going to be. Provide clear and simple instructions to the class.

Create roles and responsibilities for each group member (recorder, reporter, supplies manager, and so on). Have a final product that each group presents. Ensure students are always ready to explain what they are doing and what they have learned.

How should students behave when working in small groups?

Ensure groups do not talk too loudly to disturb other groups or classes. Inform other Facilitators that you will be doing small group work activities in your class.

Inform students that you expect them to interact and express their agreement or disagreement with courtesy. For example, it is not acceptable to tell another student that he or she is stupid or remove materials from the hand of another student.

How should I behave as the Facilitator of small group work?

It is important not to criticize or negatively interact with students. Show respect and empathy for each student and encourage all students to show the same attitude.

Provide students with exercises they are able to solve. Students must practice and repeat exercises to master and automate mathematical concepts. Activities should be at the students' level so they are able to find solutions, but not so easy that they do not progress.

For the emerging level, problems should be about adding and subtracting within 100, with only one step to find the answer. For the developing level, use problems with multiple steps to solve.

Provide positive feedback and support so that students enjoy learning and have confidence in the future. Always encourage students using language such as "Good work!", "I like how you explained that problem!", "You are on the right path!", or "Let us all clap for her!".

TIP > Adapt the names in the problem to your context.

Example one-step problems

1. There are 18 boys and 23 girls in the class. How many students are there in total?
2. John went to the store. He bought 12 cans of beans and 16 cans of tomato sauce. How many cans did he buy in total?
3. There are 101 leaves on a tree. 35 more leaves grew on the tree. How many leaves are on the tree now?
4. Leon picked up 292 shells at the seashore in the morning and 324 shells in the afternoon. How many shells did he pick up in total?
5. There were 105 parents in the program and 698 students, too. How many people were present in the program?

Math Training Session 9: Solve Money Problems

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Design activities to teach students about money.
- Compose one-step, real-life addition or subtraction problems involving money.

KEY MESSAGES

- Learning how to count, use and identify coins and bills is an important basic money skill to learn at an early age.
- Play or real money is a useful teaching aid to incorporate into lessons on money.
- Real-life word problems and role-playing activates students' imagination on how to use money.

Why should we teach about money?

Learning how to count, use and identify coins and bills is an important basic money skill to learn at an early age. One of the more difficult but basic money skills is understanding how to make change and knowing how much change you will receive when spending money and purchasing items. This means developing the subtraction skill is critical.

Topics related to money are covered during weeks 27 and 28 of the emerging level lessons. Setting up role-playing scenes and giving students real-life problems or stories makes teaching money skills easier by activating their imagination and making learning fun.

It is important for students to see, touch and feel the coins and bills in order to differentiate between them. If there is not sufficient real money available to do these exercises, you can make play money in order to teach how to pay for things, buy things and make change. During this session, we will make some play money for that purpose and compose some real-life problems to support these activities in your lessons.

It is important to introduce problem-solving at an early age because it provides a context in which learning mathematics becomes meaningful to students. However, it is important that the problems are age appropriate.

For the emerging level, problems should be about adding and subtracting within 100 with only one step to find the answer. The first 2 examples are appropriate for this level. The third example is too complex.

Also, it is important to create daily lessons where students pretend to engage in money activities such as going to the market to buy something. Role-playing with real or play money to solve these problems will make the class active and interesting. The weekly plan for Week 27 has examples of such activities for you to use in your class.

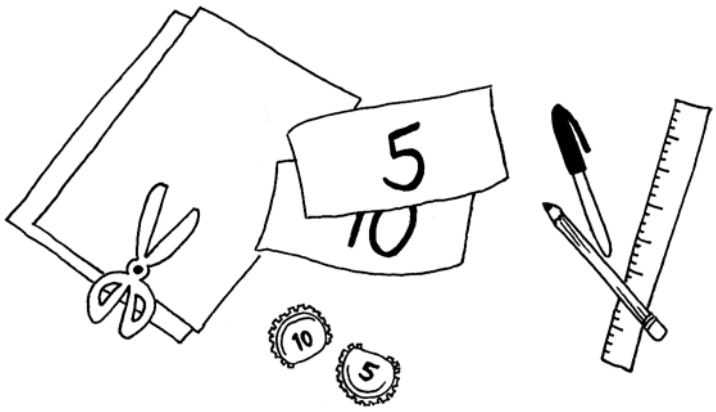
How to make bills and coins to use in class

To make paper bills, cut paper into rectangles of the same size as real money, using a ruler, pencil and scissors. Then write the denomination of each bill using a marker.

To make coins, you can collect discarded bottle caps and write the denomination of each coin on the cap, using a marker. Alternatively, you can cut circles of varying sizes using cardboard paper and write the denomination of each coin on it.

Make enough coins and bills so that you can do group activities and each group can receive their own set of bills and coins.

Store the teaching aids carefully in a box or container to protect them from damage.



Math Training Session 10: Reflection and Conclusion

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Reflect on the training experience and complete the Math Training post-test.

Math Training Post-test – Phase 1

Name: .....

Affiliation: .....

Position /Job Title: .....

1. Why is it important for students to learn math?

.....

.....

.....

.....

2. Identify and explain the 4 math competencies.

.....

.....

.....

.....

.....

.....

3. Explain the 3 different styles of how students learn math.

.....

.....

.....

.....

.....

.....

4. Name 3 teaching aids used in math.

.....

.....

.....

5. Explain the difference between boys' and girls' ability to learn math, if any.

.....

.....

6. Name and explain 3 teaching techniques for teaching Number Sense and Operations.

.....

.....

.....

.....

.....

.....

7. Name and explain 2 teaching techniques for building fluency with numbers in a fun way.

.....

.....

.....

.....

PART 2

Math Training

Phase 2

Upon completing Math Training – Phase 2, trainees will be able to:

1. Design active and fun learning activities to teach measurement, and explore data and geometry.
2. Use teaching aids and active student-centered techniques in daily lessons.
3. Develop problem-solving skills in students.

Math Training Session 12: Measurement

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

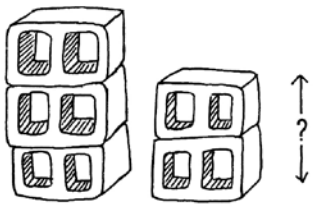
- Incorporate teaching aids and games to teach measurement – comparison of length, mass and capacity using non-standard measures.

KEY MESSAGES

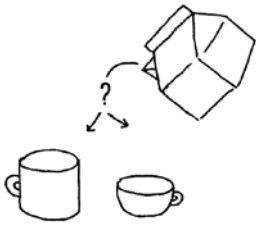
- The big ideas in measurement are: attributes (length, mass, capacity, time), units (meter, grams, liters, hours, minutes), measurement sense and measurement relationships.
- In order for students to understand measurement concepts they should be talking to each other, manipulating objects, doing investigative activities, solving problems, and learning using correct math vocabulary.
- Teaching aids like sticks cut in equal lengths, toothpicks, straws, paper clips, pieces of chalk, paper strips of equal lengths, beads, marbles, stones, handmade balance, cups, plastic containers, buckets, bottles, cans, stop-watches, analog clocks, digital clocks, calendars and other everyday objects should be integrated into classroom activities.

Why do we learn measurement?

