READING TO LEARN MATHS

Sine theta is equal to opposite divided by hypotenuse.
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THE LANGUAGE OF MATHS

GENRES IN MATHS

Learning maths is usually talked about in terms of learning concepts. But concepts do not exist outside of the language that we use to talk about them. In R2L, we use three strategies to focus on the language used in maths.

1. Procedures used to teach maths processes
We carefully analyse these procedures, then plan what to say as we teach them, then jointly construct them in writing with our students.

2. Maths word problems
We use Detailed Reading strategies to identify the key elements of maths word problems - the data given, the solution required, and the operations to solve it.

3. Maths definitions and explanations
We use Detailed Reading and Rewriting to discuss, define, explain and reinforce our students’ understanding and memory of technical language in maths.

The strategies in this book do not replace maths teaching in general, but focus on just the language. They are based on carefully observing the oral texts that teachers use to teach maths operations, and then carefully planning how we will say these oral texts.

TEACHING PROCEDURES FOR MATHS PROCESSES

Students typically learn to do each maths process by watching the teacher demonstrating it on the board, as a worked example in numerical form. The teacher doesn't demonstrate silently, but explains each step as the students watch and listen. The students then practice the process themselves, by working out related problems.

Maths textbooks or worksheets usually show worked examples of processes and formulae. Sometimes a procedure for how to do the process is written, but rarely in any detail. Likewise, maths principles are explained by the teacher orally, and may be demonstrated with formulae on the board or in a textbook. Oral procedures and explanations, with worked examples, are the primary mode in which maths is taught. Students demonstrate their knowledge of the procedure by working out problems, and they may be expected to demonstrate their understanding of the principle with an oral explanation.

When the teacher demonstrates a maths process, top students are able to understand and follow each step, as it is worked out on the board, and remember the procedure. When they do their individual practice with problems, these students get most of them correct, and so get most benefit from the practice. Other students misunderstand or misremember parts of the procedure, and make more mistakes with their individual problems, so they get less benefit. Other students are not able to follow and remember the procedure and so cannot understand the example on the board. The teacher often has to spend most time with these students, trying to repair their problems with not understanding and remembering.

The answer to this problem is very simple - get the students to say and write down the procedures for maths process, as they are learning to do them. This can be very easily done using the following strategy for teaching procedures.
TURNING ORAL PROCEDURES INTO WRITTEN ONES

1. In this strategy, the teacher starts by carefully analysing what to say at each step of demonstrating a maths process. The teacher writes these steps down as a lesson plan.

2. In the lesson, the teacher uses this lesson plan to explain each step in the process as it is demonstrated on the board.

3. The process is then repeated several times with different examples, but using the same words to explain each time. These are guided practices. At each step, we ask the students what to do next, and they start giving back the words we used for each step. We affirm their responses, and repeat the exact words we have chosen to use.

4. In addition, students take turns to come out and write the maths on the board, as the teacher and students guide them. After two or more guided practices, all students in the class will know the words for each step in the procedure.

5. At this point the students take turns to write the procedure on the board. As in Note Making or Joint Rewriting, the class tells the scribe what to write, as the teacher prompts and elaborates where necessary.

6. The class writes the procedure into their maths books as it is written on the board.

Where a word needs spelling, it can be written on the board for the scribe to copy. We can also stop to discuss and define terms as they are written up.

Why and when to use this strategy

This strategy ensures that all students are completely familiar with a maths process before they are expected to use it to solve problems. Every student in the class will be able to solve the problems successfully, and even the top maths students will achieve better results than they previously could. This is a more efficient approach for students to learn maths processes than making a series of errors struggling to solve problems. Instead, problem-solving becomes an efficient activity for students to consolidate their memory of the steps, and to transfer the skill flexibly to a variety of situations.

The technique can be used with maths processes at any level, from basic numeracy to quadratic equations. Crucially the teacher must plan the procedure beforehand, by writing down the wordings for each step that will be used in the lesson.

Planning these procedures can be surprisingly difficult, considering exactly what steps are involved, and what words to use in each step. It is a revealing activity, to find how complex it can be for students to follow oral procedures that the teacher normally gives spontaneously without a detailed plan.

Being able to do a maths operation successfully is an essential step towards being able to understand and explain the maths concept behind it.
**ACTIVITY: DEMONSTRATION LESSON**

This lesson is demonstrated with a Year 8 class on video. Read the lesson plan and watch the lesson online at:

http://www.boardofstudies.nsw.edu.au/7-10-literacy-numeracy/

Samples of the website are shown opposite.

