ClassRoom

π Enters the 5th Class

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I write this to tell myself that it was not a dream …

This past year, I taught a bunch of fifth standard kids in Sahyadri School KFI (Krishnamurti Foundation India), who, like all others of their age, were high-energy kids; they were willing to explore but found it difficult to sit down in one place. I had a great relationship with them. The air in the classroom was of love, trust and wonder!

We did all we could with newspaper cutouts of squares and rectangles to explore the relation (if any) between area and perimeter. (We also used biscuits as part of this exploration, but more about that on another day.) An exciting 40 minutes of measuring area and perimeter of different squares and rectangles ended with "Hurry up! Let's go to the Assembly, quick," when one voice was heard, "but what about Circles, Akka?"

That was a trigger good enough for me to get into action mode.

I cut out about 50 colorful circles of different sizes from old magazine sheets using circular plates, bottle caps, and such objects available (there was no compass used); borrowed thread from the Art room; took a few half-meter scales from the physics lab; and was in the class with an objective to measure the Perimeter of the Circle.

The steps followed during this exploration were:

1. Each kid took two circles, the size and color being their choice.
2. Using the 50 cm scale and jute thread, each child measured the boundary – the "Perimeter" of the circle.
3. I introduced the word "Circumference." (Even at this point, there was no clue as to what was in store for us – to either the teacher or the student.)

A question is raised, "Akka, what else should we measure?"

Keywords: Perimeter, circle, circumference, diameter, ratio, pi, investigation, pedagogy

A pin drops in my head …

"Can we find the length of the longest line in a circle?"

"How Akka?"

Let us try …

One innovative mind, "Fold the circle and we will get it, Akka!"

"I know Akka, that's a diameter …"

My own innovation kicks in and I make a 23 × 5 table on the black board with all their (a fifth standard class of 23 children) names written, just like what you can see here.

S. No.	Name	Boundary of the circle (A)	Longest line (B)	$A \div B$

4. "Children, please measure the length of the longest line within the circle…"
5. "Divide the length of the boundary of the circle by the length of the longest line."
6. "Come to the black-board and write down your measurements."
7. "Do the division and write down the quotient in the appropriate column against your name, beside the measurements you have already written."
8. "Please write the same table in your notebook."

The table created interesting observations; there were many kids who wanted to express their thoughts:

1. Why do we all have '3.' something?
2. Why do I have a recurring decimal?
3. Akka, did you measure the circles first and then cut them?
4. Is my division correct?
5. Can we cut circles on our own?
6. Check my division, Akka, it just doesn't seem to end…

And so on …

That was the Eureka moment.

A 10-year-old had discovered the value of π for herself…

In the next class, we spoke about π to an extent and the mistakes that happen during the measurement of Perimeter. That was one WOW class…!

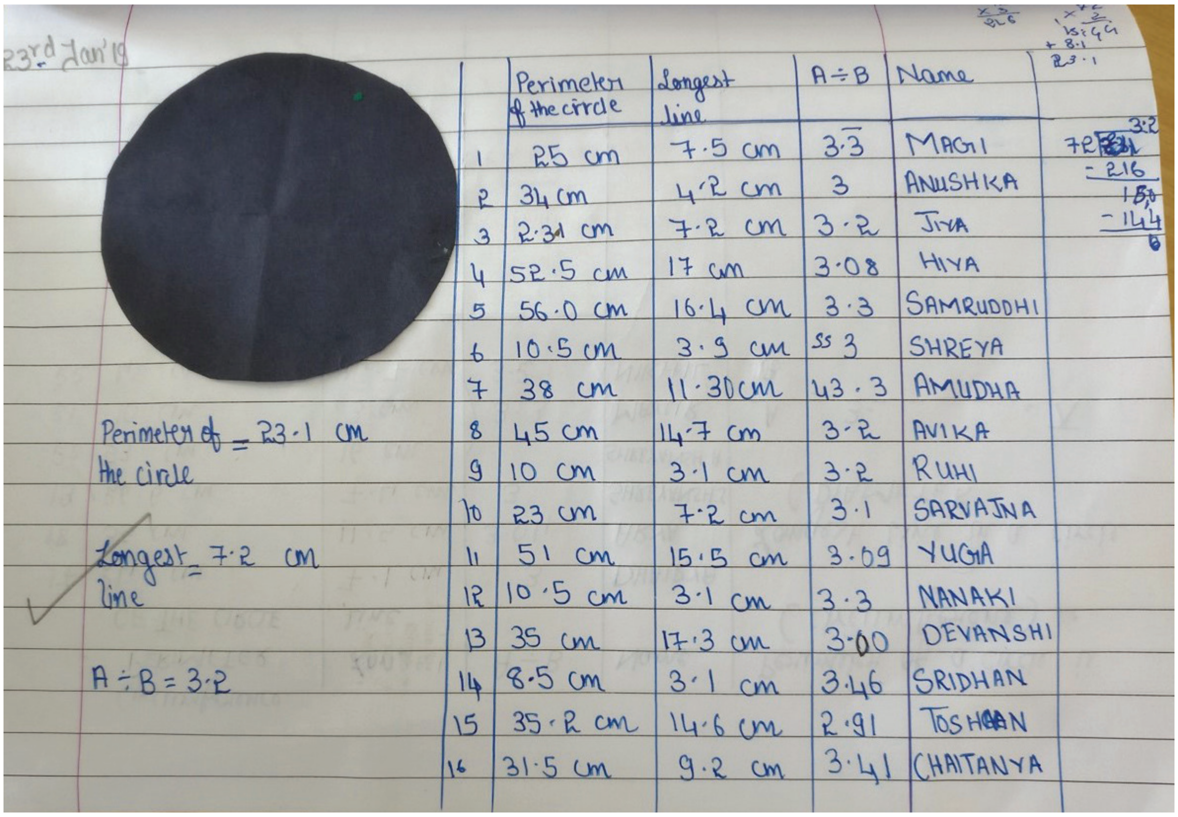
The wonder of Mathematics was the highlight of those two classes. I am not sure how many among those 23 children would have got the concept completely, but I am very certain that they had a glimpse of the mystery of Mathematics. In the years to come, they would see more of it…

