Open-Ended Maths Tasks

Bloom's Taxonomy
Multiple Intelligences
Habits of Mind
Thinker's Keys
Creative and Critical Thinking
Graphic Organisers

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Introduction

What are open-ended tasks?

Questions prompt thinking. In order to get better thinking out of our students, we need to ask better questions. What sort of questions do you ask in your classroom? Questions can be either closed or open.

Closed questions are used to obtain knowledge or an understanding of facts and have only one correct answer. Closed questions provide little creativity and children are usually asked to find the 'right' answer to ascertain their comprehension of facts. An example would be 'If I have 3 dozen eggs, how many eggs do I have?' This question has 2 closed parts to it. Students need to know the fact that there are 12 in a dozen, and that 3 times 12 is 36. They are all facts and there is only one right answer.

Open-ended questions involve thoughtful and investigative responses . More than one correct answer is acceptable and children are encouraged to be creative when responding to open-ended questions. Some open-ended questions may have more than one right answer but a maximum of correct answers. An example would be 'My mum gave me 28 lollies to share equally between myself and my friends. How many friends could I share my lollies with and how many would we get each?' This question has several possible correct answers, but not an infinite amount of correct responses. (Myself and 1 friend 2 x 14; myself and 3 friends 4 x 7; myself and 6 friends 7 x 4). The focus of this open question is to assess students' ability to use division or multiplication accurately.

Other open-ended questions can have an almost infinite range of acceptable responses. An example would be 'How would you spend $5.00 on your lunch at the canteen?' Students can explore how to spend their money using a canteen menu and there are almost endless possibilities of acceptable responses. The focus of this open question is to assess students' ability to use addition or subtraction of money, including decimals.

A great way to engage students is to use open-ended questions to provide investigations and projects for children to explore and apply their knowledge. Being able to use processes or procedures taught in class is encouraged when responding to open-ended questions, where their skills can also be further assessed.

This book focuses on the use of open-ended questions in the maths classroom. Current trends in curriculum and learning focus on the need to prepare students for a life where problem-solving skills are a necessity. Open-ended questions promote effective problem-solving skills and can easily be incorporated with thinking tools such as Bloom's Taxonomy, Gardner's Multiple Intelligences, Costa's Habits of Mind, Creative and Critical Thinking skills and the use of various visual organisational tools.

Whilst the importance of using open-ended questions in classrooms is being

encouraged, the use of closed questions is certainly not being dismissed. Closed questions are still vital and very relevant when teaching basic skills, number facts and times tables, or using processes for solving algorithms accurately and reciting knowledge of facts.

If you assess your use of closed and open questions in your classroom, closed questions may feature more predominantly. Alternatively, you may find that you ask more open-ended questions than you realise. Asking open-ended questions may appear to require more effort, however with practice, this will easily become second nature in your teaching.

A classroom which incorporates open-ended tasks into its learning program should be a classroom where students area encouraged to

- be independent thinkers
- share, reflect on and value alternative responses
- be excited about learning
- be responsible for their learning
- complete tasks reflective of their true abilities

It should also be noted that examples given in this book can certainly over-lap and are not category specific, especially when using Bloom's Taxonomy. An application task could also be used as an evaluation. Example – Demonstrate 3 ways to solve the multiplication problem of 13 x 9. Children have to apply the skills taught in class and their own abilities to demonstrate 3 accurate methods of reaching an answer. You could also evaluate their understanding of the methods taught in class and how advanced their thinking is when solving such a problem.

A creative thinking Fluency task could also be knowledge in Bloom's and an Intrapersonal Multiple Intelligence. Example – How many terms about measurement can you come up with in 3 minutes? This task requires children to fluently recall terms they are familiar with (Fluency), which requires them to access their knowledge about measurement (Knowledge) as well as being confident and in touch with their own abilities (Intrapersonal).

Open-ended task cards can be quite flexible in terms of the context in which you use them and the purpose of the activity.

