The Vigyan Pratibha Project

Towards Students' Deeper Engagement in Science and Mathematics

http://vigyanpratibha.in

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What is Vigyan Pratibha?

- A talent nurture and exposure programme in science and mathematics for Class 8, 9 and 10 students.

- Target schools: Kendriya Vidyalayas, Navodaya Vidyalayas and AECS schools (~ 1700 schools), State Govt. schools

Nurture dimension

“Science circle” activities by school teachers ~100 hours in a year (students attend voluntarily on the basis of interest).

Exposure dimension

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75% of students accessing exposure activities will be from disadvantaged groups identified on the basis of defined criteria: location, language, parents' education, socio-economic status, gender, etc.

What makes Vigyan Pratibha different?

- Extended nurture
- Not top-down, done in partnership with teachers and schools:
  - Teachers will be continuously supported by peers and experts
- Underlying wholistic vision of science and mathematics education
- Multi-agency effort backed by DAE and other Govt. agencies (partner institutions such as SINP, IMSc, IOP, etc.)
- HBCSE's will contribute its expertise developed over decades of work in Science, Technology and Mathematics Education (STME).

Vigyan Pratibha Learning Units (LUs)

- Modules for learning a set of concepts/skills/reasoning competencies
- Incorporate different pedagogies
- Adapted to the syllabus and learning abilities of age groups, but having the capacities to take students to deeper levels of learning
- Bringing contexts to content
- Incorporate necessary elements of holistic science education
  1) An experience of the systems under study
  2) Knowing the observables
  3) Analysis of observables leading to theories, concepts
  4) Showing how theories have led to practices
  5) Discussing effects of practices

24 LUs for Class 8

Adolescence and Gender

Colouring a Map

Twists in the Fibers

Cleaning Copper

Making a Map

Thirsty Crow
and the water

Milk to Curd

Koehnisberg's Bridges

Euclid's Game

3D-Birds

Components of Ash

Know your Rice

Diffusion across surfaces

Area and Perimeter

Shadows

Congruence of triangles

Magnets

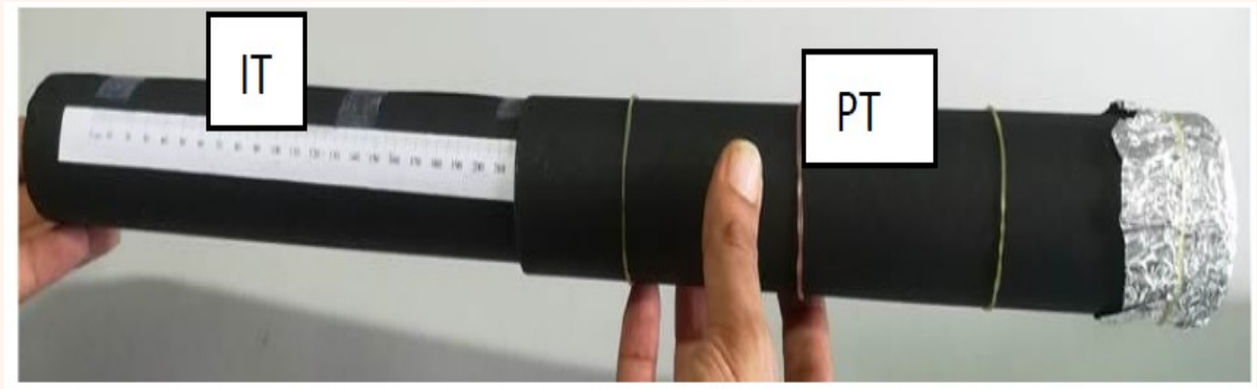
Pin-hole Camera

Phases of Moon

Microorganisms
at your
doorsteps

Parallax and Reflection

Pin-Hole Camera



- Easy to build and to know that you can study optical processes with just paper and glue (without any optical devices).
- Historically and Pedagogically very useful in development of concepts in optics.

Object

Image in pinhole camera.

Micro-organisms at your Doorsteps

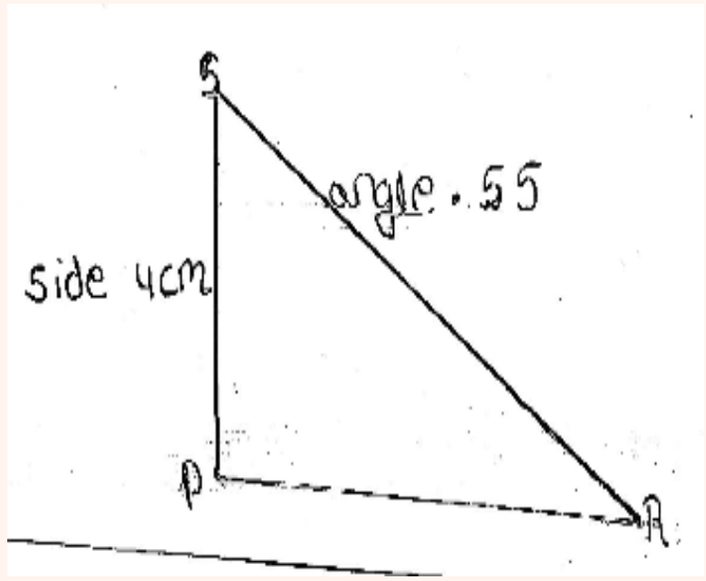
- Shows the possibility to observe a large diversity of micro-organisms **alive** in surroundings instead of dead specimens.
- Major challenge: handling of microscopes (sometimes sterile environments/season).

