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Getting Ready to Read: Previewing a Text

MATHEMATICS

A well-designed textbook, website or other print resource has a variety of elements or features that are applied consistently to help the reader locate and use the material. Some texts have more of these features, and clearer cues, than others do. Previewing a course text can help students to identify the text features and use them efficiently.

Purpose

- Learn how to navigate subject-specific textbooks and resources.
- Examine the layout and features of a particular text, and how to use it.

Payoff

Students will:

- become familiar with different course texts and resources (print and electronic).
- use strategies for effectively previewing and locating information in different texts, using the table of contents, indices and/or navigation bar.

Tips and Resources

- Most informational texts use a variety of visual, graphic and text features to organize information, highlight important ideas, illustrate key concepts, and provide additional information. Features may include headings, subheadings, table of contents, index, glossary, preface, paragraphs separated by spacing, bulleted lists, sidebars, footnotes, illustrations, pictures, diagrams, charts, graphs, captions, italicized words or passages, boldface words or sections, colour, symbols, and icons.
- In a mathematics textbook, the lesson title tells the reader the learning focus of the lesson, subheadings are often used to identify the parts of the lesson that are for learning and the parts that are for practising. Accompanying diagrams, calculations, and tables are alternate forms of mathematics information, that are integral to the meaning of the whole mathematics text.
- For more ideas, see teacher resource, *Suggested Prompts for a Text-Features Search.*

Teaching Reading in Social Studies, Science, and Math, pp. 266-269
Beyond Monet, pp. 94, 105
Cross-Curricular Literacy: Strategies for Improving Secondary Students' Reading and Writing Skills, pp. 20-21
Cross-Curricular Literacy: Strategies for Improving Middle Level Students' Reading and Writing Skills, Grades 6-8, pp. 28-29, 42-43.
Reaching Higher video

Further Support

- Provide students with a copy of a course-related text that has all of the visual and graphic features (e.g., diagrams, charts, illustrations, captions, maps, headings, titles, legends) removed or blanked out. Ask students to scan the text and suggest what the blanked-out sections might be. Have students read the body of the text and summarize the information. Ask students to identify the parts of the text that they had difficulty reading, and suggest what additional features would help them to navigate and understand the text better. Alternatively, provide students with a copy of a course-related text showing the text features only, without the body of the text. Discuss what information they can gather from the features and what predictions they can make about the content. Note the connections among the features of a text, the words, and how they help readers understand the content.
- Encourage students to preview the features of a text before they read for content. Have partners share their previewing strategies.
- Have students create text search prompts for other course-related materials.

Getting Ready to Read: Previewing a Text

MATHEMATICS

What teachers do	What students do
Before • Select a subject-related textbook, Website, or print or electronic resource. • Create a text search handout. Use ten to twelve prompts to guide students to particular features of the text (e.g., "List the major topics in this textbook." "Locate information about integers." "Where would you find a review of each chapter?" "What symbol tells you that you need a graphing calculator?") See Teacher Resource, *Suggested Prompts for a Text-Features Search*. • Read the prompts out loud, if needed.	• Ask clarifying questions about the prompts and the task. • Read the task prompts and note the features of text that might be useful in completing the task.
During • Ask students to work in pairs to complete the search within a specific time frame. • Have partners share their findings with another pair.	• Read and respond to the prompts. Record findings. • Share and compare findings. Use cooperative group skills to complete the task.
After • Discuss which items were easy and which items were challenging to find. • Ask students which features of text were very helpful and not very helpful, and which features should be added to the text. • Ask students to use the text features to complete a relevant reading task.	• Identify the easy and challenging prompts. • Identify the features of text they used and explain how they helped or hindered their task. • Use the text features appropriately to complete the reading task. Make connections between different texts, noting the features that are common to many texts and subject areas, and those that are unique to a particular text or subject area.

Notes

Suggested Prompts for a Text-Features Search

1. Using the Table of Contents, find the chapter number for the topic ____________.
(e.g., ratio and rate, statistics and probability, exponents)

2. In the Index at the back of the text, find and list all the pages that deal with ______.
(e.g., integers, line of best fit, surface area)

3. On page _____, what is the purpose of the coloured box?
(e.g., highlights the key ideas of the section)

4. On page _____, what is the purpose of the icon beside question _____ ?
(e.g., indicates that the use of a graphing calculator or spreadsheet is required)

5. Where would you go in the textbook to quickly find a definition for ___________?

6. Where would you find the answer to question _____ on page _____?

7. In Chapter Two, which page reviews skills needed for the mathematics in this chapter?

8. Turn to page _____. How does the textbook review the concepts of the chapter?

9. Which page has the “Review Test” for Chapter Four?

10. Open the text to page _____. What does the word “cumulative” mean?
(e.g., cumulative review).

11. On page _____, what is the purpose of the **boldface** type?

12. Name the topic for the Chapter Problem in Chapter Five.

13. Where would you go in the textbook to quickly find information on __________ ?
(e.g., Geometer’s Sketchpad®, graphing calculator, spreadsheet)

Getting Ready to Read: Analyzing the Features of a Text

MATHEMATICS

There's more to a good book or website than the words. A well-designed textbook uses a variety of graphical and text features to organize the main ideas, illustrate key concepts, highlight important details, and point to supporting information. When features recur in predictable patterns, they help the reader to find information and make connections. Readers who understand how to use these features spend less time unlocking the text, and have more energy to concentrate on the content.

In this strategy, students go beyond previewing to examine and analyze a textbook and determine how the features will help them to find and use the information for learning. You can use the same strategy to deconstruct other types of text – in magazines, e-zines, newspapers, e-learning modules, and more.

Purpose

- Familiarize students with the main features of the texts they will be using in the classroom, so that they can find and use information more efficiently.
- Identify patterns in longer texts.
- Create a template that describes the main features of the texts, and post it in the classroom so that students can refer to it.

Payoff

Students will:

- develop strategies for effectively locating information in texts.
- become familiar with the main features of the texts they will be using.

Tips and Resources

- Text features may include headings, subheadings, table of contents, index, glossary, preface, paragraphs separated by spacing, bulleted lists, sidebars, footnotes, illustrations, pictures, diagrams, charts, graphs, captions, italicized or bolded words or passages, colour, and symbols.
- See Student/Teacher Resource, *Features of a Mathematics Textbook – Sample.*

Cross-Curricular Literacy: Strategies for Improving Secondary Students' Reading and Writing Skills, pp. 20-21.
Cross-Curricular Literacy: Strategies for Improving Middle Level Students' Reading and Writing Skills, Grades 6-8, pp. 28-29, 40-41.
Teaching Reading in the Content Areas: If Not Me, Then Who? , pp. 16-18.
* See *also* ***Previewing a Text*** to provide students with another opportunity to look at text features.

Further Support

- Provide students with an advance organizer to guide them as they read a particular text. This organizer might be a series of prompts that ask the students to preview particular features of text and note how they are related to the main body of the text.
- Teach students the SQ4R strategy (Survey, Question, Read, Recite, Review, Reflect). For example, **survey** the title, headings, subheadings, maps, pictures, sidebars, bold or italic print, etc. Turn the title, headings, and captions into **questions**. **Read** the passage to answer the questions. **Recite** the answers to their questions to summarize the passage. **Review** the passage to remember the main idea and important information and details. **Reflect** on the passage and process to check that they understand the text, and to generate additional questions.
- Model for students how to use the features of computer software and Internet websites to help them navigate and read the program or site (e.g., URLs, pop-up menus, text boxes, buttons, symbols, arrows, links, colour, navigation bar, home page, bookmarks, graphics, abbreviations, logos).

Getting Ready to Read: Analyzing the Features of a Text

MATHEMATICS

What teachers do	What students do
Before	
• Ask students to recall a magazine or informational book they recently read, or a website they recently viewed. Ask them to describe how the text looked and how they found information. Ask students what they remember about the content, and have them suggest possible reasons for how they were able to locate and/or remember information.	• Recall something recently read or viewed and identify some features of that particular text. • Note similarities and differences among the responses from other students. • Make connections between what they remember and the features of the text.
• Select and provide copies of a text, resource or textbook chapter. Ensure every student has a copy of the selected text.	
• Organize students into groups of 3 to 5. Assign two different sequential chapters or sections to each group.	
• Ask groups to scan the assigned chapters and note features of the text that are similar between the chapters and those that are unique to a chapter. Groups record their findings on chart paper (e.g., point-form notes, Venn diagram, compare/contrast chart).	• Quickly scan chapters, and note the different features of the text. • Contribute to the group discussion and chart-paper notes.
• Ask each group to send an "ambassador" to the other groups to share one thing the group discovered, trading it for one thing the other group discovered. The ambassadors return to their original group and report.	• Share findings with other groups, noting such things as chapter previews, tables of contents, charts and graphs, typography (italics, bold), questions, chapter reviews/summaries, timelines, and headings.
During	
• Remind students that textbooks have many different elements or features that are designed to help students learn the material being presented. Some textbooks have a greater variety of elements than others.	• Share the groups' findings.
• Ask each group to report about the features of their text for example, some textbooks contain an annotated overview of the textbook layout.	
• Create a textbook or chapter template on chart paper, indicating the common features and noting any unique features (see Student/Teacher Resource, *How to Read a Mathematics Textbook – Sample*).	• Contribute to the template that the class develops.
After	
• Assign a relevant reading task to a small group so that students can practise using the features of the text to locate information and help them understand and remember what they read.	• Use the features of text to complete the assigned reading task. • Note the features that help the reader to locate, read, understand, and remember information.
• Encourage students to use the template to make predictions about where they might find particular information or use the features to complete a task.	• Refer to the template for future reading tasks.
• Discuss how this strategy might help students navigate websites, e-zines, and online media.	• Recall how they have used features of electronic texts to help find and read information.

Notes

Features of a Mathematics Textbook – Sample

Textbook Title:	Doing Mathematics
Table of Contents:	This is a list of the topics and subtopics in each chapter.
Chapters:	These are used to group big, important mathematical ideas.
Chapter Introduction:	This gives a brief overview of the important mathematics in the chapter and lists the curriculum expectations. The Chapter Introduction also poses a problem that can be solved by applying the mathematical concepts in the chapter.
Skill Review:	This provides review material for mathematical skills learned in earlier grades. Proficiency with these skills is an aid to doing the mathematics in this chapter.
Chapter Sections:	There are 3 – 15 sections in each chapter. A chapter section focuses on a smaller part of the important mathematics in the chapter. Chapter sections usually include a “Minds On” activity, information and examples about the key mathematics in the section, a brief summary of the key ideas and practices questions.
Chapter Review:	This is a summary of the mathematics in the chapter, additional examples, and extra practice questions that connect the mathematics in each section of the chapter.
Chapter Review Test:	This is a sample test that you can use to self-assess your understanding of the mathematics in the chapter.
Cumulative Review Test:	This is a sample test that you can use to self-assess your understanding of the mathematics in several consecutive chapters.
Technology Appendix:	This section has specific instructions for graphing calculators, CBRs, spreadsheets, Fathom, The Geometer’s Sketchpad. Technology icons in the chapter material will indicate that this appendix can be used for more detailed instructions.
Icons:	This textbook has technology, career, and math history icons. These visuals help you to quickly locate related text.
Answers:	The answers to most practice questions, review, and review tests are provided at the back of the textbook.
Glossary:	This is an alphabetical listing of the new terms introduced throughout the textbook. Italicized words in the text will also appear in the glossary.
Index:	This provides a quick way to look up specific information or concepts. The page references are given.

Getting Ready to Read: Anticipation Guide

MATHEMATICS

What we already know determines to a great extent what we will pay attention to, perceive, learn, remember and forget. (Woolfolk, 1998)

An *Anticipation Guide* is a series of questions or statements related to the topic or point of view of a particular text. Students work silently to read and then agree or disagree with each statement.

Purpose

- Help students to activate their prior knowledge and experience and think about the ideas they will be reading.
- Encourage students to make personal connections with a topic or unit of work so that they can integrate new knowledge with their background experience and prior knowledge.

Payoff

Students will:

- connect their personal knowledge and experience with a curriculum topic or issue.
- engage with topics, themes and issues at their current level of understanding.
- have a purpose for reading subject-area text.
- become familiar with and comfortable with a topic before reading unfamiliar text.

Tips and Resources

- In the context of mathematics, an anticipation guide increases comprehension by activating prior knowledge of mathematics skills and concepts and/or the contexts for math investigations and problems.
- An anticipation guide works best when the statements challenge students' thinking about a math topic or concept. The idea of the guide is to create curiosity about a math topic or concept and motivate students to read the text or problem and investigate the concept.
- In creating an anticipation guide to activate prior knowledge about math skills and concepts, write statements that challenge students' preconceived ideas or intuitive understandings of a concept e.g., Agree/Disagree: the volume of cylinder created by connecting an 81/2" x 11" sheet of paper vertically is more than the volume of the cylinder created by connecting the same paper horizontally.
- Anticipation guides can also provide a scaffold for students in developing skills in making mathematical conjectures and in developing hypotheses. After students take a position by agreeing or disagreeing with the statements in the anticipation guide, they usually want to continue by investigating the statement.
- Two on-line resources for more information about anticipation guides are:
  http://www.indiana.edu/~l517/anticipation_guides.htm
  - *Description, Purpose, Uses and Examples of Anticipation Guides* and
  http://www.ncsd.k12.pa.us/pssa/Reading/xguide.htm
  - *Prior Knowledge Strategies Across Content Areas - Extended Anticipation Guides*.
  See Student/Teacher Resource *Anticipation Guide – Sample*
  See Teacher Resource *Anticipation Guide – Template*

Further Support

- To provide extra support for students who struggle with reading, use strategies to communicate the information in the anticipation guide visually e.g., pictures and diagrams.
- Put students in pairs to complete the anticipation guide if they are having trouble making connections with the theme or topic, or if they are having trouble with the language (for example, ESL students).
- To provide an opportunity for struggling students to contribute in a more supportive situation, divide the class into small groups of four or five and ask them to tally and chart their responses before participating in a whole-class discussion.
- Read statements aloud to support struggling readers.

Getting Ready to Read: Anticipation Guide

MATHEMATICS

What teachers do	What students do
Before • Preview the task, lesson or unit to identify big ideas e.g., knowing that π ≈ 3.14 is less useful to students than understanding that π is a ratio between the circumference and diameter of a circle. • Using the Student Resource, *Anticipation Guide Template,* create an anticipation guide with general statements (3-4 for a lesson, 8- 10 for a unit) about these big ideas, each requiring the students to agree or disagree. • Ensure that every student has an opportunity to respond to each statement in the anticipation guide by recording a response in the "Before" column. • Ask students to explain their thinking in making their choices. At this stage it is acceptable for students to simply be guessing.	• Each student responds to each statement either by circling "agree" or "disagree" in the "Before" column on an individual copy of the statements or by using a signal such as "thumbs up" or "thumbs down" to statements written on a chart or overhead. • Justify and/or explain their response to the statements in the anticipation guide in pairs, small groups or whole class discussion.
During • Refer students to the statements in the anticipation guide as they participate in the task or lesson activities.	• Make connections between the text and the mathematics in the task or lesson activities and the statements in the anticipation guide.
After • Ask students to record a response to each statement in the anticipation guide in the "After" column. • Ask the students to compare the "Before" and "After" responses to each statement in the anticipation guide. • Use the comparisons of their responses to the statements in the anticipation guide to guide the discussion about the learning in the task or lesson.	• Respond to each statement in the anticipation guide by recording a response to each statement in the "After" column. • Compare the "Before" and "After" responses and suggest reasons for differences. • Use the statements in the anticipation guide to reflect on the learning in the task or lesson.