<table>
<thead>
<tr>
<th>Steps</th>
<th>Questions</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Read the question.</td>
<td>What does it say?</td>
<td>In a triangle LMN, angle M = 90°. Side LN is 9.2m and side LM is 8.2m. Find the angle L to the nearest degree.</td>
</tr>
<tr>
<td>2 Make a note of the important information in the question.</td>
<td>What is the first important information? What is the next important information?</td>
<td>The triangle is a right angled triangle Side LM is 8.2 Side LN is 9.2 Right angle at M</td>
</tr>
</tbody>
</table>
| 3 Draw a labelled diagram with this information. | What are the angles called? What are the lengths of the sides? | ![Diagram of triangle LMN with sides labeled 8.2 m and 9.2 m.]
| 4 Label the angle to be found as Θ | Which angle is Θ? | |
| 5 Write down the three trigonometric ratios related to the right angled triangle. | What is the first trigonometric ratio? What is the next ratio? What is the next ratio? | \[ \sin \Theta = \frac{\text{opposite side}}{\text{hypotenuse}} = \frac{MN}{9.2}, \quad \cos \Theta = \frac{\text{adjacent side}}{\text{hypotenuse}} = \frac{8.2}{9.2}, \quad \tan \Theta = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{MN}{8.2} \]
| 6 Find the right ratio to solve the question. | Which ratio gives both sides? | \[ \cos \Theta \]
| 7 Use this ratio to solve the question. | What are the steps to simplify the ratio? What is the value of Θ? | \[ \cos \Theta = \frac{8.2}{9.2} \]
\[ 9.2 \times \cos \Theta = 8.2 \]
\[ \Theta = \cos^{-1} \frac{8.2}{9.2} \]
| 8 Use a calculator to calculate the angle. | What is the answer? | \[ \Theta = \text{Shift Cos} \frac{8.2}{9.2} \]
\[ \Theta = 27° \]
Planning for success in secondary Mathematics

A resource for teachers, students and parents

This resource demonstrates strategies that can be used to help high school students to succeed in Mathematics. The strategies are presented in four stages: teacher modelling, first guided practice, second guided practice and joint construction.

The videos below demonstrate the strategies in action across the four stages.

Four stages in action

<table>
<thead>
<tr>
<th>Stage one</th>
<th>Stage two</th>
<th>Stage three</th>
<th>Stage four</th>
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</thead>
</table>

Stage 1

**Teacher modelling**
In the first stage, the teacher demonstrates the mathematical process with a worked example that has been carefully planned beforehand. The teacher explicitly describes each step of the process as it is modelled.

The first step is to read the problem which may be written on the board or appear in a text. After reading, the students are asked to identify key information in the problem/question. The teacher writes this information sequentially on the board. The teacher then demonstrates how to use the information to solve the problem.

Stage two

**First guided practice**
In this stage, a second problem is selected and written on the board. The teacher asks students to say each step of the process they would use to solve the problem.

Because the teacher has explicitly modelled each step previously, students’ responses approximate what has already been modelled. Although responses may not be exact, it is important to acknowledge the response and adjust as necessary. In this way, students’ understanding is affirmed.

Each step is then written on the board.

Stage 4

**Joint construction**
Finally, the whole procedure is described as a sequence of steps. Students take turns to describe each step on the board. The class tells the scribe what to write with the teacher’s guidance.

This activity is known as joint construction because the class is jointly constructing a text with the guidance of the teacher. The text in this case is a procedure for completing a mathematical process.

Students should keep a copy of the procedure so that they can refer to it if they wish when they are solving problems.

This process helps all students to achieve; less able students are provided with an opportunity to understand and remember the steps needed to undertake a mathematical process, while more able students have the opportunity to better explain how they solve problems.

Read video transcript
PLANNING MATHS LESSONS

These eight steps for Reading to Learn Maths lessons have been developed through repeated practice with junior, middle and upper primary classes. The details can be varied according to the grade level, the needs of your students, and the time available in your program. Depending on concept, class etc, these steps may take one or more lesson times. The steps also classified within the principle of modelled to guided to independent practice.

**Step 1** Plan the procedure
Teacher carefully plans procedure prior to lesson (This plan is the teachers’ information only – it can be pinned on the board to follow while teaching).

**Step 2** Introduce the maths topic
This puts the learning into context. In the primary, it may be a real life situation, role play or narrative, to relate to students’ experience. In secondary maths, it may be prior knowledge, and how the topic fits in.

**Step 3** Demonstrate the process
Teacher works through an example, saying the steps in the procedure which were planned prior to the lesson.

**Step 4** Guided practice
Repeat 2 or more times with different examples and increasing handover to students. (Keep to the exact wordings of the planned procedure.)
Ask students to say each step.
Students scribe on the board while teacher and other students guide, as well as answering questions.

**Step 5** Joint construction of procedure.
Students take turns to scribe on the board, as other students say the steps used.
Students write in their books. In early years, teacher may record and copy for students.

**Step 6** Guided problem solving

**Step 7** Independent problem solving
Students complete (assessable) independent activities related to the procedure, including homework activities.