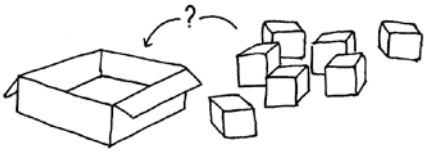
The ability to measure and compare length, distance, height, weight and volume is essential for daily life and work. Students should also be able to estimate measures, which is a very difficult concept for young students. Using words like 'closer to', 'more or less than', and 'about' in daily activities helps to build foundations for a reasonable range of answers. Everyday experiences help students think about measurement. For example:



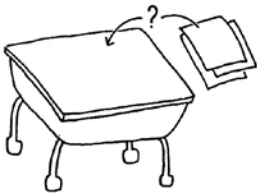
- Comparing 2 towers of cement blocks by height.



- Choosing a large enough glass to hold a small carton of liquid.



- Finding whether a collection of blocks will fit inside a box.



- Deciding how many sheets of paper are needed to cover a table.

Students know about measurement ideas before formal schooling. In the emerging level, your role is to deepen this understanding. The big ideas for measurement are:

- Attributes (length, mass, capacity, time), units (meters, grams, liters, hours, minutes), and measurement sense.
- Measurement relationships.

What are the learning objectives for each level?

Big Idea	Emerging Level	Developing Level
1. Attributes, units, and measurement sense	**Measurement** ▪ Measure lengths of different objects or images of objects using non-standard measures. ▪ Measure weights of objects using non-standard measures. ▪ Measure capacity using non-standard measures. **Time** ▪ Understand concept of time (morning, afternoon, evening, today, yesterday, tomorrow, week, year). ▪ Identify tools that measure time (analog clock, digital clock, calendar). ▪ Name the days of the week. ▪ Identify the time (to the nearest hour) of everyday events (lunch time, bedtime and so on).	**Measurement** ▪ Measure lengths of 3 to 5 different objects or images of objects using standardized measures. **Time** ▪ Understand concept of time (morning, afternoon, evening, today, yesterday, tomorrow, week, year). ▪ Identify tools that measure time (analog clock, digital clock, calendar). ▪ Name the days of the week. ▪ Identify the time (to the nearest hour and half hour).
2. Measurement relationships	**Measurement** ▪ Compare lengths using language such as 'as long as', 'as short as', 'longer than', 'shorter than', 'as tall as', and 'taller than'. ▪ Compare weights using language such as 'heavy as', 'heavier than', 'as light as', and 'lighter than'. ▪ Compare the capacity using language such as 'weighs as much as', 'more than', and 'less than'.	**Measurement** ▪ Order, estimate and compare lengths using language such as 'as long as', 'as short as', 'longer than', 'shorter than', 'as tall as', and 'taller than'. ▪ Order, estimate and compare weights using language such as 'heavy as', 'heavier than', 'as light as', and 'lighter than'. ▪ Order, estimate and compare the capacity using language such as 'weighs as much as', 'more than', and 'less than'.

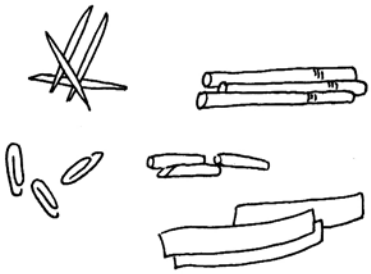
What is length?

The length of an object can be found by determining the number of units, laid end to end, that make up the distance from one point to another. Length is often what students notice first about an object. In everyday situations, students explore length in objects in their environment.

In the emerging level, students learn about length by comparing objects directly. For example, they might line up 2 objects side by side to see which is longer. They also compare objects indirectly. For example, they might use a string to measure the width of a door, use the same string to measure the width of a desk, and then compare the 2 widths. Students focus first on using sticks, pencils, string and so on. to investigate length before they use standard units such as centimeters or meters. There are many terms that are used interchangeably with length such as width, height, depth and distance, all of which are explored in the emerging level.

Teaching aids play a major role in teaching measurement concepts. Some teaching aids for length are sticks cut in equal lengths, toothpicks, straws, paper clips, pieces of chalk and paper strips of equal lengths.

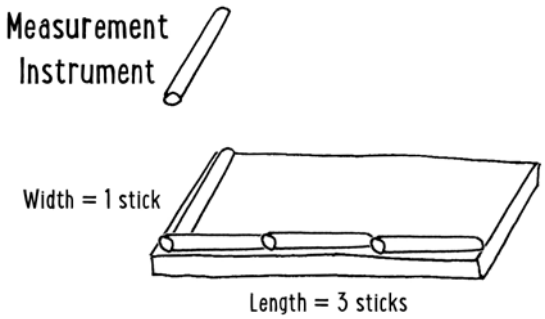
How long is it?	Length	Measure along an object from end to end
How wide is it?	Width	Measure from one side of an object to the other side
How high is it?	Height	Measure from the lowest point to the highest point of an object or a person
How deep is it?	Depth	Measure from the top of something to the bottom, from front to back, or from the outside in
How far is it?	Distance	Measure the space between 2 points



Teaching aid example 1: Measure and compare length

Sticks cut in equal lengths, toothpicks, straws, paper clips, pieces of chalk, and paper strips of equal lengths are examples of teaching aids for length.

Show how to measure the length and width of an object using everyday items. Say: "I use the stick to measure. I want to measure the length and width of the desk. I'll see how many sticks it takes to measure the length and width."



What is mass? How is it different from weight?

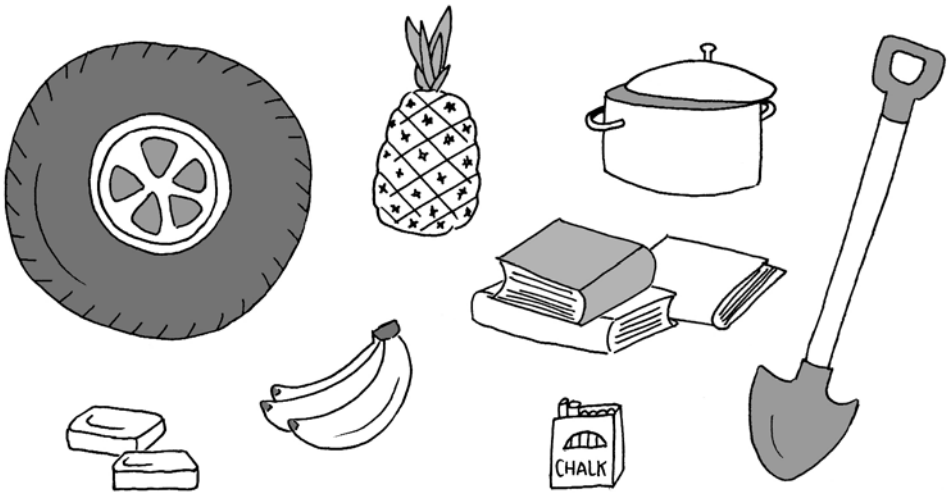
Mass refers to the amount of matter in an object. Students often refer to the weight of an object, rather than its mass. Scientifically, weight is a measure of the pull or force of gravity on an object. The weight of an object can vary, depending on its location in space, whereas the mass of the object remains constant. For example, the weight of an object is less on the moon than on the earth, while the mass of the object remains the same. Students do not need to distinguish between mass and weight in the emerging level, but Facilitators can model proper language and can encourage students to refer to mass rather than weight.

Students develop concepts of mass through comparison activities. They might hold an object in each hand and determine which object is heavier. In the emerging level, students also use balances to compare objects by mass. For example, they might use a balance to find which of 2 objects is heavier or to find collections of objects that have approximately the same mass. In the developing level, students compare the mass of an object with the mass of the standard unit of a kilogram or part of a kilogram.

A common misconception among students is that large objects have a greater mass than small objects. Opportunities to compare the mass of objects of different sizes informally will allow students to address their misconceptions about relationships between size and mass.

