التعليم فوق الجميع | education above all

DRAW AND CALCULATE LIKE AN ARCHITECT (ALL AGES)

Ages 4 to 7 (Level 1)

Description:	Learners use body parts in scale drawing of floor plans and calculate area using simple counting methods
Leading question:	How can you draw floor plan sketches and calculate areas using your body parts as measuring tools?
Age group:	4-7-year-old
Subjects:	Mathematics
Total time required:	~6 hours over 4 days
Self-guided / Supervised activity:	Medium to High supervision required
Resources required:	Paper and pencil, a ruler (for smaller measures), a tape measure (for larger measures).
Learning outcomes:	• Measuring length with non- standard units • Scale drawing converting Foot to Digit • Find areas of rectangles by drawing unit squares and counting • Multiply using a geometric/visual method • Giving directions verbally • Apply mathematical knowledge and skills in a real-life scenarios
Required previous learning:	• Counting and simple addition. • Preferably, learners have done the “Beauty in Shapes and Measurements” IFERB projects before.
Topics/concepts covered and skills developed	• Geometry and measurement • Measuring length using everyday non-standard units • Scale drawing • Area and perimeter • Giving directions verbally

Day	Time	Activity and Description
1	20 minutes	In this project, learners will learn how an architect draws floor plans, and what methods they use to calculate the size of rooms or houses. Learners will also use their body parts (non-standard units) to measure lengths.

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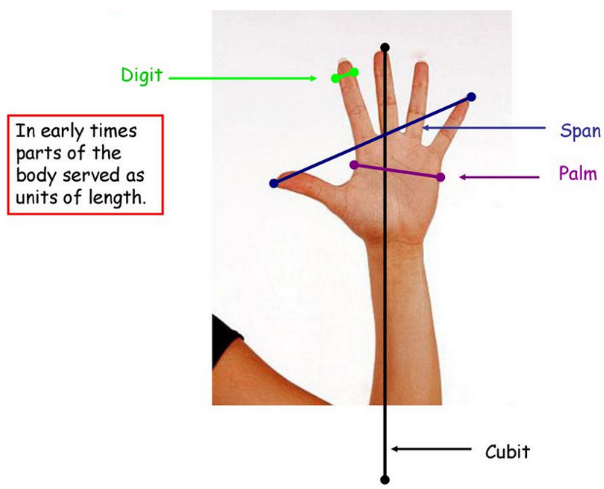
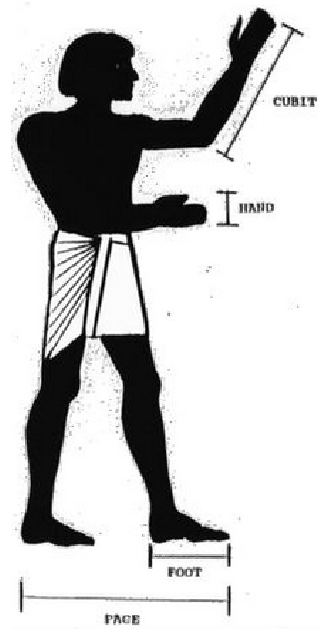
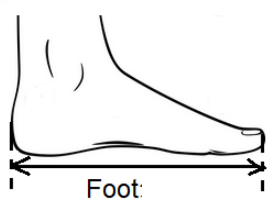
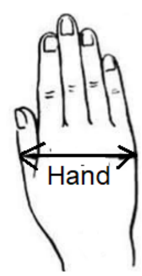
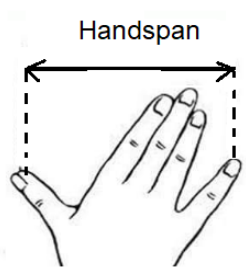
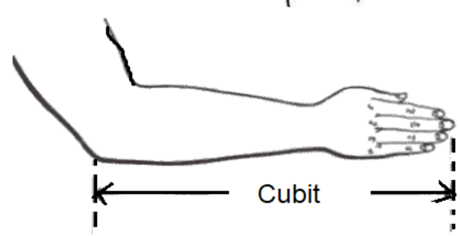
		To measure is to find a number that shows or represent the size or amount of something.   ..    

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	15 minutes	Input: examples of non-standard units used by ancient people to measure length included: the **Foot**, the **Hand**, the **Handspan**, the **Cubit**, the **Digit**, the **Pace** etc. ● The **Cubit** is a measurement equal to the length from your elbow to the tip of your middle finger when your arm is extended. Egyptians mainly used their cobits to measure objects, ● The **Foot** is a measurement equal to the length of your foot from the toe to the heel. King Henry I of England standardized this measurement to measure his foot which was 12 inches long. ● The **Handspan** is a measurement equal to the length from the tip of the thumb to the tip of the last finger when your hand is stretched out. ● The **Digit** is a measurement equal to a finger's breadth. Four digits are equal to a **Palm** and five digits are equal to a **Hand**. Greeks mainly used their fingers to measure objects. The Hand is still used to measure the height of horses. ● The **Pace** is a measurement of the distance from one step to another. The Roman Army used the Pace to judge speed. ● The **Fathom** is a measurement equal to the length between both your base fingers when you outstretch both your arms. The Fathom was used to measure the depth of water **Activity 1: Personal Measure** In this activity, learners will measure their Cubit, Foot, Handspan, Digit, Palm, Hand, Pace, Fathom and those of two of their family members/friends and enter their findings in the table below.

Person	Personal Measure	(unit) (cm)
Learner	Cubit	
	Foot	
	Handspan	
	Digit	
	Palm	
	Hand	
	Pace	
	Fathom	
Family member 1	Cubit	
	Foot	
	Handspan	
	Digit	

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	Palm	
	Hand	
	Pace	
	Fathom	
Family member 2		

15 minutes

- What do you notice from your findings?
- Is there any relation between the Handspan and the Cubit?

If not mentioned as a result of the previous questions, draw the learners attention to the following insights:

- Each person's body part unit is different from another's body part unit. This is the reason why measuring length using body parts units is referred to as measurement of length using non- standard units.
- The Handspan is about half the Cubit

Activity 2: Comparing measurements made using Body Parts (Non-Standard Units) to those made using Standard Units

In this activity, learners will use the Personal Measure (Body Parts) to measure different items and compare their results with those obtained using Standard Units.

Learners will write down the measures in a table like the one below:

15 minutes

Item	**Personal Measure (Body part)**	**Estimate using a Personal Measure (cm or in)**	**Actual using a ruler or tape measure (cm or in)**
Length of a pencil	Digit		
Length of a foot mat	Foot		
Length from table to door	Pace		
Length of room	Cubits		

20 minutes

How close are the estimates obtained using Personal Measure to actually using a ruler or tape measure?

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Activity 3: Measuring the dimensions of a room

In this activity, learners will use mainly the **Foot**, and the **Digit** non-standard unit. Of course, you know that your foot size is smaller than the actual Foot unit used on measuring tapes (as different people have different foot sizes!)

1. Pick one of the house rooms with a rectangular floor shape, preferably the smallest room in the house.
2. Stand on one corner of the room you have chosen, and walk by the wall, step by step, to reach the other corner.
3. You must start with the back of your foot touching the wall behind, and then place the other foot right in front of and touch the other foot, and keep counting your steps until you reach the facing wall.

4. Repeat with the 4 sides of the room, and write down the measures in a table like the one below

Room side 1	
Room side 2	
Room side 3	
Room side 4	

Is any of the sides equal in length to another side? Does this apply to all rectangles?

In a rectangle, usually the measure of the longer side is called length (L); and the measure of the shorter side is called width (W).

On a piece of paper, you will draw a sketch of the room. The room is much bigger than the sheet of paper, so architects usually draw a smaller sketch that looks like the actual room but smaller (something like a photograph of you compared to the real size of you).

