The Five E (5E) instructional model is one of many resources that have been developed to support teaching across Australia. The Five E model is based on the idea that children learn best when they are able to work out concepts for themselves over a period of time, through various learning activities structured by the teacher. This idea is informed by a constructivist view of learning, in which students build connections between existing and new knowledge.

The way in which *Making Maths Accessible* incorporates the Five E instructional model is based upon research findings about how students learn maths. These findings indicate that students learn best when they have an opportunity to engage in explorations in a hands-on/minds-on environment in which they make and pose explanations for their discoveries.

Engagement, Exploration, Explanation, Elaboration and Evaluation are the recursive phases of the 5E teaching, learning and assessing cycle. The 5E model (Trowbridge & Bybee, 1996) incorporates five stages of learning:

Engage

This stage is designed to interest students in the learning, linking it with past learning and common background knowledge. It stimulates curiosity and promotes questioning, while linking the learning to real world experiences. This has a twofold purpose – it interests students in what is coming, while simultaneously showing them the purpose for the learning by situating it in their existing worldview. Teachers can guide this stage by asking specific questions to elicit prior knowledge from students.

Explore

This stage allows students to directly engage with key concepts by inciting them to probe, enquire and question, using their existing knowledge to connect it to new concepts and ideas. These connections may occur rapidly, or may need to be broken down several times before they are clear. The teacher is responsible for directing questioning appropriately and providing probing questions to push children in the right direction.

Explain

In this stage, students begin to logically sequence events and facts from their exploration, with a view to being able to communicate this information to others. The teacher can use this stage to act as a facilitator, offering further explanations and clarifying terms, etc, as necessary. This stage is useful in ascertaining the learner's development and grasp of the key ideas and concepts so far.

Elaborate

This stage allows students to expand what they've learned so far and to connect this directly with their prior knowledge and learning, hopefully reaching understanding. The teacher can therefore verify student understanding fully at this stage.

Case Study: Li

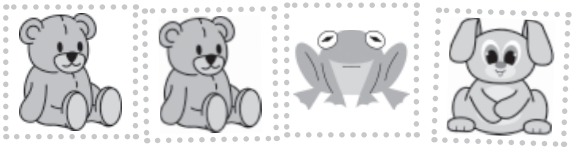
Li and her parents are immigrants from Vietnam. Li has many friends and attempts to converse with them in English but must watch closely for facial expressions and gestures to give her clues about what they are saying. Her computational skills in mathematics are excellent, but she is easily frustrated when trying to solve word problems.

Using no more than six of the following animal pictures, create a new set of pictures that meet the following guidelines.

- If you pick one picture from the new set, you are more likely to pick a bear than a frog.
- If you pick one picture from the new set, you are more likely to pick a frog than a rabbit.
- If you pick one picture from the set, you are less likely to pick a rabbit than a bear or a frog.

Answer the following questions as you explain your thinking.

1. How many pictures did you need in all?
2. How many pictures of each animal did you need?



Bear more likely than frog. Rabbit less likely than bear.

Beginning — Early Intermediate — Intermediate — Advanced — Proficient

Understanding	Participating	Communicating
☐ Smile. ☐ Pronounce the student's name correctly. ☐ Be sure the student knows your name. ☐ Establish routines so students know what to expect. ☐ Face the class when speaking. ☐ Speak slowly and distinctly. ☐ Avoid slang and explain idioms. ☐ Write legibly. ☐ Repeat important information. ☐ Allow students to audio record lessons. ☐ Label objects in the classroom, such as *recycle bin* and *overhead projector*. ☐ Create attractive, content-related display boards. ☐ Provide plenty of wait time. ☐ Be patient, kind, understanding and friendly. ☐ Teach to appeal to all five senses.	☐ Smile. ☐ Create a positive, non-threatening classroom environment. ☐ Create a nurturing environment. ☐ Find opportunities to bring the students' culture and language into class. ☐ Give frequent, genuine praise. ☐ Establish routines so students know what to expect. ☐ Post procedures and schedules. ☐ Use flexible grouping. ☐ Assign bilingual students as peer partners. ☐ Have groups present work using blank paper and textas. ☐ Highlight contributions of mathematicians from other cultures. ☐ Be patient, kind, understanding and friendly.	☐ Smile. ☐ Be patient, kind, understanding and friendly. ☐ Provide plenty of wait time. ☐ Create word walls. ☐ Use personal response boards. ☐ Ask for thumbs up/thumbs down or other physical responses.