Notes

Student/Teacher Resource

Anticipation Guide – Samples (Grades 7 & 8)

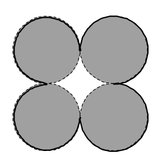
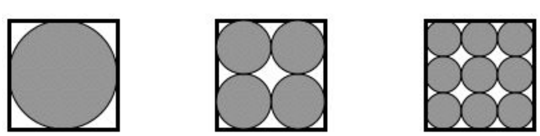
Instructions:

- Check “Agree” or “Disagree” beside each statement below *before* you start the Gazebo task.
- Compare your choice and explanation with a partner.
- Revisit your choices at the end of the investigation. Compare the choices that you would make *after* the investigation with the ones that you made before the investigation.

Anticipation Guide
TIPS Section 3: **Grade 7** Summative Task, The Gazebo **–** http://www.curriculum.org/occ/tips/index.shtml

Before		Statement	After	
Agree	Disagree		Agree	Disagree
		1. An equilateral triangle and a square are both regular polygons.		
		2. A regular polygon could have 13.5 sides.		
		3. A square with sides that are 4 metres long will also have a diagonal that is 4 metres long.		
		4. All the diagonals in a regular polygon have the same length.		

Anticipation Guide
TIPS Section 3: **Grade 8** Summative Task, Multi-dart **–** http://www.curriculum.org/occ/tips/index.shtml

Before		Statement	After	
Agree	Disagree		Agree	Disagree
		1. The total length of the outside curves (i.e. the bold parts) is 3 times the circumference of one of the circles. 		
		2. You will have more pizza to eat if you buy the original on the left instead either of the other two choices.  original 2x2 3x3		
		3. If you double the length of each side of a square, then the area is also doubled.		

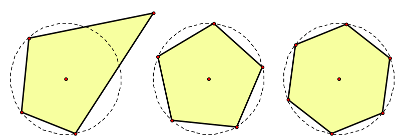
Student/Teacher Resource

Anticipation Guide – Samples (Grades 8 & 9)

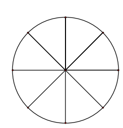
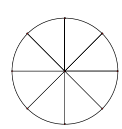
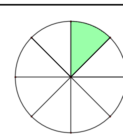
Instructions:

- Check "Agree" or "Disagree" beside each statement below *before* you start the Gazebo task.
- Compare your choice and explanation with a partner.
- Revisit your choices at the end of the investigation. Compare the choices that you would make after the investigation with the ones that you made before the investigation.

Anticipation Guide
Investigations connected to discoveries about π - **Grade 8**
(based on TIPS Section 3: Grade 7 Summative Task, The Gazebo – http://www.curriculum.org/occ/tips/index.shtml)

Before		Statement	After	
Agree	Disagree		Agree	Disagree
		1. There is a relationship between the longest diagonal and the perimeter of any regular polygon.		
		2. Each of these polygons has a *diagonal* that is also a *diameter* of the illustrated circle. 		
		3. The ratio between the perimeter of a square and its diagonal is the same for any two squares.		

Anticipation Guide
TIPS Section 3: **Grade 9** Summative Task, Cones **–** http://www.curriculum.org/occ/tips/index.shtml

Before		Statement	After	
Agree	Disagree		Agree	Disagree
		1. If you are allowed to cut along the marked radii of this circle, you can create nets for 8 different cones. 		
		2. Each cone formed using part of this circle will have the same volume. 		
		3. The angle in the shaded sector is 45°. 		

Anticipation Guide - Template

Instructions:

- Check "Agree" or "Disagree" beside each statement below *before* you start the task.
- Compare your choice and explanation with a partner.
- Revisit your choices at the end of the task. Compare the choices that you would make *after* the task with the choices that you made before the task.

Before		Statement	After	
Agree	Disagree		Agree	Disagree
		1.		
		2.		
		3.		
		4.		
		5.		

Getting Ready to Read: Finding Signal Words

MATHEMATICS

Writers use signal words and phrases (also called *transition words* or *connectors*) to link ideas and help the reader follow the flow of the information.

Purpose

- Preview the text structure.
- Identify signal words and phrases and their purposes.
- Familiarize students with the organizational pattern of a text.

Payoff

Students will:

- make connections between reading and writing tasks in related subject-specific texts.
- read and reread subject-specific reading material.
- practise their reading strategies of skimming, scanning, and rereading; make predictions about the topic and content as they read and reread; learn signal words; and use the signal words when summarizing.

Tips and Resources

- *Signal words* are words or phrases that cue the reader about an organizational pattern in the text or show a link or transition between ideas. S*ignal words* can also cue mathematical thinking, action, and communication processes.
- Mathematics activities, questions and problems often have an organizational pattern that starts with setting the context, followed by mathematics information about the context, and finally a question or several questions based on the context and information. Students can use signal words to identify the question(s) and the required format of the response(s). When students know the question(s), they can reread the problem with deeper understanding. In other types of reading, the initial paragraph clearly identifies the purpose of the text. However in mathematics reading, the purpose (e.g., responding to a specific question) is often not identified until near the end of the text.
- Mathematics prompts are signal words that students need to identify and understand in order to provide the required type of response. For example, the *signal words* "create" "compare" and "describe" require different types of responses.
- In mathematics learning and assessment tasks, *signal words* can highlight the types of mathematics knowledge and skills (i.e., Knowledge and Understanding, Application, Thinking/Inquiry/Problem Solving, Communication) inherent in the prompts.
- In Ontario's large scale assessments, *signal words* are used consistently so that students can better understand the mathematics that they should include in their responses. For a sample list which includes EQAO's key words, see the Student/Teacher Resource, *Signal Words – Mathematics Prompts.*
- A graphic organizer can provide a visual guide to the organizational structure of a text (see Student/Teacher Resource*, Signal Words – Flow Chart for Sample Organizational Structure*). See Student/Teacher Resource, Finding Signal Words – Samples.

Further Support

- Before students read an unfamiliar or challenging selection, provide them with the signal words and the related organizational pattern (e.g., mathematics context, mathematics information, prompt, response).
- Encourage students to scan reading passages to identify signal words and preview the text structure before they read.
- Have students reread the text after identifying signal words. (Students may read independently, with a partner, or listen as another person reads aloud.)

Getting Ready to Read: Finding Signal Words

MATHEMATICS

What teachers do	What students do
Before • Show a text passage that has signal words highlighted e.g., from a textbook lesson, from a released EQAO assessment task, or from an Ontario Curriculum Mathematics Exemplars task. • Brainstorm a list of additional signal words. • In small groups, have students rephrase the signal words (see Student/Teacher Resource, *Signal Words – Mathematics Prompts*). • Tell students that authors use particular organizational structures to sequence and link ideas together so that readers understand the flow of ideas and the requirements of a mathematics task. • Have students determine the location of the mathematics prompts in the organizational structure. • Use a graphic organizer (e.g., flow chart) to help students understand the organizational structure of the text.	• Scan the familiar passage to identify highlighted words and phrases. • Contribute to brainstorming. • Rephrase signal words. • Analyse the text to determine the location of the mathematics prompts.
During • Ask partners to scan a selected text and identify the signal words. • Ask students to identify how some of the signal words relate to the meaning of the passage e.g., "These signal words indicate a sequence. This will help me track the ideas and information in order. A sequence pattern sometimes means I will be reading a procedure or a set of instructions." • Ask students to use the signal words to help them read to understand the ideas, information, and mathematical instructions in the passage.	• Identify and record signal words. • Compare their words with the findings from other partners. • Use the signal words as clues to recognize the organizational pattern of the text. • Read the passage and identify the mathematics context, important mathematical information, mathematical prompts. • Orally share analysis of the mathematics text with a partner.
After • Model how to glean the key mathematical ideas from the context, information, and prompts using the signal words and phrases. • Create a class chart of the signal words and how they might be used to help the reader understand the text. See Student/Teacher Resource, *Signal Words – Mathematics Prompts.* Ask students to describe how using the signal words helped them to understand and identify the mathematics context, information, and prompts. Students might record their responses in a learning log or share orally with a partner.	• Identify the key parts of the mathematics text. • Contribute to the class chart. • Describe how they used the signal words to help understand what they read and then decide what mathematical information to use and actions to take.

Notes

Signal Words – Mathematics Prompts

Mathematics signal words or mathematics instructional words can be used as a strategy to:

- identify the type of mathematical response required: comparison, computations, description, explanation, justification, list, calculation steps.
- ensure that the mathematical response is directly answering the question or problem posed and includes all necessary mathematical details.

These mathematics signal words are commonly used as mathematical prompts:

Calculate:	Compute the number that answers the question.
Classify:	Organize objects into groups, sets, or categories according to a rule.
Compare:	Tell what is the same and what is different.
Construct:	Build or make a model.
Create:	Make your own example.
Describe:	Draw, model, say, or write about what something is to create a mental picture for the reader.
Draw:	Represent something in a pictorial form.
Estimate:	Make a reasonable guess about a quantity of an object based on your knowledge of the physical characteristics of the object and its environment.
Explain:	Use words and symbols to make your solutions clear and understandable.
Justify:	Give reasons and evidence to show your answer is correct or proper.
List:	Write down or identify in point form.
Measure:	Use an object or tool to describe the physical characteristics of an object.
Model:	Show an idea or process using objects and/or pictures.
Predict:	Work out and say what you think will happen based on what you know.
Relate:	Show and explain a connection between ideas, objects, drawings, numbers, and events.

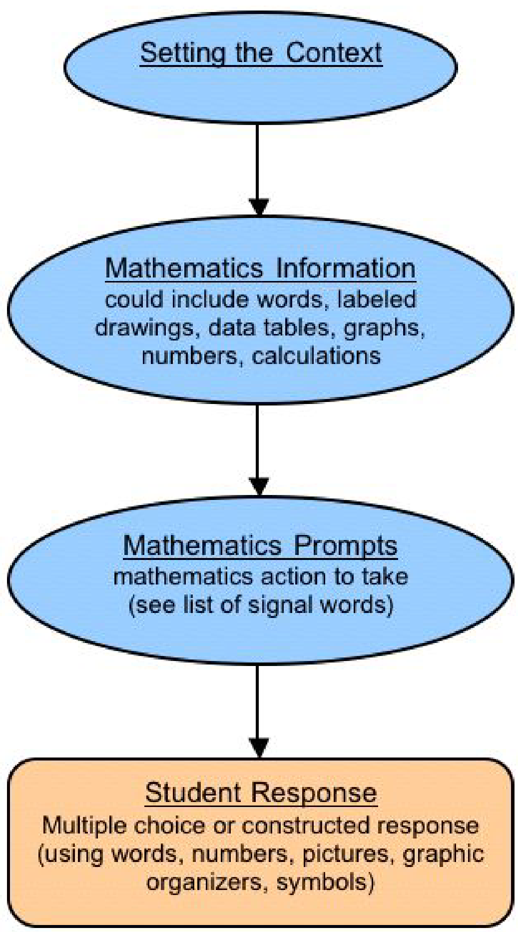
Represent:	Communicate ideas and information in different ways to show understanding (e.g., make a model, draw a picture, show a calculation).
Simplify:	Reduce the complexity while maintaining equivalency.
Solve:	Make a plan and carry out the plan to develop a solution to a problem.
Sort:	Separate objects, drawings, ideas, or numbers according to an attribute or characteristic.
Show your work:	Record all calculations. Include all the steps you went through to get your answer. You may want to use words, numbers, graphs, diagrams, symbols, and/or charts.

Signal Words – Flow Chart for Sample Organizational Structure

Mathematics activities, questions, and problems often follow a sequence: setting a context, giving mathematics information, prompting a response. When students see this organizational pattern, they can better identify the information they are searching for as they read the text.

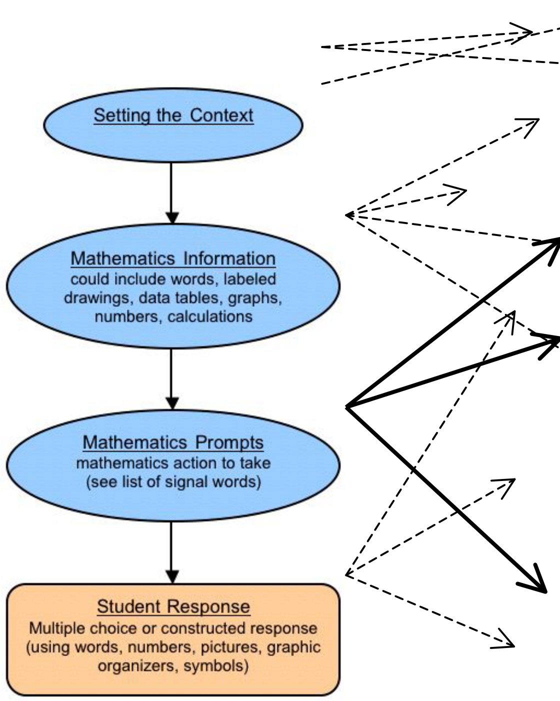
Setting the Context	is describing the situation for the task.
Mathematics Information	could include words, labeled drawings, data table and graph, numbers and calculations.
Mathematics Prompt	identifies the action that the student should take. Mathematics *signal words*, like explain, describe, compare are used. Materials to use are often included in the prompt.

Student responses could include the selection of a response in a multiple choice task or explanations and justifications for constructed response tasks (short, extended), using words, numbers, pictures, graphic organizers, and symbols.

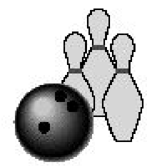


Finding Signal Words – Samples (Grade 9)

1. This example shows the organization of one EQAO Task. What are the signal words?



Task 1: Bowling!



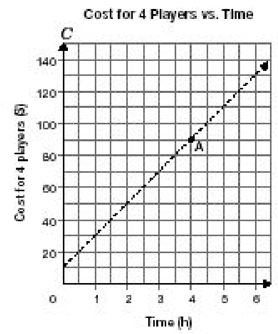
A group of 4 friends is going bowling at Bowling Bonanza. Bowling Bonanza charges

- $2.50 for each player to rent shoes
plus
- $20/h for a group of 4 to bowl.

a) The graph below represents the relationship between cost, C, in dollars, and time, t, in hours, for 4 players to bowl.

i) **Write** the coordinates of point A.

ii) **Explain** what the coordinates of point A tell you about the cost of bowling.



b) **Explain** how this graph would change if the cost for renting the shoes increased.

Hint:
Refer to slope and y-intercept.

2. Scan the text to identify *signal words* and *unfamiliar words* in this EQAO Short Answer Question. Read the question and use the flow chart to help you understand the organizational structure of the question. Identify the mathematics information and the context.