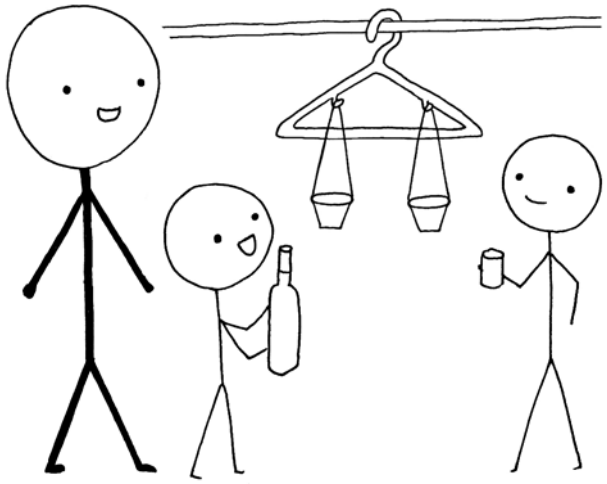
Teaching aid example 2: Measure and compare mass

Every object has mass so beads, marbles, stones – any everyday objects – are essential so that students can make a comparison, put objects in order from lightest to heaviest, and so on.



Show 2 objects and ask students "Can you guess which item is heavier?" Draw a table with 2 columns on the board and record the answers under the first column labeled 'Our predictions'. Using a simple weighing balance (or handmade balance) place the 2 objects on the balance and ask students to observe. Record the answer under the second column labeled 'Actual answer'.

You can make a handmade balance using a coat hanger or piece of wood, string and 2 disposable bowls and tie it together as illustrated in the image.



What is capacity? How is it different from volume?

Capacity is the amount that a container can hold. Students explore the capacity of containers using materials that can be poured such as water, rice or sand. Students develop concepts about capacity when they compare 2 containers. For example, they might observe that a large water bottle holds more than a small tomato paste container. Comparing containers that have approximately the same capacity is more challenging for students. To compare the capacities of the containers, students might fill one container with water, pour the water into the other container, and determine which container holds more water. Students might also use a scoop to fill both containers with rice, and then determine which container holds more scoops of rice.

A common misconception among students is that taller containers hold more than shorter containers. It is important that Facilitators provide students with opportunities to compare a variety of containers by capacity so that students develop an understanding that 2 containers of different shapes can have the same capacity.

Volume is the amount of space occupied by a solid object, measured in cubic units such as cubic centimeters. Learning about volume is not a focus in emerging level. However, you should be aware of opportunities to introduce ideas about volume incidentally, such as finding the number of cubes that fit inside a box.

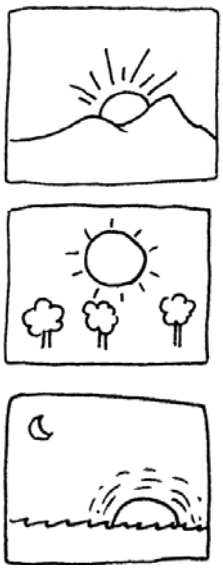
A common misconception is that volume and capacity are the same. Simply put, capacity answers the question “How much does it hold?” and volume answers the question “How much space does it occupy?” Consider how the volume of a juice box and its capacity differ. The box has volume because it takes up space, and its volume can be measured by finding the number of cubic units that represent its space. The box also has capacity because it can be filled (for example, with 200 ml of juice).

Teaching aid example 3: Measure and compare capacity

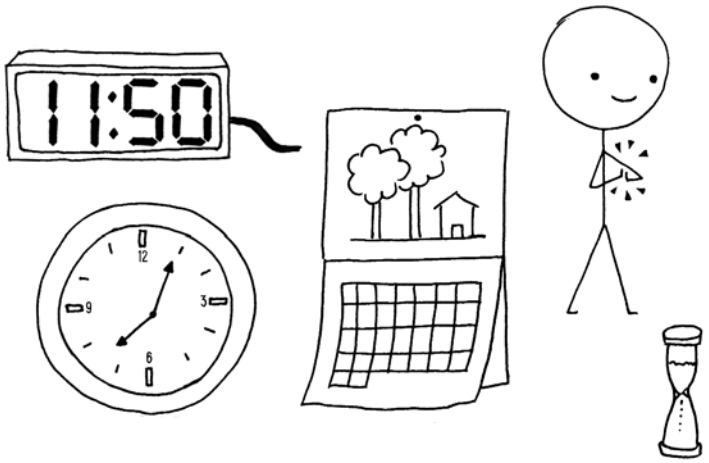
Cups, plastic containers, buckets, bottles or cans can be used with water or sand to teach a lesson on capacity. Students can make estimates and then verify or compare the capacity of 2 given containers.

Fill 2 different shaped containers (for example, a wide bucket and a narrow bottle) with the same amount of water or sand using a third measuring container. Place the containers on the table and ask students "Which container holds more?" Take a poll of student responses. Now, verify students' responses by pouring the contents of the first container into the measuring container. Show all the students. Now empty the measuring container and fill it again with the contents of the second container illustrating that both containers held the same amount of water or sand.

What is time?



Time is the duration of an event from its beginning to its end. Because time is not something students can touch, it is an abstract concept for students and can be difficult for them to understand. You can help students develop concepts about time by referring to the passing of time. For example: "It took us only 2 minutes to clean our desks" or "It will be 10:30 in 15 minutes. At that time, we will go to the school yard." Activities related to time should help students estimate, measure, and describe the passage of time using non-standard instruments (for example, find the time it takes for students to form a line by counting the number of times the Facilitator claps his or her hands) and eventually using standard units, such as a watch to find the time it takes to complete a task. Also provide students with opportunities to read digital and analog clocks, and to relate daily events to certain times of the day such as when lunchtime begins and ends.



Teaching aid example 4: Time

Steady hand claps, sand timers, stopwatches, analog clocks, digital clocks and calendars are examples of teaching aids that are useful for teaching time.

How do we record a measurement?

Measurement involves both a number and a unit. To say that the length of a rope is 15 is meaningless unless a unit is specified. So you can say that the length of the rope is 15 sticks or 15cm or 15m. Units can be non-standard or standard. Measuring with non-standard units involves the use of arbitrary units such as sticks, paper clips and chalk sticks. Measuring with standard units involves the use of conventional units such as meters, kilograms or liters. The process of measuring any attribute involves the same steps:

1. Choose a unit of an appropriate size for the given context. For example, kilometers rather than centimeters for measuring the distance between 2 towns.
2. Compare that unit with the object being measured.
3. Report the number of units by stating the number of non-standard or standard units and the name of the unit itself. For example: “The length of the pencil is 6 paper clips” or “The capacity of the bottle is 2 liters”.

What is a non-standard unit?

The use of non-standard units allows students to focus on the attribute being measured. For example, using square tiles to measure area emphasizes the idea that area involves finding the number of square units needed to cover a surface. Students should have experience in using a variety of non-standard units to measure attributes before being introduced to more abstract, standard units. The following chart lists materials that might be used as non-standard units for attributes that are investigated in the primary grades.

Attribute	Examples of non-standard units
Length	Sticks cut in equal lengths, toothpicks, straws, paper clips, pieces of chalk, paper strips of equal lengths
Mass	Beads, marbles, stones, everyday objects
Capacity	Cups, plastic containers, buckets, bottles, cans
Time	Steady hand claps, sand timers, stop watches, analog clocks, digital clocks, calendars

Math Training Session 13: Data

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Design a data exploration activity to develop students' ability to collect, sort and classify objects into given categories, and to ask questions.

KEY MESSAGES

- The big idea in data analysis is the 4-step problem-solving process: 1) Formulate an investigation question that can be addressed with data; 2) Collect data to address the question; 3) Analyze the data; and 4) Interpret the results.