How to use this book

This book is split into two sections. Section one presents a selection of models of thinking skills that can be used in preparing open-ended maths tasks. Each chapter features an outline of the model and an explanation of how it can be used in creating open-ended maths tasks followed by a selection of example activities. The final part of the chapter is a more detailed explanation of the history behind the model and features a list of resources providing further information on the thinking tools and examples of how to use them in the classroom.

Chapter 7, 'Converting closed questions to open-ended,' gives examples of how

units of work using open-ended tasks and incorporating Bloom's Taxonomy, creative and critical thinking and Multiple Intelligences can be created from traditional maths questions. This chapter is organised in the following way:

	Junior Primary	Middle Primary	Upper Primary
Number			
Decimal Fractions			Page 51
Division		Page 48	
Addition	Page 45		
Measurement			
Perimeter			Page 53
Mass		Page 49	
Time	Page 46		

Section two contains reproducible copies of the task cards. The task cards can also be downloaded at **go.hbe.com.au**, to be printed and laminated as desired.

The cards have been separated into levels of

- Junior primary (years prep, 1 and 2)
- Middle primary (years 3 and 4)
- Upper primary (years 5 and 6)

each addressing the curriculum content for that stage in one of two topics, number or measurement.

However, the levels indicated can also be used as a guide, and you will be able to work out from your students' ability which cards are most appropriate.

Within each level, tasks are separated into either

- 5–10 minutes. This indicates the task is suitable for a topic intro and warm-up.
- 15+ minutes. This denotes it is to be used as a project-based and extension task.
- Although task cards could be prepared using any of the thinking tools outlined in this book, we have chosen to use the levels of the revised Bloom's Taxonomy (Anderson and Krathwohl, 2001, and see p. 33). Each task has been developed to encourage critical thinking at one of the six levels.

State Learning Standards

As teachers, we acknowledge the importance and significance of changes in attitude to teaching and student learning in recent directive documents. The inclusion of 'thinking' in these documents acknowledges that the ever-changing world we live in requires a population of competent thinkers. Students need to use existing knowledge to produce new understandings in creative ways.

In developing this set of cards we acknowledge the different models of strategies, practices and taxonomies suggested by many informed people to improve student thinking. Gardner, Blooms, Costa and Kallick are a few.

We believe that by allowing our students to solve mathematical tasks that are meaningful, interesting and challenging, and providing them with appropriate and varied means of solving them, we will develop students who automatically use their higher-order thinking to attempt to solve all problems that life presents them in the future. It is pleasing to see this acknowledged in state standards materials also.

References and suggested further reading

Anderson, Lorin W. and David R. Krathwohl (eds) (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York, USA: Longman.

Task Cards in Practice

Class organisation

Task cards can be selected for their appropriateness when used in different classroom settings, depending on how you want your class to be organised for a particular lesson or activity. Some tasks are effectively used when teaching the whole class, others for small group work, others for partner work, and others are best for individual work.

Some examples are:

What can you do in one minute? For example, how many times can you write your name, hop, count to ten?

Although the question asks what the individual can do in one minute, this task would be most effective when students work with a partner or small group. This would ensure each individual student has personal time and/or count for themselves.

What jobs use measurement tools? Draw or name as many people as you can that use measurement tools in their work. Can you group or classify your findings?

A great activity for partner work, as students can bounce ideas off each other and each student should be able to contribute equally to create a list. Students could utilise co-operative skills when classifying their findings through fair discussion.

Jamie says odd numbers are better than even numbers. Is he right?

A suitable question for individual responses, with quiet thinking time for students to formulate an opinion. Class responses could then be shared or debated.

Make a list of activities you do during the day which take approximately 3 minutes.

This task would work well using Think/Pair/Share. Give students a few minutes to think and make a list individually. Students work with a partner to expand their list and finally responses are shared with the whole class.

What numbers can you create using all of these digits 9 4 6 1 3 7 and a decimal point. Rank/group/categorise these numbers.