Congruence Conditions

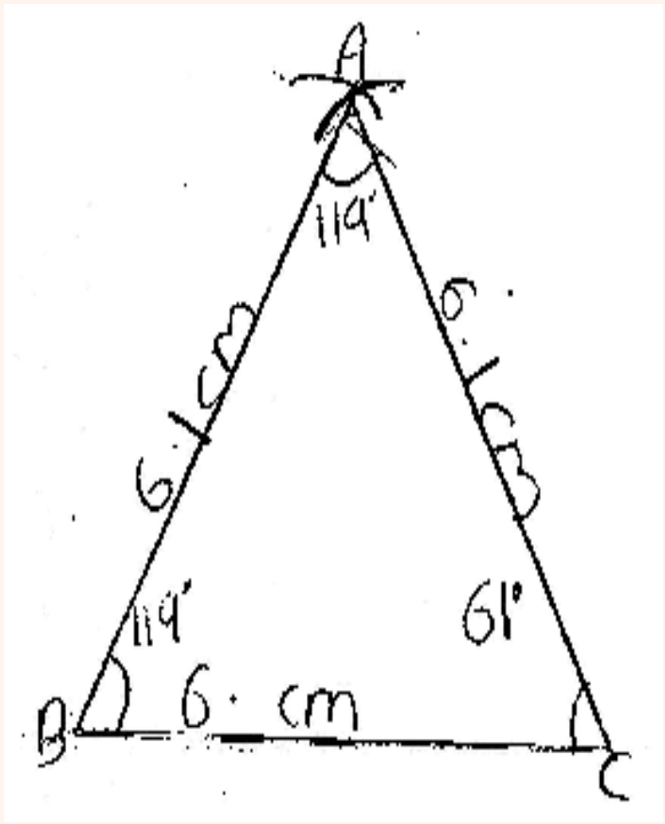
- Arriving at why minimum three conditions are needed to construct a unique triangle.
- Understanding the relationship between constructing a unique triangle and congruence conditions.
- Figuring out conditions needed for congruence of quadrilaterals.
- Arriving at an explanation for minimum conditions needed for any polygon.

What we learnt from the trials

- Children had trouble naming sides and angles



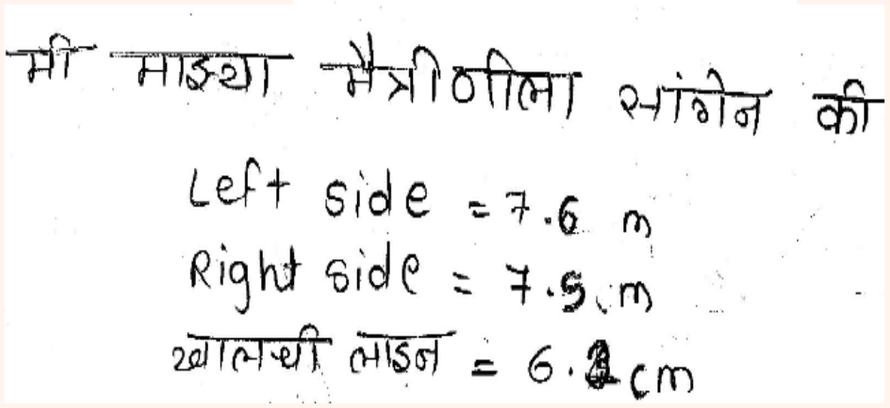
- Children had difficulties in measuring angles



Some interesting student responses

Name	Sides	
Triangle	3	3
Quardrilateral	4	5
Pentagon	5	7
Hexagon	6	9
Octogon	8	13