Why do we collect and study data?

The main purpose of collecting and studying data is to answer questions when the answers are not immediately obvious. Students naturally ask questions and they should be encouraged and nurtured. Data exploration activities help students develop ways to gather information to answer these questions so that they learn when and how to make decisions on the basis of evidence. The big idea of data analysis is the **4-step problem-solving process to data analysis scenarios, which is**:

1. Formulate an investigation question that can be addressed with data.
2. Collect data to address the question.
3. Analyze the data.
4. Interpret the results.

In the emerging level, weeks 34 and 35 are dedicated to data exploration activities. During this time, students are introduced to recording information using a tally table, and later using a bar chart. Class polls are conducted on

investigation questions that are simple and relate to their daily lives. You can define these questions yourself or with students. In analyzing and interpreting the data, students should be encouraged to ask questions and provide responses using qualifying terms such as 'most', 'least', 'greatest', 'smallest', 'as much as' and 'as many as'.

How to write an investigation question

An investigation question is a simple question that you are seeking an answer to which can be found using a poll. The question should be asked in a manner so that it gets one answer from each participant in the poll. Example questions are as follows:

- What is your favorite subject in school?
- What is the most popular type of game you play?
- How many different types of animal have you seen in your life?
- What are the favorite sports of this class?
- What are the favorite foods of this class?
- What is the most popular football team?

How to collect and document data

Once the question is defined, the next step is to decide whom to poll to find the answer to the question. For the emerging level, all the activities are conducted amongst the class students themselves – a class poll. A class poll is an easy way to engage students in a data exploration activity using a topic of interest for your students. You can replace the examples of favorite sport and favorite food with any topics that your class will find interesting and fun. You can also expand this to other classes or the community. However, for the emerging level, try not to exceed gathering data from more than 20 participants as it may be difficult for students.

Tally Table

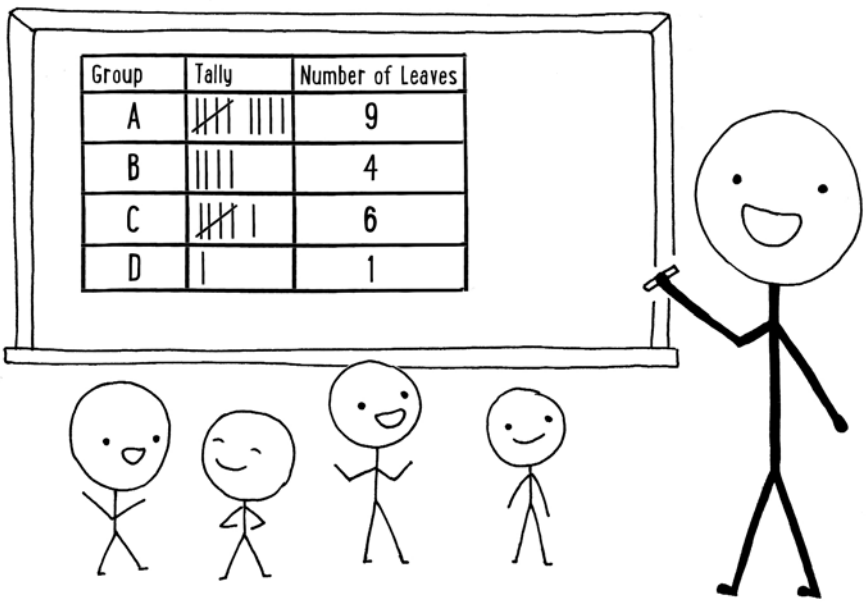
One way to collect data is by conducting a poll of your selected participants and writing down their responses in a tally table. To take a tally is to count and make a mark for each count in groups of 5.

This table illustrates how numbers are represented in the form of a tally:

1	|	6	𝍸 |
2	||	7	𝍸 ||
3	|||	8	𝍸 |||
4	||||	9	𝍸 ||||
5	𝍸	10	𝍸 𝍸

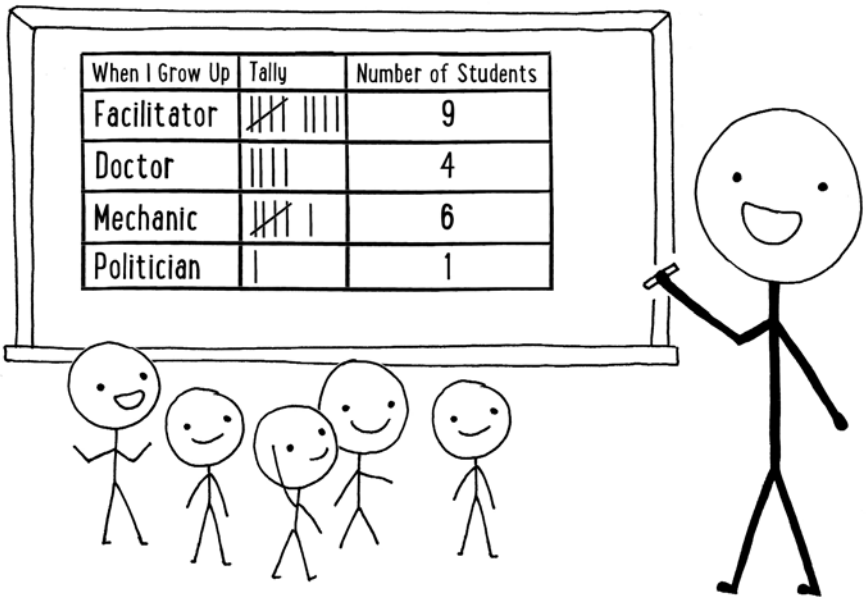
To tally is an easy way of documenting the count or number of respondents per category during a poll. It also exercises students' ability to count. Once the counting is completed, review the tally marks and quickly count by 5s to know the total per category. Below are a few examples of tally tables:

Example 1:
Tally table generated during emerging level Week 34, Lesson 1



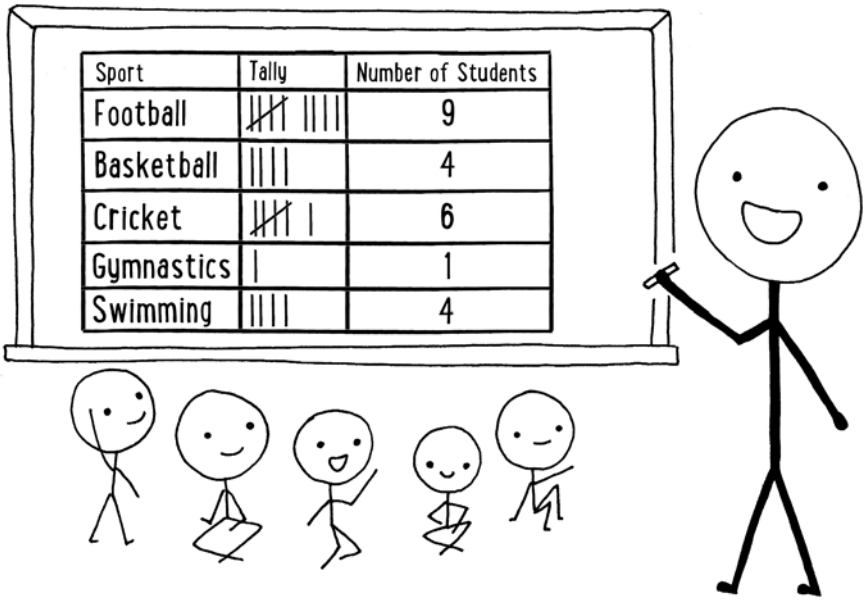
Example 2:

Tally table generated during emerging level Week 34, Lesson 4



Example 3:

Tally table generated during emerging level Week 35, Lesson 1



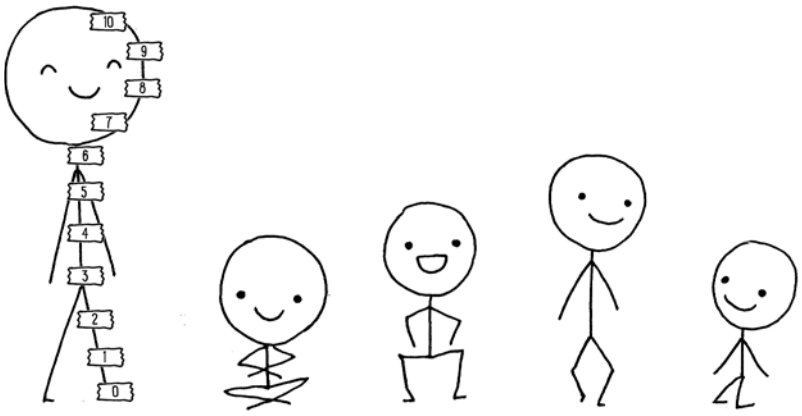
Bar Chart

Another way to document data is using a bar chart. A bar chart presents grouped data using rectangular bars with lengths proportional to the values they represent. The categories are marked along the horizontal axis of the chart and the count is marked along the vertical axis. The bar heights give a visual picture of which category has more, less or equal amounts.

For the emerging level, this concept is introduced in the form of a game – 'I am a bar chart!' in Week 35, Lessons 2, 3, 4 and 5.

How to play the game 'I am a bar chart!'

'I am a bar chart!' is a fun game where students use their own body to represent the height of the bars in a bar chart. It gives them the visual sense of data sizes as they grow and shrink using their body. Consider the investigation question: "What are the favorite sports of this class?" After conducting the class poll and tallying the results in a tally table, you can introduce the concept of a bar chart. Once you have explained what the horizontal axis and vertical axis represent, you can explain the game below.

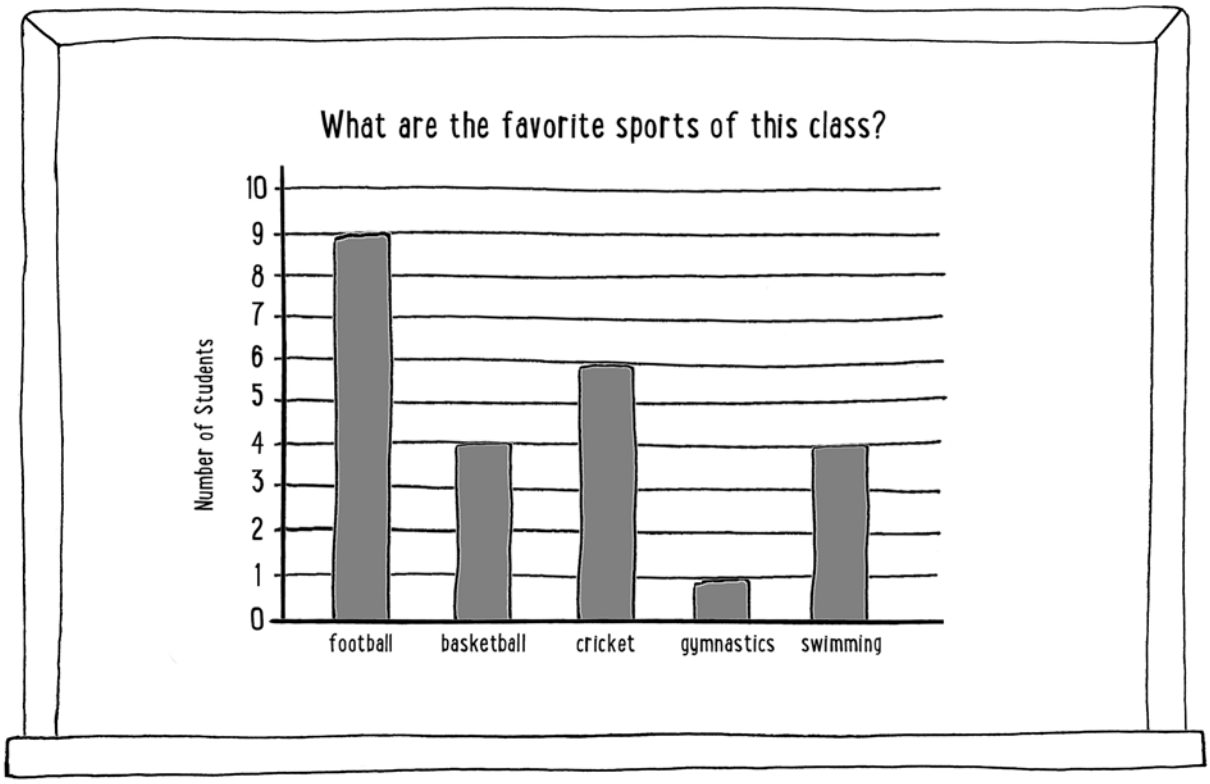


Steps

1. Invite 1 student to come up and play the role of the vertical axis.
2. Mark this student from his or her foot to head, at equal intervals using masking tape to indicate 1 to 10.

3. Have as many students as categories to play the role of a category. For example, each can represent one of the sports.
4. Have them crouch down next to the student playing the vertical axis as a way to represent zero per category.
5. Now ask them to slowly grow upward by standing up from their crouching position to the height that they represent in relation to their category.
6. Ask the rest of the class if each category is as tall as they should be.

After playing the game, you can draw the representation of the results on the board using a bar chart.



How to analyze and interpret data

Once data has been collected and represented in the form of a tally table or bar chart, ask questions that encourage students to use qualifying terms such as 'most', 'least', 'greatest', 'smallest', 'as much as' and 'as many as'. This can be done in the form of small group work, pair work or as a whole group. Some example questions and answers are given below:

Example 1: Questions about the data collected

- Which sport is the class favorite? Can you explain why?
  Example answer: "9 people say they like football, which is the largest number on the table so most people in this class enjoy football."
- Which sport is the least favorite? Can you explain why?
  Example answer: "Only 1 person likes gymnastics, which is the smallest number on the table so it is the least favorite sport of this class."
- Which sports are liked by the same number of people?
  Example Answer: "4 people like basketball and 4 like swimming. There are as many students who like basketball as swimming."

Example 2: Additional questions

- What other observations can you make with these results?
- Would you expect different results if we collected data from the other class or from the community? Can you explain why?
- How might the results look if we asked the community? Can you explain why?
- What if we collected this data in [insert the name of a country here]? Can you explain why?

Math Training Session 14: Geometry

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Incorporate teaching aids and games to develop students' spatial sense and their ability to identify the characteristics of 2-dimensional shapes (rectangle, square, circle and triangle).

KEY MESSAGES

- The big ideas in spatial sense and geometry are – properties of 2-dimensional shapes and 3-dimensional figures, geometric relationships, and location and movement.
- Develop students' ability to analyze and describe the geometric properties of shapes and figures, not on their ability to learn the definitions.
- Classroom activities such as games should provide opportunities for students to manipulate, compare, sort, classify, compose and decompose these geometric forms.
- Teaching aids such as cutouts of 2-dimensional geometric shapes and examples from the environment such as boxes, cans and balls should be integrated into classroom activities.

Why do we learn spatial sense and geometry?

