STUDENTS CREATING A VARIETY OF POLYGONS TO HAVE THEIR PERIMETERS CONCEPTUALISED AND MEASURED

by YM Poon

This module consists of two lessons.

LEARNING TARGETS

After these two lessons, lasting totally 1 hour, students are expected

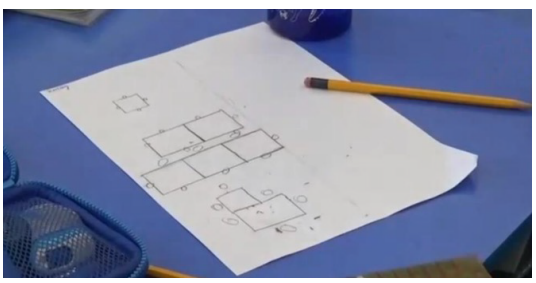
- to recognise what the perimeter of a 2D shape is
- to be able to determine the perimeter of different polygons
- to be able to observe and compare the perimeter of different polygons

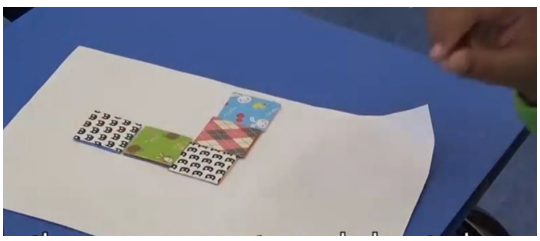
LEARNING AND TEACHING STRATEGIES SUGGESTED

In the first of the two lessons, before introducing the formal definition of perimeter, teachers

- **let students focus on the boundary of a polygon** by relating it to the number of students who can be seated around joined tables (represented by small square cards);
- **let students make their own polygons** with the tables to identify and measure the boundary of different shapes, by counting the numbers of students seated;
- among different shapes formed with the same number of tables, let students find out the changed or unchanged numbers of possible seats and
- **let students show and tell about their different polygons**, to compare with their classmates'.

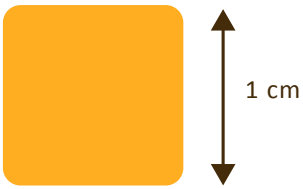
Two samples of student work:



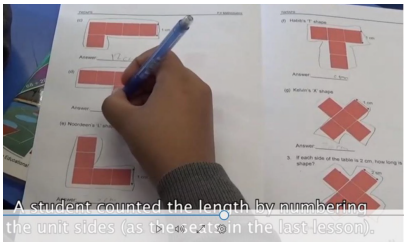


In the second lesson, the word “boundary” is introduced and formally used. Different polygons formed in lesson 1 by students with 5 tables are printed on a worksheet.

A square card that represents a table looks like this:



A sample of student work:



Four groups of questions are raised in the worksheet. Through such questions, teachers

- let students focus on the length of boundaries by involving **cm as a unit** of length;
- let students try to shift from **counting seats to counting unit lengths** in finding the lengths of boundaries;
- let students further shift from **counting unit lengths to calculating** from the number of sides in the perimeter and the length of each side and
- let students further consolidate the idea of **different** lengths of **boundaries**, **even if** the **same number of tables** are used. (In later lessons about areas, this point is to be contrasted with a disclosure that the same number of tables always have the same total area.)

Moreover, the following considerations are also embedded in all of the above strategies.

- providing visuals and real objects related to the selected tasks, so that they may easily come up, on their own, with a great variety of approaches and configurations of shapes and
- encouraging students to draw pictures and make diagrams by requiring them to show their ideas (instead of being satisfied with a half-understood standard answer).

ASSESSMENT TOOLS

“Show and tell” is the recommended tool for assessment. When students share and discuss,

- they may realise it if they have misunderstood what perimeter is for a polygon,
- both teacher and classmates can help clarify any such possible misunderstanding, and
- students can summarise mathematical facts in their own words, enriching the meaning of a final accurate definition.