Linguistic Obstacles

To observe a student in conversation with other students does not necessarily indicate he or she is fluent in academic English (Cummins, 1981). Being proficient in social situations is very different from being fluent in the language of mathematics. Look for clues by comparing written work, spoken responses and conversational language. Even when students are at the advanced level of proficiency in the language of mathematics and the content of the course, the number of steps required to solve problems may pose a challenge. The length of the text is also a factor in students' persistence. If the text is too long, they will probably give up.

Common meanings for words such as *product* (something produced by labour or the result of a multiplication computation), *sum* (or *some*) or *base* (baseball base or bottom face of a geometric figure) may confuse ELLs in mathematical contexts. Although a student may know *product* in his or her primary language, he or she may not be able to use the word unless the vocabulary is actively taught, defined in a modified text, or discovered while participating in activities.

Authors of mathematics texts generally write in a very terse or compact style. Each sentence contains a large amount of compressed information with little redundancy. Unlike reading a story, when solving maths problems, students find it difficult to determine meaning by using the surrounding context. Instead, they must construct meaning by making connections between the new information and their prior knowledge about the topic. The stronger and more varied the background a reader has in terms of knowledge and skills, the faster he or she will learn and be able to apply what he or she reads (Barton & Heidema, 2002).

Is Reading Maths Hard?

Janey bought *some products* to use in her hair with a *sum* value of $12. The *products* should last a month. Since they were on sale, she decided to buy enough to last a year. What number would she multiply by to find the *product* of the *products?*

A company builds *tables* with tops of increasing sizes so the *tables* nest. Create a *table* to represent the measurements of the *tables.*

The examples in figure 3.6 reveal the knowledge and skills not taught in other content areas that are required to read mathematics. Students must be able to read left to right, right to left, top to bottom, and bottom to top (see examples 1 and 2). They must be proficient at decoding not only words, but also numeric and non-numeric symbols and graphics (see example 3).

Use of technical terminology and abstractions, words with different meanings in everyday language and mathematics, and synonyms pose additional challenges for English language learners and their maths teachers. Think about the difficulties an ELL might have with the words *series*, *figures*, *pattern* and *square* (see example 4).

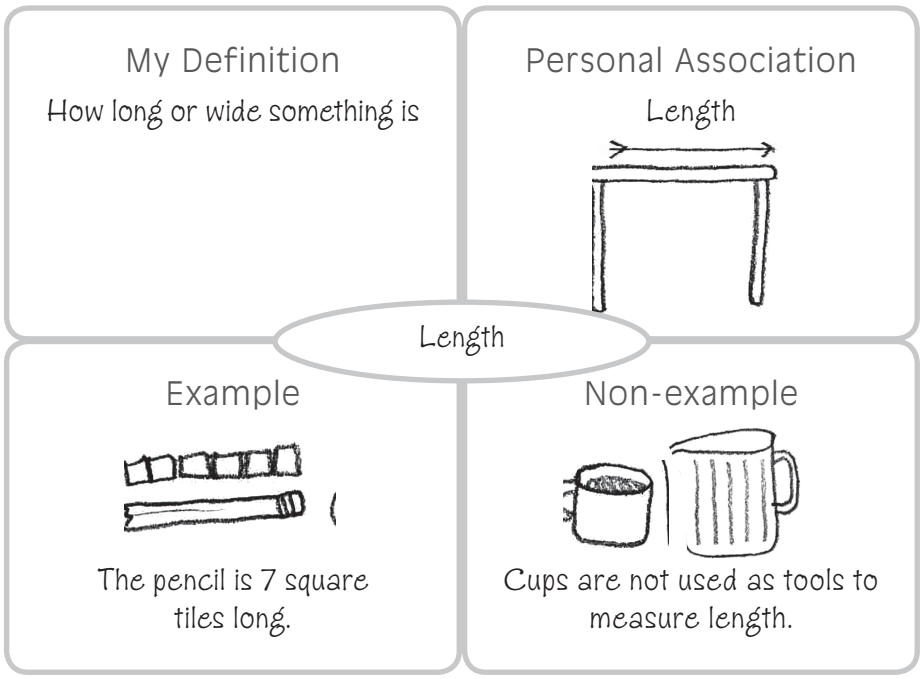


Figure 3.7: Sample vocabulary organiser.