See below how to do it:

To do this, instead of using your **Foot** to draw the sides of the rectangle, you use your finger: **Digit.**

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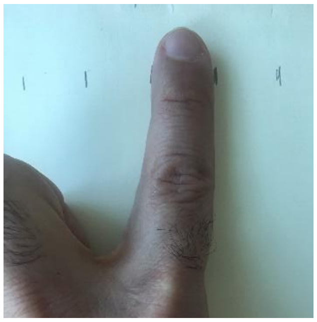
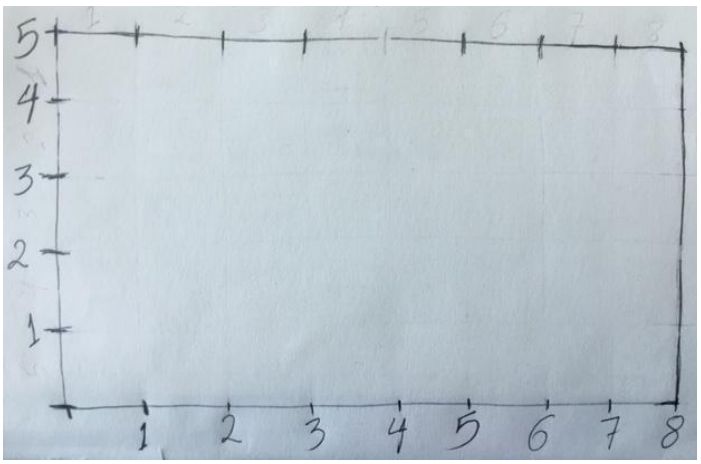
		 In the example below, see a sketch of a room whose Length L = 8 feet, and width W= 5 feet. The actual size of the sketch is 8 Digits by 5 Digits.  As you also notice, we do not need to write the sizes of the other sides, as in a rectangle opposite sides are equal in size. Now draw the sketch of the room you chose on a sheet of paper. On your sketch, create a grid using the Digit marks, as shown below:

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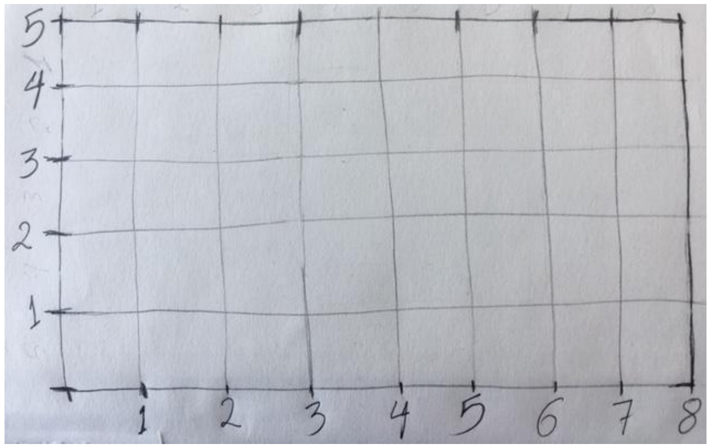

Count the number of squares in your diagram.
Notice that the side length of the small square is 1 digit, so we call it a unit square.

The number of squares inside the sketch is called the <u>Area</u> of the sketch.
<u>Area</u> is the size of the floor surface inside a certain shape, which is the count of unit squares enclosed within. Notice that a square is a special rectangle where its Length = Width

In the example above, we saw that the sketch has 40 unit squares within, so its area is 40 squared Digits, and we conclude that the area of the room is 40 Squared Feet.

What is the area of your sketch? (in squared Digits)

What is the area of your room? (In Squared Feet*)
*Foot measure used here is the Learner’s foot size and not the universal Foot scale.

Learners will answer the questions on the Day 1 Worksheet (rectangle area problems).
</td>
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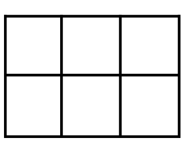
<tr>
<td>2</td>
<td>10 minutes</td>
<td>
Yesterday you tried to draw floor plans of a room, and to use a smaller scale to represent a large drawing on a small piece of paper. Also you learned how to find the area of a rectangular room.

What is the area of the below rectangle?



The area can also be calculated simply by multiplying Length X Width.
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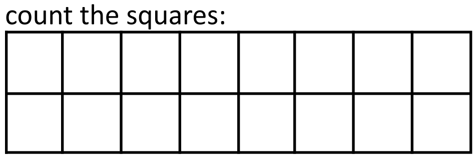
For example: in the example of the room whose Length is 8 Feet and Width is 5 Feet, the area counted was 40 Squared feet. This could have been found by multiplying 8X5 = 40.
Learners will use a faster way of calculating area.

Try multiplying: The Length of your room x its Width, is it equal to the area you counted?

So now we learned another way to solve multiplication questions!

To find out the answer for 2 x 8, you can draw a rectangle with L=8 and W = 2, and count the squares:



Another way of solving for 8x2 is by adding 8 + 8 (Keep 8 in our head, and then continue counting 8 places: 9, 10, 11, 12, 13, 14, 15, 16)

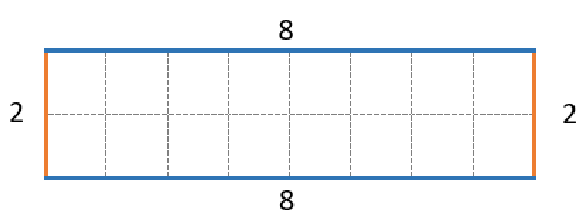
8x3 is by adding 8 + 8 + 8 (8 in the head, count 8 more places, then 8 more places)

20 minutes

Solve Question 1 of the Day 2 Worksheet <u>without using a calculator</u>

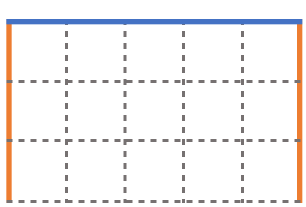
15 minutes

Another important thing that architects need to know is the Perimeter of the room. This tells us how long of a fence or walls are needed to put around any shape.
This is calculated by adding all the measures of the sides of the shape.



Looking at the above shape, the perimeter = 8+2+8+2 = 20 units of length.

Calculate the perimeter of the square whose side is 5 Feet <u>without using a calculator</u>.



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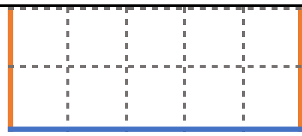
45 minutes

5 minutes</td>
<td>
Individual activity: solve the Day 2 Worksheet questions 2, 3, 4 and 5 without using a calculator.

Learners will discuss their solutions with a parent or older siblings.</td>
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<td>3</td>
<td>5 minutes

45 minutes</td>
<td>Today learners will draw a sketch of their house floor map using a Digit to represent 1 Foot.

When doing this, architects imagine that the roof of the house is transparent, and we draw the map as if we are looking at the house from the top, like a flying bird.

As an example, below is a simple floor map.


Source: https://www.tuko.co.ke/276066-3-bedroom-house-plans-designs-kenya.html

Ask the learners: what do you notice? (give them enough time to look closely at the floor map).
Here are some of the things that they might notice or to which you can draw the learners' attention:
The walls are drawn on the map
There are some arcs to represent doors
The function of each room is marked (bedroom, kitchen, bathroom…)
Learners will now draw a floor map of their house and then present it to the family.

Learners will try to ensure:
The floor map is up to scale (each 1 Foot of actual measure is represented by 1 Digit)
The map accurately represents the actual rooms of the house</td>
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		● The name of each room or space is written on the map (like: bathroom, kitchen...etc.)
	10 minutes	Parents will provide feedback to the learner ● What they love most about the floor plan ● Suggested areas of improvement The learner will use the feedback to revise the floor plan
	10 minutes	Without using a calculator, learners will figure out a way to calculate the overall area of the house using the floor map. Tip: This is done by adding the areas of the different rooms or spaces inside the house.
4		Learners will play a treasure hunt game with the family.
	30 minutes	Learners will hide 3 items around the house and mark where they hid them on the floor map. They will ask 3 family members to find one of the hidden items each. If it were too easy, they can make it harder by hiding smaller items, and giving an approximate location. Learners will explore how we could help people navigate using verbal instructions.
	30 minutes	Learners will imagine how they would help a blind person who could not see the map. They will blindfold one of their family members and give them directions to go from one location to another in the house using the following verbal directions only: ○ Move (a number of) steps forward ○ Turn to the left ○ Turn to the right
	10 minutes	Questions for discussion will family members after the treasure hunt game: ● How good were your directions to guide the blindfolded member? ● Did you have to correct any of the directions you gave? Why? ● How do you think boats navigate their way in the sea without using technology? ● Imagine ways to help sailors navigate in the oceans when they are unable to see land. Hint: Learners can be prompted to look out into the sky and imagine the north star (the brightest star in the sky) and the direction that the sun rises (east) and sets (west).