← Minimum Number of Conditions

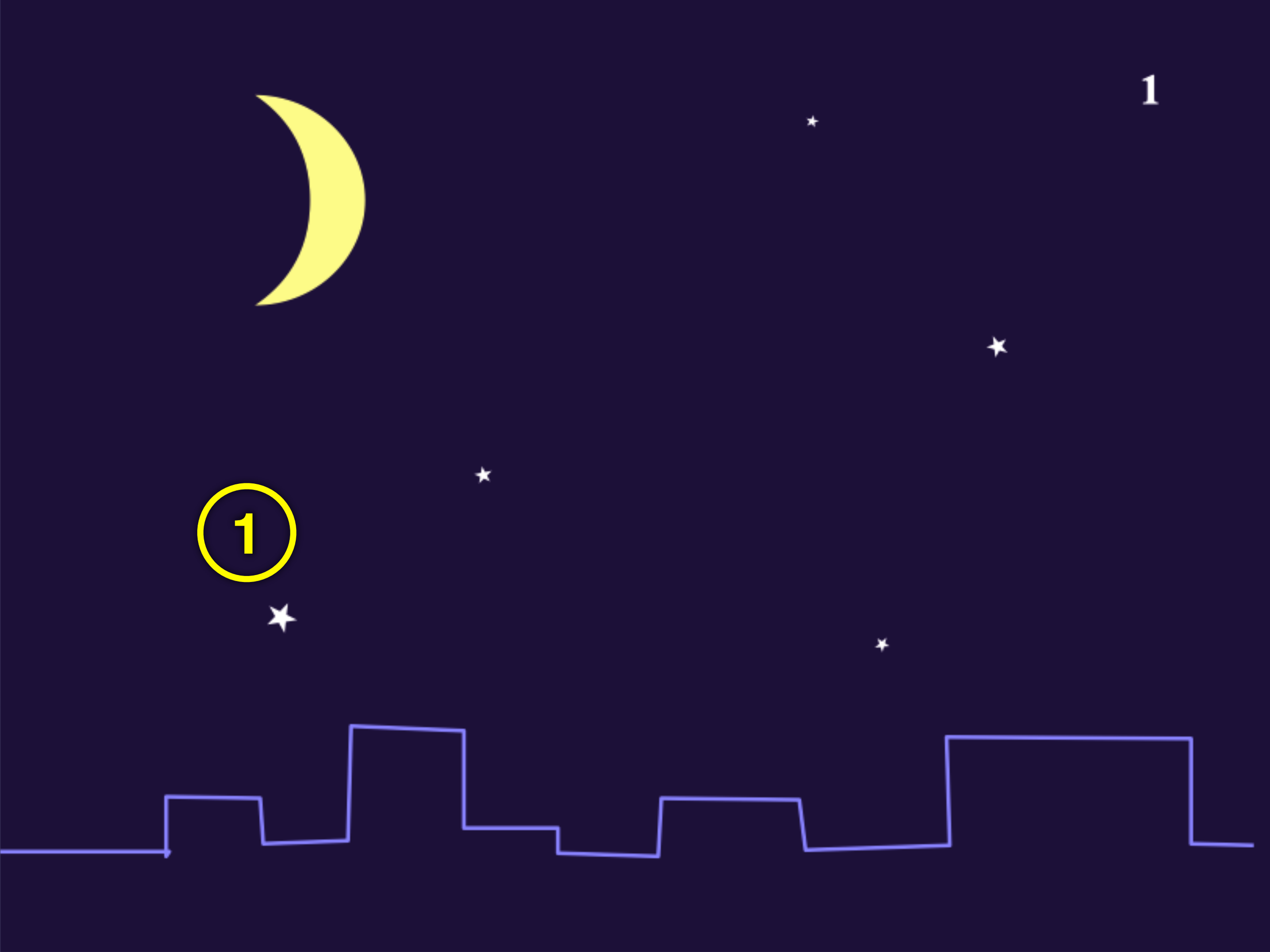



SUB : Biology

A challenge:
Getting children to think

- Vigyan Pratibha is a programme that encourages curiosity, exploration, thinking…
- How do we use students' thinking in teaching?
- What is thinking?
- Do students think in the classroom?

What is thinking?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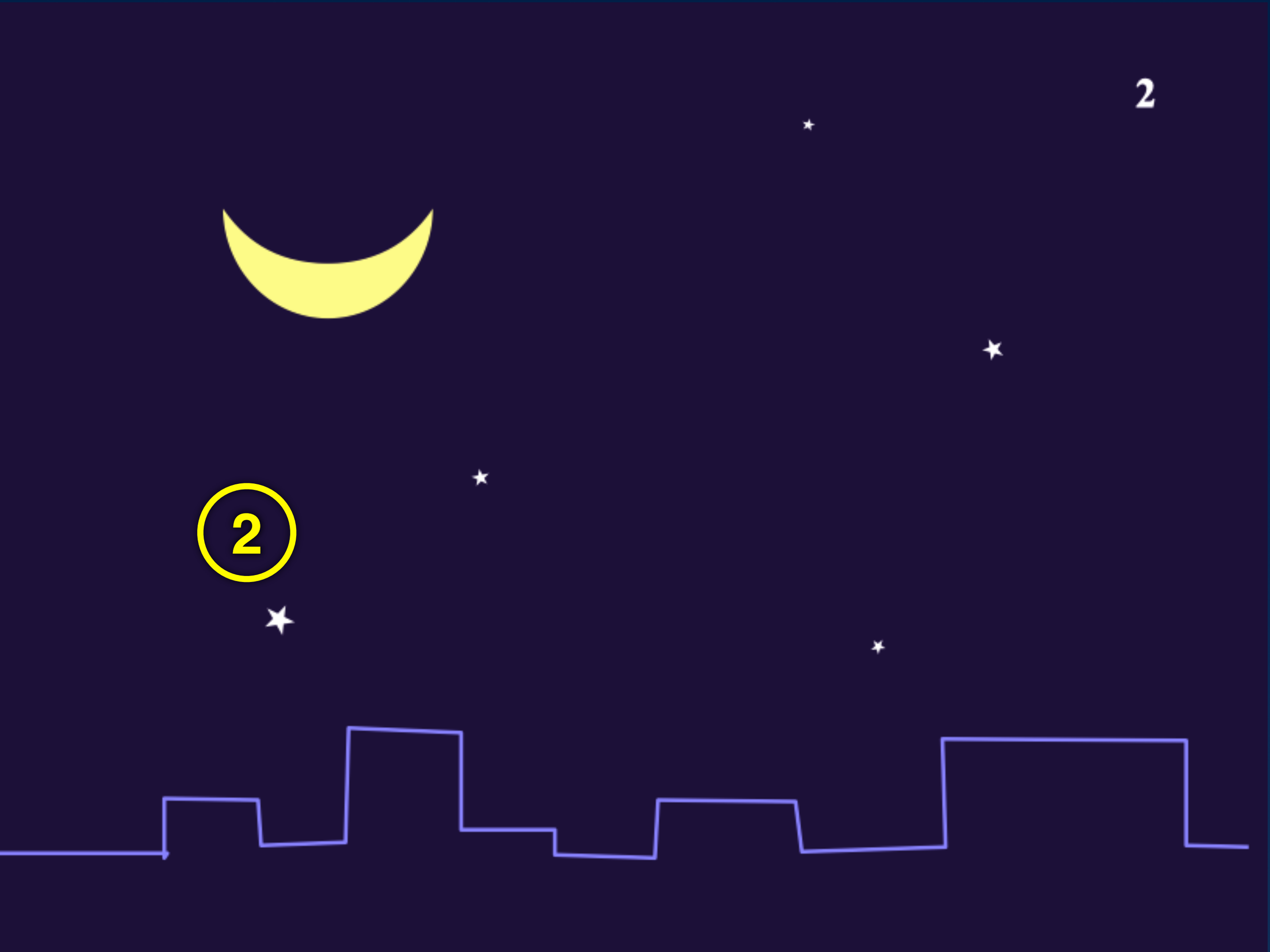
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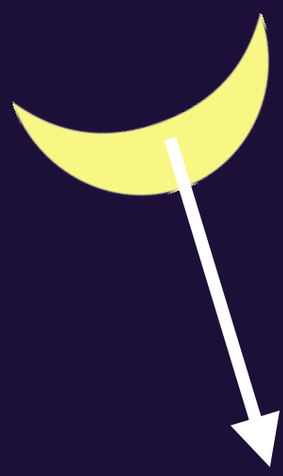
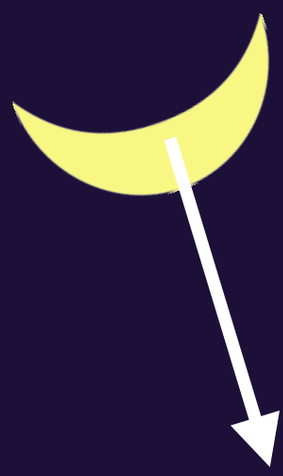
2