A great warm-up activity to use with the whole class when beginning a lesson on place value, which encourages fluency skills in their thinking. Each student could contribute a number to make a class list on the board, then students could be given time as an individual or with a partner to rank/ group or categorise the numbers. Examples could then be shared with the whole class again.

Examples for each level:

Junior primary task

Design a necklace using four different colours. How long will your necklace be?

Extension questions

- What other patterns can you make using the same beads?
- Add another colour and how does this affect your pattern?
- Does this affect the length?
- Compare your necklace with a friend's. What similarities and differences do you notice?

Middle primary task

Using a supermarket catalogue, work out a shopping list of items that reach a total mass of 20 kg.

Extension questions

- What is the total cost?
- Use recipe books to find out what you could make using these items.
- What is the average weight of the items?
- What is the difference in mass between the lightest and heaviest item?
- Order the items in terms of their cost or mass.
- Demonstrate to another student how you calculated the total cost or mass accurately.
- Write your own task card question on the topic of mass, which will require another student to apply and demonstrate their skills with this concept.

Upper primary task

Use a map to plan a road trip between 500 and 1000 km long. Where will you go?

Extension questions

- Estimate the cost of petrol for the entire trip
- How much time will it take to complete the trip?
- Plan your itinerary with arrival and departure times
- Can you find an alternate route to the same destination that would be shorter/longer in distance? Compare the time and petrol costs.
- Explain to the class how you calculated the distances accurately.

Open-ended task card questions are useful when used as a class discussion point to help prepare students for incorporating critical thinking skills and planning how they will approach the task. Students could ask questions about the task and share their ideas about how to respond to it. Teachers may want their students to focus on the importance of selecting relevant information when problem solving. By altering questions to include some irrelevant information, students use critical thinking skills to plan their response.

Example tasks

Junior:

Number: Create your own snakes and ladders board game.

Measurement: Design your own very special alarm clock.

Middle:

Number: What is the most popular number in the class? Why do people have favourite numbers?

Measurement Design a maze. Use any materials you like. Make sure that the correct path in your maze is between 85 centimetres and one metre in length.

Upper:

Number: Write down your telephone number. What multiplication problems can you create using all of the digits?

Measurement: You have made 36 chocolates to give a friend for a present. Design some boxes to hold the chocolates.

Originality

Originality is a way of continuing to develop creative, divergent thinking by using knowledge to assist in the creation of new approaches. Original thinkers express novel, unique responses, though not all of the ideas need to be practical or realistic. Attempts at originality are personal and should display a new approach for the individual, as what may be original to one person may be not be to another depending on previous knowledge and experiences.

Example tasks

Junior:

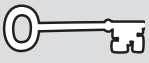
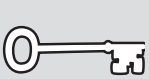
Number: Think of a number between 0 and 20. Make up 4 clues about your number. Can a friend guess your number?

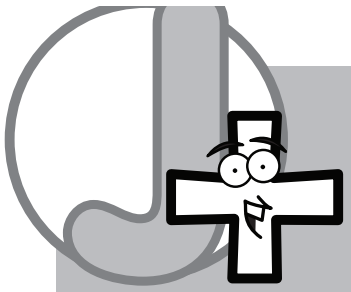
Measurement: Create your own measurement tool.

Middle:

Number: Write a submission to your parents for an increase in your pocket money. How would you best show how you would use the money? How much money do you think the jobs you do are worth?

Measurement: You and a friend are asked to be in charge of the judging of the 'egg and spoon race.' How will you do this? Include instructions to give to the competitors and how you will determine the winner.