	10 minutes	**Literacy Extension and Reflection:** Learners will verbally share sentences about their key learning points about measurements, Body Parts (Non-standard units), how architects work, and/or how they intend to use the knowledge acquired in the project and share these with their family. Young learners can share verbally.
Assessment Criteria:		- The house floor map is accurate and clear - Worksheet questions are answered correctly using methods and skills introduced in earlier activities - Learners are engaged and show grit while working on project tasks - Learners give good verbal instructions as directions
Additional enrichment activities:		Draw the floor map of another space (School, playground…)
Modifications to simplify the project tasks if need be		A simpler version of this project can be to learn how to draw floor mapping of a rectangular space using simple conversion of Foot to Digit and counting the unit squares enclosed to find the area.

Day 1 Worksheet

Answer the below questions without using a calculator

1. Draw a floor map of a room whose Length is 4 Feet, and Width is 5 Feet.

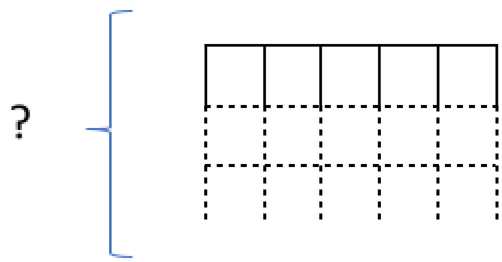
   Then find the area of this room in Square Feet.

2. Draw a floor map of a room whose Length is 7 Feet, and Width is 7 Feet.

   Then find the area of this room in square feet.

3. What do we call the rectangle whose Length is equal to its Width?

4. A rectangle has an area of 20 Squared Feet. Its Length is 5 Feet. What is its width?
   Hint: Keep building rows below until you reach a count of 20 squares. Then, you will find the Width!



5. A rectangle has an area of 36 Squared Feet. One of its sides measures 6 Feet, can you find the measure of the other side? (Hint: see how you solved the previous question).

Day 2 Worksheet

Answer the below questions without using a calculator

1. Find the answers to the following multiplication questions

2 x 3=

4 x 6 =

2 x 7=

3 x 3=

3 x 5=

2 x 6=

2 x 9=

3 x 8=

2. Draw a sketch for a rectangle whose Length is 6 Digits, and width is 5 Digits.

   Calculate the Perimeter and Area of this rectangle.

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3. Draw a sketch for a rectangle whose Length is 7 Digits, and width is 6 Digits.

   Calculate the Perimeter and Area of this rectangle.

4. Draw a sketch for a rectangle whose Length is 8 Digits, and width is 4 Digits.

   Calculate the Perimeter and Area of this rectangle.

5. Find the area of the below shape (Hint: find two rectangles and add their areas).

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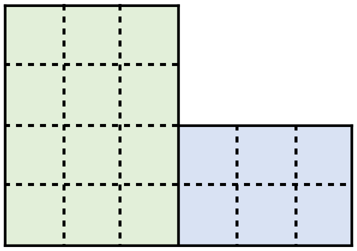


Ages 8 to 10 (Level 2)

Description:	Learners use body parts in scale drawing of floor plans and apply multiplications and divisions on area problems.
Leading question:	How can you draw floor plan sketches, calculate areas and the required building materials using only your body parts as measuring tools?
Age group:	8-10-year-old
Subjects:	Mathematics
Total time required:	~ 6 hours over 4 days
Self-guided / Supervised activity:	Medium supervision required by an adult.
Resources required:	Paper and pencil, a ruler (for smaller measures), a tape measure (for larger measures)
Learning outcomes:	● Measuring length using non- standard units ● Scale drawing using simple conversions ● Use multiplication to find areas of rectangles ● Practice solving division problems using multiplication ● Dividing and applying division on word problems. ● Giving directions verbally ● Apply mathematical knowledge and skills in a real-life scenario
Required previous learning:	● Familiarity with multiplication and division
Topics/concept covered and skills developed	● Measurement of length using non-standard units ● Estimates ● Scale drawing ● Area of rectangles ● Division by multiplication ● Verbal directions ● Application of Mathematics in real life

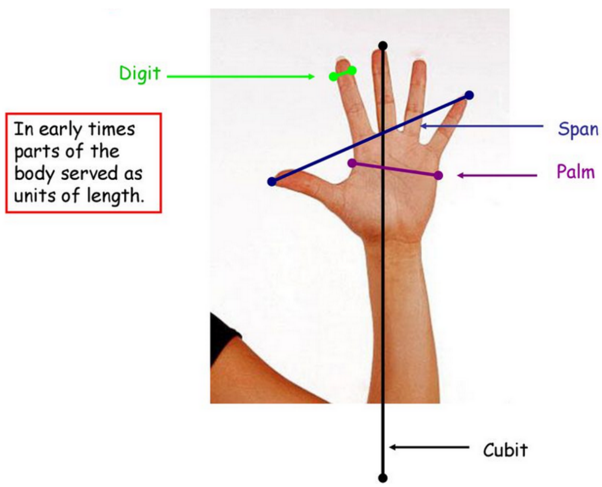
Day	Time	Activity and Description
1	20 minutes	In this project, learners will learn how an architect draws floor plans, and what methods they use to calculate the size of rooms or houses. Ask the learners if they can explain to you what a measurement is. Probe to know if the learner is familiar with some examples.

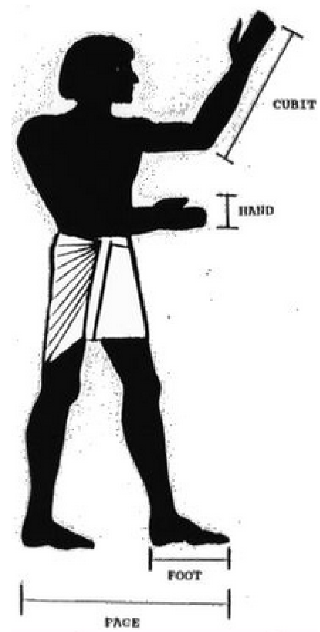
Input: measurement is finding a number that shows the size or amount of something.

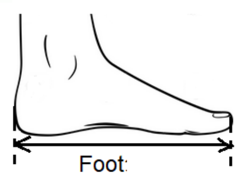
Body parts (Non -standard units) used to measure objects

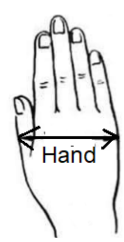
Learners will use their body parts (non-standard units) to measure length.

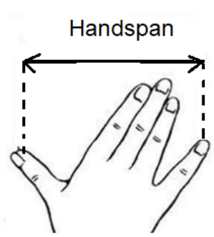
Ancient people measured objects using different body parts. These are called non-standard measurements.

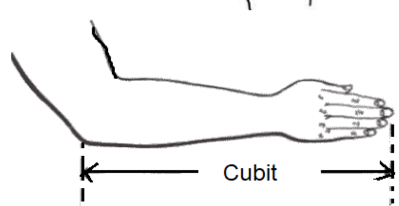












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10 minutes

Input: Examples of non-standard units used by ancient people to measure length included: the **Foot**, the **Hand**, the **Handspan**, the **Cubit**, the **Digit**, the **Pace** etc.

- The **Cubit** is a measurement equal to the length from your elbow to the tip of your middle finger when your arm is extended. Egyptians mainly used their cobits to measure objects,
- The **Foot** is a measurement equal to the length of your foot from the toe to the heel. King Henry I of England standardized this measurement to measure his foot which was 12 inches long.
- The **Handspan** is a measurement equal to the length from the tip of the thumb to the tip of the last finger when your hand is stretched out.
- The **Digit** is a measurement equal to a finger's breadth. Four digits equals a **Palm** and five digits equals to a **Hand**. Greeks mainly used their fingers to measure objects. The Hand is still used to measure the height of horses.
- The **Pace** is a measurement of the distance from one step to another. The Roman Army used the Pace to judge speed.
- The **Fathom** is a measurement equal to the length between both your base fingers when you outstretch both your arms. The Fathom was used to measure the depth of water

Activity 1: Personal Measures

In this activity, learners will measure their Cubit, Foot, Handspan, Digit, Palm, Hand, Pace, Fathom and those of two of their family members/friends and enter their findings in the table below.

Person	Personal Measure	Body part length (unit)
Learner	Cubit	
	Foot	
	Handspan	
	Digit	
	Palm	
	Hand	
	Pace	
	Fathom	
Family member 1	Cubit	
	Foot	
	Handspan	
	Digit	

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	Palm	
	Hand	
	Pace	
	Fathom	
Family member 2		

5 minutes

- What do you notice from your findings?
- Is there any relation between the Handspan and the Cubit?