- Poll 1: Which picture (picture 1 or picture 2) is closer to what you actually see in the sky?





Anaxagoras, Athens, ~400 BC

“Moon shines by the reflected light of the sun”

Some elements of thinking

- Observing – noticing a pattern (Curiosity)
- Describing the pattern; confirming it (Articulation/ language)
- Imagining
- Coming up with an explanation (reasoning)
- Checking the explanation (reasoning)

Some elements of thinking

- Curiosity
- Articulation/ language
- Imagination
- Reasoning
- Some other aspects: asking a question, probing for unstated assumptions, examining the concepts one uses, etc.

Do students think in the classroom?

Example: Finding the right partitioning

Here is a problem for you.

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Rules:

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- Do not speak out the answer!

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A farmer had hens and goats. He counted 50 heads altogether and 144 legs. How many hens and how many goats did he have?

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- Let us say 25 hens (50 legs) and 25 goats (100 legs). You get 150 legs. Too many legs. So too many goats.
- Let us try 30 hens (60 legs) and 20 goats (80 legs). You get 140 legs, which is just a little less. So we need one or two more goats.

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- Is it 21 or 22 goats? (At this point it is easy to calculate and check.)

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- Is it 21 or 22 goats? (At this point it is easy to calculate and check.)
- This approach is not very efficient and calls for only minimal mathematical thinking.

You are not supposed to use algebra!

The algebraic approach:

- Let the number of hens be *x* and the number of goats be *y*.

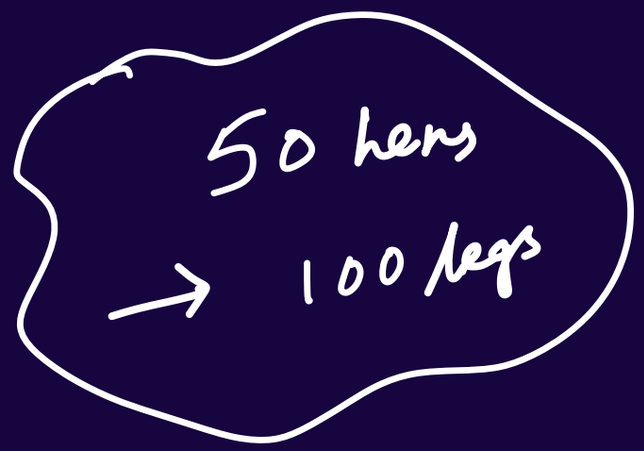
$x + y = 50$

$2x + 4y = 144$

Therefore, ...

Reasoning using just arithmetic

Suppose the farmer had only hens.