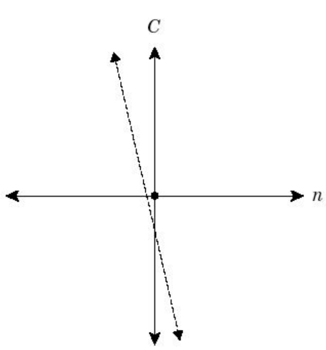
2. Veza uses the equation $C = 43n + 50$ to model the cost of soccer shirts for the team, where

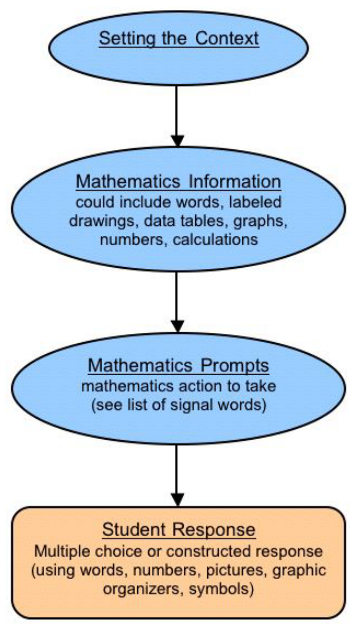
C represents the total cost in dollars,
and
n represents the number of soccer shirts.

Veza sketches the graph of this relationship.

Explain why the graph shown **cannot** represent the total cost of soccer shirts.

List at least two reasons.





EQAO Questions are from the 2002-2003 Release Material (www.eqao.com)

Getting Ready to Read: Extending Vocabulary (Creating a Word Wall)

MATHEMATICS

Students are required to learn, on average, over 2000 words each year in various subject areas. Those who have trouble learning new words will struggle with the increasingly complex texts that they encounter in the middle and senior school years. A word wall is a wall, chalkboard or bulletin board listing key words that will appear often in a new unit of study, printed on card stock and taped or pinned to the wall/board. The word wall is usually organized alphabetically.

Purpose
- Identify unfamiliar vocabulary and create a visible reference in the classroom for words that will appear often in a topic or unit of study.

Payoff
Students will:
- practise skimming and scanning an assigned reading before dealing with the content in an intensive way. Students will have some familiarity with the location of information and with various elements of the text.
- develop some sense of the meaning of key words before actually reading and using the words in context.
- improve comprehension and spelling because key words remain posted in the classroom.

Tips and Resources
- *Skimming* means to read quickly – horizontally – through the text to get a general understanding of the content and its usefulness
- *Scanning* means to read quickly – vertically or diagonally – to find single words, facts, or details.
- For directions, see Student Resource, *Skimming and Scanning to Preview text*. Direct students to scan texts for unfamiliar words/symbols at the beginning of a unit and before starting activities that have written instructions.
- Before building the word wall, consider ***using Analyzing the Features of Text*** to help students become familiar with the text.
- Consider posting certain words for longer periods (for example: words that occur frequently in the unit, words that are difficult to spell, words that students should learn to recognize on sight, and words like *justify* that are used in all strands).
- Have students refer to the word wall to support their understanding and spelling of the words.
- Consider using a vocabulary organizer on the back of the word wall card, see *Getting Ready to Read: Extending Vocabulary – The Frayer Model.*
- Include symbols on a mathematics word wall.
- Use word wall cards for word sort activities. Direct students to place cards into assigned categories (e.g., angles, shapes) or ask students to choose their own categories for a given set of cards. This helps students develop classifying skills.
- Select about 4 word wall cards (e.g. triangle, square, rhombus, parallelogram) and ask students to determine which word does not belong, giving reasons for their answers.
  See Student/Teacher Resource, *Creating a Word Wall- Sample Word Wall Cards.*
  See Teacher Resource, *Creating a Word Wall – Terminology.*
  See Student/Teacher Resource, *Creating a Word Wall- Words with Multiple Meanings.*

Further Support
- Add a picture to the cards, as a support for ESL students and struggling readers.
- Provide each student with a recording sheet (or recipe cards) so they can make their own record.
- If it appears that students will need additional support, review the terminology on the word wall in the two classes following the activity.
- Consider differentiating instruction and assessment for some students by allowing more time for scanning text for unfamiliar words as well as an opportunity for clarification before starting tasks. A personal copy of the task can be highlighted as the student scans the text.

Getting Ready to Read: Extending Vocabulary (Creating a Word Wall)

MATHEMATICS

What teachers do	What students do
Before • Preview a unit of study for key vocabulary (including both words and symbols). • Make a list of words/symbols that you anticipate students will identify as unfamiliar. Reflect on: - which words are critical for developing understanding of the concepts in this unit; - which words should be familiar to students from prior learning but will likely need review; - which words will be unfamiliar to most students. • Prepare strips of card stock (approximately 4" by 10" for words). • Have recipe cards available for student records. • Distribute the Student Resource, *Skimming and Scanning to Preview Text*, and read and clarify the techniques with the students. • Choose a text (e.g., chapter in a textbook, instructions for an activity) for students to scan for unfamiliar words or symbols.	• Follow along on the handout as the teacher reviews skimming and scanning.
During • Direct students to independently scan the text for unfamiliar words or symbols. • Ask students to create a personal list of unfamiliar words and symbols. • Direct students to small groups and ask the groups to compare personal lists and create a group master list as well as print the key vocabulary word in large letters on card stock. • Assign each group a location to post their words.	• Scan the text for words/symbols they do not know, making a personal list of the words/symbols. • Compare personal lists. Choose the words for a group master list. • In each group, print the key vocabulary words in large letters on card stock and post in assigned location.
After • Lead some discussion of the words and ask students to speculate on their meaning. If appropriate, describe prefixes (e.g., hex, quad) and suffixes (e.g., lateral) common to mathematical terms. • Pose questions to assess students' understanding of words that appeared on your list but are not identified on student lists. • Consolidate the lists of key words/symbols from each group to create a class list of words. • Have the students complete their own word lists with the word on the front of a recipe card and a vocabulary organizer on the back (e.g., definition and picture, Frayer Model). • Throughout the unit/activity refer to the word wall when necessary to support students' understanding.	• Contribute to class discussion. • Use a textbook glossary or mathematics dictionary to find the meaning of unfamiliar words.

Notes

Student/Teacher Resource

Creating a Word Wall – Sample Word Wall Cards (Grade 7)

Front of Card

integer

Back of Card

Frayer Model

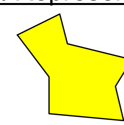
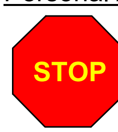
<u>Definition</u> An integer is a positive or negative counting number, or zero.	<u>Characteristics</u> • has no decimal part • has no fractional part
<u>Examples</u> -2 0 325	<u>Non-examples</u> 0.5 -1.2 $\frac{2}{3}$

Front of Card

octagon

Back of Card

Verbal and Visual Word Association

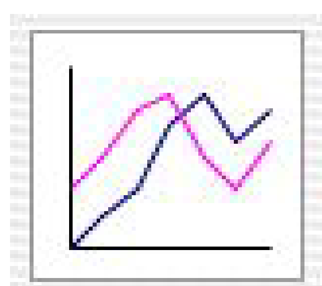
<u>Vocabulary Term</u> octagon	<u>Visual Representation</u> 
<u>Student Definition</u> A polygon with 8 sides	<u>Personal Association</u>  A stop sign is a *regular* octagon

Front of Card

broken-line graph

Back of Card

Picture



Creating a Word Wall – Terminology (Grades 7 & 8)

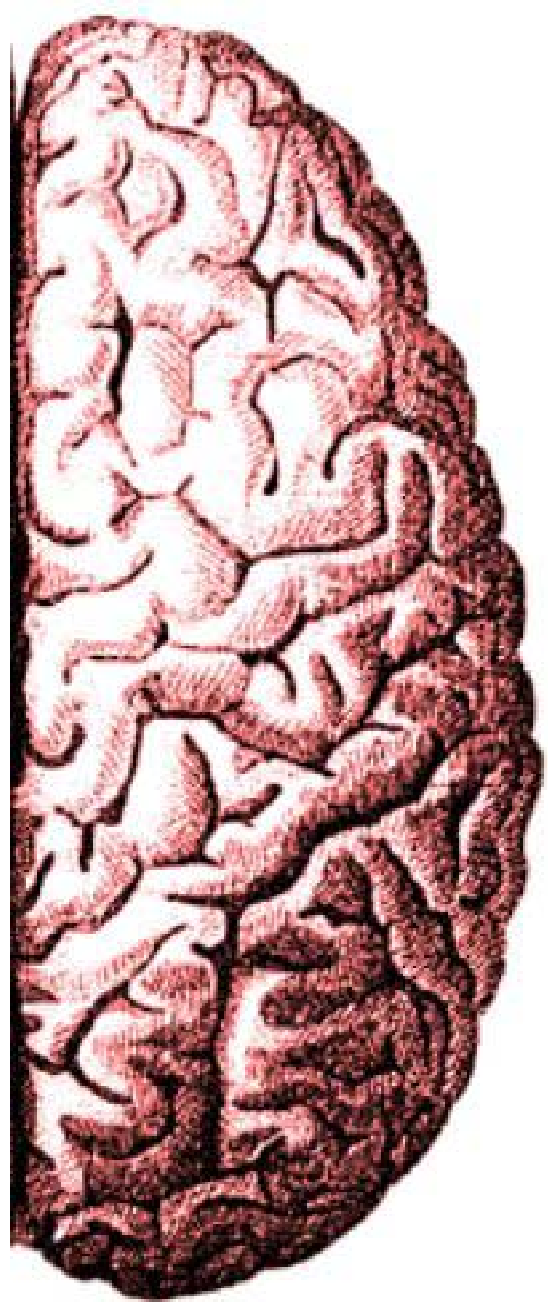
The columns for grades 7 and 8 show examples of terminology that may be included in a word wall.

	Grade 7	Grade 8
All Strands	calculate, compare, conclude, conjecture, create, demonstrate, describe, develop, estimate, evaluate, explain, explore, generate, hypothesis, justify, list, model, represent,	
Number Sense and Numeration	algorithm, ascending order, composite number, consecutive numbers, descending order, difference, equivalent, exponent, greatest common factor, integer, lowest common multiple, order of operations, percent, perfect square, place value, power, prime factorization, prime number, product, rate, ratio, repeating decimal, scientific calculator, square root, terminating decimal, whole number	rational numbers, scientific notation, $\cong, \sqrt{\ }$
Measurement	altitude, dimensions, equilateral triangle, kite, parallelogram, pentagon, prefixes (e.g., bi-, tri-, quad-, penta-, hex-, sept-, etc.), prism, pyramid, quadrilateral, regular polygon, rhombus, suffixes (e.g., -gon, -lateral), surface area, three-dimensional, trapezoid, two-dimensional, m(AB) i.e., *the length of line segment AB as used in Geometer's Sketchpad*	arc, chord, circumference, diameter, radius, sector, segment, π
Geometry and Spatial Sense	acute, angle bisector, congruent, isosceles, midpoint, net, obtuse, reflection, reflex angle, rotation, scalene translation, triangle	alternate angles, complementary angles, corresponding angles, interior angles, opposite angles, parallel lines, perpendicular lines, Pythagorean Theorem, supplementary angles, transversal, $\perp$, $\parallel$
Patterning and Algebra	algebraic expression, equation, expression, formula, inspection (*a method for solving equations*), numerical coefficient, trial and error, variable	inequality, inequation
Data Management and Probability	average, bar graph, bias, box and whisker plot, broken line graph, census, circle graph, data, database, histogram, mean, measure of central tendency, median, mode, outcome, primary data, probability, range, scatter plots, secondary data, spreadsheet, frequency,	

Creating a Word Wall – Words with Multiple Meanings

"Double-Think" Words

angle
base
chord
common
complex
degree
difference
fair
irrational
kite
mean
median
mode
net
obtuse
pentagon
plane
power
prime
quarters
range
rational
real
regular
right
root
scale
sign
similar
slope
term
unit
unknown
variable



Getting Ready to Read: Extending Vocabulary - Concept Circles

MATHEMATICS

The *Frayer Model*, *Concept Circles*, and *Verbal and Visual Word Associations* are three examples of visual organizers that help students understand key words and concepts. A *Concept Circle* is an organizer which is divided into sections to hold words/symbols that are connected by a common relationship. The *Frayer Model* is a chart with 4 sections which can hold a definition, some characteristics/facts, examples, and non-examples of the word/concept. A *Verbal and Visual Word Association* is also a chart with 4 sections, but with one section reserved for a visual representation.
Extending vocabulary using *Concept Circles* follows.

Purpose
- Identify unfamiliar concepts and vocabulary.
- Create a visual reference for concepts and vocabulary.

Payoff
Students will:
- develop understanding of key concepts and vocabulary.
- draw on prior knowledge to make connections among concepts.
- compare attributes and examples.
- think critically to find relationships between concepts and to develop deeper understanding.
- make visual connections and personal associations.

Tips and Resources
- Preview by scanning text (see Skimming and Scanning to Preview Text, pg. 32 *Think Literacy: Cross-Curricular Approaches, Grades 7-12*).
- Include targeted vocabulary/concepts in a classroom word wall. See ***Extending Vocabulary (Creating a Word Wall)***.
- Consider using the back of a word wall card for the vocabulary/concept organizer. When necessary, students can refer to the flip-side of a word wall card to clarify their understanding.
- Develop vocabulary/concept organizers in small groups using different strategies, for example, use a graffiti strategy by posting large Frayer Model charts (with a different word/concept on each chart). Students then move in small groups to add their knowledge to each posted chart. See **Extending Vocabulary - The Frayer Model.**
- Strategically place the development of the organizer within the framework of the lesson/unit plan e.g., the day before beginning a geometry unit, assign a homework activity that asks students to find pictures of hexagons, octagons, and obtuse angles from printed media. Then, during the next day's "Minds On" activity, use the pictures in the development of the organizers.
- Be cognizant of math words that have different meanings in non-mathematical contexts (e.g., mean, rational, root, odd, radical, similar).
- Use organizers for developing understanding of symbols as well as words (e.g. $\leq$, π).
- Ensure that students understand that organizers such as the Concept Circle do not include all possible different types of examples.
  See Student/Teacher Resource, *Concept Circles – Samples.*
  See Student/Teacher Resource*, Concept Circles – Templates.*

Further Support
- Encourage students to use the organizers for reference as they might use a glossary or dictionary.
- Consider allowing students to use organizers during assessments.
- Use vocabulary organizers as assessment *for* learning to plan next steps.
- Combine the features of the organizers. For example, include pictures that provide a personal association within the sectors of a concept circle.
- When students are familiar with each type of organizer, consider allowing student choice in which type of organizer is used.