Among other, learners may notice from their findings that:

- Each person's body part unit is different from another's body part unit. This is the reason why measuring length using body parts units is referred to as measurement of length using non- standard units.
- The Handspan is about half the Cubit

15 minutes

Activity 2: Comparing measurements using Body Parts (Non-Standard Units) to those made using Standard Units

In this activity, learners will use the Personal Measure (Body Parts) to measure different items and compare their results with those obtained using Standard Units Learners will write down the measures in a table like the one below

Item	**Personal Measure (Body part)**	**Estimate using a Personal Measure (cm or in)**	**Actual using a ruler or tape measure (cm or in)**
Length of a pencil	Digit		
Length of a foot mat	Foot		
Length from table to door	Pace		
Length of room	Cubits		

30 minutes

How close are the estimates obtained using Personal Measure to using a ruler or tape measure?

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10 minutes

Activity 3: Measuring the dimensions of a room

For this activity, learners will use mainly the **Foot**, and the **Digit** non-standard units. Of course, you know that your foot size is smaller than the actual Foot unit used on measuring tapes (as different people have different foot sizes!)

1. Pick one of the house rooms with a rectangular floor shape, preferably the smallest room in the house.
2. Stand on one corner of the chosen room, and walk by the wall, step by step, to reach the other corner.
3. You must start with the back of your foot touching the wall behind, and then place the other foot right in front of and touch the other foot, and keep counting your steps until you reach the facing wall.

4. Repeat with the 4 sides of the room, and write down the measures in a table like the one below

Room side 1	
Room side 2	
Room side 3	
Room side 4	

Is any of the sides equal in length to another side? Does this apply to all rectangles?

In a rectangle, usually the measure of the longer side is called length (L); and the measure of the shorter side is called width (W).

On a piece of paper, learners will draw a sketch of the room.

The room is much bigger than the sheet of paper, so architects usually draw a smaller sketch that looks like the actual room but smaller (something like a photograph of you compared to the real size of you).

See below how to do it:

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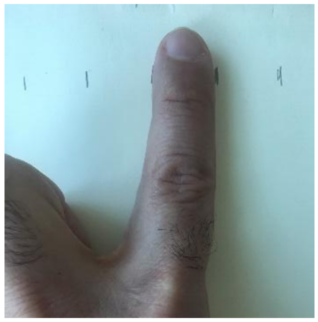
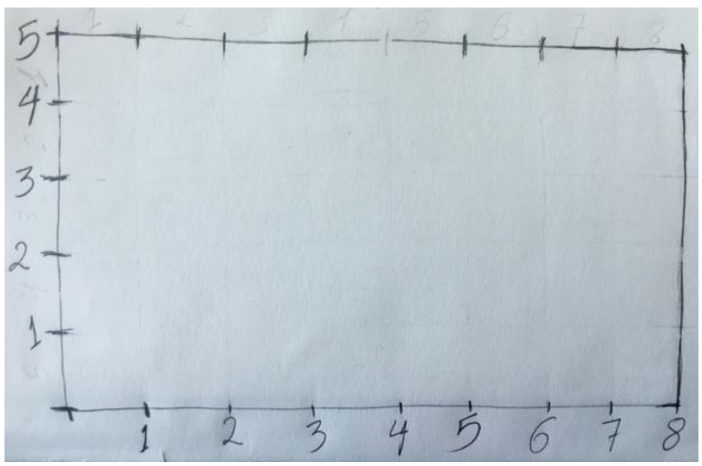
To do this, instead of using your Foot to draw the sides of the rectangle, you use your finger: Digit.



In the example below, see a sketch of a room whose Length L = 8 feet, and width W= 5 feet. The actual size of the sketch is 8 Digits by 5 Digits.



As you also notice, we do not need to write the sizes of the other sides, as in a rectangle opposite sides are equal in size.

Now draw the sketch of the room you chose on a sheet of paper.

On your sketch, create a grid using the Digit marks, as shown below:

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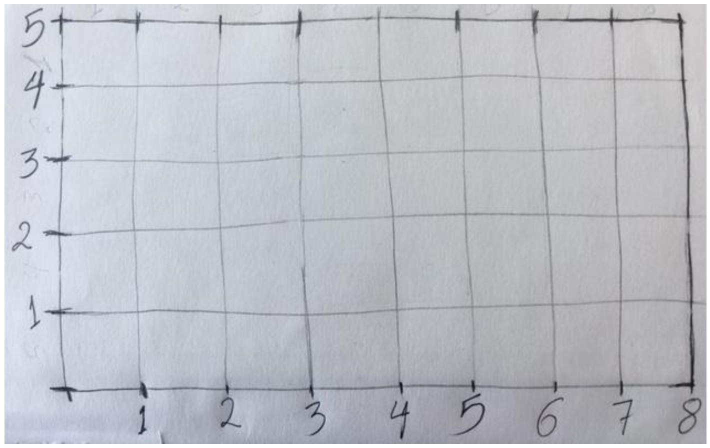

Count the number of squares in your diagram.

Notice that the side length of the small square is 1 digit, so we call it a unit square.

The number of squares inside the sketch is called the **Area** of the sketch.

The Area is the size of the floor surface inside a certain shape, which is the count of unit squares enclosed within.

In the example above, we saw that the sketch has 40 unit squares within, so its area is 40 **squared Digits**, and we conclude that the area of the room is 40 **Squared Feet**.

- What is the area of your sketch? (in squared Digits)
- What is the area of your room? (In Squared Feet*)
- What is the area of your sketch? (in squared Digits)
- What is the actual area of your room? (In Squared Feet*)
- What is the Perimeter of your room?

*Foot measure used here is the Learner’s foot size and not the universal Foot scale.

In scale drawing, you can choose any scale you like and mention that on your drawing. For example, in some maps the scale can be 1:10’000, which is 1 centimetre representing 100 meters.

Try to answer the questions on the **Day 1 Worksheet** without using a calculator.

Feedback and Reflection:

Show your answers and discuss them with one of your parents.

		Parents should give feedback and facilitate a conversation based on the following questions: ● What are the three most important things I have learned so far? ● What have I found difficult? ● What additional support do I need from my family to complete this project?
2	5 minutes 45 minutes	Today you will draw a sketch of the house floor map using a **Digit** to represent 2 **Feet**. When doing this, Architects imagine that the roof of the house is transparent, and we draw the map as if we are looking at the house from the top like a flying bird. As an example, below is a simple floor map.  Source: https://www.tuko.co.ke/276066-3-bedroom-house-plans-designs-kenya.html What do you notice? Input: Learners may notice that: - The walls are drawn on the map - There are some arcs to represent doors - The function of each room is marked (bedroom, kitchen, bathroom…) Learners will draw a floor map of the house up to the scale 2 **Feet** : 1 **Digit** ; and then present it to the family. The learner will try to ensure: - The floor map is up to scale (every 2 Feet of actual measure are represented by 1 Digit) - The map accurately represents the actual rooms of the house - The name of each room or space is written on the map (like: bathroom, kitchen...etc.)

