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.

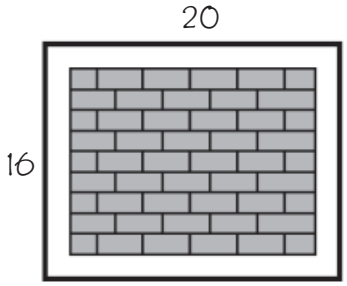
Elaborate

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: Joao

Joao, a year eleven student, moved to Australia last year from Brazil, where he attended a private school. He lives with his older brother, a university professor. The idioms and slang that Joao's friends use occasionally confuse him, but he communicates easily in both social and academic situations and readily learns abstract concepts.

Ardene and Gerald made a sketch of a courtyard and surrounding flowerbed that they would like to add to their schoolyard. The area has outside measurements of 16 metres by 20 metres and 221 m^2 of the area is the courtyard. If the width of the flowerbed is uniform on all sides, find its width, *x*. Justify your solution.



Let x = the width of the flowerbed.
Since the width of the flowerbed is x, and there is one on each side of the courtyard, set up and solve the problem:

$$\overset{13}{(16-2x)}\ \overset{17}{(20-2x)} = 221$$

$$320 - 32x - 40x + 4x^2 = 221$$

$$\frac{-221}{4x^2 - 72x + 99} = 0$$

$$x = \frac{72 \pm \sqrt{5184 - 4(4)(99)}}{2(4)}$$

$$x = 72 \pm \sqrt{3600}$$

$$\frac{x = 72 \pm 60 =}{8} = 1.5 \text{ or } 16.5$$

16.5 m is not a reasonable width for the flowerbed. Therefore, the width is 1.5 metres, which I verified by checking.

Beginning — Early Intermediate — Intermediate — Advanced — Proficient

Student Name	Activity	Practice	Manipulatives (specify which)	Technology	Example/ Non-example	Concept Sorts	Who Am I?	Window Panes	Four-Quadrant Problem Solver	See-Plan-Do-Reflect	Bonded Brains
Joao	Understanding										
	Participating										
	Communicating										

Table 5.4: Debriefing the Explore Phase of a 5E Lesson

Content Objective	Language Objective	Study/Metacognitive Objective
Understanding	*Participating*	*Communicating*
What concept(s) will students explore? *Area (number of squares) increases but not at a constant (linear) rate.* What activity will I use to encourage students to explore the concept(s)? *How Many Squares?* What tools or materials will allow students to become directly involved in exploring the concept(s)? *Graphing calculator* What vocabulary and symbols do students need to understand for this phase? *Quadratic relationship* *Quadratic parent function* $y = x^2$ *Reinforce:* *Independent* *Dependent* *Domain* *Range* *Term number* *Function rule*	What accommodations could I include in this phase to make learning more accessible? *Table* *Graphing calculator* *Flexible grouping* *Peer tutors (if needed)* *Picture dictionaries (if needed)* What questions might students raise? *How do I determine an appropriate viewing window?* *How do I know what scale to use?*	Student to Student *Students work in groups of two to four.* Student to Teacher *Students may ask for clarification but are allowed to explore with the group.* Teacher to Student *The teacher is a facilitator in this phase.* Facilitation Questions *As the term number increases, what happens to the number of squares?* *Does the number of squares increase at a constant rate?* *What does this rate of change tell you about the relationship?* *What is the independent variable?* *What is the dependent variable?* *What is a reasonable domain and range for your data?* *How can you use the domain and range to set your calculator window?* *Based on the graph, this appears to be what type of relationship?* *What is the parent function for this type of relationship?* *How can you find the areas of each rectangle?* *How can you use the square part of each rectangle, 1 by 1, 2 by 2, 3 by 3, and so on, to determine the function rule?*

In the Explore phase, students work together, and the teacher asks facilitation questions. Allow time for students to problem solve through tasks. Listen to what students say as they interact.

Explain

The Explain phase of the lesson is directed by the teacher to allow students to formalise their understanding of the mathematics objectives addressed in the lesson. In this phase, debrief the How Many Squares? reproducible from the Explore phase. Use the facilitation questions to prompt student groups to share their responses to the data analysis.

1. Debrief the How Many Squares? reproducible. Ask students to share how they developed their scatter plots and why they chose this method. If students had difficulty developing the scatter plot, be sure to explain the procedure in detail.