My own learnings from this were the following:

1. Preparation for a class is an absolute necessity.
2. Time to do an activity is a range. (Each child measured the boundary of the circle, the longest line and then stuck the circles in his or her notebook. I noticed that each child's requirement is different; each child's attitude is different. Some children wish to do the task as perfectly as possible and take more time; others wish to race through the task; yet others take time to begin – they are the slow starters; and yet others are hesitant and uncertain, as they are not sure they have the skill to proceed.)
3. Every answer is correct. (I used jute string to measure the perimeter, so there was the factor of stretchability and therefore some variations in the lengths measured. The emphasis was to discover the approximation up to the first decimal place.)
4. Set aside enough time to ensure that every single child has completed the task. This is important.
5. Students who have finished the task can help those who have not.

6. Your preparation is never enough.
7. Be prepared to be surprised.
8. There is room for error…

Please note that in the following picture, one of the kids has chosen to write the columns in her own order. It was an enriching class for quite a few of us.



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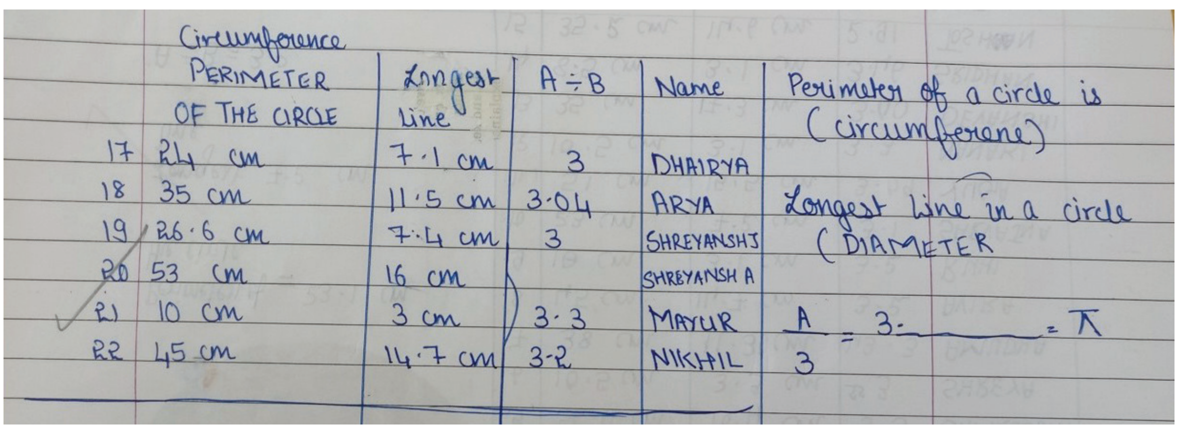
Perimeter of the circle = 23.1 cm

Longest line = 7.2 cm

A ÷ B = 3.2

	Perimeter of the circle	Longest line	A ÷ B	Name
1	25 cm	7.5 cm	3.3̄	MAGI
2	34 cm	4.2 cm	3	ANUSHKA
3	2.31 cm	7.2 cm	3.2	JIYA
4	52.5 cm	17 cm	3.08	HIYA
5	56.0 cm	16.4 cm	3.3	SAMRUDDHI
6	10.5 cm	3.9 cm	3	SHREYA
7	38 cm	11.30 cm	43.3	AMUDHA
8	45 cm	14.7 cm	3.2	AVIKA
9	10 cm	3.1 cm	3.2	RUHI
10	23 cm	7.2 cm	3.1	SARVAJNA
11	51 cm	15.5 cm	3.09	YUGA
12	10.5 cm	3.1 cm	3.3	NANAKI
13	35 cm	17.3 cm	3.00	DEVANSHI
14	8.5 cm	3.1 cm	3.46	SRIDHAN
15	35.2 cm	14.6 cm	2.91	TOSHAAN
16	31.5 cm	9.2 cm	3.41	CHAITANYA