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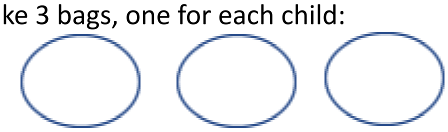
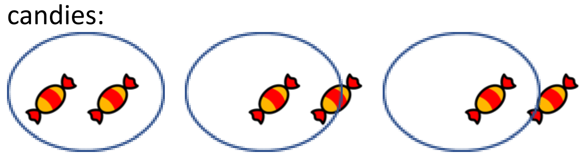
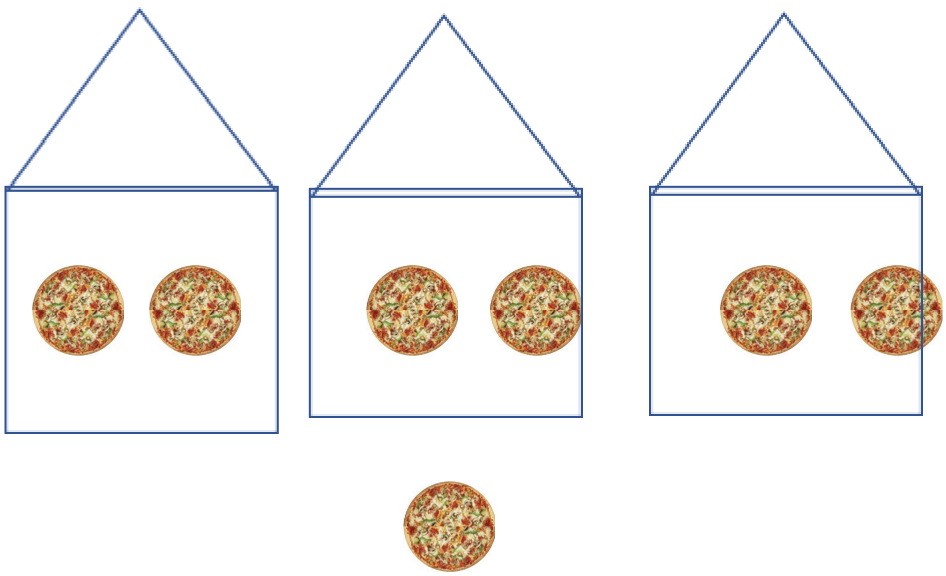
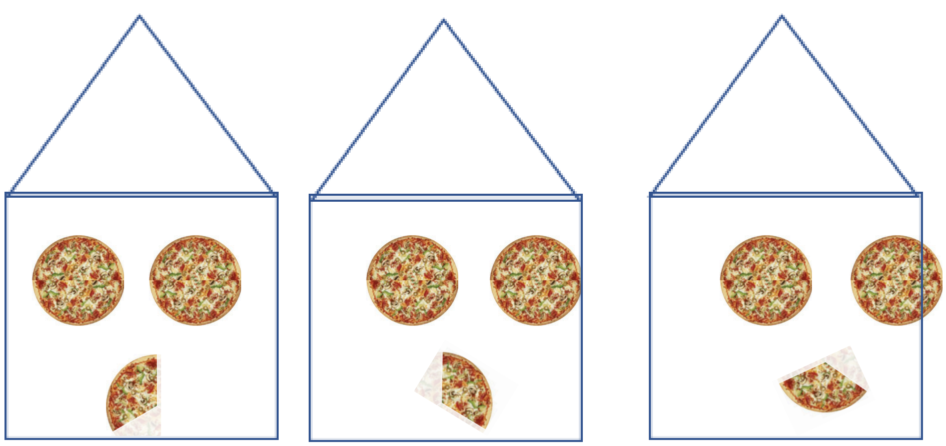
	15 minutes 10 minutes 5 minutes	Learners present the floor map to the parents. Parents will provide feedback to the learner ● What they love most about the floor plan ● Suggested areas of improvement The learner will use the feedback to revise the floor plan <u>Without using a calculator</u> - Learner calculates the overall area of the house using the floor map (by adding the areas of the different rooms or spaces inside the house) - Learner calculates the Perimeter of the house Present answers to one of the parents. Criteria for revision: - Followed the methods used in this lesson, or logically deducted an own method - The answers are correct
3	15 minutes	Introduction: Division is like distribution. Dividing 6÷3 is like distributing 6 candies to 3 children. If this is the case, how many candies will each child have? (give learners enough time to reflect about this question). If they give you an answer, ask them to explain how they got it. One possible process: Make 3 bags, one for each child:  Then start by giving every child 1 candy, and repeat again until you run out of candies:  The answer is 2 candies for every child. If you notice, division is about giving an equal share to everybody. Try distributing 15 candies to 3 children, how many will each get?

	30 minutes	(The learner to figure out. *Answer is 5*) Example: Distribute 7 pizzas in 3 families. How many will each family get?  7÷3= **2** Pizzas per family, with a **remainder of 1** **Pizza** Another way of solving this, is to actually cut the remaining pizza and distribute it evenly on the three families. So, 1 pizza cut into 3 equal shares will result in a fraction that is $\frac{1}{3}$  This way, the answer is written as $2\frac{1}{3}$ because each family got 2 whole pizzas and one third of a pizza.

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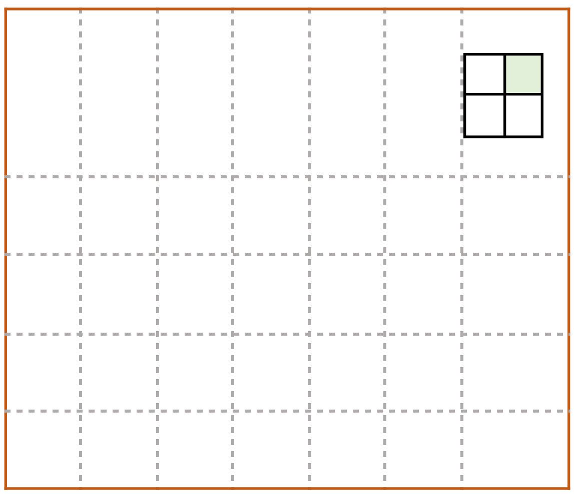
10 minutes

Solve the Day 3 Worksheet Question 1 without using a calculator.

Architects use the different measurements of the house to calculate the material needed to complete the house construction. For example: using the area, they can calculate how many tiles they need to cover the floor.
For example:

A room of L 7m and W 5m, is to be covered by square tiles of S= 0.5; how many tiles are required?



If you notice on the sketch above, each unit square will take 4 tiles of side 0.5.
So, the number of tiles can be calculated in 2 steps:

- First calculating the room Area = 7 x 5 = 35 squared m.
- Then multiplying the area by 4, 35 x 4 = 140 tiles.

15 minutes

Another Method

- First calculating the room Area = 7 x 5 = 35 squared m.
- Then calculating the tile area = 0.5 x 0.5 = 0.25
- Then dividing the Area of the room by the area of the tile: 35 ÷ 0.25
  As you know 0.25 is $\frac{25}{100}$
  35 ÷ 0.25 = 35 ÷ $\frac{25}{100}$ = 35 x $\frac{100}{25}$ = 35 x 4 = 140 tiles.

5 minutes

As you see above, we solved a division problem using multiplication.

	10 minutes	Now it is your turn to calculate <u>without using a calculator</u>: if you were to change the tiles in your house with square tiles of side 0.5 foot, how many tiles would you need? Show your solution and answer to one of the parents. Criteria: - The method is correct with logical steps - The answer is correct Solve Questions 2 and 3 on the **Day 3 Worksheet** <u>without using a calculator</u>, and show your work and answers to one of your parents
4	30 minutes 30 minutes 10 minutes 10 minutes	Learners will play a treasure hunt game with the family. Learners will hide 3 items around the house and will mark where they hid them on the floor map. They will ask 3 family members to find one of the hidden items each. If it were too easy, they can make it harder by hiding smaller items, and giving an approximate location. Learners will explore how we could help people navigate using verbal instructions. Learners will imagine how they would help a blind person who could not see the map. They will blindfold one of their family members and give them directions to go from one location to another in the house using the following verbal directions only: - Move (a number of) steps forward - Turn to the left - Turn to the right Questions for discussion with family members: - How good were your directions to guide the blindfolded member? Did you have to correct any of the directions you gave? Why? - How do you think boats navigate their way in the sea without using technology? - Imagine ways to help sailors navigate in the oceans when they are unable to see land. Hint: Learners can be prompted to look out into the sky and imagine the north star (the brightest star in the sky) and the direction that the sun rises (east) and sets (west). Literacy Extension and Final Reflection: Learners will write one paragraph about their key learning points about measurements, body parts (Non-standard units), how architects work, and/or how they intent to use the knowledge acquired in the project and share these with their family
		- The house floor map is accurate and clear

Assessment Criteria:	- Worksheet questions are answered correctly using methods and skills introduced in earlier activities - Learners are engaged and show grit while working on project tasks - Learners give good verbal instructions as directions
Additional enrichment activities:	Draw the floor map of another space (School, playground…) and calculate how many tiles it will require.
Modifications to simplify the project tasks if need be	Simpler version of this project can be to learn how to draw floor mapping of a rectangular space using simple conversion of Foot to Digit and counting the unit squares enclosed to find the Area.