Getting Ready to Read: Extending Vocabulary – Concept Circles

MATHEMATICS

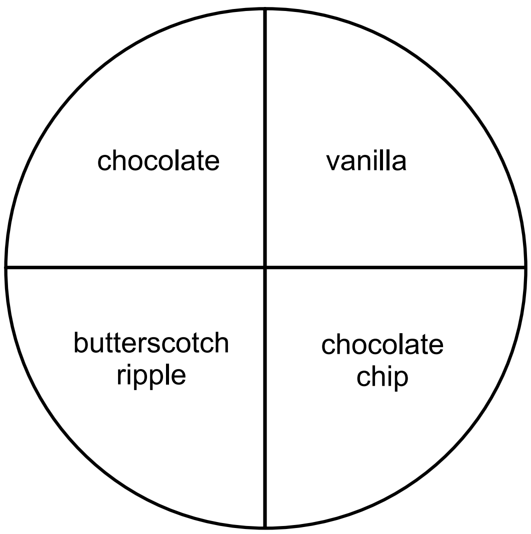
What teachers do	What students do
Before • Preview an activity or unit of study for key vocabulary and concepts. • Modify the preview list using input from student preview lists. • Use a graphic organizer to identify relationships among the words and symbols found during the preview and to show connections to students' prior knowledge from previous units, grades and/or student experiences. • Determine which of the words/symbols are critical in developing deeper understanding of the mathematics in the activity or unit. • Ensure that students understand how to read a concept circle by using a non-mathematical example (e.g. Concept: Countries – Canada, France, Germany, Japan). • Choose 3 to 6 words/symbols that relate to a concept. Place the words into sections in the concept circle. • Create 2 to 4 different concept circles.	• Preview an activity or unit of study to create a list of unfamiliar vocabulary and concepts. • Name the concept or relationship shown in the sections of the example concept circle. Suggest alternative words/symbols for the sections of the circle. Suggest non-examples for the sectors. • Ask questions to clarify understanding.
During • Choose an Oral Communication strategy such as Think/Pair/Share (see **Pair Work: Think/Pair/Share**). • Direct students to determine the relationship among the words/symbols in the concept circle. • Engage students in a whole class discussion to reach a consensus about the relationship among the words/symbols in the concept circle.	• Individually record responses then share responses in pairs. • Ask questions to clarify understanding • Contribute to classroom discussion, giving reasons for responses.
After • Ask students for other words/symbols that could be included if there were more sections. • Discuss non-examples i.e. words/symbols that are connected to the concept but do not belong in the circle e.g., "triangle" is connected to "quadrilateral" because a triangle is also a polygon, however "triangle" does not belong in a "quadrilateral" concept circle because a triangle does not have 4 sides. • Determine how to store the organizer for future reference e.g., on the back of a word wall card, in student notebooks, on a poster in the classroom. • Discuss additional notes/pictures that can be added to the organizer.	• Suggest other connecting words/symbols. • Suggest non-examples that have connections to the concept word/symbol but do not belong in the circle. • Decide if a personal copy is needed and whether additional notes/pictures need to be included.

Notes

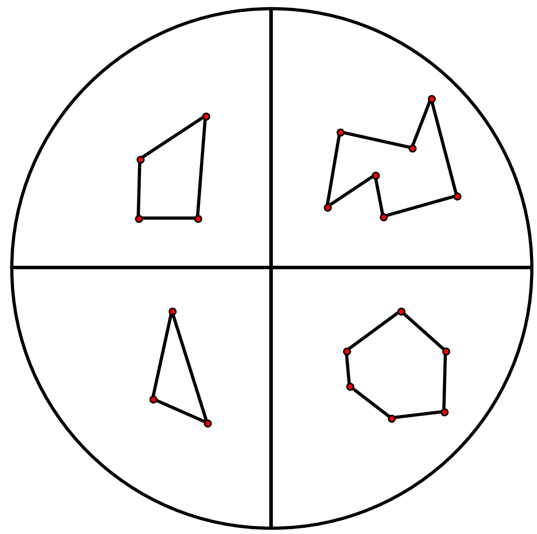
Concept Circles – Samples (Grade 7 – Geometry and Spatial Sense)

Sample Concept Circle

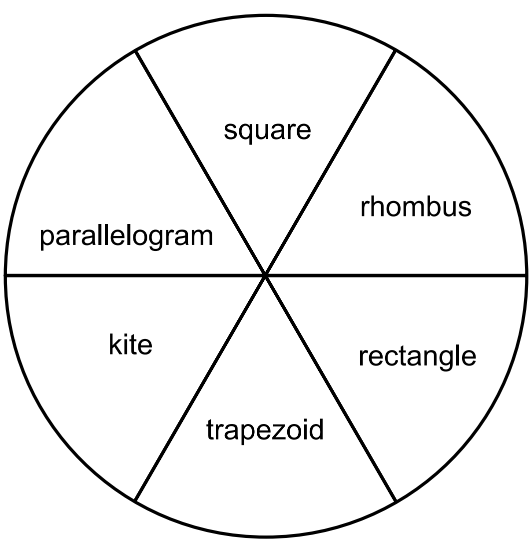
Concept: ______________________________



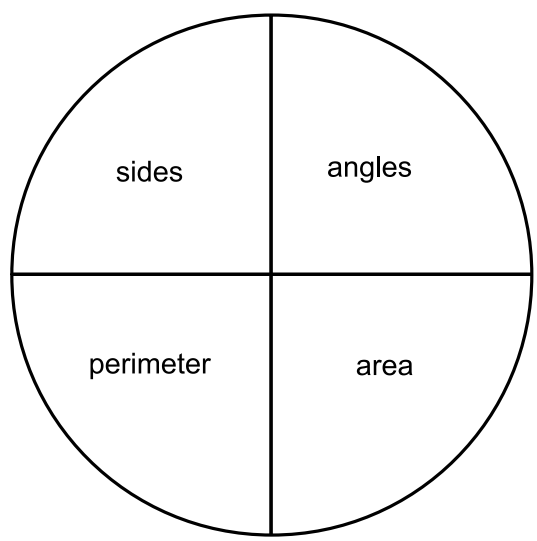
Concept: ______________________________



Concept: ______________________________



Concept: ______________________________



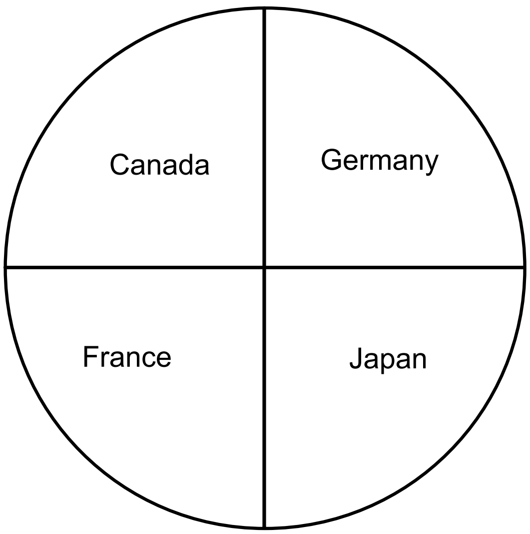
Possible Answers: Ice-cream flavours, Polygons, Quadrilaterals, Measurable Attributes of a Polygon

Student/Teacher Resource

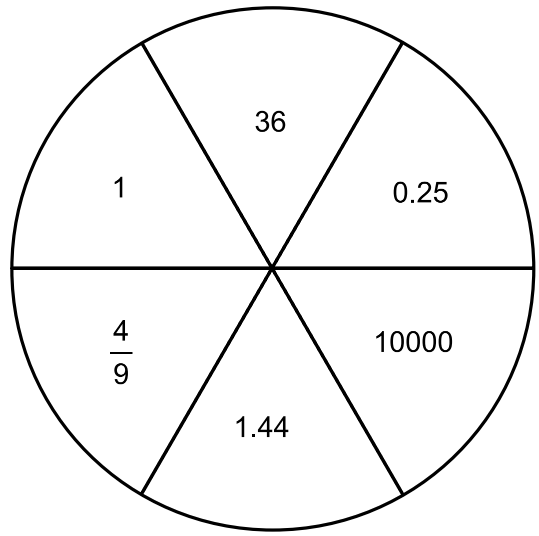
Concept Circles – Samples (Grade 8 Number Sense and Numeration)

Sample Concept Circle

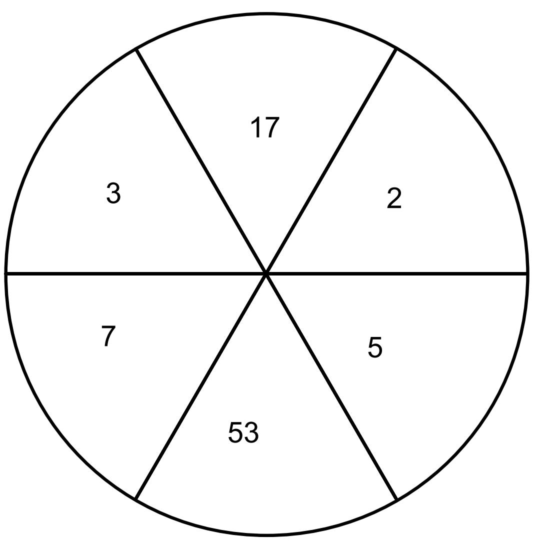
Concept: ______________________________



Concept: ______________________________

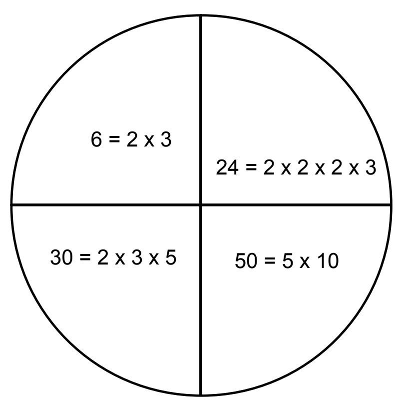


Concept: ______________________________



Concept: ______________________________

One of the entries in this circle does not belong. Name the concept then change the incorrect entry to make it connect to the concept you named.

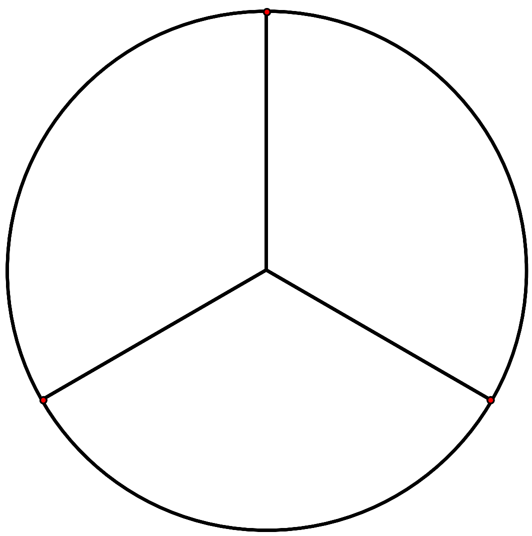
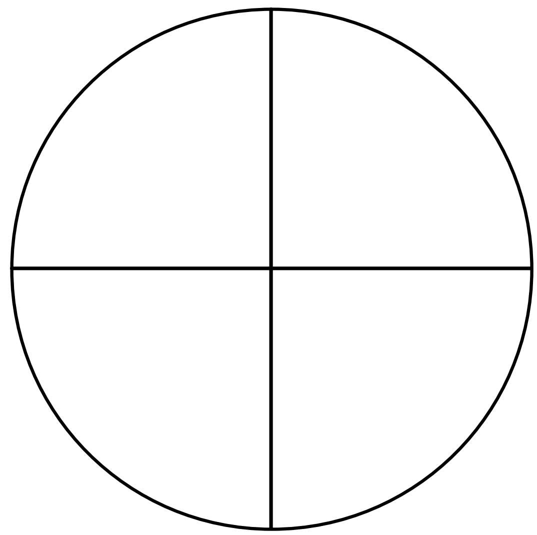
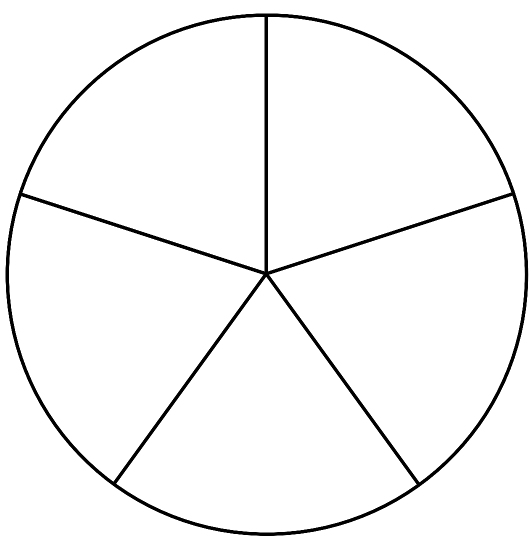
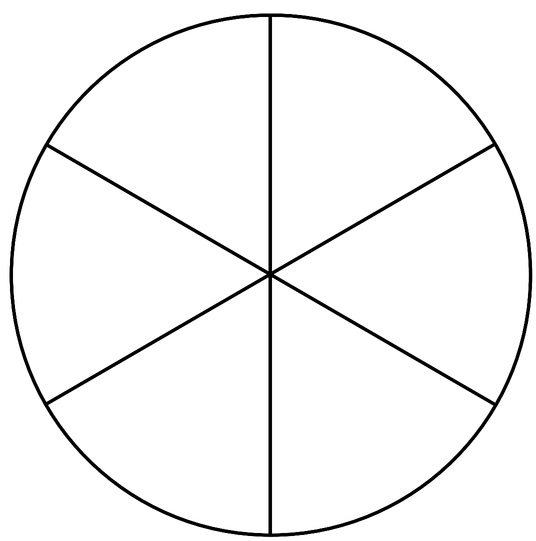


Possible Answers: Countries, Perfect Squares, Prime Numbers, Prime Factorization

Student/Teacher Resource

Concept Circles - Templates

1. Put related concepts (e.g. units, shapes, words, phrases, symbols) into each section then direct students to identify the relationship among the contents of the sections.
2. Modify the strategy by:
   a. leaving one section empty, to be filled by students;
   b. including one non-example and asking students to find which item does not belong and to justify their answer.

Concept: ______________________ 	**Concept:** ______________________ 
Concept: ______________________ 	**Concept:** ______________________ 

Getting Ready to Read: Extending Vocabulary - Verbal and Visual Word Associations

MATHEMATICS

The *Frayer Model*, *Concept Circles*, and *Verbal and Visual Word Associations* are three examples of visual organizers that help students understand key words and concepts. A *Verbal and Visual Word Association* is a chart with 4 sections, where one section is reserved for a visual representation. The *Frayer Model* is also a chart with 4 sections which can hold a definition, some characteristics/facts, examples, and non-examples of the word/concept. A *Concept Circle* is an organizer which is divided into sections to hold words/symbols that are connected by a common relationship. Extending vocabulary using *Verbal and Visual Word Associations* follows.

Purpose
- Identify unfamiliar concepts and vocabulary.
- Create a visual reference for concepts and vocabulary.

Payoff
Students will:
- develop understanding of key concepts and vocabulary.
- draw on prior knowledge to make connections among concepts.
- compare attributes and examples.
- think critically to find relationships between concepts and to develop deeper understanding.
- make visual connections and personal associations.

