Open-Ended Maths Tasks

Number and Measurement

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

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Table of Contents

Introduction: What are open-ended tasks? **5**

The Australian Curriculum **8**

- Australian Curriculum: Mathematics reference table 10

Task cards in practice **15**

Section one Thinking skills in mathematics **21**

1) **Creative and critical thinking** **21**
2) **Multiple Intelligences** **31**
3) **Visual organisational tools** **35**
4) **Habits of Mind** **39**
5) **Bloom's Taxonomy** **43**
    - Examples of how to create open-ended units of work 45
6) **Tony Ryan's Thinker's Keys** **47**
7) **Converting closed questions to open-ended** **51**
    - Generic skills table 61

Section two Task cards **63**

- **Junior Primary** **64**
    - Number 64
    - Measurement 82
- **Middle Primary** **107**
    - Number 107
    - Measurement 125
- **Upper Primary** **143**
    - Number 143
    - Measurement 161

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 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 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.

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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 Numbers			Page 57
Division		Page 54	
Addition	Page 51		
Measurement			
Perimeter			Page 59
Mass		Page 55	
Time	Page 52		

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

The cards have been separated into levels of

- Junior primary (years Foundation, 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.

The Australian Curriculum

As Australian teachers, we acknowledge the importance and significance of directives in teaching and student learning from ACARA (Australian Curriculum, Assessment and Reporting Authority) in the development and implementation of the Australian Curriculum.

The stated aims of the Mathematics Learning Area from the Australian Curriculum are to "ensure that students:

- are confident, creative users and communicators of mathematics, able to investigate, represent and interpret situations in their personal and work lives and as active citizens
- develop an increasingly sophisticated understanding of mathematical concepts and fluency with processes, and are able to pose and solve problems and reason in *Number and Algebra, Measurement and Geometry, and Statistics and Probability*
- recognise connections between the areas of mathematics and other disciplines and appreciate mathematics as an accessible and enjoyable discipline to study."

  (ACARA, 2013, http://www.australiancurriculum.edu.au/Mathematics/Aims)

The Australian Curriculum further identifies Numeracy as one of seven general capabilities which "encompass the knowledge, skills, behaviours and dispositions that, together with curriculum content in each learning area and the cross-curriculum priorities, will assist students to live and work successfully in the twenty-first century."

"Students become numerate as they develop the knowledge and skills to use mathematics confidently across all learning areas at school and in their lives more broadly. Numeracy involves students in recognising and understanding the role of mathematics in the world and having the dispositions and capacities to use mathematical knowledge and skills purposefully."

"Mathematics has a central role in the development of numeracy in a manner that is more explicit and foregrounded than is the case in other learning areas. It is important that the Mathematics curriculum provides the opportunity to apply mathematical understanding and skills in context, both in other learning areas and in real world contexts. A particularly important context for the application of Number and Algebra is financial mathematics. In *Measurement and Geometry*, there is an opportunity to apply understanding to design. The twenty-first century world is information driven, and through *Statistics and Probability* students can interpret data and make informed judgments about events involving chance." (http://www.australiancurriculum.edu.au/Mathematics/General-capabilities)

CRITICAL AND CREATIVE THINKING

The Australian Curriculum identifies another of the seven general capabilities as "Creative and Critical Thinking".

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"In the Australian Curriculum, students develop capability in critical and creative thinking as they learn to generate and evaluate knowledge, clarify concepts and ideas, seek possibilities, consider alternatives and solve problems. Critical and creative thinking are integral to activities that require students to think broadly and deeply using skills, behaviours and dispositions such as reason, logic, resourcefulness, imagination and innovation in all learning areas at school and in their lives beyond school.

The Melbourne Declaration on Educational Goals for Young Australians (MCEETYA, 2008) recognises that critical and creative thinking are fundamental to students becoming successful learners. Thinking that is productive, purposeful and intentional is at the centre of effective learning. By applying a sequence of thinking skills, students develop an increasingly sophisticated understanding of the processes they can employ whenever they encounter problems, unfamiliar information and new ideas. In addition, the progressive development of knowledge about thinking and the practice of using thinking strategies can increase students' motivation for, and management of, their own learning. They become more confident and autonomous problem-solvers and thinkers.