Day 1 Worksheet

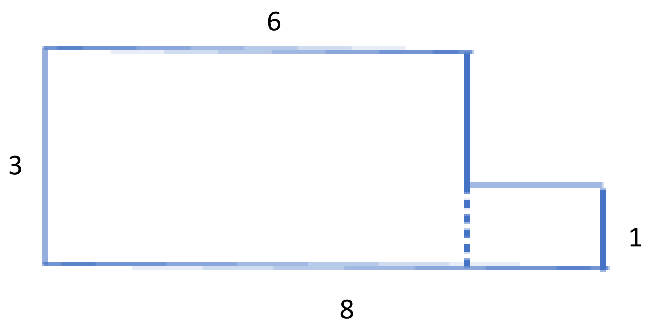
Answer the below questions without using a calculator

1. Draw a floor map of a room whose Length is 14 Feet, and Width is 12 Feet, using the scale 2 Foot is represented by 1 Digit

   Then find the area of this room in Squared Feet.

2. A rectangle has an area of 20 Squared Feet. Its Length is 5 Feet. What is its width?
   Hint: use the formula A = L x W,
   20 = 5 x ?

3. A rectangle has an area of 35 Squared Feet. One of its sides measures 5 Feet, can you find the measure of the other side?
4. Find the Area and Perimeter of the house in the sketch below. Each unit on the sketch represents 1 meter.



Day 3 Worksheet

Answer the below questions without using a calculator.

1. Find the answer to the below division problems.

9÷3=

18÷3=

18÷6=

12÷2=

13÷2=

24÷3=

25÷3=

11÷5=

23÷5=

17÷4=

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23÷6=

31÷5=

19÷2=

14÷3=

29÷6=

2. The perimeter of a rectangular room is 20 m. Its Width is 4 m, what is its Length?

3. A rectangular room is 12m by 7m. How many square tiles of side 0.5 m are required to cover the floor?

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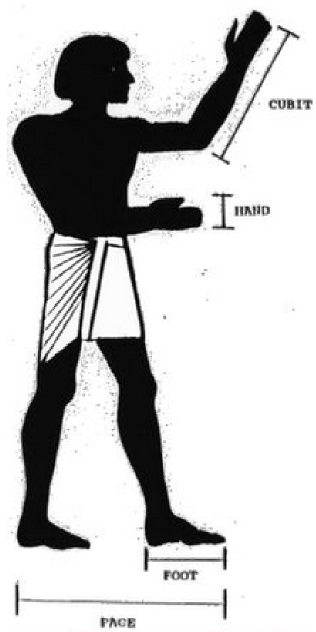
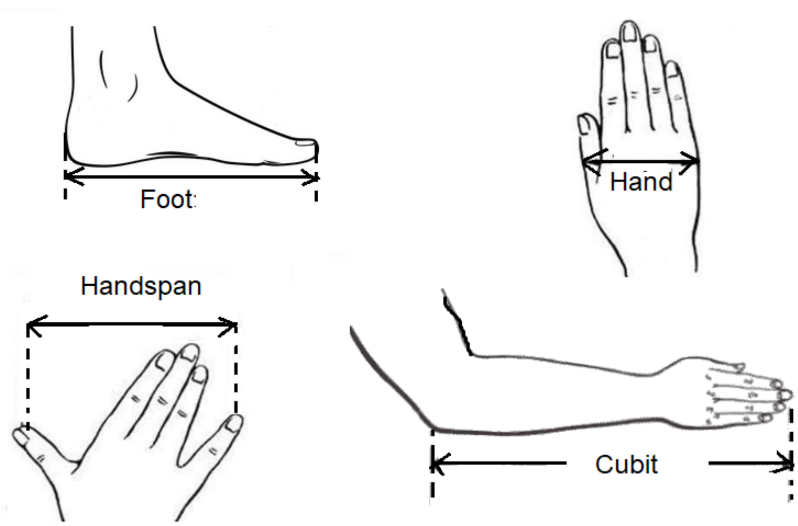
Ages 11 to 14 (Level 3)

Description:	Learners use body parts in scale drawing of floor plans and apply arithmetic operations to identify construction requirements.
Leading question:	How can you draw floor plan sketches, calculate areas and the required building materials using only your body parts as measuring tools?
Age group:	11-14-year-old
Subjects:	Mathematics
Total time required:	~6 hours over 4 days
Self-guided / Supervised activity:	Medium supervision by an adult
Resources required:	Paper and pencil, a ruler (for smaller measures), a tape measure (for larger measures)
Learning outcomes:	- Measurement of length using non-standard units - Scale drawing using simple conversions - Multiplication and its application to finding areas of rectangles - Dividing and applying division on word problems - Apply mathematical knowledge and skills in a real life scenario
Required previous learning:	- Multiplication and division of decimal numbers
Topics/concepts covered and skills developed	● Measurement of length using non-standard units ● Estimates ● Scale drawing ● Area of rectangles ● Division by multiplication ● Verbal directions ● Application of Mathematics in real life

Day	Time	Activity and Description
1	15 minutes	In this project, learners will learn how architects draw floor plans, and what methods they use to calculate the size of rooms or houses. Body parts (Non -standard units) used to measure objects Learners will use their body parts (non-standard units) to measure length. Ancient people measured objects using different body parts. This is called non-standard measurements. Measurement is finding a number that shows the size or amount of something.

		  Examples of non-standard units used by ancient people to measure length included: the **Foot**, the **Hand**, the **Handspan**, the **Cubit**, the **Digit**, the **Pace** etc. ● The **Cubit** is a measurement equal to the length from your elbow to the tip of your middle finger when your arm is extended. Egyptians mainly used their cobits to measure objects,

	10 minutes 5 minutes	● The **Foot** is a measurement equal to the length of your foot from the toe to the heel. King Henry I of England standardized this measurement to measure his foot which was 12 inches long. ● The **Handspan** is a measurement equal to the length from the tip of the thumb to the tip of the last finger when your hand is stretched out. ● The **Digit** is a measurement equal to a finger's breadth. Four digits equal to a **Palm** and five digits equal to a **Hand**. Greeks mainly used their fingers to measure objects. The Hand is still used to measure the height of horses. ● The **Pace** is a measurement of the distance from one step to another. The Roman Army used the Pace to judge speed. ● The **Fathom** is a measurement equal to the length between both your base fingers when you outstretch both your arms. The Fathom was used to measure the depth of water **Activity 1: Personal Measures** In this activity learners will measure their Cubit, Foot, Handspan, Digit, Palm, Hand, Pace, Fathom and those of two of their family members/friends and enter their findings in the table below. Learners will write down the measures in a table like the one below

Person	Personal Measure	Body part length (unit)
Learner	Cubit	
	Foot	
	Handspan	
	Digit	
	Palm	
	Hand	
	Pace	
	Fathom	
Family member 1	Cubit	
	Foot	
	Handspan	
	Digit	
	Palm	
	Hand	
	Pace	
	Fathom	

Family member 2		

- What do you notice from your findings?
- Is there any relation between the Handspan and the Cubit?

Among other, learners may notice from their findings that:

- Each person's body part unit is different from another's body part unit. This is the reason why measuring length using body parts units is referred to as measurement of length using non- standard units.
- The Handspan is about half the Cubit

15 minutes

Activity 2: Comparing measurements made using Body Parts (Non-Standard Units) to those made using Standard Units

In this activity, learners will use the Personal Measure (Body Parts) to measure different items and compare their results with those obtained using Standard Units Learners will write down the measures in a table like the one below

Item	**Personal Measure (Body part)**	**Estimate using a Personal Measure (cm or in)**	**Actual using a ruler or tape measure (cm or in)**
Length of a pencil	Digit		
Length of a foot mat	Foot		
Length from table to door	Pace		
Length of room	Cubits		

How close are the estimates obtained using Personal Measure to those obtained using a ruler or tape measure?

30 minutes

Activity 3: Measuring the dimensions of a room

For this activity, learners will use mainly the **Foot**, and the **Digit** which are non-standard units. Of course, you know that your foot size is smaller than the actual Foot unit used on measuring tapes (as different people have different foot sizes!)

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10 minutes

1. Pick one of the house rooms with a rectangular floor shape, preferably the smallest room in the house.
2. Stand on one corner of the room, and walk by the wall, step by step, to reach the other corner.
3. You must start with the back of your foot touching the wall behind, and then place the other foot right in front of and touch the other foot and keep counting your steps until you reach the facing wall.

4. Repeat with the 4 sides of the room, and write down the measures in a table like the one below

Room side 1	
Room side 2	
Room side 3	
Room side 4	

Is any of the sides equal in length to another side? Does this apply to all Rectangles?

In a rectangle, usually the measure of the longer side is called length (L); and the measure of the shorter side is called width (W).

On a piece of paper, you will draw a sketch of the room.