Topic	Fractions	Money	Length	Mass
Tony Ryan's Thinker's Keys				
The Reverse Listing Key 	List 5 fractions which are not equivalent to half.	Find 5 items you cannot buy from the canteen with only $1.	What things would you never measure in millimetres?	What items cannot be weighed using a balance scale? Explain why.
The What If Key 	What if you had to pay for things in terms of their fractional amount of 100?	What if there were no 10 cent pieces? Would prices change?	What if the tape measure was not invented and you could only use a straight and flat ruler?	What if you couldn't weigh fruit or vegetables? How else could shop owners work out costs?
The Alphabet Key 	Use an A-Z sheet to list all the items you can think of which can easily be divided into fraction.			
The BAR Key 		Invent a new coin or note by making it bigger, add something to it and replace something on it.		
The Construction Key 			Construct an animal which has a length on 54 cm.	
The Disadvantages Key 	What are the disadvantages of cutting a cake into fractions? How could you improve or correct these disadvantages?	What are the disadvantages of earning money?	What are the disadvantages of using a wooden ruler?	
The Different Uses Key 			Find 10 uses for a broken ruler.	Find 10 uses for an old balancing scale.
The Prediction Key 		Predict how we will use money in 20 years' time.		
The Picture Key 		Using a circle, show how you can link it to the topic of money.		
The Ridiculous Key 	Everyone who earns money must pay a quarter of it to charity.	The Government should give everybody $100 to a day to live. Substantiate this.		



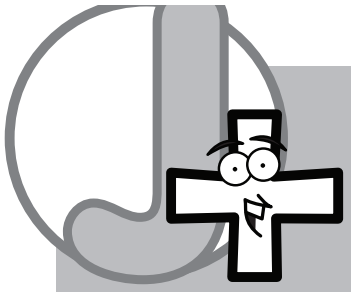
Junior Primary

Create

Number

5-10 minutes

- The answer is 35 cents. What could the question be?



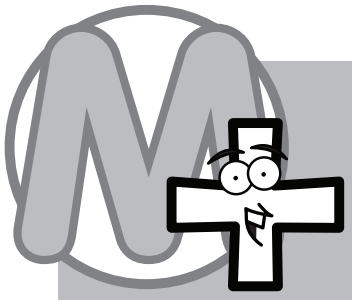
Junior Primary

Create

Number

5-10 minutes

- Roll two dice and calculate the answer. Predict how many more times you would have to roll the dice to make a number over 100. How would you test your prediction?



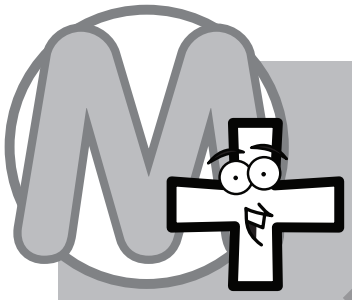
Middle Primary

Analyse

Number

5-10 minutes

- How many different equations can you make using the following numbers: 1.2, 0.7, 0.5, 0.6, 0.2, 0.4, and 1.0?



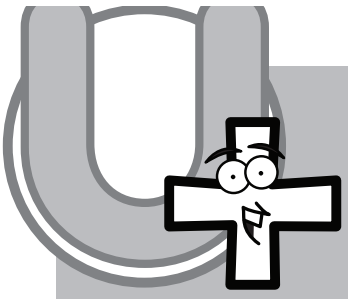
Middle Primary

Analyse

Number

5-10 minutes

- ✹✹ - 4 = ✹✹ What might the missing numbers be?



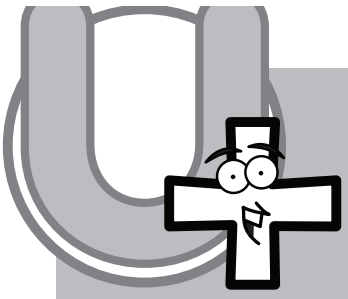
Upper Primary

Create

Number

5-10 minutes

- What numbers can you create using all of these digits 9 4 6 1 3 7 and a decimal point? Rank/group/categorise these numbers.



Upper Primary

Create

Number

5-10 minutes

- Write down your telephone number. What multiplication problems can you create using all of the digits? Solve the sums you can, use a calculator for others.