Tips and Resources
- Preview by scanning text (see Skimming and Scanning to Preview Text, pg. 32 *Think Literacy: Cross-Curricular Approaches, Grades 7-12*).
- Include targeted vocabulary/concepts in a classroom word wall. See ***Extending Vocabulary (Creating a Word Wall)***.
- Consider using the back of a word wall card for the vocabulary/concept organizer. When necessary, students can refer to the flip-side of a word wall card to clarify their understanding.
- Develop vocabulary/concept organizers in small groups using different strategies, for example, use a graffiti strategy by posting large Frayer Model charts (with a different word/concept on each chart). Students then move in small groups to add their knowledge to each posted chart. See **Extending Vocabulary – The Frayer Model.**
- Strategically place the development of the organizer within the framework of the lesson/unit plan e.g., the day before beginning a geometry unit, assign a homework activity that asks students to find pictures of hexagons, octagons, and obtuse angles from printed media. Then, during the next day's "Minds On" activity, use the pictures in the development of the organizers.
- Be cognizant of math words that have different meanings in non-mathematical contexts (e.g., mean, rational, root, odd, radical, similar).
- Use organizers for developing understanding of symbols as well as words (e.g. $\leq$, π).
- Ensure that students understand that organizers such as the Concept Circle do not include all possible different types of examples.
  See Teacher Resource, *Verbal and Visual Word Association – Samples.*
  See Teacher Resource, *Verbal and Visual Word Association – Template.*

Further Support
- Encourage students to use the organizers for reference as they might use a glossary or dictionary.
- Consider allowing students to use organizers during assessments.
- Use vocabulary organizers as assessment *for* learning to plan next steps.
- Combine the features of the organizers. For example, include pictures that provide a personal association within the sectors of a concept circle.
- When students are familiar with each type of organizer, consider allowing student choice in which type of organizer is used.

Getting Ready to Read: Extending Vocabulary – Verbal and Visual Word Associations

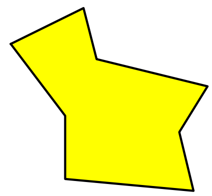
MATHEMATICS

What teachers do	What students do
Before • Preview an activity or unit of study for key vocabulary and concepts. • Modify the preview list using input from student preview lists. • Use a graphic organizer to identify relationships among the words found during the preview and to show connections to students' prior knowledge from previous units, grades and/or student experiences. • Select words that can be represented visually. Nouns are good choices for this strategy. • Determine which of the words are critical in developing deeper understanding of the mathematics in the activity or unit. • Illustrate how to use the organizer with an example that has every part completed except the vocabulary term.	• Preview an activity or unit of study to create a list of unfamiliar vocabulary and concepts. • Name the unknown vocabulary term in the example. Suggest alternative entries for the boxed areas. • Ask questions to clarify understanding.
During • Choose an Oral Communication strategy such as **Think/Pair/Share**. • Instruct students to draw a rectangle divided into 4 sections (see Teacher Resource, *Verbal and Visual Word Association - Samples*). • Direct students to write the term in one section then to complete the remaining sections with a visual representation, a personal association, and a definition. • Circulate and assess *for* understanding making mental notes of incomplete or incorrect illustrations and definitions. • Engage students in a whole class discussion to share responses.	• Draw a rectangle divided into 4 sections. • Individually record responses then share responses in pairs. • Ask questions to clarify understanding • Contribute to classroom discussion, giving reasons for responses.
After • Create incomplete visual representations and ask students how the illustrations can be improved e.g., add a right angle marker to an illustration of a right triangle. • Discuss non-examples. • Determine how to store the organizer for future reference e.g., on the back of a word wall card, in student notebooks, on a poster in the classroom. • Discuss additional notes/pictures that can be added to the organizer. • Encourage students to collect pictures from print media to further illustrate the term.	• Contribute to classroom discussion. Critique incomplete visual representations that the teacher creates. • Suggest non-examples and give reasons for responses. • Decide if a personal copy is needed and whether additional notes/pictures need to be included. • Look for additional visual support.

Notes

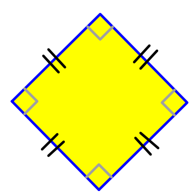
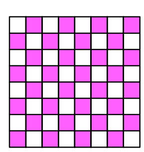
Verbal and Visual Word Association - Samples

Vocabulary Term	Visual Representation
Definition in student's words	Personal Association

octagon	
A polygon with 8 sides	 A stop sign is a *regular* octagon.

<u>Observations from Example 1:</u>

This completed organizer clearly indicates that the student understands that the term octagon encompasses more than just regular octagons, i.e., those shaped like a stop sign with sides of the same length and interior angles with the same measure.

square	
○ a rectangle with equal sides or ○ a rhombus with equal angles or ○ a regular quadrilateral or ○ a quadrilateral that has equal sides and angles	 - a checkerboard or the little squares in a checkerboard

<u>Observations from Example 2:</u>

Encourage students to draw figures in less common orientations. Notice how this square is "tilted". Challenge students to modify an incorrect or incomplete definition by giving a non-example of the vocabulary term that will fit the student's definition. For example, if a student defined a square as a parallelogram with sides of equal length, then draw a rhombus and ask the student whether it fits the definition and if it is indeed a square.

<u>More Tips and Comments:</u>

- Consider students' developmental stage of understanding when assessing student definitions of mathematical terms.
- Figures like rectangles can be difficult to define since various combinations of their properties can uniquely define the figure (see example above).

Verbal and Visual Word Association - Template

- Print template on card stock. Complete as a whole class.
- Print the vocabulary word on the reverse side then place the card on a word wall for future reference.

Getting Ready to Read: Extending Vocabulary – The Frayer Model

MATHEMATICS

The *Frayer Model*, *Concept Circles*, and *Verbal and Visual Word Associations* are three examples of visual organizers that help students understand key words and concepts. The *Frayer Model* is a chart with 4 sections which can hold a definition, some characteristics/facts, examples, and non-examples of the word/concept. A *Verbal and Visual Word Association* is also a chart with 4 sections, but with one section reserved for a visual representation. A *Concept Circle* is an organizer which is divided into sections to hold words/symbols that are connected by a common relationship. Extending vocabulary using the Frayer Model follows.

Purpose
- Identify unfamiliar concepts and vocabulary.
- Create a visual reference for concepts and vocabulary.

Payoff
Students will:
- develop understanding of key concepts and vocabulary.
- draw on prior knowledge to make connections among concepts.
- compare attributes and examples.
- think critically to find relationships between concepts and to develop deeper understanding.
- make visual connections and personal associations.

Tips and Resources
- Preview by scanning text (see Skimming and Scanning to Preview Text, pg. 32 *Think Literacy: Cross-Curricular Approaches, Grades 7-12*).
- Include targeted vocabulary/concepts in a classroom word wall. See ***Extending Vocabulary (Creating a Word Wall)***.
- Consider using the back of a word wall card for the vocabulary/concept organizer. When necessary, students can refer to the flip-side of a word wall card to clarify their understanding.
- Develop vocabulary/concept organizers in small groups using different strategies, for example, use a graffiti strategy by posting large Frayer Model charts (with a different word/concept on each chart). Students then move in small groups to add their knowledge to each posted chart.
- Strategically place the development of the organizer within the framework of the lesson/unit plan e.g., the day before beginning a geometry unit, assign a homework activity that asks students to find pictures of hexagons, octagons, and obtuse angles from printed media. Then, during the next day's "Minds On" activity, use the pictures in the development of the organizers.
- Be cognizant of math words that have different meanings in non-mathematical contexts (e.g., mean, rational, root, odd, radical, similar).
- Use organizers for developing understanding of symbols as well as words (e.g. $\leq$, π).
- Ensure that students understand that organizers such as the Concept Circle do not include all possible different types of examples.
  See Student/Teacher Resource, *The Frayer Model – Samples.*
  See Student/Teacher Resource*, The Frayer Model – Templates.*

Further Support
- Encourage students to use the organizers for reference as they might use a glossary or dictionary.
- Consider allowing students to use organizers during assessments.
- Use vocabulary organizers as assessment *for* learning to plan next steps.
- Combine the features of the organizers. For example, include pictures that provide a personal association within the sectors of a concept circle.
- When students are familiar with each type of organizer, consider allowing student choice in which type of organizer is used.

Getting Ready to Read: Extending Vocabulary – The Frayer Model

MATHEMATICS

What teachers do	What students do
Before • Preview an activity or unit of study for key vocabulary and concepts. • Modify the preview list using input from student preview lists. • Use a graphic organizer to identify relationships among the words found during the preview and to show connections to students' prior knowledge from previous units, grades and/or student experiences. • Select concepts that have potentially confusing connections or concepts that have several different characteristics. • Determine which of the words are critical in developing deeper understanding of the mathematics in the activity or unit. • Share a completed Frayer Model for a familiar non-mathematical concept but remove the name of the concept from the model. (See Student/Teacher Resource, *The Frayer Model – Samples.)* • Create large Frayer Models on chart paper.	• Preview an activity or unit of study to create a list of unfamiliar vocabulary and concepts. • Determine the concept name. • Ask questions to clarify understanding of the attributes of a Frayer Model.
During • Brainstorm as a whole class to create a list of words/phrases that connect to the concept. • Form small groups and distribute one chart paper Frayer Model to each group. • Direct students to place words and phrases from the brainstormed list into appropriate sections of the Frayer Model i.e. essential characteristics, non-essential characteristics, examples. • Direct students to add more words/phrases as well as non-examples. • Circulate and pose questions to refine understanding of the term. • Ask a reporter from each group to present the group's Frayer Model. Post the models around the room.	• Contribute to brainstorming. • List essential characteristics that apply to all examples. • List non-essential characteristics that apply to subsets of the term/concept • Suggest additional words and phrases and non-examples that refine understanding of the term. • Ask questions to clarify understanding • Actively listen and reflect on learning.
After • Discuss how understanding of a concept is refined by thinking about non-examples. • Consider assigning individual completion of a Frayer Model or a collective classroom model for display on a wall or on the back of a word wall card. • Later in the lesson or unit of study, use a different colour pen to add new knowledge to the Frayer Model.	• Reflect on the presentations, discussions and posted Frayer Model and decide if a personal copy is needed.

Notes

The Frayer Model – Samples

Determine the unknown words in the given Frayer Models.
How does thinking about non-examples clarify your understanding about the word?

Essential Characteristics

- contains water
- has a shore
- is surrounded by land except at areas where it meets another body of water
- larger than a pond

Nonessential Characteristics

- may contain water plants and fish
- likely contains fresh water
- may provide an area for recreational activity
- may provide a habitat for wildlife
- may be formed by glaciers
- may be an expanded part of a river
- may be formed by a dam

?

Examples

____ Ontario
____ Simcoe
____ Temagami
Ramsey ____
____ Victoria
Loch Ness
Lac Champlain
(replace _____ with the unknown word)

Non-examples

- pond
- puddle
- swimming pools
- Elliot Lake (town)
- Georgian Bay
- Pacific Ocean
- St. Lawrence River

Essential Characteristics

- is a number
- has no fractional or decimal part
- can be modeled with two colour tiles

Nonessential Characteristics

- may be positive
- may be negative
- may be zero

?

Examples

-2
0
325

Non-examples

0.5
-1.2
$\frac{2}{3}$
π
$\sqrt{2}$

Answers: lake, integer

The Frayer Model – Samples (Grade 8)

Notice that the top two boxes are titled "Definition" and "Facts/Characteristics".
How does thinking about non-examples clarify your understanding about the word?

Equation

Definition	**Facts/Characteristics**
An equation is a mathematical statement that shows that two expressions are equal.	- *always has exactly one equal sign* - *the left side is equivalent to the right side* - *some equations have 0, 1, 2 or more solutions* - *some equations contain just numbers* - *some equations are algebraic models for relationships and they have corresponding graphical models and numerical models (e.g., tables)*
Examples	**Non-examples**
3x – 2 = 4x + 7 (linear equation) *ab = ba (an identity)* *F = 1.8C + 32 (a formula)* *5 + 6 = 11 (a number statement)* *P = 2l + 2w (a formula)* *x = 3 (statement of value)*	*2x + 3y (expression)* *3 (number)* *perimeter (word)* *x < y (inequality)* *= 4.2 (has no left side)*

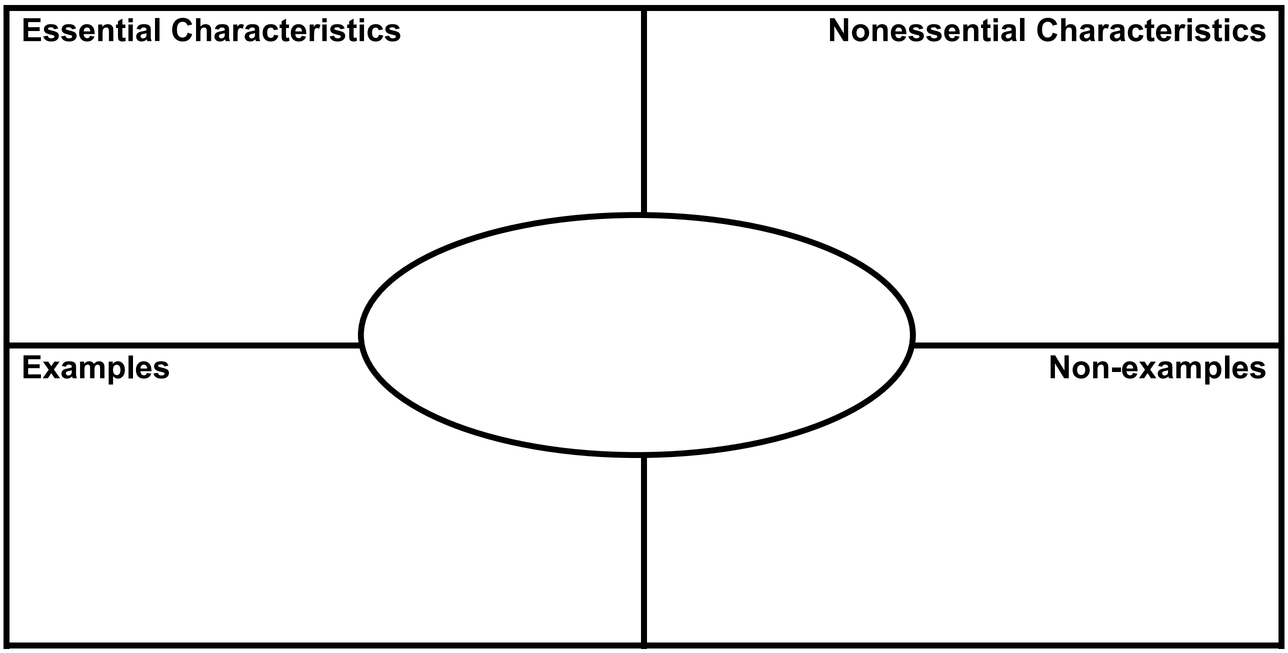
Complete a Frayer Model using the word ___________________________.

