

# **Open-Ended Maths Tasks**

## **Space, Chance and Data**

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 require little creativity and children are usually asked to find the 'right' answer to ascertain their comprehension of facts. An example would be *"The news is on television every night. Which of the following is the correct answer to describe the probability of the event happening? 100%, 50:50, 3 out of 10, or maybe.* Students need to know what the terms mean and how they relate to probability. There is only one right answer, 100%.

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 *"What words describe the chance of the news being on television tonight?"* This question is an example of providing a scenario where there is a 'certain' chance of the event taking place. To rationalise the scenario, students use prior knowledge to ascertain the appropriate term to explain the chance. *"The news is on television every night, so it would have to be on tonight. I am certain it will be on TV tonight"*. There are several possible correct answers though. Students can display an understanding of alternative terms for 'certain chance'. However there would only be a limited number of appropriate terms – definite, absolute, 100%, etc. The focus of this open question is to assess students' ability to understand the different terminology used to describe chance events and that certain factors influence the accuracy of the terms that can be used.

Other open-ended questions or tasks can have an almost infinite range of acceptable responses. An example would be *"Create a question and survey the class for answers. Show your results using an appropriate graph and make statements about your findings."* Students can decide on the survey question based on their own interests and there are almost endless possibilities of acceptable questions that could be posed. Students then use their prior experiences and knowledge in deciding what type of graph would be appropriate to display the survey results. Finally, students can decide on what findings were of interest to them and how to make conclusions about the results. The focus of this open question is to assess students' ability to apply their skills in planning and conducting surveys or questionnaires and displaying the data using appropriate techniques. (VELS Level 3 and 4 outcomes)

A great way to engage students is using open-ended questions or tasks which 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 the teacher can further assess their skills.

This book focuses on the use of open-ended questions or tasks 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 the Mind, Creative and Critical Thinking skills, and using 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 such as correct names and terminology used in identifying shapes, ordering chance events or using processes for finding the mean, median or mode of data collected.

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 what you realise. Asking open-ended questions can require more effort and preparation; however, with practice, they can easily become second nature in your teaching.

A classroom which incorporates open-ended tasks into their learning programs should be a classroom where students are 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 overlap and are not category specific, especially when using Bloom's Taxonomy.

An application task could also be used as an evaluation. Example – *Write three questions which people can only give a yes or no answer to.* Children have to apply the skills taught in class about survey questioning to demonstrate an understanding that in order for data to be collected accurately, the question needs to be specific. This task can also help you evaluate their understanding of this skill and could be followed up with them completing a survey and displaying the results using a graph.

A creative thinking Fluency task could also be Remembering in Bloom's and an Intrapersonal and Interpersonal Multiple Intelligence. Example – *How many terms can you come up with that would describe the chance of you going for a swim on a 30 degree day? Compare your terms with a friend. What did you discover?* This task requires children to fluently recall terms they are familiar with (fluency), which requires them to access their knowledge about chance (remembering/understanding), as well as being confident and in touch with their own abilities (Intrapersonal) and being able to share and compare with a classmate (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. Feel free to use them in a way that suits your teaching style and the learning preferences of your students.

	<b>Junior Primary</b>	<b>Middle Primary</b>	<b>Upper Primary</b>
<b>Space</b>			
<b>Mapping</b>			Page 55
<b>Geometry</b>		Page 52	
<b>Shapes</b>	Page 49		
<b>Chance and Data</b>			
<b>Probability</b>			Page 57
<b>Probability</b>		Page 53	
<b>Probability</b>	Page 50		

## 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:

Section two contains reproducible copies of the task cards. The task cards can 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, Chance and Data or Space.

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.

# 1

# Creative and critical thinking

The task card questions developed for this book can be easily incorporated into a creative and critical thinking teaching program (see boxed text, p. 23). Critical thinking tends to involve tasks that are logical, rational, sequential, analytical and convergent. This is 'left brain' thinking. Creative thinking tends to involve tasks that are spatial, flexible, spontaneous, analogical and divergent. This is 'right brain' thinking.

One model of teaching using creative and critical thinking skills was outlined in the book, *Activities for Developing Thinking Skills* (Wellner and Yoder, 2005). Their approach incorporates the four creative thinking skills in the cognitive domain identified by Frank E. Williams (1970, see boxed text on p. 27). In this model, they identify four key components to both creative and critical thinking. These skills are often introduced sequentially, with each new thinking approach building upon the thinking skills developed in the previous component.