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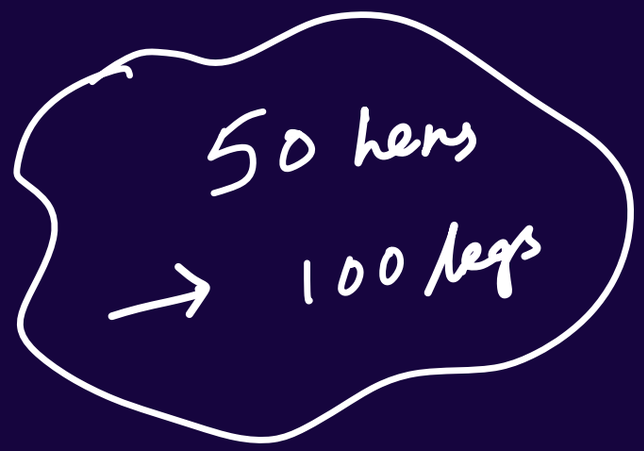

- You have 44 legs less than required.
- If you exchange a hen for a goat, you are exchanging 2 legs for 4 legs.

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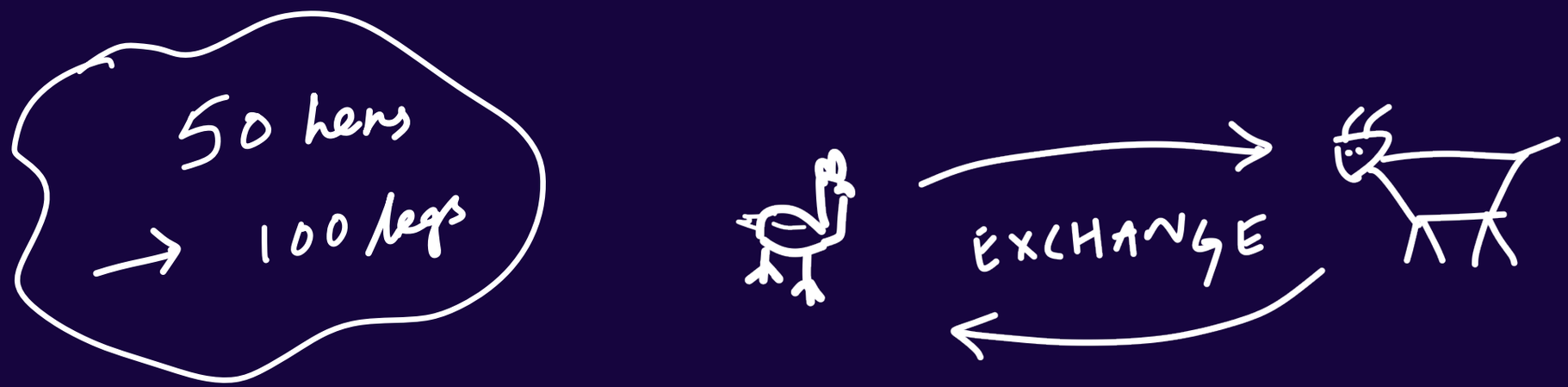

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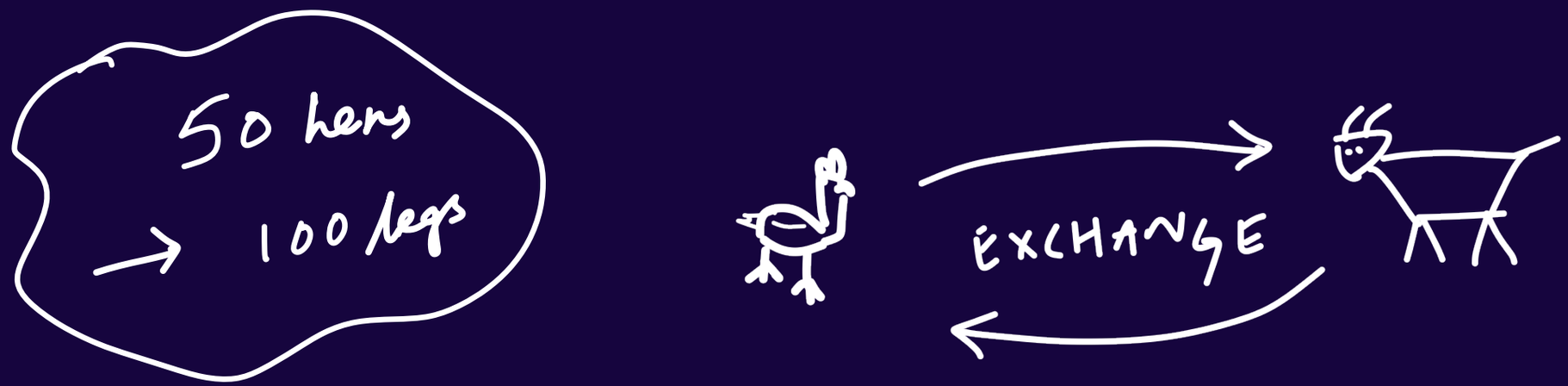

- You have 44 legs less than required.
- If you exchange a hen for a goat, you are exchanging 2 legs for 4 legs.
- And you get 2 extra legs!
- If you exchange 22 hens for 22 goats, you get 44 extra legs!

Example of a student's reasoning

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- So the remaining 44 legs are hind legs (or "back" legs).

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- Let us count the hen's two legs and only the two front legs of the goat.
- This gives us 100 legs.
- So the remaining 44 legs are hind legs (or "back" legs).
- So there are 22 goats. Remaining are hens.

A nice example of student's thinking!