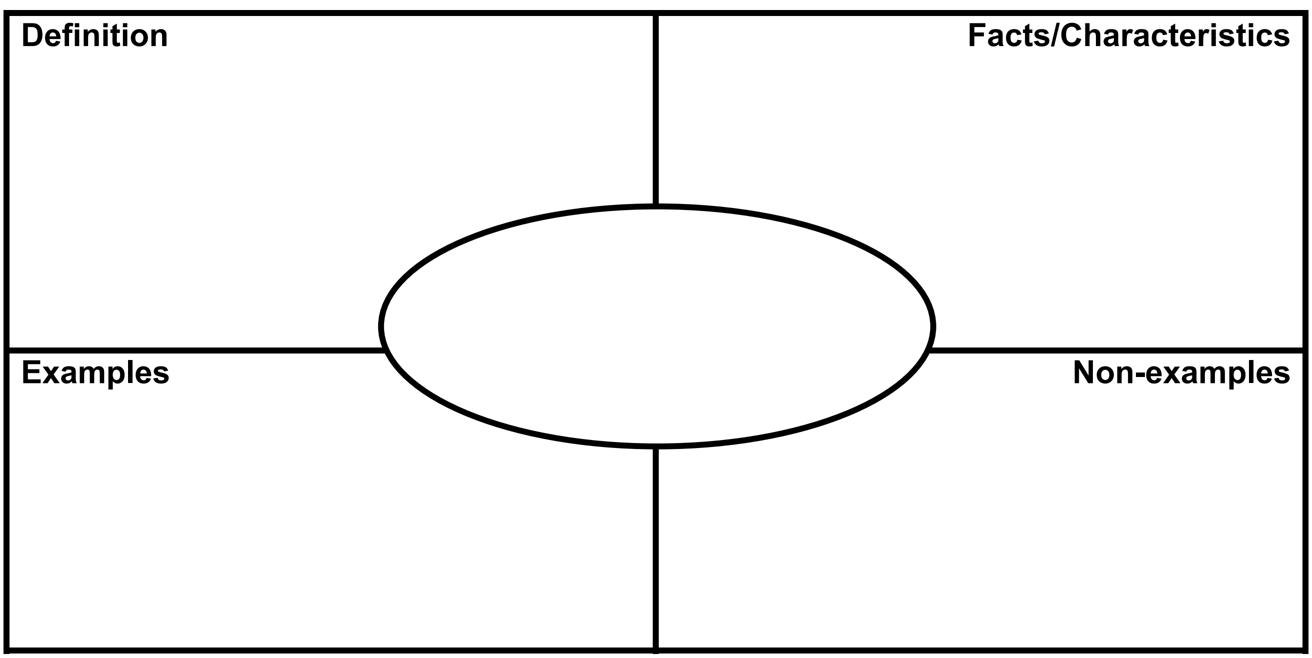
Definition	**Facts/Characteristics**
Examples	**Non-examples**

Student/Teacher Resource

The Frayer Model – Templates for Two Versions

- Choose the version whose headings best suit the concept/word.
- Print the template on card stock.
- Direct students to complete the template individually, in small groups or as a whole class.
- Print the vocabulary word on the reverse side then place the card on a word wall for future reference.





Engaging in Reading: Most/Least Important Idea(s) and Information – Reading a Problem

MATHEMATICS

Whether your preferred Problem Solving model, is a 3-step, 4-step (e.g., Polya model), or *n*-step outline, the first step is always "Read and understand the problem". *Reading* a problem is not the same as *understanding* a problem, and not *understanding* a problem is not alleviated by simply reading it over again, more carefully and slowly. Learning styles, "chunking", as well as decoding the text, play a significant part in *reading* a mathematics problem. The KMWC (Know/Model/Words/Cross out) graphic organizer breaks *reading* down into 4 steps (see the Student Resource, *Reading a Problem – The KMWC Template*) which guide readers from print to understanding of both the information and the question contained within a word problem.

Purpose

- Read and understand problems by:
  - *unblocking* information presented in a block of text
  - representing information in an alternate format.

Payoff

Students will:

- be able to read a word problem with understanding.
- develop their ability to identify the relevant parts within a problem stated in a block of text.
- have visual or concrete representations, as well as textual descriptions, of a problem before attempting to solve the problem.

Tips and Resources

- Determining the main ideas in a mathematics problem is not always a clear, straightforward process. "Mathematics texts contain more concepts per word, per sentence, and per paragraph than any other text (Brenan & Dunlap, 1985; Culyer, 1988; Thomas, 1988). In addition, these concepts are often abstract, so it is difficult for readers to visualize their meaning."
- People read with understanding in different ways; what is natural and comfortable for one is awkward and difficult (if not impossible) for another. For example, one person can *read* mathematical text simply by looking at it with hands folded in his or her lap; another person cannot *read* the same mathematical text without a pen or pencil in their hand to circle, underline, highlight or otherwise graphically interact with the written text.
- Simple intensity of concentration and/or reading speed is often insufficient criteria for the understanding of a word problem.
- Learning styles, as well as decoding the text, play a significant part in *reading* a mathematics problem.
- For a blank template that can be handed out in class, see student resource, *Reading a Problem – The KMWC Template*. (Note: this template is NOT a problem-solving template; it is a problem-reading template.)
  See Teacher Resource, *Reading a Problem – KMWC Tips.*
  See Student/Teacher Resource, *Reading a Problem – KMWC Example.*

Teaching Reading in Mathematics 2nd Edition, pg iv

Further Support

- See Teacher Resource*, Reading a Problem – KMWC Tips.*

Engaging in Reading: Most/Least Important Idea(s) and Information – Reading a Problem

MATHEMATICS

What teachers do	What students do
Before • Find an example problem in which the information and question are not immediately obvious. • Model reading the problem using the KMWC graphic organizer. • Assign the intended problem.	• Scan the problem.
During • Direct students to use the KMWC graphic organizer with a selected problem. • When students begin to list facts be accepting of all facts regardless of whether the information is extraneous to the problem. • Circulate among the students in order to assist with any terminology or concepts that need clarifying. • Watch for misinterpretations of the given facts.	• Use the graphic organizer to: - Make a list of all facts contained in the problem. - Identify any terminology or concepts that need defining or explaining before going on to the next stage. - Make a model of the situation as described by the facts from stage 1. The model can be a diagram, a construction with manipulatives or whatever the student might create to develop a concrete/visual representation of the facts. - Estimate any unknown quantities - Restate the problem in his/her own words. - Cross out the listed facts that are not necessary.
After • Direct students to solve the problem.	• Proceed with the solving of the problem.

Notes

Reading a Problem – KMWC Tips

Teachers often ask the students to read a problem and then quickly move into discussions with the class, groups, or individual students about possible strategies for approaching the problem. But far too often the students, after looking at the problem, have actually not been able to read it with understanding. The attached graphic organizer addresses this problem on several levels. The KMWC model has four stages:

K: What facts do I **KNOW** from the information in the problem?

At this first stage, students are asked to write down the facts given in the problem. While this seems like a simple and obvious task, there are at least three major considerations to be aware of around it.

(i) For students who have been traditionally unsuccessful at problem solving, the decoding of a word problem has become a daunting task because it has never, or at least infrequently, led to the satisfaction of success. So the first thing that these students need is the built-in success that comes with a simple task — but one that actually moves forward in the process of problem solving. Writing down the facts within a word problem is first of all a simple task that they can understand and at which they can immediately experience success, and second, a means of breaking apart a block of words and numbers.

(ii) There is a temptation for teachers to try to be 'helpful' but that help may inadvertently decrease student independence. For example, in observing a student writing down the facts of the problem, teachers might notice that a student wrote down something unimportant to the problem like, "It was winter." The temptation might be, with all the best intentions of helping the student save time, say to the student that it was not necessary to record that it was winter. What we fail to realize in such a situation is that while the student was engaged in a part of problem solving that they finally understood, we have come along and, while trying to be helpful, unconsciously given them the message that they don't actually know what to do. Just when the student was finally doing some problem solving activity that they understood, the student is told (or rather the student 'hears') that they really don't understand - we've inadvertently discouraged student initiative.

(iii) This is NOT the time to have all students try to leave out or cross out any unnecessary information given in the word problem. Although this is a good strategy for the confident reader, students who have trouble getting past the problem itself are often not able to distinguish between relevant and irrelevant information. Insisting on them trying to cross out extraneous information sometimes leads to the crossing off of necessary information. [See Stage 4 in **KMWC**.]

This first stage is also the time when the students discover words, phrases or concepts that are included in the wording that they don't know and must ask about before they can proceed any farther.

Reading a Problem – KMWC Tips (continued)

M: Can I **MODEL** the situation with a picture or manipulatives?

The second stage takes into account the fact that not everyone *reads* the same way. It is well established that there are various learning styles and for many people it is very important for conceptual understanding that they be given the opportunity to create a concrete or visual representation of a stated situation - a model of some sort - whether with manipulatives or through a drawing/diagram. Hence, the second stage is the opportunity (offered only, not necessarily required) for modeling the facts picked out in the first stage.

This is also the stage in problem solving when students might have to estimate quantities or measurements that are not explicitly given but only indirectly described.

W: **WHAT** does the problem ask me to find?

It is only in this third stage that many students are able to state in their own words (if the problem was not originally absolutely clear), what the problem was asking for. Often students are asked to read the problem and to immediately re-state it in their own words; this not only often doesn't get done but also builds anxiety in students around problem solving in general. It is very important that students be able to put into their own words any word problems that are not immediately clearly understood if the students are going to be able to consider possible strategies that address the problem.

C: **CROSS OUT** any facts that are not needed.

At this stage it is safe to ask even the non-confident reader to cross out the facts from the first stage that are not needed. Understanding the problem situation gives insight into what facts may or may not pertain to what is being asked.

If a student still is not sure of what facts are important or unimportant, let them work on a solution to the problem (whether as a class, in groups or alone). And then, after a solution has been obtained have the student go back and cross out what now would be obvious as not having been necessary facts or information. While it may seem at first to be a bit redundant to do this after a solution has been obtained, it is critical to note that students who could not identify irrelevant information in the word problem at the outset will not quickly develop that skill unless you give them the opportunity to practice looking at those facts and seeing them as irrelevant. It does not matter that this may only be possible for a while at the end of the problem solving. What matters is that those facts are finally recognized as unnecessary information in the context of the problem situation. This development must not be by-passed.

Reading a Problem - The KMWC template

K: What facts do I **KNOW** from the information in the problem?
"What words or ideas don't I understand?"
M: Can I **MODEL** the situation with a picture or manipulatives?
"Is there any missing information that I can estimate?"
W: **WHAT** does the problem ask me to find?
C: **CROSS OUT** any facts that are not needed.

Student/Teacher Resource

Reading a Problem – KMWC Example (Grade 7)

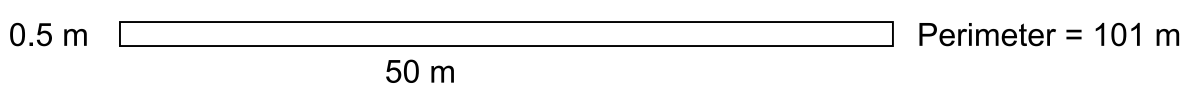
Problem:
Marek got a puppy for Christmas. Wanting to create a 'dog run' (without a roof) in their large backyard, Marek persuaded his father to buy enough chain link fencing to create a rectangular 'dog run' 50m long and wide enough for the puppy, keeping in mind that the puppy would grow in size. When Marek's friend Tristan asked if he could bring over his dog, a Labrador retriever, to exercise in the 'dog run', Marek laughed and said that Tristan's dog would rub off his fur if he tried to use the 'dog run'. Tristan complained that Marek could have used the same amount of fencing to give his puppy more area to run around in and also have created a 'dog run' that Tristan's dog could have used. Is this true? Justify your answer.

K: What facts do I **KNOW** from the information in the problem?

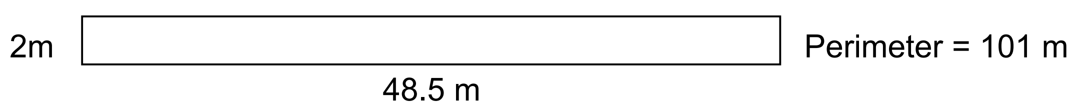
1. Marek got a puppy for Christmas
2. created a rectangular 'dog run' without a roof in a large backyard
3. it was 50 m long
4. it was wide enough for a puppy that would grow
5. Marek has a friend named Tristan who has a Labrador Retriever
6. a Lab would rub off its fur in the dog run
7. Tristan claimed a wider dog run with the same amount of fencing could have more room for the puppy

"What words or ideas don't I understand?" e.g., dog run, Labrador retriever

M: Can I **MODEL** the situation with a picture or manipulatives?



"Is there any missing information that I can estimate?" : The width is maybe 0.5 m



W: **WHAT** does the problem ask me to find?

Is it true that the area of the wider dog run is larger than the area of the first one?

C: CROSS OUT any facts that are not needed.

Facts #1,4 and 5 are not needed, as well as "large backyard" in #2.

Reading a Problem – KMWC Example (Grade 9)

Problem:

Gina and Tamiya lived in different neighbourhoods but were the best of friends at school. Each had a regular babysitting customer and each one was paid at the end of any week that they babysat. Gina was paid a flat amount for anything up to 10 hours after which she was paid an extra $10/hr. Tamiya was given $15 to cover any bus fare she might have paid for that week plus an hourly rate.

At lunch on Mondays, the two girls would usually talk about how much money they had made by babysitting the previous week. One time during such a conversation they discovered that they had both babysat for the same number of hours that week. What was even more unexpected was that they had each earned the same amount for the week as well, namely $100.

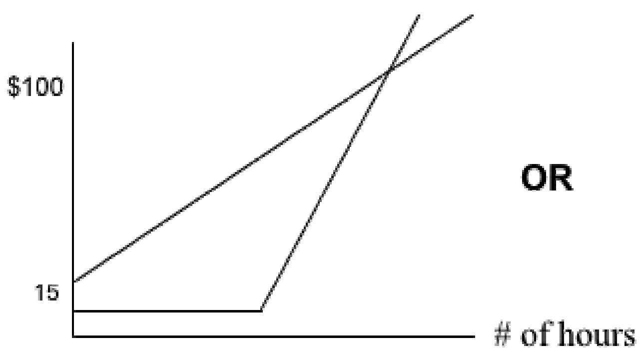
Is it possible that some other week they could have each babysat the same amount of hours and again earned the same amount, but different from $100? Justify your answer.

K: What facts do I KNOW from the information in the problem?

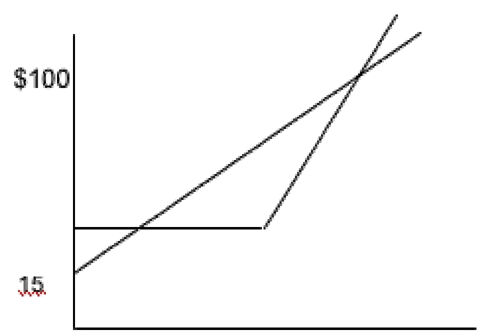
1. Gina and Tamiya lived in different neighbourhoods
2. Gina and Tamiya were the best of friends at school
3. Each had a regular babysitting customer
4. Each was paid at the end of any week that they babysat
5. Gina was paid a flat amount up for anything up to 10 hours after which she was paid an extra $10/hr
6. Tamiya was given $15 plus an hourly rate
7. At lunch on Mondays, the two girls would talk about how much money they had made by babysitting
8. They discovered that they had both babysat for the same number of hours and both earned $100

"What words or ideas don't I understand?" e.g. flat amounts

M: Can I MODEL the situation with a picture or manipulatives?