	Circumference PERIMETER OF THE CIRCLE	Longest line	A ÷ B	Name
17	24 cm	7.1 cm	3	DHAIRYA
18	35 cm	11.5 cm	3.04	ARYA
19	26.6 cm	7.4 cm	3	SHREYANSH J
20	53 cm	16 cm		SHREYANSH A
21	10 cm	3 cm	3.3	MAYUR
22	45 cm	14.7 cm	3.2	NIKHIL

Perimeter of a circle is (circumference)

Longest line in a circle (DIAMETER

$\frac{A}{3} = 3.\_\_\_\_ = \pi$

Pedagogical Endnotes

It is worth noting that this exploration which culminated in an estimate of π integrated many different concepts and skills in early mathematics, such as measurement, perimeter, circumference, division of decimal numbers, presentation of data in tabular form, pattern finding, stating/articulating a conjecture, thinking about a converse and so on. In short, it encompassed a good many facets of what it means to "do mathematics." It is worth reflecting on the many strands that emanate from this seemingly simple exploration.

We list below some pedagogical implications of the actions done by the children. The column on the left lists statements and instructions from the above article, while the corresponding entries on the right make some pedagogical remarks concerning the statements.

Pedagogical aspects of instructions given by the teacher

Statement number	Statement from the text, above	Pedagogical remarks
4	"Children, please measure the length of the longest line within the circle…"	This instruction requires children to fold the circular shape exactly, use a measuring scale accurately, and record the length of the diameter using decimals.
5	"Divide the length of the boundary of the circle by the length of the longest line."	The children had just learnt division of decimals. Perhaps more work, time and energy were required to learn this concept and feel comfortable with that. It was thus a good opportunity to revisit the concept while integrating it into the current task of exploring the ratio of two specific numbers.
6	"Come to the black-board and write down your measurements."	Noticing that the least count is 0.1 cm or 1 mm, the entries in the table would not have more than one digit after the decimal point.
7	"Do the division and write down the quotient in the appropriate column against your name, beside the measurements you have already written."	It may not be obvious to many children that there can be multiple answers to such an exercise, and none of these answers is 'wrong.' Such learning comes only after the children have had sufficient exposure of 'doing mathematics.'
8	"Please do make the same table in your notebook."	This served as a quick introduction to collecting and recording the data.

Pedagogical aspects of observations made by the children and questions posed by them

Statement number	Statement from the text, above	Pedagogical remarks
1	"How come we all have 3. something?"	Is there a pattern in the data and if so, how do we know that the pattern actually exists?
2	"Why do I have a recurring decimal?"	Making connections across the different concepts that seem to be unrelated at first glance.
3	"Akka, did you measure the circles first and then cut them?"	What comes first and what comes as a follow-up property: Do the circles follow this particular pattern, or were they 'constructed' first in order to obtain this pattern?

Statement number	Statement from the text, above	Pedagogical remarks
4	“Is my division correct?”	How do I make sure my answer is correct? It involves moving from procedural learning towards conceptual learning.
5	“Can we cut the circles on our own?”	Will the pattern be true for any circles, irrespective of who constructs them?
6	“Check my division, Akka; it just doesn’t seem to end…”	Is my answer wrong because I have not encountered such a thing before?

SABITHA RAGHUNATH describes herself as “three scores and one year old.” She has worked with CBSE, ICSE and State Board schools for over 35 years, teaching physics and mathematics for 10 to 16-year-olds; her latest stint was at Sahyadri School KFI. She has served as an examiner for the ICSE. She enjoys being with children and loves learning and teaching, mathematics included. Even today, she continues to challenge, be challenged, experiment and have fun in class. She believes that every one of us is capable of learning. Sabitha may be contacted at raghunath.sabitha@gmail.com.

SNEHA BHANSALI is a PhD scholar in mathematics education at the University of Iowa. Her thesis focuses on understanding how mathematics teachers adapt in a holistic school environment. Her other research areas include mathematics teacher education and the use of technology in a mathematics classroom. She has designed two mathematical content courses for preservice elementary teachers with a focus on authentic assessment and growth mindset. She has also designed and offered summer camps based on various themes for a wide range of students from the underprivileged to the gifted. Sneha may be contacted at bhansali.sneha07@gmail.com.