RATIONALE BEHIND THESE LEARNING AND TEACHING STRATEGIES

In this module, strategies are adopted to help ethnic minority (EM) students to learn more effectively. Tasks are designed with multiple entry points and posed in meaningful contexts and engaging exercises. All these help accommodate the learner diversity (e.g. ages, native languages, mathematics learnt and cultural preferences) in the classroom. For instance, instead of just the teacher defining the perimeter of 2D shapes with examples, students can create their own polygons. Furthermore, alternatively or for enrichment, tables (or cards representing them) could be triangular, rectangular or even hexagonal. In such a way, students can learn without fear of ‘incorrect’ deviation from standard answers. Even better, they can experience the fun in open-ended exploration and appreciative recognition from classmates and the teacher, finding mathematics lessons, instead of boring, engaging and enjoyable.

LESSON 1

Tasks and activities

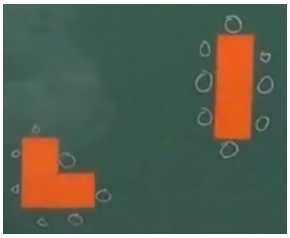
Students are asked to put a number of square tables together side by side, in as many spatial arrangements as possible. (To save time, small square cards may be used to represent tables. Materials to be used is listed in the next section.)

- Different shapes of polygons are then formed. Students sketch each polygon formed on a dot grid paper.
- Along the outline of the polygon, each side of each table can accommodate one seat. In each polygon, students are asked to count the number of seats along it's outline.
- Then students are asked to compare the numbers of seats in different polygons.

The tasks can be started with handling 3 tables and finished with handling 5 tables.

Materials required

- 5 or 6 pieces of square cards for demonstration.

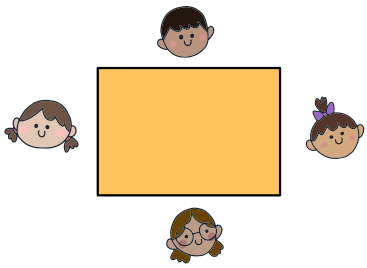


- Enough number of smaller pieces of square cards for students to make their own arrangements.

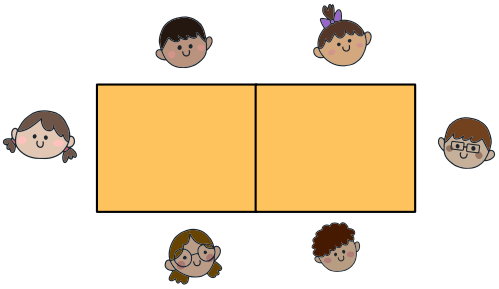
- Dot grid paper is provided for students to record their arrangements of tables and seats, so as to draw their polygons quicker and tidier, without wasting time in ruler alignments, forming right angles and making each square equal size.

Lesson flow

- Teacher defines the setting with the case of 1 table. Let us suppose a square (representing one table) can accommodate 4 seats, as shown in the figure below.



- Teacher introduces the tasks with the case of 2 tables on blackboard. When two tables are put together side by side, as shown below, 6 seats can be set.



- Teacher invites student volunteers to handle the cases of 3 tables as a demonstration of different possibilities.
- Students are asked to work in groups on the possibilities of 5 tables.

Questions are also prepared to encourage students' observation, thinking and sharing

- With respect to the same number of tables used, why are the numbers of seats sometimes the same and sometimes different?
- When 5 tables are put together, which arrangement(s) can accommodate the most number of seats? Which arrangement(s) can accommodate the least number of seats?
- Again with 5 tables in different arrangements, can you identify the longest boundary? And then the shortest? Name every arrangement, and then arrange all of them from the shortest to the longest boundary.

LESSON 2

Lesson flow

- There are 3 stages in this lesson.