OR



"Is there any missing information that I can estimate?"

W: WHAT does the problem ask me to find?

Can the graphs of the pay rates cross each other more than once?

C: CROSS OUT any facts that are not needed.

Facts #1,2,3,4 and 7 are not needed.

Engaging in Reading: Visualizing

MATHEMATICS

Unseen text is the information that resides inside the reader's head: ideas, opinions, essential background knowledge. The unseen text is unique to each reader. (Cris Tovani, 2002)

Visualizing text is a crucial skill for students because if they can get a picture, often they've got the concept. When students don't get those pictures in their heads, the teacher may need to think aloud and talk them through the ideas in the text, explaining the pictures that come to mind. Visualization can help students to focus, remember, and apply their learning in new and creative situations. It is an invaluable skill in subjects such as Math, Science, and Design & Technology, where understanding spatial relationships can be a key to solving complex problems.

Purpose
- Promote comprehension of the ideas in written texts by forming pictures in the mind from the words on the page.

Payoff
Students will:
- reread and reflect on assigned readings.
- develop skills for independent reading.
- improve focus and attention to detail.

Tips and Resources
- Words on a page can be a very abstract thing for some students. They might not immediately inspire pictures in the mind or create other types of sensory images. Teaching students to visualize or create sensory images in the mind helps them to transform words into higher-level concepts.
- Students develop skills of visualization and improve comprehension when they integrate information presented visually e.g., in pictures, diagrams, drawings, models etc. with text. Consider photocopying the instructions for a task such as the grade 7 exemplars task: http://www.edu.gov.on.ca/eng/document/curricul/elementary/exemplars/math/grade7/measuret.pdf. Cut apart the text from the pictures. Ask students to match the pictures to the text (see the Student/Teacher Resource, *Visualizing – Sample Matching Activity*).
- Students may interpret the sample picture in a glossary as the only example of the word e.g., a polygon.
- Challenge students to make a visual glossary by finding a way to communicate the meaning of a mathematical word visually e.g. frac
tion s ope

- Simple warm-up exercises can help students develop mental images of mathematics. For example, project a geometric drawing, a representation of a slope, or a picture of two-coloured tiles modeling an integer on an overhead projector for a few seconds and then ask students to draw what they saw. Compare the drawings of the students. For further information about this strategy and two samples go to: http://www.learnnc.org/index.nsf/doc/quickdraw
- Problem solving strategies such as Make a Model, Draw a Picture or Diagram and Act it Out provide students with opportunities to develop skills in visualizing.
- See Teacher Resource, *Visualizing – Sample Text to Read Aloud.* Also see Student Resource, *Visualizing – Practice.*
- See Student/Teacher Resource, *Visualizing – Sample Matching Activity.*

Further Support
- Learning to visualize takes practice. Model the strategy of visualizing for your students, using a variety of mathematical texts..

Engaging in Reading: Visualizing

MATHEMATICS

What teachers do	What students do
Before • Read a story problem or the assigned text to students, asking them to try and "see" in their minds what the words are saying. • Model the strategy of visualizing by sharing some mind pictures derived from the text through Think Aloud See Teacher Resource, *Visualizing – Sample Text to Read Aloud,* which includes a think-aloud script. Invite students to sketch or share the pictures they have in their heads. • Engage students in a class discussion about the connections that they made between their experiences and the text through the pictures in their minds and how these connections enable them to understand the text. • Give students an example of the importance of the mental pictures by sharing or modeling the use of a picture or concrete model as a problem solving strategy.	• Try to create pictures in your mind as the text is read. Record the pictures as sketches or labeled diagrams; or represent the pictures with concrete materials.
During • Provide additional text samples. See Student Resource, *Practise Visualizing from Text* or a selection of problems or text from a textbook or test. • Ask students to work individually to create mind pictures from the text. • In small groups, ask each student to compare their mind pictures with other students.	• Make notes, sketches, or concrete models of the mind pictures that emerge as they read the additional text sample. • Compare and discuss their mental images. • Ask questions to understand why the mental images may differ.
After • Engage students in whole-class discussion about the kinds of things that may have triggered their mind pictures or mental images e.g., understanding of a specific word, personal experience, a problem from a previous lesson or even a previous grade. • Identify ways in which the various experiences of individuals result in different connections to the text. Identify the importance of making connections to understand the mathematics in the text. • Remind students that textbook features (such as diagrams, pictures, or a glossary) may help them create more accurate and detailed mind pictures.	• Identify the ways in which personal experiences are used to make connections to the text. • Identify ways in which the features of text may help them create pictures in their minds from the text. Identify ways in which pictures could be incorporated when note-taking.

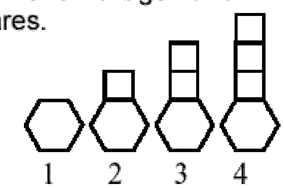
Notes

Visualizing – Sample Text to Read Aloud

TIPS: Section 2 – Patterning to Algebraic Modelling, Grades 7, 8, and 9
http://www.curriculum.org/occ/tips/index.shtml#section2

Text

The picture shows 4 stages in the construction of a walkway.
The walkway starts with a hexagon and continues with squares.



Determine the perimeter of the walkway when it has one hexagon and 352 squares.

Show your work.

Think-aloud Script

When I read the first sentence I remembered the walkway between the houses to get to the park. There wasn't a street or road but only a place for walking. The walkway in the picture in my head is made of rectangles. The walkway in this problem has squares but first there is a hexagon. I wonder if it is a regular hexagon. I can use the picture to answer this question.

The text says that the picture shows 4 stages in the construction of a walkway. At first I was confused because I thought of a stage for acting but that didn't make sense. The picture of the shapes and the numbers under them helped me understand that the 4 stages showed the sequence for building the walkway like when you are following instructions so you know what is happening first, second and so on. Now I imagine each "stage" as being in a box on a page of instructions for how to make the walkway.

This reminds me of the problems that we solved about growing patterns. The picture I have in my mind has a pattern made with equilateral triangles. We didn't have enough materials to keep extending the pattern so we made a table, and looked for relationships in the numbers in the table to make predictions and generalize the pattern. I plan to make a table to solve the problem.

(The teacher can use an overhead, blackboard, manipulatives, or chart paper to model making pictures, diagrams, constructions, and sketches of the mind pictures that emerge from making connections with the text e.g., a walkway between houses, a series of rectangles in a sidewalk, a piece of paper divided into boxes with one stage of the walkway in each box, pictures of a growing pattern using equilateral triangles etc.)

Visualizing – Practice

Read and think about each of the samples below.
Then record in your notebook the pictures that come into your mind based on the words you read.

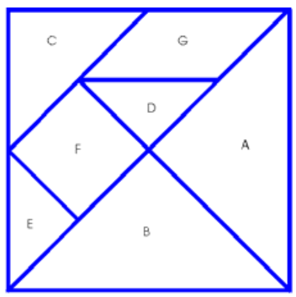
#	**Text Sample – Grade 9 EQAO Release Material** www.eqao.com
1.	A group of 4 friends is going bowling at **Bowling Bonanza.** **Bowling Bonanza** charges • $2.50 for each player to rent shoes **plus** • $20/h for a group of 4 to bowl. This group of friends wants to spend $80. How many hours can they bowl at **Bowling Bonanza?** **Give reasons for your answer** or **show your work.**
2.	William **and** his 3 friends are going bowling. He finds an advertisement in the newspaper for a new bowling alley, **Super Bowl.** William and his friends will play 6 games in 3 hours. Determine whether William and his friends should go bowling at **Bowling Bonanza** or **Super Bowl.** Use the information given in the advertisement and in the hint box. **Give reasons for your answer.**  Hint: Bowling Bonanza charges • $2.50 for each player to rent shoes and • $20/h for a group of 4 to bowl
3.	A survey is taken at a secondary school to determine the number of minutes per week that students spend reading for leisure. Aaron surveys 10 students from a Grade 10 boys' phys. ed class. Aaron's teacher says, "That's not a good sample of the entire school population, because you only asked Grade 10 students. **List** other reasons why Aaron's sample does not represent the entire school population.

Visualizing – Sample Matching Activity

TIPS: Section 3 – Grade 7, Days 1 - 4
http://www.curriculum.org/occ/tips/index.shtml#section2

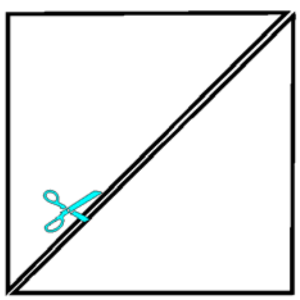
Cut the text instructions from the pictures. Ask students to match the pictures to the text instructions.

2.1: Constructing a Tangram from a Square

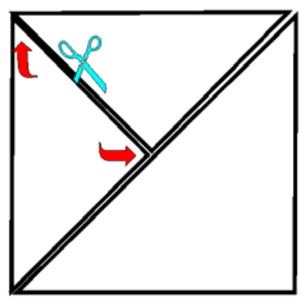


The seven tangram pieces can be geometrically constructed from a square.

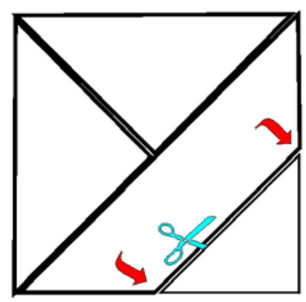
Use paper folding and scissors to cut along the folds and create the seven tangram pieces.



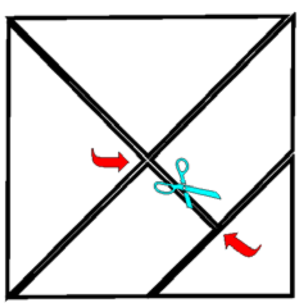
Fold along the diagonal of the square. Cut.



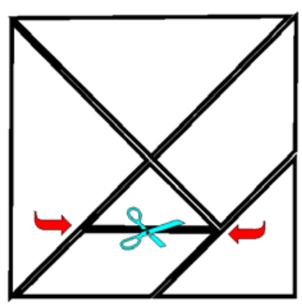
Fold the perpendicular bisector of one of the right isosceles triangles. Cut along the bisector.



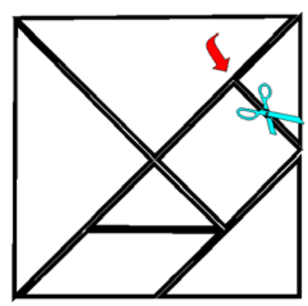
Crease the midpoints of the two sides of the large right isosceles triangle. Fold the line joining the midpoints. Cut.



Crease the midpoints of the two parallel sides of the trapezoid. Cut along the line that joins the midpoints.



Crease the midpoint of the longest side of the right trapezoid. Fold a line joining the midpoint to the opposite vertex. Cut.



Crease the midpoint of the longest side of the trapezoid. Fold an altitude from the midpoint. Cut.

Reading Different Text Forms: Reading Informational Texts

MATHEMATICS

Informational text forms (such as explanations, reports, news articles, magazine articles, and instructions) are written to communicate information about a specific subject, topic, event, or process. These texts use vocabulary, special design elements, and organizational patterns to express ideas clearly and make them easier to read. Providing students with an approach to reading informational texts helps them to become effective readers.

Purpose

- Become familiar with the elements and features of informational texts used in any course.
- Explore a process for reading informational texts, using a range of strategies for before, during, and after reading.

Payoff

Students will:

- become more efficient at "mining" the text for information and meaning.
- practise essential reading strategies and apply them to different course-related materials.

Tips and Resources

- Students often read informational texts as part of their mathematics instruction.
- Some features of informational texts are headings, subheadings, summaries, photos, screen captures of technology, diagrams, calculations, graphs, terminology, symbols, and data tables. Together, these features support readers in accessing meaning in different ways.
- Accompanying diagrams, calculations, and tables are alternate representations of mathematics and are integral to the meaning of the whole text.
- Many informational texts use visual elements (e.g., typeface, size of type, colour, margin notes, photographs, diagrams) to emphasize concepts, terminology, and symbols. The reader can use these visual elements in scanning text for particular information, in understanding the organizational structure of the text, and in relating different information elements of the text to one another. For example, the slope of a line could be explained in a definition, the line segment on a graph could be highlighted and coloured, and then the slope could be shown in a sidebar as a ratio calculation of the rise length to the run length.
- Informational text that contains mathematics often can and should be read in different directions (e.g., left to right, right to left, top to bottom, diagonally), according to the purposes of the reader.
- Recognize that students often need to read text and related visuals concurrently (e.g., a newspaper article with information that is also displayed in a graph).
- See Student Resource, *Tips for Reading Mathematics Informational Texts.*

Further Support

- Refer to the strategy*, **Analyzing the Features of a Text***, to help students see the recurring organization of the text. Such predictability of structure helps students to skim and scan text confidently.

Reading Different Text Forms: Reading Informational Texts

MATHEMATICS

Notes

What teachers do

Before

Before reading, students need to connect new content and ideas to their prior knowledge of the topic.

- Have students compare and contrast the organizational structure of the text to previous texts they have read. Identify the purposes of those structural features (e.g., to give an overview, to clarify with a picture).
- Describe prior reading strategies that students used to read mathematics texts with a similar organizational structure.
- Prompt the students to brainstorm and explain mathematical ideas, drawings, and symbols that they already know and that relate to the topic.
- Pose questions to students before they read, to help them determine a purpose for reading.
- Model (using a Think Aloud) how to predict the content based on features of the text, specialized vocabulary, illustrations, introductory information or personal experiences. Skim, scan, and sample the text to make informed predictions about the text's meaning.

During

During reading, prompt students to discuss and connect the information and ideas in the text to what they already know as they monitor their understanding. (*Monitoring their understanding* means recognizing when confusion occurs and identifying strategies that help to regain meaning.)

- Have students model reading strategies they might use, such as predicting, questioning, activating prior knowledge, inferring, monitoring, adjusting, rereading, and decoding.
- Model strategies (e.g., Think Aloud) for pausing and thinking about the text. Encourage students to chunk the text, read, pause, think and ask questions or make notes about the section of the text and explain how the information relates to other parts of the text they have already read.
- Prompt students to visualize the mathematics concepts as they read and then compare with a partner.
- Demonstrate, and then direct the students, how to use a graphic organizer to categorize and record main ideas, important details, and questions while reading. Encourage sharing and comparing of interpretations and representations to check the accuracy of their reading.
- Pose questions as students read to help them focus on particular aspects of the mathematics in the text, such as key concepts, procedures, facts, problem solving strategies, terminology and symbols.

After

After reading, help students to consolidate and extend their understanding of the mathematics in the text.