Responding to the challenges of the twenty-first century – with its complex environmental, social and economic pressures – requires young people to be creative, innovative, enterprising and adaptable, with the motivation, confidence and skills to use critical and creative thinking purposefully." (http://www.australiancurriculum.edu.au/GeneralCapabilities/Critical-and-creative-thinking/Introduction/Introduction)

In developing this set of cards we acknowledge the different models of strategies, practices and taxonomies suggested by many theorists to improve student thinking. Gardner, Bloom, Costa and Kallick are a few. The Australian Curriculum identifies a variety of theorists in the background summary for the general capability of Critical and Creative Thinking. "It draws on foundational and recent international and national research, as well as initiatives and programs that focus on critical and creative thinking across the curriculum." (http://www.australiancurriculum.edu.au/GeneralCapabilities/Pdf/Critical-and-creative-thinking)

We, too, have included many of these ideas in the development of these task cards. The Australian Curriculum states that, "students develop capability in critical and creative thinking as they learn to generate and evaluate knowledge, clarify concepts and ideas, seek possibilities, consider alternatives and solve problems. Critical and creative thinking are integral to activities that require students to think broadly and deeply using skills, behaviours and dispositions such as reason, logic, resourcefulness, imagination and innovation in all learning areas at school and in their lives beyond school." (http://www.australiancurriculum.edu.au/GeneralCapabilities/Pdf/Critical-and-creative-thinking, page 1 Introduction)

We hope that these cards promote the development of these skills. 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.

Generic skills table

Refer to this table to quickly find a specific task card that is related to a particular strand or set of skills for Junior, Middle or Upper primary year levels. These task cards are useful for revision of concepts, and their content can be easily adapted to suit any curriculum or year level.

Content Strand		Task Card Number
NUMBER	Place value	JN2, JN3, JN6, JN31, MN4, UN1, UN5, UN6, UN8, UN9, UN10, UN17
	Counting	JN15, JN19, JN25, MN5, MN15, UN19
	Addition/Subtraction	JN1, JN7, JN8, JN13, JN14, JN18, JN22, JN26, JN28, MN1, MN3, MN11, MN12, UN2, UN3, UN6, UN11, UN24, UN29, UN33
	Multiplication/Division	JN5, JN23, MN9, MN10, MN13, MN18, MN23, MN27, MN31, MN32, UN2, UN3, UN4, UN7, UN18, UN23, UN25, UN26, UN35
	Fractions	JN4, JN9, JN27 MN6 UN12, UN16, UN30, UN34, UN36
	Money	JN11, JN17, JN21, JN33, JN35 MN7, MN8, MN21, MN24, MN25, MN28, MN29 UN15, UN21, UN27, UN28, UN32
	Patterns/Algebra	JN10, JN16, JN29 MN9, MN12 UN16, UN22, UN35
	Mixed concepts/Problem Solving/Investigations/Other	JN12, JN20, JN24, JN30, JN32, JN34, JN36, MN2, MN14, MN16, MN17, MN19, MN20, MN26, MN30, MN33, MN34, MN35, MN36 UN13, UN14, UN19, UN20, UN31
MEASUREMENT	Time, Timetables	JM3, JM5, JM8, JM11, JM12, JM15, JM17, JM32, JM33, JM34, JM36, MM2, MM3, MM4, MM10, MM12, MM13, MM15, UM1, UM10, UM16, UM20, UM21, UM23, UM25, UM26, UM34
	Mass	JM1, JM10, JM19, JM28, MM14, MM26, MM27, MM30, MM31, MM35, UM6, UM17, UM19, UM24, UM27, UM29
	Area	JM7, MM6, UM9
	Volume/Capacity	JM25, JM30, MM5, MM14, UM22, UM27
	Length/Height/Distance	JM6, JM16, JM21, JM23, JM24, JM27, JM29, JM31, JM35, MM1, MM9, MM16, MM17, MM22, MM23, MM24, MM35, UM3, UM4, UM7, UM8, UM12, UM14, UM15, UM26, UM28, UM31, UM35, UM36
	Mixed Concepts/Problem Solving/Investigations/Other	JM2, JM4, JM9, JM13, JM14, JM18, JM20, JM22, JM26, MM7, MM8, MM11, MM18, MM19, MM20, MM21, MM28, MM29, MM32, MM33, MM34, MM36, UM2, UM5, UM11, UM13, UM18, UM27, UM30, UM32, UM33

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" (p. 8) for a full explanation and more ideas on how to use the task cards.

A full set of task cards are available for download at **go.hbe.com.au** and can be printed and laminated as desired.

Key Card

JNX

Task card reference number

Difficulty level
Junior Primary – F, 1 and 2
Middle Primary – 3 and 4
Upper Primary – 5 and 6

Junior Primary

Understand

Open-ended task question

- Make up phone numbers that are easy to remember with 5 digits.

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

Topic

Number

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.

5-10 minutes