Creative thinking	Critical thinking
Fluency Flexibility Elaboration Originality	Evaluation Planning Forecasting Decision Making

## Creative thinking

### Fluency

Fluency is the beginning of divergent thinking or the recall and use of stored knowledge. Fluent thinkers have the ability to think of many related ideas, questions, responses and solutions. Students can be encouraged to work independently or in small groups on fluency lists and fluency thinking tasks. These tasks may be used as a warm-up activity, for class or group discussions or as part of a lesson.

#### Example tasks

**Junior:**

*Space:* Write down everything you know about triangles.

*Chance and Data:* Make a list of games that depend on chance more than skill.

**Middle:**

*Number:* List all uses for right-angled shapes.

*Chance and Data:* Why is a Venn diagram useful?

**Upper:**

*Space:* Make a list of objects around the classroom that have parallel lines.

*Chance and Data:* What words describe the odds or chance of something happening between certain and impossible.

## Flexibility

Flexibility is the ability to adapt ideas and materials to new or different forms. Flexible thinkers are capable of varying their thinking and producing alternative questions and solutions. They can shift their point of view and consider situations differently from other students.

### Example tasks

**Junior:**

*Space:* Imagine if the lights went out at your home. Describe how you would find the way to your parents' room.

*Chance and Data:* Make a list of things that are more likely to happen to you when you are 'grown up' than when you are a child.

**Middle:**

*Space:* Use pairs of tangram shapes. Make as many new regular shapes as you can.

*Chance and Data:* How can 20 items be represented in different graphs?

**Upper:**

*Space:* Write a series of questions to form a flowchart so you can work out the name of a 3D shape.

*Chance and Data:* What 3 questions can you create about the data represented in a packet of lollies.

## Elaboration

Elaborative thinkers stretch or expand upon ideas, solutions or products, making them more refined and interesting. Elaborators may not be the originators, but their modifications or embellishments are creative and can lead to solutions that display more detail and a deeper level of understanding.

### Example tasks

**Junior:**

*Space:* Create a plan for a new playground for the school.

*Chance and Data:* Investigate favourite games, sports or activities in your class. Show what you have found out.

**Middle:**

*Space:* Using at least 30 right angles, design and construct a maze or a marble runway. Use any material to make your model.

*Chance and Data:* Change the representation of data from a bar graph into a pie graph.

**Upper:**

*Space:* Select a plane shape and give it a new name. Explain your reasoning.

*Chance and Data:* Construct a three-dimensional graph which represents the TV channel preferences of all the students in your class.

## 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:**

*Space:* Think of a number between 0 and 20. Make up four clues about your number. Can a friend guess your number?

*Chance and Data:* Create a die that has a high probability of landing on a 6.

**Middle:**

*Space:* Think of a shape. Make up four clues about your shape. Can a friend guess your shape?

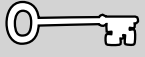
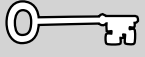
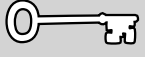
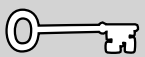
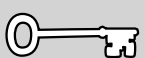
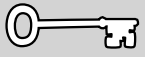
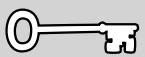
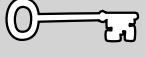
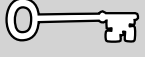

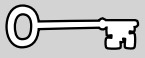

*Chance and Data:* Write ten statements where you could answer "as if".

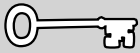


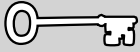
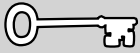



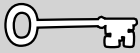
**Upper:**

*Space:* Design and make a model of a new useful tool.

*Chance and Data:* Invent a new visual representation of some measured information.