Use Think-Alouds

It is important to introduce graphic organisers by using teacher *think-alouds*. In a think-aloud, the teacher verbalises his or her thought processes (Davey, 1983). When students first begin using graphic organisers, they will need help in choosing meaningful mathematical examples and non-examples. For instance, drawing a tree is not an appropriate non-example in the case of *length* since a tree has no meaningful characteristics in common with length. A meaningful non-example possesses characteristics that can be compared to and contrasted with the term or concept being developed. In the non-example in figure 3.7, it is clear the student understands that objects used to measure volume are not examples of length. Since both length and volume are measures, the non-example is meaningful.

After the think-aloud, groups of students can begin developing their own concept definition maps, vocabulary organisers or problem solutions in their groups, with the teacher facilitating. Posting work provides the opportunity for students to examine other groups' efforts and enrich their thinking. Working together as a group and sharing the work product allows English language learners the opportunity to actively participate in learning vocabulary and concepts.

A mind is a fire to be kindled, not a vessel to be filled. —Plutarch

HOT TIP!

Prompt groups to create concept definition maps and/or vocabulary organisers on blank paper to post as a word wall.

Task: Creating a Vocabulary Organiser

Decide on a mathematics vocabulary word, and use the vocabulary organiser template in figure 3.8 (page 46) to develop it. Have students begin a new

Engage

The Engage phase of the lesson is designed to create student interest in the concepts addressed and to make connections to past and present learning. The role of the teacher is to observe and listen to students as they interact with each other.

All students can learn and succeed but not the same day in the same way. —James Spady

Display several real-life objects that represent three-dimensional geometric figures such as a drinking chocolate container (cylinder), a shoebox (rectangular prism), a gift box (cube), a ball (sphere), a party hat (cone) and a pyramid (square pyramid).

1. Choose one of the objects without telling the students which one you have chosen.
2. Play Who Am I? with the students. Start by telling the students that you are thinking of an object, and they will have to ask you questions about the object in order to determine which object you are thinking about. Answer the students' questions with only a *Yes* or *No* response, and record the question in the form of a statement on the Who Am I? transparency or computer-projected image.

Facilitation Questions: Engage Phase

Answers to all may vary.

What do we know about our object so far?

Why did you ask if it was _____? (round, could roll)

Which objects can we rule out? Why?

How were you able to guess which three-dimensional geometric figure was being described?

Why did you think the three-dimensional geometric figure was a _____?

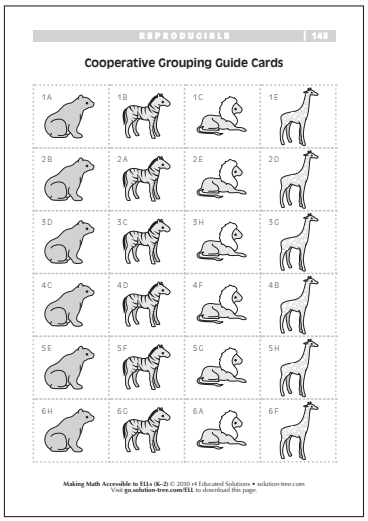
What other objects have attributes similar to the _____? Different than the _____?

3. Play Who Am I? until the students correctly identify the chosen real-life object. Add the answer to the chart (table 5.3).

Table 5.3: Sample Who Am I? Chart

Yes	No
I have faces.	I do not roll.
Answer: *The shoebox*	

4. Use the Cooperative Grouping Guide to arrange students in groups of four. (See appendix D, page 139, for instructions and reproducible masters.) Provide each group with a set of three-dimensional geometric figures: a rectangular prism, cube, sphere, square pyramid, triangular pyramid and triangular prism. (Do not use cones or cylinders.)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Cooperative Grouping Guide Cards