Students need to learn about shape, size, position, direction and movement to describe and classify the physical world we live in. Spatial sense is students' awareness of themselves in relation to the people and objects around them. Spatial sense and geometry are used in art, science, construction, dance, music and reading. For example, reading maps and building houses. Students notice shapes in natural objects of all kinds. Even distinguishing between letters of the alphabet involves attention to shape and position.

The big ideas in spatial sense and geometry are:

1. Properties of 2-dimensional shapes and 3-dimensional figures.
2. Geometric relationships.
3. Location and movement.

Students aged 4–6 years begin to recognize and describe shapes even if their explanations are incomplete. For example, when asked to identify a rectangle, a student might say: "It's a rectangle, because it looks like a door." They do not explain, for example, that the shape is a rectangle because it has 4 sides and 4 right angles. They may describe objects using vocabulary related to observable attributes: color, size (big, small, long, thin), texture (smooth, rough, bumpy), movement (slide, roll) or material (wood, plastic).

In the emerging level, focus students' attention on geometric features of 2-dimensional shapes so that students begin to think about the properties that make a rectangle a rectangle. Also guide them to use positional language to describe the position of objects and their movement using vocabulary such as 'above', 'below', 'to the left of', 'to the right of', and so on. In the developing level, we include 3-dimensional shapes. We emphasize developing students' ability to analyze and describe the geometric properties of shapes and figures, not their ability to learn the definitions.

What are two-dimensional shapes?

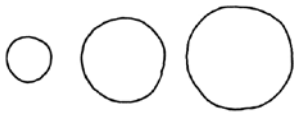
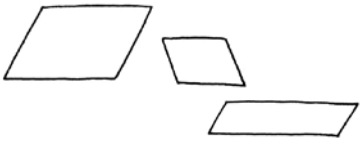
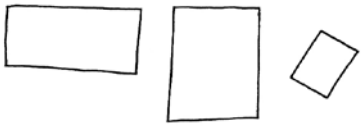
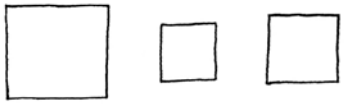
A shape that only has two dimensions (such as width and height) and no thickness are two dimensional objects.

What are the learning objectives for each level?

Big idea	Emerging level	Developing level
1. Properties of 2-dimensional shapes and 3-dimensional figures	▪ Describe objects in the environment using names of shapes. ▪ Identify shapes (circle, rectangle, square, triangle) of different orientation, size and color.	▪ Describe objects in the environment using names of shapes. ▪ Identify shapes (circle, rectangle, square, triangle) of different orientation, size and color. ▪ Identify, name, describe and classify cube, cuboid, cone, cylinder and sphere.
2. Geometric relationships	▪ Build and draw shapes with defining attributes. ▪ Combine shapes to form larger shapes.	▪ Build and draw shapes with defining attributes. ▪ Combine shapes to form larger shapes.
3. Location and movement	▪ Describe the relative position or orientation of objects (for example: on, under, over, in front, behind, between, next to, inside, outside, far, near, to the right of, to the left of).	▪ Describe the relative position or orientation of objects (for example: on, under, over, in front, behind, between, next to, inside, outside, far, near, to the right of, to the left of).

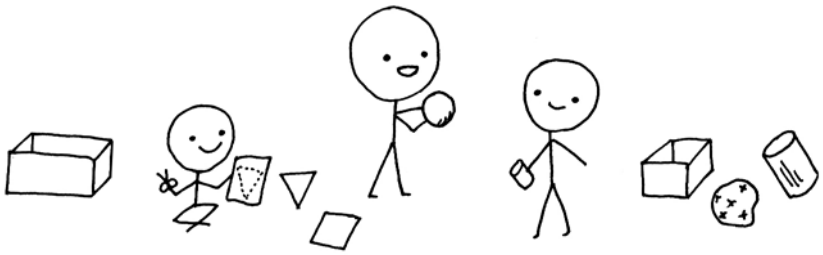
What are 2-dimensional shapes?

A shape that only has 2 dimensions (such as width and height) and no thickness are 2-dimensional objects. Below is a summary of shapes and concepts taught during the emerging level.

Name	Types	Characteristics	Examples	Common non-examples
Circle		All points on the shape an equal distance from the center.		
Triangle		Has 3 sides and 3 angles.		
Quadrilateral		Has 4 sides and 4 angles.		
	Parallelogram	A quadrilateral with opposite sides parallel.		
	Rhombus	A parallelogram with 4 equal sides.		
	Rectangle	A parallelogram with 4 90-degree angles.		
	Square	A rectangle with all sides equal.		

What are some games that teach geometry?

Classroom activities should provide opportunities for students to manipulate, compare, sort, classify, compose and decompose these geometric forms. These types of activities help students to identify and informally describe some attributes and geometrical properties of 2-dimensional shapes and 3-dimensional figures. Teaching aids such as cutouts of 2-dimensional geometric shapes, examples from the environment such as boxes, cans and balls, and games that use shapes should be integrated into classroom activities.



Game: Bag of Shapes

'Bag of shapes' is a game that encourages all students to reason and communicate how they identify or classify a shape and explain why. Through discussions of a wide variety of shapes, students learn to recognize examples and non-examples of shapes.

Steps

1. Before class, collect and/or cut out a variety of shapes in different colors and sizes using objects found in the environment, such as old newspapers, cardboard or discarded containers. There should be a mix of many shapes and sizes including shapes that resemble circles, triangles and rectangles but are not.
2. Place these objects in a bag or container.
3. During class, play the game 'Bag of shapes'. Explain the rules of the game to the class.

4. A student picks out a shape from the bag and identifies it as a triangle, rectangle, square, circle or none of the above. For 3-dimensional shapes in the developing level, use cube, cuboid, cone, cylinder or sphere.
5. The rest of the class shows a 'thumbs up' if it is correct or a 'thumbs down' if it is not correct. Alternatively, students can write 'T' for true or 'F' for false on their slate and hold it up for everyone to see.
6. Call on 3–4 students to explain why they agree or disagree with the shape identification. Encourage students to use descriptive terms and pose follow up questions based on how they explain their reasoning.

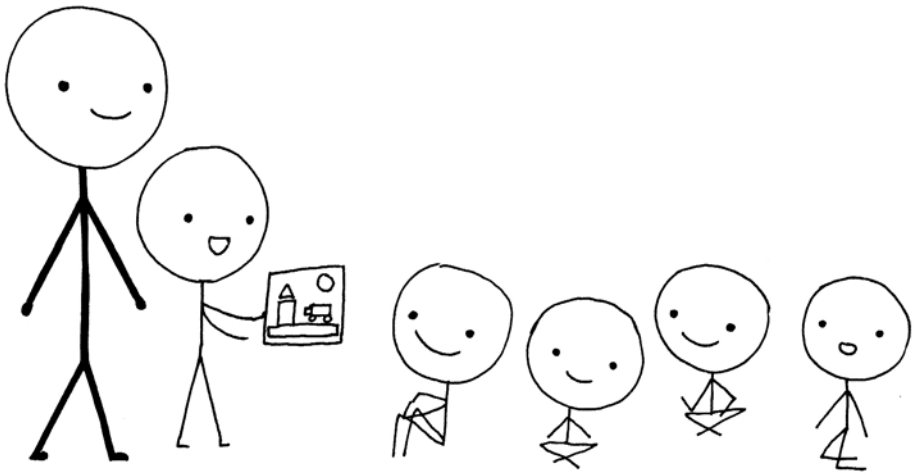
Game: Shape Neighborhood

'Shape neighborhood' is an art activity where students use their creativity to draw a scene using combinations of circles, rectangles, triangles and squares of various sizes. This activity exercises their ability to compose and decompose shapes.

