National Professional Standards for Teachers

Illustration of Practice

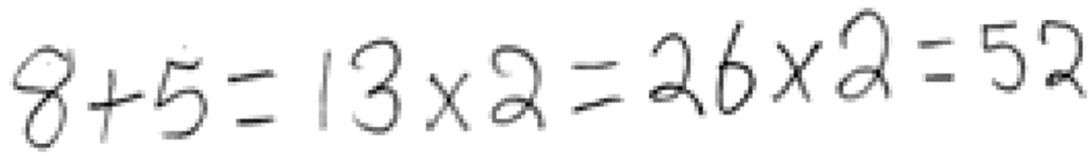
Number Sentences

Lesson Sequence	Order of Operations in Number Sentences
Foci of lessons	In this series of lessons students explore: • Problems involving more than one operation • The ways that these problems are represented • The language that describes the problems and supports mathematicians communicating ideas effectively
Knowledge, Understanding, Skills and Values	Teachers: • Explore the nature, development, use and influence of mathematics through identifying issues that create conflict • Provide support for students to make connections across the mathematics curriculum • Pose questions that do not have a right or wrong answer and provide time for students to share and explain their thinking to support them to build understanding (in this context, understanding related to the need for conventions) Students: • Identify efficient ways to add and multiply mentally • Investigate the different answers that could result from problems involving more than one operation • Appreciate the need for rules to complete multiple operations within the same number sentence • Understand that mathematicians have developed conventions to ensure that mathematical representations are communicated in a way that is understood by others, and that these have developed over time in response to changes in mathematics understandings
Focus questions	Teachers: • Am I clear about what I want students to learn and how I will provide students with depth of understanding? • How will I create an environment that encourages students to share ideas, challenge thinking and discuss issues? • How will I respond to what's happening in the learning and how will this support students to move to the next step? • How will I listen to and value the thoughts of students to develop learning within the class? Students: • What are the strategies that could be used to solve problems involving more than one operation? • Will the same strategy always be the most efficient? • How might these operations be accurately communicated in words and in symbols? • Why might a calculator produce a different answer when the same steps are keyed in? • Why might mathematicians consider a different order of operations important, and how will we know what this order is?

Plan and implement teaching programs that engage students in actively applying the key skills of the learning area to its content

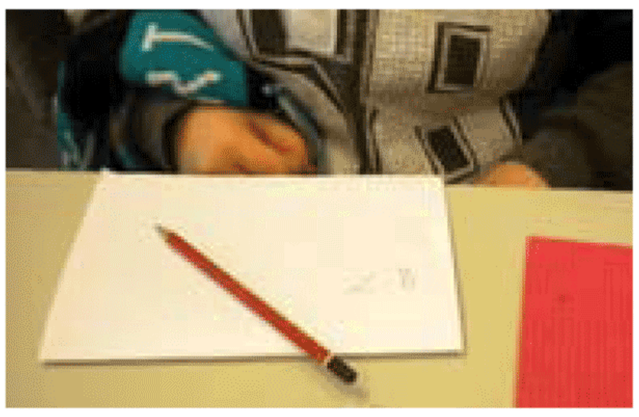
Setting the Scene	Resources Required: • Two 10 sided dice (0-9) • Digital Camera • Flip video camera Additional, if available: • Interactive whiteboard • Live scribe pens • Grip mats or foam squares (Grip mats are created from material that is used to go in drawers and cupboards to stop items from slipping; in this case they help reduce the noise of rolling dice)
	Teaching and learning activities 1. Organise students in pairs with clear expectations to work together, share, take turns, explain and question. 2. Ask students to use the 10-sided dice to roll two numbers between 0-9, add them, double the quantity and double it again. 3. Have students record the numbers rolled and calculated, without any symbols: e.g. 4, 9, 13, 26, 52 4. Have students describe the process to their partner: e.g. "You rolled 4 and 9, that's 13. Double 13 is 26, and double again makes 52." 5. Provide students with opportunities to discuss their strategies with the class. 6. Invite class to share situations which were easier or harder, what made them easier or harder and what strategies they used Teacher questions • What student behaviours will make it difficult for students to work efficiently with problems that use more than one operation? • What will we need to add to the learning to lead students to grasp concepts?
Continuing the investigations	Resources Required: • TI 15 calculators (or alternatives) Teaching and learning activities 1. Give students the opportunity to record thinking developed in the last session: e.g. 4+2x2 x2=24 2. Ask students to try the same problem using a calculator. (Note: It is a good idea to check what results you get if using calculators other than TI 15). *What is the result?* 3. *Why do you think this happened?* *Could you work with these numbers and symbols to get a result of 12? How did you do it* *What other answers might you get?* 4. Display the different responses of students. 5. Invite students to explore how mathematicians may have solved this problem and discuss how we might find out. 6. Invite students to "think like a mathematician" and suggest symbols we might use to explain to others that we added the first two numbers before we multiplied. 7. Show students how to key in brackets with the calculator and see what answers result. *Does this give the same answer as your manual process?* Teacher questions • What are the different answers that you might get if you were working with 4+2 x 2 x 2? • What opportunities does exploring the manual and calculator processes provide? • How might discussing the work of mathematicians support students to link mathematics to its development and applications? Future directions: 1. Explore different order of operations using a calculator and note any 'surprises'. 2. Predict some order of operations and test these predictions. 3. Investigate the development of order of operations in the development of mathematics. 4. Use investigations such as http://nrich.maths.org/1013 to explore multiple representations, efficiency and number sense.

Plan and implement logically sequenced teaching programs to develop higher order thinking skills, general capabilities and understanding of core concepts



Teacher Reflection

This was an incorrect response from one child in the class. It is typical of the representations of the majority of students. When asked what the "=" symbol meant the majority of students indicated that it meant, *"The answer is on the other side".* This response highlighted the need to address common misconceptions in the teaching program. The use of appropriate resources was key to consolidating the meaning of the "=" symbol.



Teacher Reflection

This task provided us with a framework to explore the efficiency with which students solve problems and the language they use to describe the process. In this situation the student worked on "getting the right answer" using a count all strategy. This led to a discussion related to efficiency.

In addition to diagnosing student understanding the tasks provided targeted teaching related to the development of language to describe thinking.