Stage 1: Introduction

- Teacher reminds the class of the various polygons they created in Lesson 1 and the numbers of students who sat around them. Some kind of graphic organisers may be used.
- Teacher introduces the definition of perimeter for 2D shapes using the term "boundary" and giving examples other than the polygons they created last time, on the board.
- Teacher distributes a worksheet (containing questions 1 to 4 shown below) and introduces cm, instead of number of students, as a new measurement unit for boundaries.
- At this point, teacher may solicit some answers for question 1. At best, several different answers emerge. Then teacher can start some discussion. If only the correct answer is ever given, teacher can ask some quieter students to express agreement or disagreement. An explanation should be required from a student who agrees. An alternative answer must be given by one who disagrees.
- To make the lesson more fun, students may be led to imagine another lesson that takes place in Lilliput, the country of small people in the story Gulliver's Travels, where the tables in their schools are 1cm wide only.

1. If each side of the table is 1 cm, how long is the boundary of one table?

Answer: _____

Stage 2 : Independent work and subsequent discussion

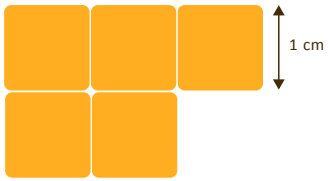
- Students work on questions 2a to g of the worksheet independently.
- Teacher helps to clarify when students are found to have any misunderstanding of the questions. For example, if teacher finds out that quite a few students answer question 2a as 20 cm, timely interventions like collective discussion (fully acknowledging wrong answers as independent and innovative approaches) are in order.
- Teacher helps students associate their answers with the corresponding cases handled in Lesson 1. Some kind of graphic organisers may again be used.

2. How long is the boundary of the following shapes?

(a)

Answer: _____

(b)

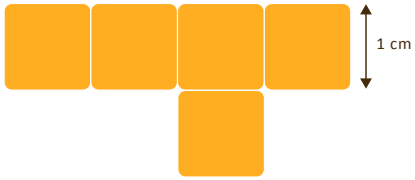


Answer: _____

(c)

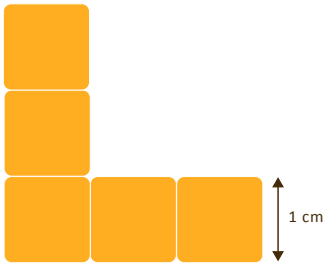
Answer: _____

(d)



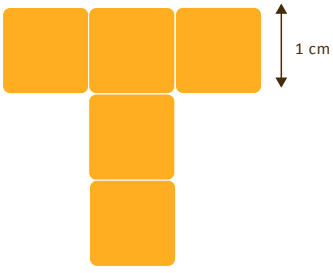
Answer: _____

(e) Norrdeen's 'L' shape



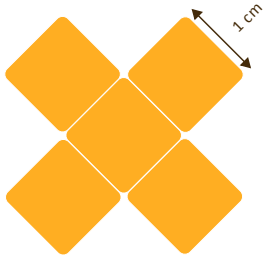
Answer: _____

(f) Habib's 'T' shape



Answer: _____

(g) Kelvin's 'X' shape



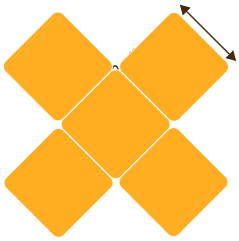
Answer: _____

- When working on question 2, sharing and discussion may help students summarise what they have observed.

Stage 3 : Exploration

– Questions 3-4 are posed as intelligent exercises which can be done as homework, or as a starter for an expanded lesson.