The room is much bigger than the sheet of paper, so architects usually draw a smaller sketch that looks like the actual room but smaller (something like how a photo of you looks exactly like you but smaller in size).

See below how to do it:

To do this, instead of using your Foot to draw the sides of the rectangle, you can use a smaller measure, like your finger: Digit.

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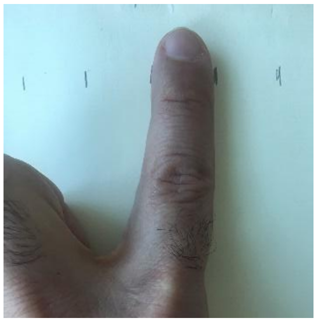
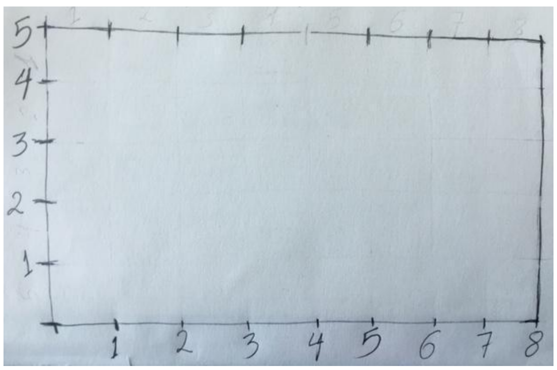


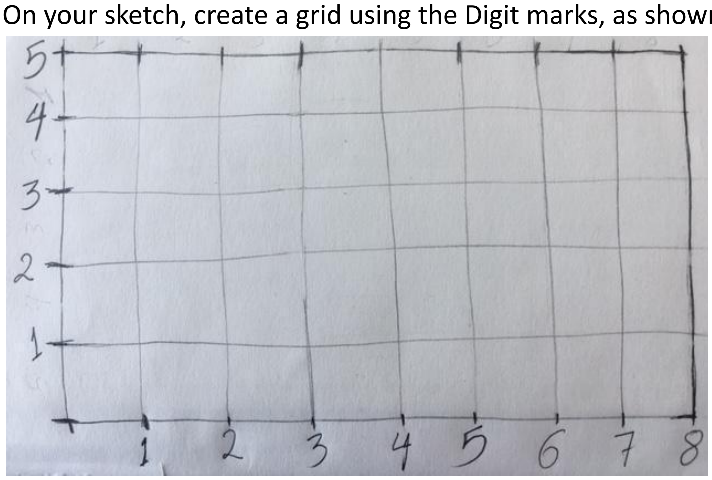
In the example below, see a sketch of a room whose Length L = 8 feet, and width W= 5 feet. The actual size of the sketch is 8 Digits by 5 Digits.



As you also notice, we don’t need to write the sizes of the other sides, as in a rectangle opposite sides are equal in size.

Now draw the sketch of the room on a sheet of paper.

On your sketch, create a grid using the Digit marks, as shown below:



Count the number of squares in your diagram.

		The number of squares inside the sketch is called the **<u>Area</u>** of the sketch. The **<u>area</u>** is the size of the floor surface inside a certain shape, which is the count of unit squares enclosed within. The Area of a rectangle = Length x Width So, if you know the length and width of a rectangle, you just multiply to get the Area without needing to sketch the diagram. In the example above, we saw that the sketch has 40 unit squares within, so its area is 40 **squared Digits**, and we conclude that the area of the room is 40 **Squared Feet**. Perimeter is the sum of all its sides. Perimeter is used to figure out the length of walls or fence needed to be put around the whole floor map. In the above room, the Perimeter= 8 + 5 + 8 + 5 = 26 Feet. Now look at your room and sketch, and find the below <u>without using a calculator</u>: - What is the area of your sketch? (in squared Digits) - What is the actual area of your room? (In Squared feet*) - What is the Perimeter of your room? (In feet) *Foot measure used here is the Learner's foot size and not the universal Foot scale. In scale drawing, you can choose any scale you like and mention that on your drawing. For example, in some maps the scale can be 1:10'000, which means that 1 cm on the drawing represents 10'000 cm = 100 meters in reality. Try to answer the questions on the Day 1 Worksheet <u>without using a calculator</u>. (Answer Key for Question 4: Area = 18.55 m^2, and Perimeter = 22.2 m; For Question 5: The Actual Area is 1500 m^2). Show your answers and discuss them with one of your parents based on the following questions:. ● What are the three most important things I have learned so far? ● What have I found difficult? What additional support do I need from my family to complete this project?
2		Today learners will draw a sketch of the house floor map using a **Digit** to represent 2 **Feet**. When doing this, Architects imagine that the roof of the house is transparent, and we draw the map as if we are looking at the house from the top like a flying bird.

	5 minutes	As an example, below is a simple floor map.  Source: https://www.tuko.co.ke/276066-3-bedroom-house-plans-designs-kenya.html What do you notice? Learners may notice that: - The walls are drawn on the map - There are some arcs to represent doors - The function of each room is marked (bedroom, kitchen, bathroom…)
	30-40 minutes	Learner will draw a floor map of the house up to the scale 5 feet : 1 digit ; and then present it to the family. Learners will try to ensure: ● The floor map is up to scale (every 5 Feet of actual measure are represented by 1 Digit) ● The map accurately represents the actual rooms of the house ● The name of each room or space is written on the map (like: bathroom, kitchen...etc.)
	5 minutes	Learners present the floor map to the parents. Parents will provide feedback to the learner ● What they love most about the floor plan ● Suggested areas of improvement
	10 minutes	The learner will use the feedback to revise the floor plan
	5 minutes	Learner will add the areas of the various rooms and internal parts of the house to find out the total livable area of the house. Learners attention that if the scale is **5 feet : 1 digit**, then each unit square on the sketch of dimensions 1 digit by 1 digit represents a square of 5 feet by 5 feet **1 squared digit on the sketch represents 25 squared feet in reality**.

	10 minutes	Learners calculate the Perimeter of the house using their floor map without using a calculator. Learners present answers to one of the parents. Parents will check to see if - Learners followed the methods used in this activity , or logically deducted an own method - The answers are correct Do you think if you measured the dimensions of the house from the outside, there will be any difference from the measurements you made on the inside? Learners answer and explain. In fact, the overall house area includes the area occupied by walls, which is usually overlooked when just adding the inside areas of the rooms. Let's try to calculate or estimate how much area do internal walls actually take, which is the space they take off the floor map because of their thickness. Try to measure the thickness of one of the internal walls of the house by placing your foot next to the wall against the internal thickness part as shown in the photo below:  The wall thickness is around 4/5 or 0.8 Foot, so in the example below, you can see that there are 8 internal walls (we do not count the external walls if all our measurements were done inside the house). Let's say we measured the lengths of all internal walls and it was 50 feet. Hence, the area that the internal walls occupy is equal to 50 x 0.8 = 40 squared feet! Therefore, the actual internal Area of the house is: internal Area of rooms + Area of walls. In the example below, assume the sum of all room areas is 650 Sq. Ft, we must add to it 40 Sq. Ft to count the area of internal walls, hence the internal area of the house is 690 Sq. Ft, out of which the liveable area is 650 Sq. Ft. In this case the livable area is 94% of the total internal area: $\frac{650}{(650+40)}$ x 100

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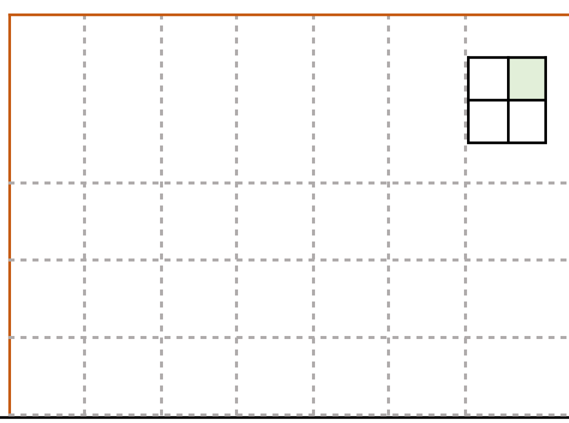
	10 minutes 5 minutes	 <u>Without using a calculator</u>, do the following: - Calculate the areas of the internal walls of the house. - Add this to the livable are to find out the Total internal area of the house - What percentage is the Livable Area out of the Total Internal Area? If we measure the house dimensions from outside, what do we need to subtract from it in order to find out the actual livable area?
3	10 minutes	Today, learners will make some calculations for the material that was required to construct their house. After knowing the area, Architects can calculate how many tiles they need to cover the floor, and hence make the order. For example: A room of L 7m and W 5m, is to be covered by square tiles of S= 0.5; how many tiles are required? 