Steps

1. Provide colored pencils and paper for all students. If this is not available, they can also draw on their slate with chalk or go outdoors and draw on the sand.
2. Invite students to close their eyes and imagine a scene. It can be their compound where they live or their village or neighborhood or the schoolyard or football field.
3. Ask them to imagine this area in their minds with their eyes closed for 2–3 minutes.
4. Now invite each student to take a piece of paper and a pencil and draw the scene using only shapes such as triangles, rectangles, squares and circles. They can put these shapes together to make different images. Give an example by drawing a house using a triangle and square on the board.
5. Give students 10–20 minutes to complete this activity. Encourage them to have fun and be creative as you walk around and observe them.

6. After they complete their drawing, invite 4–5 students to show their work and explain the drawing using geometry vocabulary. For example: "I drew a football using a circle and I drew the football field using the rectangle shape."



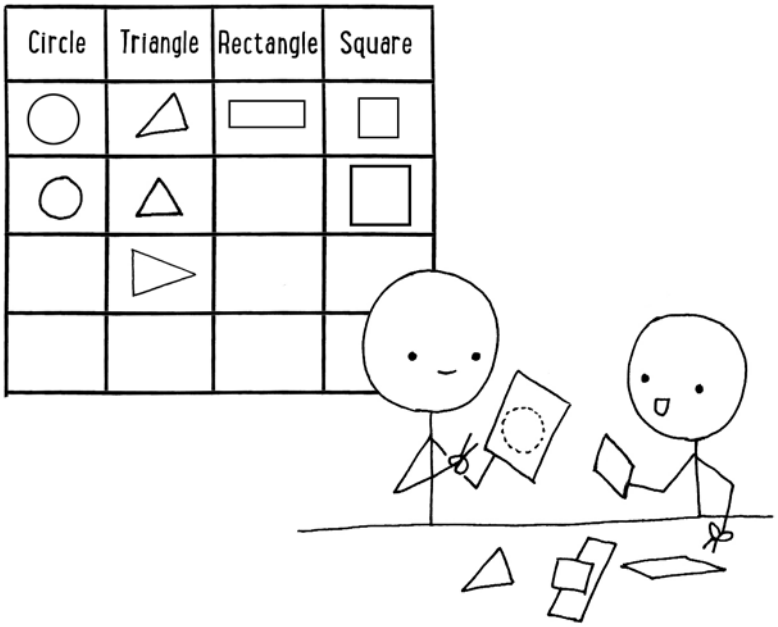
Game: Shape Table

'Shape table' is a game that helps students to sort shapes while engaging them in an art activity that involves measuring, drawing with a ruler and cutting. It develops their motor skills, creativity and ability to classify shapes. The end product, which is the 'Shape table', can be mounted on the wall of the classroom to be referenced throughout the school year.

Steps

1. Pass out scissors, colored paper, rulers, pencils and glue to small groups of students.
2. Mount a large flipchart page on the wall with a table drawn on it entitled 'Shape table'.
3. Present each group with a description of cutouts that they need to make. For example: 1 red triangle measuring 6cm on each side; 1 blue rectangle with sides measuring 8cm x 3cm.
4. Give students 15–20 minutes to draw and cut out the shapes.

5. Then invite each student to come up to the shape table and decide which column a shape belongs to.
6. Once the whole class agrees with the classification, help the student to glue the shape in the appropriate column of the shape table.
7. At the end of the activity, all the shapes should be glued onto the table.
8. During other lessons, you can make reference to the shape table.



Game: Who am I?

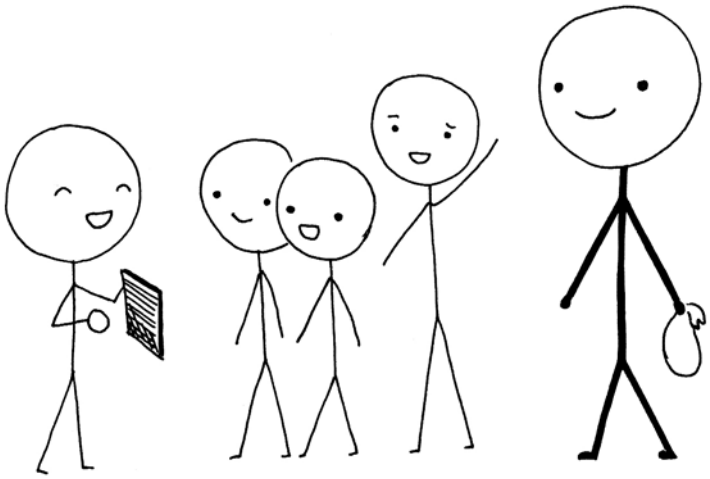
'Who am I?' is a game that develops students' ability to describe observable characteristics of objects such as their shape, size, color, texture, movement and material.

Steps:

1. Form small groups of students.
2. Tell students that they are going to play a game called 'What shape am I?' and that each student in a group will have a chance to be the leader.
3. Pass out a piece of cardboard to each leader, which will be used as a cover to hide the shape.

4. Have each leader pick at random a shape cutout from the 'Bag of shapes' and hide it behind the cover.

5. Now each leader in their group will pose a series of questions to the rest of his or her group to get them to guess the shape. For example:



   - "I have 3 sides and am the color of blood. What am I?" Answer is "You are a red triangle."
   - "I have 4 sides that are the same length. I am the color of leaves." Answer is "You are a green square."

6. Walk around and observe the groups and provide support to use correct geometry vocabulary words.

7. After 5 minutes, change the group leaders and repeat the activity.

Game: I Spy

'I spy' is a game used in reading and math. For geometry, it can be modified as follows – students listen to descriptions and use it to identify the corresponding object as fast as possible. This activity develops students' ability to identify objects by their observable characteristics.