- It was creative, clever and the argument was elegant.
- It was not abstract. Rather, it was based on concrete objects.
- But it had a mathematical element. One might describe it as finding the right, or the most useful partitioning.
- And also finding the right words to make the argument clear and convincing.
- Note that if the teacher had directly imposed the algebraic approach, this thinking may not have emerged.

An example from classroom teaching (Class 6)

683.12

Hundreds, tens, ones, (.) tenths, hundredths

Thanks to Shikha Takker! This example is taken from her work.

Takker, S., & Subramaniam, K. (2019). Knowledge demands in teaching decimal numbers. *Journal of Mathematics Teacher Education*, 22(3), 257-280.

A student's question

- **Year 1:** A teacher introduces place values in decimal numbers through an analogy with whole numbers. Recalls whole number place values, prompts for decimal place values.
    - Student 1: "Oneths"
    - Student 2: "Oneths" *nahi hota chal*
    - Teacher: [Appears to ignore, moves ahead.]
- **Year 2:** a similar episode
    - Student 1: Ma'am, "oneths" *kyun nahi hota hai*?
    - Teacher: … Nikita is asking why is oneths not there?
    - Student 2: Ma'am, *hota hai.*
    - A long discussion ensues on why "oneths" are not there.

The example

683.12

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Student's question: Why is there no (distinct place) for "oneths"?

Our questions: Why are the students asking this? Is it important to respond in detail?

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Poll 2: Are there "oneths" in a decimal number?

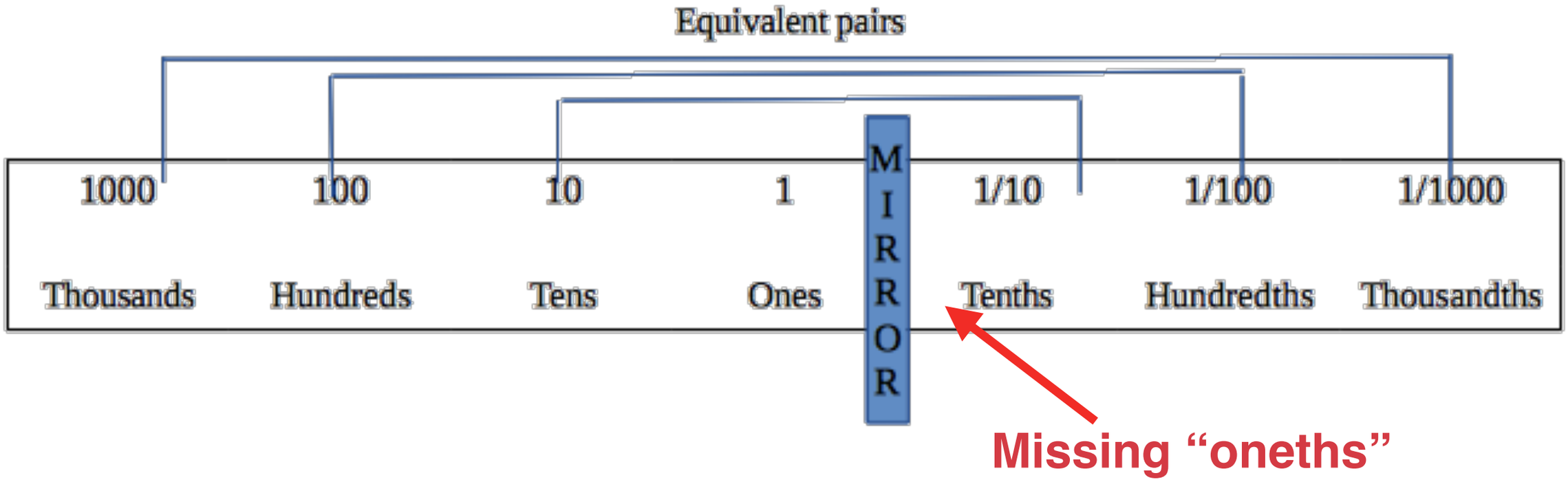
Why are there no “oneths”

- In order for the teacher to deal with the student’s question, the teacher needs to draw on two kinds of knowledge.