Evaluate

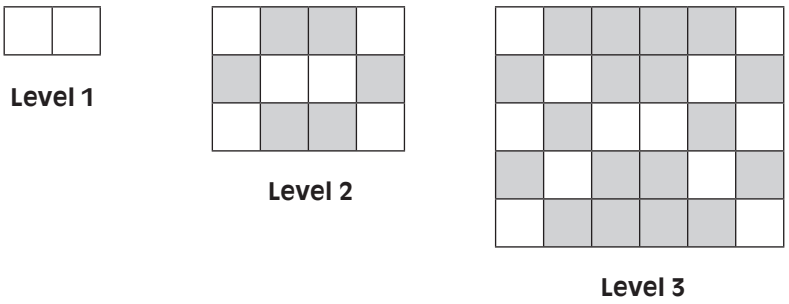
Throughout the lesson, the teacher determines whether the learning has reached the desired level of understanding of the key concepts. A more formal assessment is appropriate in the Evaluate phase of the 5E model.

HOT TIP!

Many students find that problem-solving organisers help them organise their thought processes.

You will recall that performance assessments such as Square to Square are intended to allow students to arrive at the solution in a variety of different ways. Some students may solve using a table, while others may use the graphing calculator, and still others may solve algebraically (see figs. 5.12 and 5.13).

Orlando has the popular game Square to Square on his mobile phone. Each time he successfully completes a game, a new, more difficult game board appears. The game boards for levels 1, 2 and 3 are shown below.



Level 1

Level 2

Level 3

If Orlando gets to level 10, how many shaded squares will his game board contain? Justify your answer.

Answer: ***270***

Figure 5.12: Sample Square to Square performance assessment.

1. Distribute the Square to Square reproducible. Have students read the problem to themselves silently. Then set up the scenario and clarify vocabulary.
2. If you deem it necessary, provide a word bank to help students understand your expectations of their justifications. Beginning and early intermediate students may not be expected to write complete sentences.
3. Upon completion of the activity, use a rubric to assess student understanding of the concepts and procedures addressed in both the mathematics and language objectives.

Table 5.9 (page 108) shows how the Evaluate phase of this lesson supports students in understanding, participating and communicating.

It is appropriate for students to complete performance assessments in small groups or as a class as the assessments are phased in. Only after students have worked performance assessments in groups and have been provided opportunities for teacher and peer feedback should they be expected to work performance assessments independently.

- Retention and use of maths vocabulary are more meaningful after students have had a direct experience with the concept. Is there opportunity to formalise the concepts and vocabulary? Is there opportunity for students to draw conclusions and communicate them to each other and to you, the teacher? (Explain)
- Does the activity allow students to extend and expand what they learned in the first three stages? (Elaborate)
- Does the assessment allow you to determine whether the learner has reached the desired level of understanding of the key ideas and concepts? (Evaluate)

Since we know the 5E model is effective in meeting our students' needs, we will use the 5E lesson plan template to organise our thoughts (see appendix E, page 175). The adaptation of the traditional textbook lesson to the 5E model need not be a daunting task. What table 6.2 expresses what may be in fact a short thought process.

Table 6.2: 5E Lesson Plan for Finding Slope

Content Objective	Language Objective	Study/Metacognitive Objective
Students will find and use slopes of lines, including those of parallel and perpendicular lines. *Note: The focus in this textbook lesson is on finding slopes. The next lesson in the textbook centres on writing equations of lines in polygons graphed on a coordinate plane.*	Students will speak and write using newly acquired content vocabulary.	Students will justify solutions, verbally or nonverbally, depending upon proficiency level.

Materials	Preparation
For the student: • Graphing calculator • Patty paper • Coordinate grid paper • Geoboards with rubber bands • Vocabulary organiser templates	1. Write or find one performance assessment and three multiple-choice problems, and make copies (one per student) for the Evaluate phase of the lesson. 2. Copy vocabulary organiser template (one per student). 3. Read and select facilitation questions appropriate for students' needs.

Engage

Again, the adaptation of the traditional textbook lesson to the 5E model need not be a daunting task. Table 6.3 expresses what may be in fact a short thought process: a teacher's plan for the Engage phase of this adapted textbook lesson.

The Engage portion of the lesson is designed to interest students in finding slopes to investigate geometric figures using geoboards and rubber bands. It is important to establish rules and to overtly teach appropriate behaviour for different settings, such as group work, independent work and testing, especially when students use tools, such as rubber bands, with the potential for misuse. Set expectations prior to distributing materials.