Steps

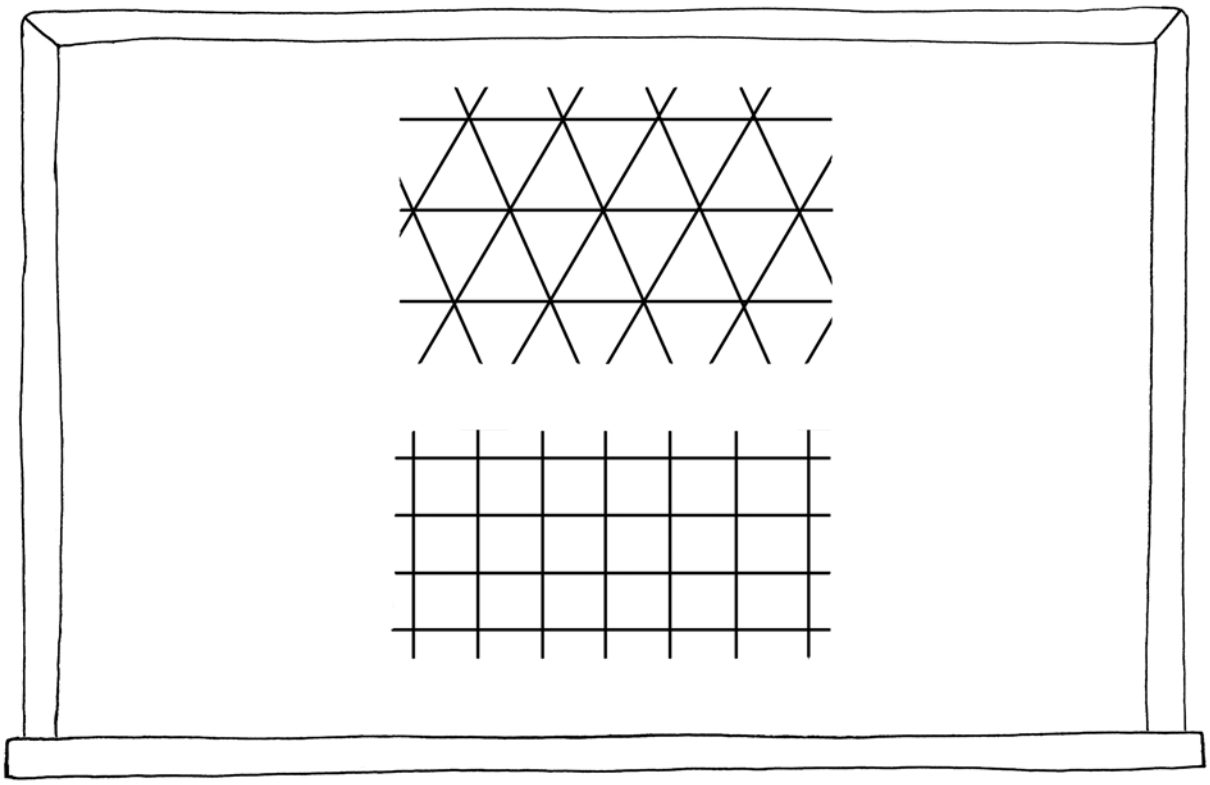
1. Layout a variety of objects of all sizes and colors and materials on the floor for all students to see. The objects should be a mix of 2-dimensional shapes (triangle, rectangle, circle and square) and other shapes that are not in this category (cut out of a star or moon or heart, leaves, stones and so on.)
2. Gather everyone around this collection of shapes.
3. Now, present a descriptive statement and invite students to pick out the matching object as fast as possible. Example statements are: "I spy something red", "I spy something larger than the size of your hand", "I spy something with 3 sides" or "I spy something with no sides."
4. Hold up the object or objects and discuss with the students if the selection was correct, posing critical thinking questions such as "Can you explain why?"

Game: How Many . . . . . Do You See?

In this game 'How many *triangles* do you see?' or 'How many *rectangles* do you see?' and so on, students exercise their ability to see patterns and find shapes in patterns. This game uses tessellations. A tessellation is any pattern made up of repeating shapes that covers a surface completely without overlapping or leaving any gaps. A checkerboard is a tessellation made of squares. The squares meet edge to edge with no gaps and no overlapping areas. The pattern of bricks on a wall is a tessellation made of rectangles. Making tessellations combines the creativity of an art project with the challenge of solving a puzzle.

Steps

1. Before class, draw a simple tessellation on a large piece of flipchart or on the board with a ruler.
   Examples of simple tessellations:



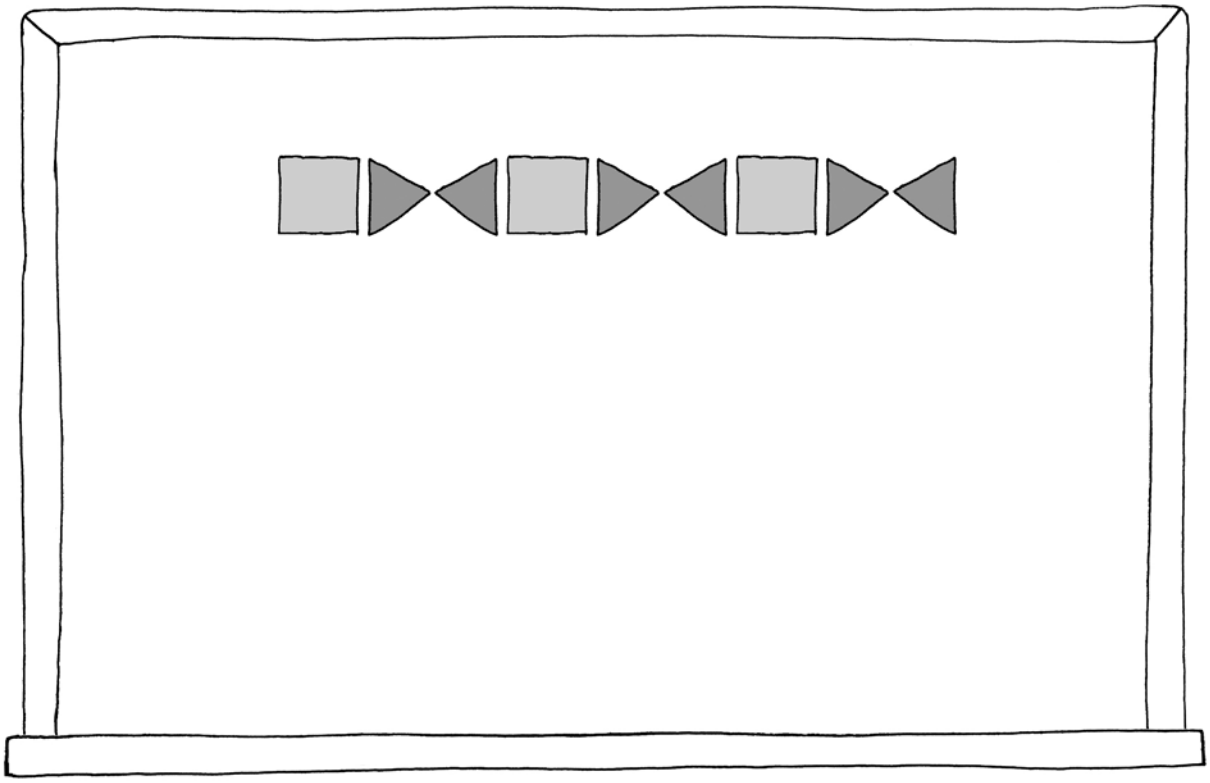
2. Now, ask students to look at the pattern and identify shapes of different sizes. For example, the triangle tessellation has at least 21 small triangles, 8 medium triangles and 3 large triangles.
3. Point to the different shapes or use colored chalk to color it in.

Game: Make Shape Patterns

'Make shape patterns' is an activity that develops students' ability to compose and decompose shapes and form repeating patterns.

Steps

1. Before class, make sets of shape cutouts of the same size and color.
2. During class, demonstrate how to form patterns by giving an example. For example with 3 orange squares and 6 green triangles, you can make the following pattern:



3. Say: "I made a shape pattern. I used 3 orange squares and 6 green triangles. My pattern repeats 3 times."
4. Explain that a pattern repeats the same order of shapes a few times.
5. Now, form pairs or small groups, pick a leader for each group and pass out the sets of shapes to the leader.
6. Give students 10–15 minutes to form one pattern using their set of shapes in their groups.
7. Walk around and support groups in defining their patterns.
8. Have groups walk around and see each other's patterns; the group leader stays next to his or her pattern and presents it to the visiting groups. The leader should describe the pattern.

Math Training Session 15: Reflection and Conclusion

Training session summary

TRAINING SESSION OBJECTIVES

By the end of the session, trainees will be able to:

- Reflect on the training experience and complete the Math Training Post-test.

Math Training Post-test – Phase 2

Name: .....

Affiliation: .....

Position/Job Title: .....

1. Name and explain the measurement attributes taught in the emerging level.

.....

.....

.....

.....

.....

.....

2. Identify at least 2 teaching aids used for measurement activities.

.....

.....

3. Name the 4 steps of the problem-solving process for data activities.

.....

.....

.....

.....

4. Name some examples of how to record data during a class poll.

.....

.....

5. Name and explain 2 activities that teach geometry.

.....

.....

.....

.....

.....

.....

6. Identify at least 2 teaching aids useful for geometry.

.....

.....