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		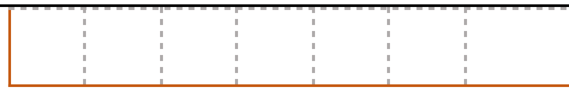 If you notice on the sketch above, each unit square will take 4 tiles of side 0.5. So, the number of tiles can be calculated in 2 steps: ○ First calculating the room Area = 7 x 5 = 35 m^2. ○ Then multiplying the area by 4, 35 x 4 = 140 tiles. Another Method ○ First calculating the room's internal Area = 7 x 5 = 35 m^2. ○ Then calculating the tile area = 0.5 x 0.5 = 0.25 m^2 ○ Then dividing the Area of the room by the area of the tile: 35 ÷ 0.25 As you know 0.25 is $\frac{25}{100}$ 35 ÷ 0.25 = 35 ÷ $\frac{25}{100}$ = 35 x $\frac{100}{25}$ = 35 x 4 = 140 tiles. (As you see above, we solved a division problem using multiplication.) For the cost of tiles, it is usually sold per square meter, for example if the tiles are sold for 3$ per m^2, then the tiles to cover the room in this example would cost: 35 x 3 = $105.
	15 minutes	Now it is your turn to calculate <u>without using a calculator</u>: if you were to change the tiles in your house with small square tiles of side 0.5 foot, how many tiles would you need? And how much would that cost, if the tiles are sold at $0.3 per Sq foot? Show your solution and answer to one of the parents. Criteria: - The method is correct with logical steps - The answer is correct
	30 minutes	Solve the **Day 3 Worksheet** and show your work and answers to one of your parents.
	15 minutes	If we were to estimate the amount of paint required for the walls and ceiling of the room, in the previous example, we need: - The dimensions of the room: Length, Width and Height. - The dimensions of any doors or windows - We estimate that 1 L of wall paint covers 10 m^2, or 100 Sq feet.

	30 minutes 5 minutes	Let's assume that we have a room of dimensions Length 7m, Width 5m, & Height 2.5 m. The room has 1 door and 1 window whose area adds up to 4 m^2. Find out how many L of paint it requires, if we apply 2 coats of paint, and what would that cost if the paint is for \$3.5 per L. To solve this problem, we follow the below steps: - The total area that requires painting: - Ceiling: is same as floor L x W = 7 x 5 = 35 m^2 - Area of walls, after taking out the areas of doors and windows: ○ Wall 1: 7 m x 2.5 m ○ Wall 2: 5 m x 2.5 m ○ Wall 3: same as Wall 1 ○ Wall 4: same as Wall 2 ○ Area of walls = 2x(7x2.5) + 2x(5x2.5) – Area of doors and windows • = 35 + 25 – 4 = 56 m^2 - To calculate the amount of paint required, we divide this area by the estimate of 10 m^2/L : ○ 56 m^2 ÷ 10 m^2/L = 5.6 L of paint for one Coat ○ For 2 coats we need 2 x 5.6 L = 11.2 L - The cost of that is 11.2 L x 3.5 \$/L = 39.2 \$ Now it is your turn to calculate **without using a calculator**: if you were to paint all the walls and ceiling of your house from the inside, how many liters of paint are required (for 2 coats)? And how much would that cost? Assuming that 1 L of paint covers 100 Sq Ft for a single coat, and costs \$3.5 per L. Show your solution and answer to one of the parents. Criteria: - The method is correct with logical steps - The answer is correct or reasonable
4	20 minutes 20 minutes	Learners will play a treasure hunt game with the family. Learners will hide 3 items around the house and will mark where they hid them on the floor map. They will ask 3 family members to find one of the hidden items each. If it were too easy, they can make it harder by hiding smaller items, and giving an approximate location. Learners will explore how we could help people navigate using verbal instructions. Learners will imagine how they would help a blind person who could not see the map. They will blindfold one of their family members and give them directions to go from one location to another in the house using the following verbal directions only:

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		- Move (a number of) steps forward - Turn to the left - Turn to the right Learners hide an item somewhere in the house. They write down the verbal instructions that a person needs to get from a certain location, to where that thing is hidden. Then they blindfold a family member and give the written instructions to another member to read it out loud for the blindfolded member to reach the location and find the hidden item. *Note: The learner must be aware that if the blindfolded person could not find the item, it is their instructions to blame. Hence, they need to re-write their instructions and repeat until the blindfolded person finds the hidden item. Questions for discussion with family members after the Treasure hunt game: - How good were your directions to guide the blindfolded member? Did you have to correct any of the directions you gave? Why? - How do you think boats navigate their way in the sea without using technology? Imagine ways to help sailors navigate in the oceans when they are unable to see land. Hint: Learners can be prompted to look out into the sky and imagine the north star (the brightest star in the sky) and the direction that the sun rises (east) and sets (west). Tip: If learners have access to a compass, the parent can mention how helpful it can be for navigating in the sea. Literacy Extension and Final Reflection: Learners will write 2 or 3 paragraphs about their key learning points about measurements, body parts (Non-standard units), how architects work, and/or how they intend to use the knowledge acquired in the project and share these with their family.
Assessment Criteria:		- Worksheet questions are answered correctly using methods and skills introduced in earlier activities - All calculations are done without using a calculator. (A parent may use a calculator to verify answers) - Learners are engaged and show grit while working on project tasks - The floor map is accurate and clear

Additional enrichment activities:	- Draw the floor map of another space (School, playground…), and calculate how many tiles and liters of paint it requires.
Modifications to simplify the project tasks if need be	- Simpler version of this project can be to learn how to sketch floor maps of a rectangular space using simple conversion of Foot to Digit, and then using the sketches to calculate Areas and Perimeters.

Day 1 Worksheet

Answer the below questions without using a calculator

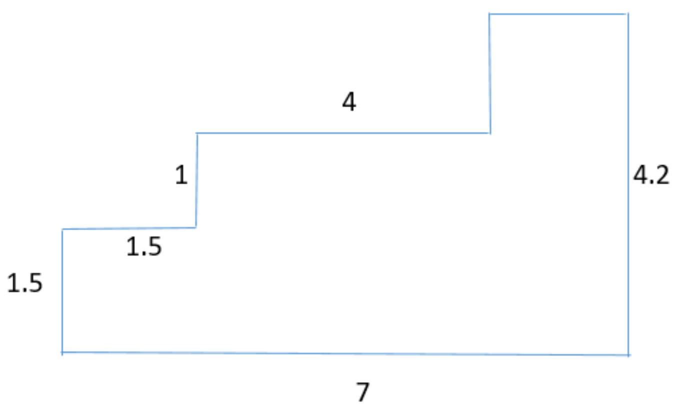
1. Draw a floor map of a room whose Length is 14 Feet, and Width is 12 Feet, using the scale 2 Foot is represented by 1 Digit

   Then find the area of this room in Squared Feet.

5. A rectangle has an area of 20 Squared Feet. Its Length is 5 Feet. What is its width?
   Hint: use the formula A = L x W,
   20 = 5 x ?

6. A rectangle has an area of 35 m^2. One of its sides measures 5 m, can you find the measure of the other side?

7. Find the Area and Perimeter of the shape in the sketch below. Each unit on the sketch represents 1 meter. All lines intersect at 90 degree angles. (The shape is not drawn to scale, so don't use measurements to identify missing lengths, but calculate them using opposite side lengths).



8. On a drawing of scale 1 :1000, the area of a rectangular piece of land if 15 cm^2. What is the actual area of this land in m^2 ?

Day 3 Worksheet

Answer the below questions without using a calculator

4. A rectangular room is 12m by 7m. How many square tiles of side 0.5 m are required to cover the floor?

5. a. The perimeter of a rectangular hall is 36 m. Its Width is 6 m, what is its Length?

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b. How many square tiles of side 0.3 m are required to cover the floor of the room?

c. What will be the cost of the tiles if they are for \$4.5 per m^2 ?

6. A square room has an internal perimeter of 26 m. Find out how many square tiles of side 0.25 m are required for its floor, and the cost if you were to use tiles sold at \$5 per m^2 ? (Hint: first identify the side length, then the area of the room, and last calculate the number of tiles).

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