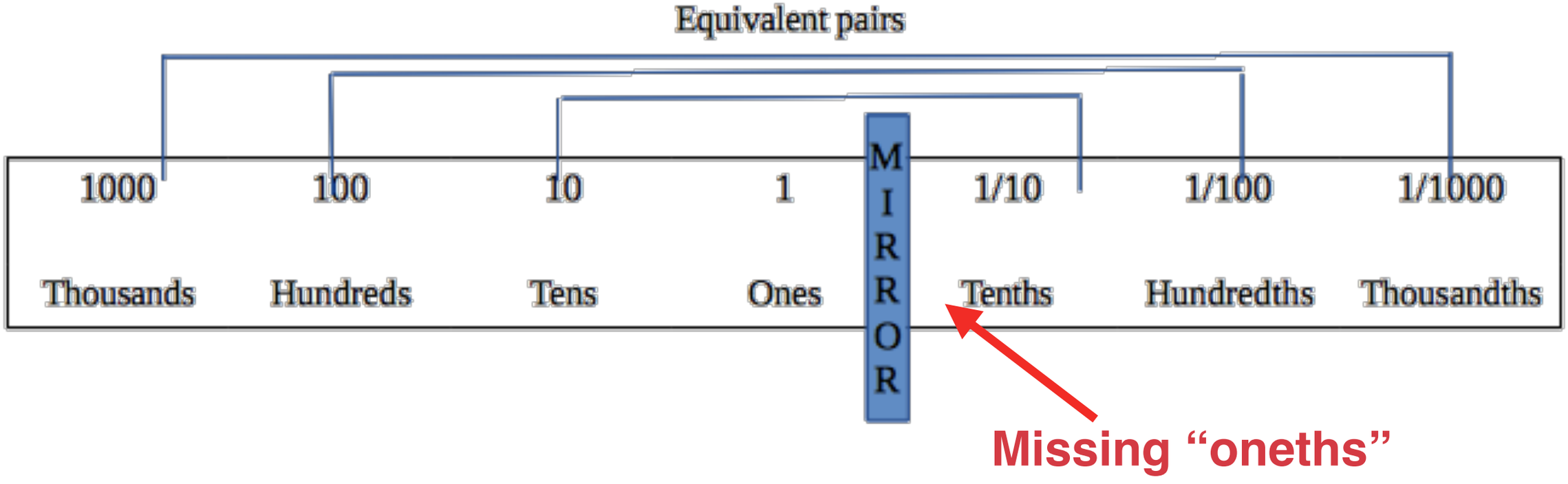
- Part is knowledge about the way students think.

- Part of the knowledge is mathematical.

- Shulman: The amalgam of pedagogical and content knowledge is Pedagogical Content Knowledge (PCK).


Equivalent pairs
1000
100
10
1
MIRROR
1/10
1/100
1/1000
Thousands
Hundreds
Tens
Ones
Tenths
Hundredths
Thousandths
Missing “oneths”

6 8 3 . 1 2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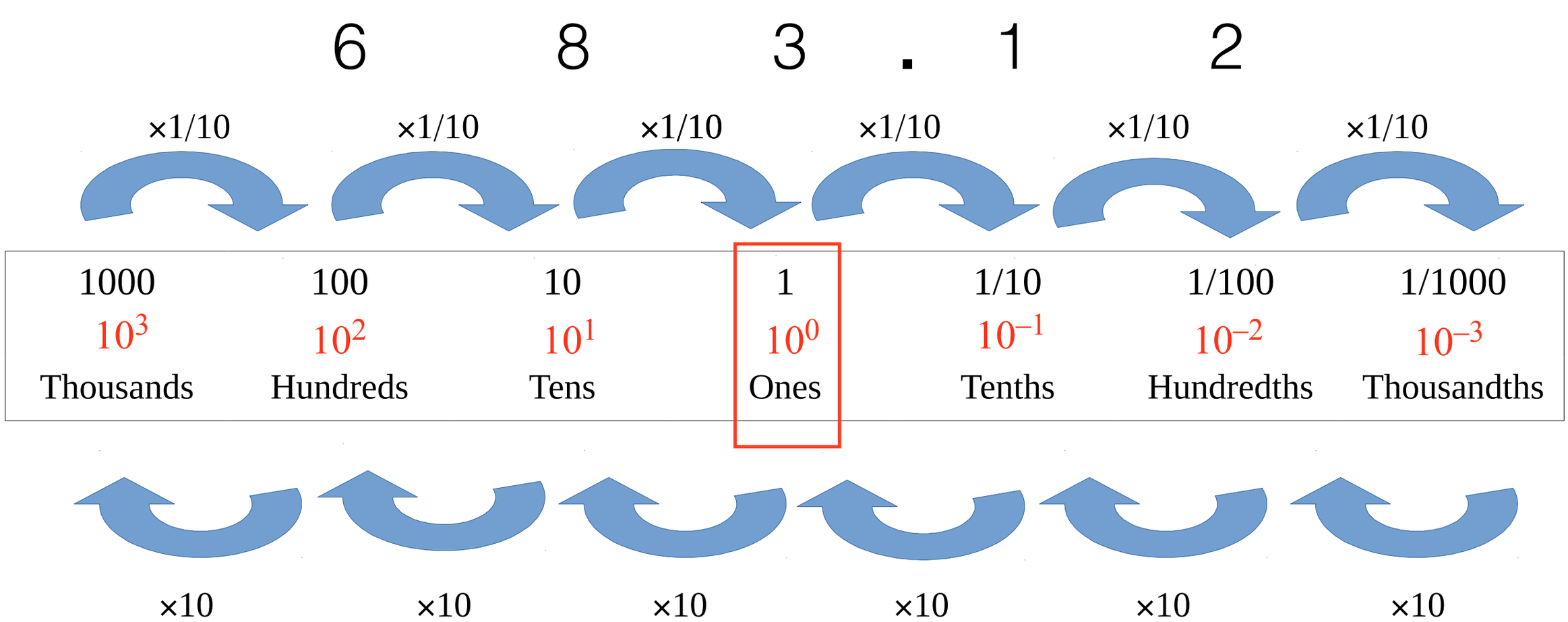
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Ones
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Tenths
1/100
10^{-2}
Hundredths
1/1000
10^{-3}
Thousandths
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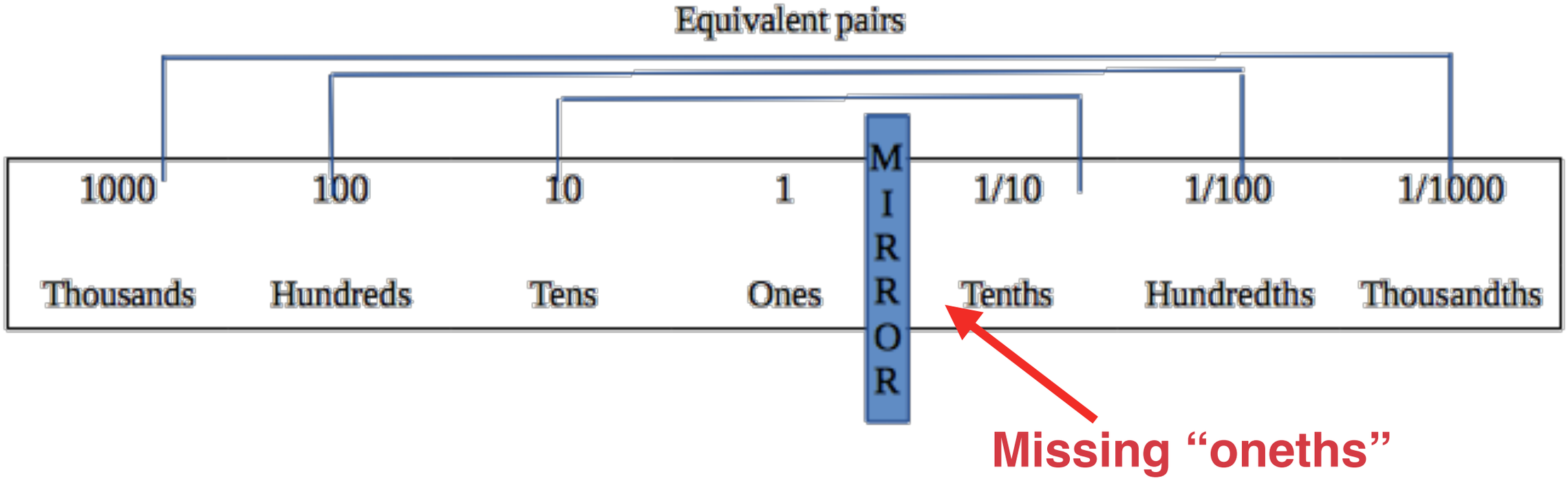
What actually happened