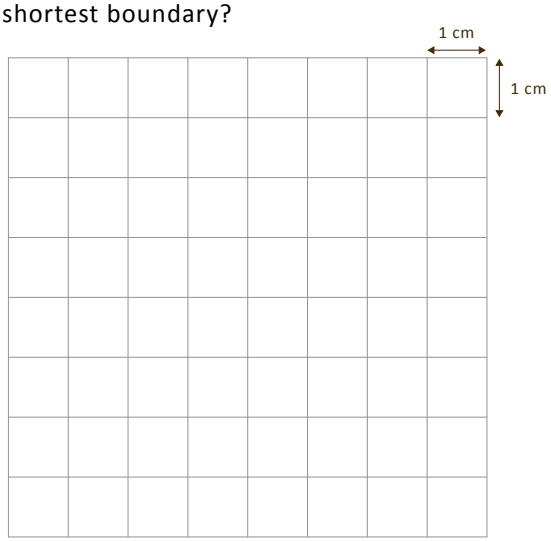
3. If each side of a table is 2 cm this time, how long is the boundary of Kelvin's 'X' shape?



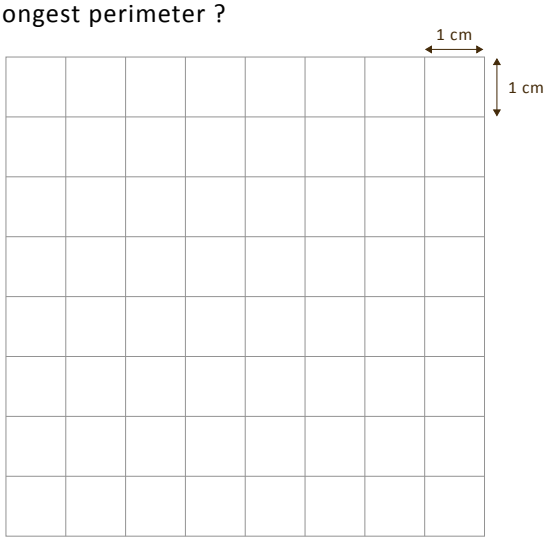
Answer: _____

4. If each side of a table is 1 cm,

(a) how can you arrange 6 tables to make the shortest boundary?



(b) How can you arrange 6 tables to make the longest perimeter ?



Suggested questions for teacher to encourage students to observe, think and share

- Compare the answers in questions 2a to g and the cases of 5 tables in Lesson 1. Are they the same? If not, in what way are they different? If you think they are the same, tell me the answer for, say, question 2a again. (If their answer is 12, say "That's not the complete answer" and ask yet again, until a correct and complete answer, with units, is given. If the correct answer they gave is 12 cm or 12 students, ask which lesson they are talking about, and so on, until the whole class realises that the answer for 2a is 12 students in Lesson 1, and 12 cm in Lesson 2.)
- If every table used in Lesson 1 is changed into a rectangular table, e.g. with 1 and 2 student(s) sitting on the shorter side and longer side respectively, then what result can you get when 2 tables are put side by side together, in various parallel or perpendicular alignments?
- For each of the polygons formed in the preceding suggested question, if the shorter side and longer side are marked as 1cm and 2 cm respectively, what would be your answers for the lengths of boundaries of the various polygons?

QUESTIONS FOR EVALUATION OF THESE TWO LESSONS

Were students more engaged?

- Have you observed normally inactive students participated more actively?
- Have the most expressive students been more or less dominating in these two lessons, at the expense of the others being deprived of their thinking time, space and chances to make attempts?
- Do you think EM students' interest in learning mathematics has increased in these two lessons?

Have language barriers been overcome?

- Has the understanding of key vocabulary items been supported throughout the lesson?
- Has language been used in nonthreatening ways? (e.g. Has think-pair-share been enabled?)
- Have pictures been well used to replace words?
- Has any graphic organiser (like reminders of Lesson 1 activities and/or intermediate conclusions in table form to facilitate comparisons) been used?

Was there enough time for independent learning and working?

- Has the idea of perimeter been successfully transferred from counting the number of seats to the number of units in measurement, providing a foundation to learn other measurement methods, like tracing with a thread or calculation?

REFERENCES

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). Elementary and middle school mathematics: Teaching developmentally (7th ed.). Allyn & Bacon.