Topic	Shapes (2D and 3D)	Mapping and Location	Chance/ Probability
<b>Tony Ryan's Thinker's Keys</b>			
<b>The Reverse Listing Key</b> 	List 2D shapes that are not used in making different 3D shapes.	Give 10 maths words that have nothing to do with mapping.	What events would never have a certain chance of happening?
<b>The What If Key</b> 	What if every object was named after the shape it was made from? E.g. a rectangular prism tissue box.	What if there were no directions such as N, S, E and W, and only right, left, forwards and backwards?	What if everything in life had a 50/50 chance of happening? What benefits would there be? What difficulties could be faced?
<b>The Alphabet Key</b> 	Use an A-Z sheet to list all the items you can think of that are three-dimensional.	Use an A-Z sheet to list as many things that can be found on a world globe.	What words can describe the chance of an event, starting with each letter of the alphabet.
<b>The BAR Key</b> 	Find a household object which is a prism. Use BAR to improve the design of this object (e.g. tissue box).	Invent a new system for giving directions.	
<b>The Construction Key</b> 	Construct an animal using at least five different types of 3D or 2D shapes.		
<b>The Disadvantages Key</b> 		What are the disadvantages of using a street directory to find your way into the city?	What are the disadvantages of surveying your class to find out their opinion about a given topic?
<b>The Different Uses Key</b> 	Invent a useful tool to do your homework which uses different 2D shapes in its design.	Find 10 uses for a 100-year-old road map of your local area.	
<b>The Prediction Key</b> 		Predict how we will find our bearings or travel to unfamiliar destinations in 20 years time.	
<b>The Picture Key</b> 		Using a circle, show how you can link it to the topic of location.	How could this line represent the chance of an event happening? 
<b>The Ridiculous Key</b> 		No numbers exist. How would you know where your house is and how to direct someone to it without getting lost?	
<b>The Commonality Key</b> 		What do maps and ice-cream have in common?	

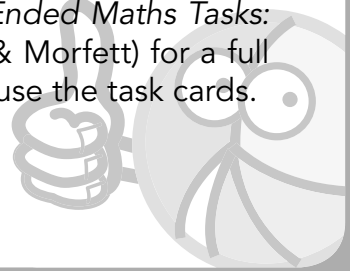
Topic	Shapes (2D and 3D)	Mapping and Location	Chance/ Probability
<b>Tony Ryan's Thinker's Keys</b>			
<b>The Inventions Key</b> 	Invent a new shape. Give it an appropriate name. How is it different to other shapes?		Invent a spinner which represents 50/50 chance with materials other than paper.
<b>The Alternative Key</b> 		How can you get to Sydney without a road map?	
<b>The Question Key</b> 	Give five questions which have the answer of square.	Give five questions which have the answer of north.	Give five questions which have the answer of impossible.
<b>The Brainstorming Key</b> 			There are too many possible combinations of ice-cream to have. Create an easy solution.
<b>The Forced Relationship Key</b> 		Give an alternative method for directing a visitor to the school from your classroom to the office by using only an analogue watch and a trundle wheel.	
<b>The Combination Key</b> 	Combine the attributes of a sphere and a prism into a new product.		
<b>The Interpretation Key</b> 		Mary drove east for 12 hours and ended up in a capital city of an Australian state. Where did she start? Where did she finish?	
<b>The Brick Wall Key</b> 		List spatial situations that cannot be disputed, e.g. South is always the opposite direction to North.	
<b>The Variations Key</b> 		How many ways can you direct someone to the canteen from your classroom?	How many different situations can you have a 20% chance of something happening?

# Task Cards

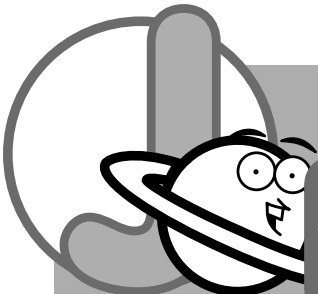
## Ideas for using task cards

- Whole class activity
- Early finishers
- Homework
- Evaluation of student learning
- Individual learning
- Weekly class challenge
- Group work
- Thinking book

See "Task cards in practice" in *Open-Ended Maths Tasks: Space, Chance and Data* (Emry, Lewis & Morfett) for a full explanation and more ideas on how to use the task cards.



## Key Card



### Difficulty level

Junior Primary – Prep, 1 and 2  
Middle Primary – 3 and 4  
Upper Primary – 5 and 6

Junior Primary

Open-ended task question

### Remember

Task encourages thinking at the **level of Bloom's Taxonomy** denoted here.

- List what letters of the alphabet are symmetrical.

### Topic

Space

5-10 minutes

### Type of task

- 5–10 minutes indicates the task is suitable for a topic intro, warm-up or for early finishers.
- 15+ minutes denotes that it is suitable for a whole lesson activity or a project-based or extension task.