- The teacher did not deal with the students' question in the first year.
- In the second year, the teachers posed the question back to the students.
- The students had their own ways of explaining why there are no "oneths".
- Suppose there are "oneths".

  - 7 oneths would be the same as 7/1 (Because 1 tenth is 1/10).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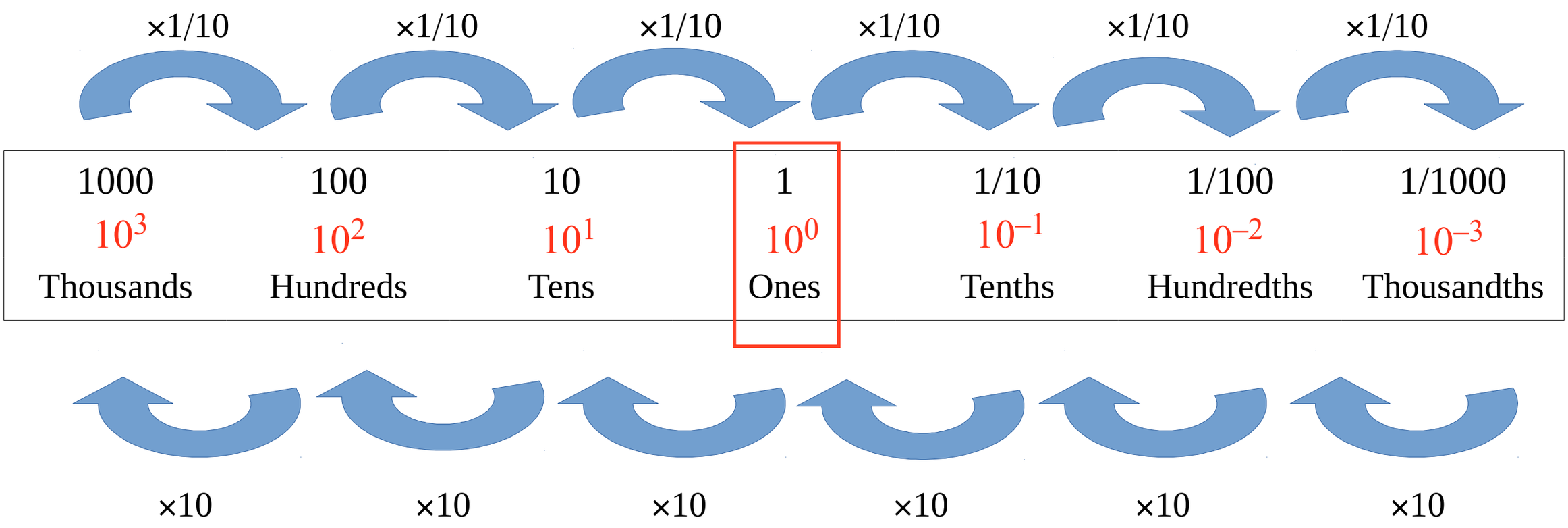
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Thank you!

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