- Ask partners to restate or paraphrase the mathematical focus of the text.
- Prompt students to identify similarities and differences in their rephrasing. Differences in summaries could show misunderstandings as well as differences in depth of comprehension.
- Have students identify key mathematical terms in the lesson, pointing out where those terms are used.
- Model making connections between prior knowledge and the meaning in the mathematics informational text using a Think Aloud. For example, "When I was reading about circumference of a circle, I was thinking about the linear measure around a circle. This is like the linear measure or perimeter around a rectangle."
- Discuss processes and strategies students used while reading. Prompt students to explain their choices of strategies. For example, "What were you trying to find out when you were reading? How did you find it out?" In sharing processes and strategies, students learn that alternative pathways can be used to read a text.

Student Resource

Tips for Reading Mathematics Informational Texts

Before Reading

Set a purpose for reading about mathematics. Ask yourself why you are reading this mathematics text.
- Are you reading it to find an explanation of a mathematics concept or terminology?
- Do you want to know different ways to apply a formula?
- Are you stuck on a review question and want to see if there is a similar example in the text?

Get to know the structure of the mathematics text.
- See which elements appear: headings, subheadings, illustrations, highlighted words, and captions,
- Examine the titles, headings, and subheadings, and scan for mathematics words that stand out.
- Look for words and phrases that give hints about how the mathematics information is organized. Also, note the use of colour, font, font style to distinguish certain types of mathematics information.

Make predictions about the meaning of the mathematics in the text.
- Read any overviews (e.g., chapter goals), summaries (e.g., lesson goals), or questions (e.g., homework practice questions) in any part of the text to predict the meaning of the text.
- **Examine each labelled diagram, picture, and photo and read their titles or captions. Think about the** mathematics they are showing.
- Describe what you already know about the topic and how it relates to this new mathematics topic.
- List some questions you might have about the mathematics topic.

During Reading

Chunk the text.
- Skim the sections you think will support your purpose for reading.
- When you ffind specific mathematics information you want, divide the reading task into smaller chunks, by paragraphs or sections by subheadings
- Read a chunk, slowly, word by word. Pause and think about what you read.

Read and record.
- You may need to reread the passage several times as you jot down your mathematics reading thoughts.
- Write a brief one-sentence summary or brief point form notes to help you remember important and interesting information.
- Use a graphic organizer (e.g., list, word web, table) to record and organize your reading thoughts.

Questions I Have	Main Math Idea	Supporting Details	Math Words and Symbols

After Reading

- Read the selection again to confirm the main idea and supporting details.
- Make connections to what you already know about the topic. How does the information you have read add to or alter what you knew about the topic?
- Continue to record your thinking about and responses to the text. Write a summary; complete a graphic organizer; create a sketch; or retell to yourself or a friend.

Reading Different Text Forms: Reading Graphical Texts (Reading Graphs)

MATHEMATICS

Graphical text forms (such as diagrams, photographs, drawings, sketches, graphs, schedules, maps, charts, timelines, and tables) are intended to communicate information in a concise format and illustrate how one piece of information is related to another. Providing students with an approach to reading graphical text also helps them to become effective readers.

Purpose

- Become familiar with the elements and features of graphical texts used in any course.
- Explore a process for reading graphical texts, using a range of strategies for before, during, and after reading.

Payoff

Students will:

- become more efficient at "mining" graphical texts for information and meaning.
- practise essential reading strategies and apply them to different course-related materials.

Tips and Resources

- Friel, Curcio, and Bright (2001) define students' graph comprehension as being able to read and make sense of graphs created by others or by themselves. There are three levels of graph comprehension:
    - reading the data (literal);
    - reading between the data (making comparisons, observing relationships);
    - reading beyond the data (making inferences, predictions).
- "Students develop graph sense gradually as a result of creating graphs and using already designed graphs in a variety of problem contexts that require making sense of data." (Friel, Curcio, and Bright, 2001)
- When interpreting graphs, it is important that students have ample opportunity to explain and justify their reasoning and receive feedback from others. Paired or small group activities are recommended.
- Making students aware of the similar structural components and conventions that graphs share will help them to read new graphs that they encounter. (See Student/Teacher Resource, *Reading Graphs – Features of Two Variable Graphs.)*
- Current magazines and newspapers can be great resources for graphs, especially when focusing on biased and misleading graphs.
- Technology-rich environments, in which students can explore and experiment with graphs, may be helpful in developing the kind of flexible thinking that supports the understanding of graphs.
- Providing graphs with no scale or units on the axes helps students to focus on the qualitative meaning of the graph, developing their ability to read between and beyond the data. (See Student Resource, *Reading Graphs – Reading Between the Data.)*
- Help students to make connections between reading graphs and activities requiring similar skills in which they have experience e.g., playing grid-based board games (e.g., Chess, Sink the Ship), using spreadsheets, and reading maps.
- The supporting resources for this strategy include the Student/Teacher Resource, *Reading Graphs – A Four Step Process*, and examples for three of the steps.
- See Student Resource, *Reading Beyond the Data.*
- See Teacher Resource, *Reading Graphs – Answers to Student Resources.*

Further Support

- Provide students with an advance organizer to guide them as they read a particular graphical text. This might be a series of prompts to guide them through the reading task.

Reading Different Text Forms: Reading Graphical Texts (Reading Graphs)

MATHEMATICS

What teachers do	What students do
Before • Ask students to brainstorm the purposes and features of the type of graph in question. • Read the title and ask students to recall what they already know about the topic. • Model (using "think aloud") how to predict the content of the graph based on the title, labels, and type of graph. Invite students to predict what the graph might show.	• Individually brainstorm purposes and features of the type of graph in question. • Recall prior knowledge related to the title of the graph. • Predict what the graph might show.
During • Discuss the four levels of reading graphs. (See Student/Teacher Resource, *The Four Levels of Reading Graphs: A Four Step Process*). Previewing the Graph: - Provide students with questions that focus on the basic elements of the graph. For example: - What does the title tell us about the information in the graph? - What information is provided in the label on the horizontal axis? vertical axis? - What are the units in the scale? What is the range of values? By what increment does the scale increase? Reading the Data (literal): - Use the labels and scales on the axes to read or locate specific information on the graph. Reading Between the Data (making comparisons): - Encourage students to make comparisons and look for relationships in the data. - Pose comparison questions related to the data using phrases such as "Which is greater?" and "How did the value change?" - Explore some "what if" statements. For example, what if the data point was placed a little to the left? right? down? up? Compare what happens when you move diagonally up to left in the graph versus down to the right.	• Work with partners to discuss the focus questions provided. • Ask questions to clarify understanding of the basic elements of the graph. • Read specific data on a given graph. For example, place the top right corner of a rectangular piece of acetate on the data point and follow the edges of the acetate back to the two axes to read the information on each axis. • Look for relationships in the data and make comparisons in the data. Discuss these comparisons in the data with partners. • Investigate "what if" statements posed by the teacher.
After Reading Beyond the Data (making inferences and drawing conclusions): - Encourage students to synthesize the information in the graph. Pose questions that lead students to identify trends, make predictions, extend the data, or draw inferences.	• Work with partners to identify trends, make predictions, extend the data, or draw inferences from the data. • Individually record thinking by answering questions related to the graph. • Identify strategies for reading graphs that can be used in the future.

Notes

Reading Graphs – A Four Step Process

I. Previewing the Graph

Before answering any questions about the information in a graph, try to understand the basic elements of the graph:

- What **type of graph** is it? (e.g. pictograph, bar graph, line graph, scatter plot, circle graph)
- What does the **title** tell you about the information in the graph?
- Read the labels on each axis.
- What are the units for the scales?
- Read the legend (if there is one).

II. Reading the Data

Some questions about data can be answered by stating a fact directly from the graph. To answer these types of questions, use the labels and scale on the horizontal and vertical axes to read or locate specific information on the graph.

III. Reading Between the Data

The answers to some questions require that you interpret information by identifying relationships and trends within the graph. Compare two or more points on the graph to determine a relationship or trend (see Student Resource, *Reading Graphs – Reading Between the Data*, questions 1-4).

IV. Reading Beyond the Data

Some questions about data in graphs ask you to extend, predict, or infer an answer using your own prior knowledge and experience. To read beyond the data is to draw conclusions from evidence in the graph.

- Identify your own knowledge and experience related to the question.
- Consider the evidence in the graph that supports your prediction or conclusion.
- See Student Resources, *Reading Graphs – Reading Between the Data,* questions 5-7 and *Reading Graphs – Reading Beyond the Data*.

Student/Teacher Resource

Reading Graphs – Features of Two Variable Graphs

Graphs with an "L-shaped" framework are used to organize and analyze information about *two variables*, e.g., weight and cost, time and distance, colour and number.

The variables can *vary* by **quantity** or by **type**,
e.g., "Cost" varies by quantity ($2, $5) whereas "colour" varies by type (blue, red).

The horizontal axis is used to show the *quantity* (e.g. $2) or *type* (e.g. blue) of one of the two variables. This variable is called the *independent* variable.

The second variable is called the *dependent* variable.
The vertical axis is a number line, used to show the *quantity* of the second variable.

The axes are usually labeled with the name of the variable and units of measure if applicable e.g., Cost ($). When both axes are number lines then the location of the data point (0, 0) is called origin.

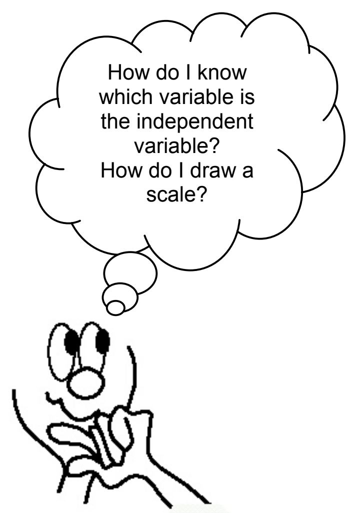
Title

The title provides an introduction to the data contained within the graph.

Label

The vertical axis is used to show different **quantities** of the second variable. This axis needs a **scale** and units of measure.

Data can be represented in a variety of ways, for example, by points in a scatter plot, lines on a line graph, or bars on a bar graph.



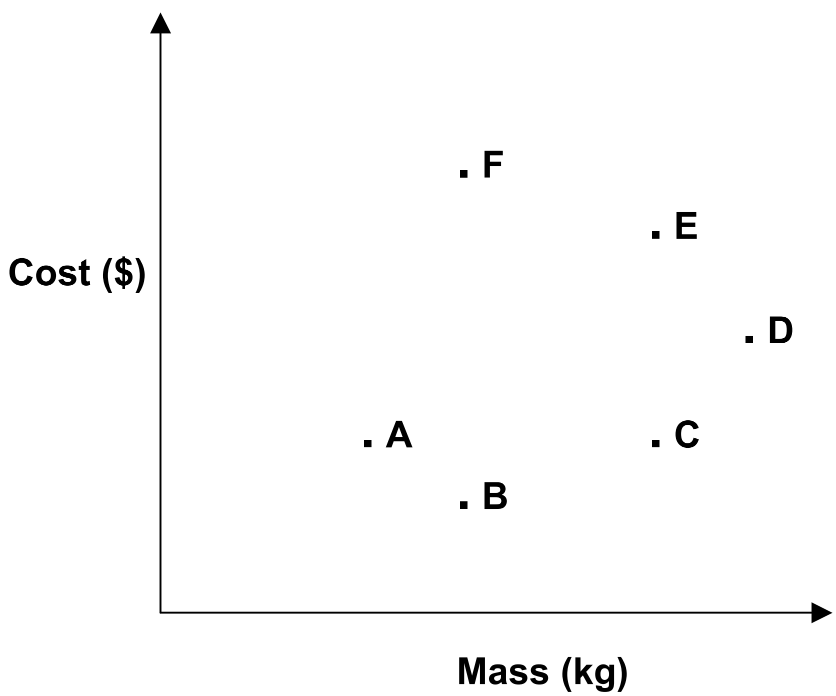
Label

The horizontal axis is used to show different **quantities** or different **types** of the first variable. When the axis is used to show different quantities then it needs a **scale** and units of measure.

Reading Graphs - Reading Between the Data

Bulk Birdseed

Seven different sized bags of birdseed are available for sale at the costs represented in the graph below. Each point represents information about one bag of birdseed.



Answer the following questions and justify your reasoning.

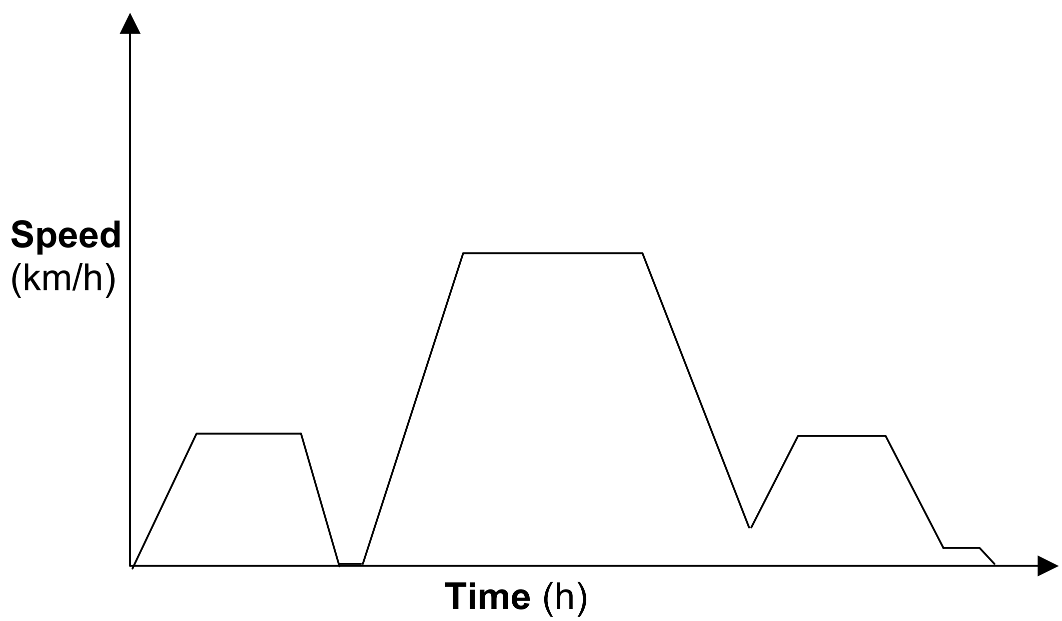
1. Which bag is the lightest?
2. Which bag is the most expensive?
3. Which bags have the same mass?
4. Which bags cost the same?
5. Does bag F or bag C give you better value for your money?
6. Does bag B or bag D give you better value for your money?
7. Which two bags give you about the same value for your money?

Reading Graphs - Reading Beyond the Data

Think/Pair/Share Activity

1. **Think:** Study the graph below. Think about what is happening as the afternoon drive unfolds. Write down possible explanations for the changes in the car's speed.

An Afternoon Drive



2. **Pair:** With a partner, discuss what might be happening as the afternoon drive unfolds. Compare your ideas to clarify your understanding of the graph.

3. **Share:** Share your ideas with the whole class. Ask questions to further clarify your understanding of the graph.

Reading Graphs - Answers to Student Resources

Answers to *"Bulk Birdseed"*

1. Bag A is the lightest.
2. Bag F is the most expensive.
3. Bags B and F have the same mass, and bags C and E have the same mass.
4. Bags A and C cost the same.
5. Bag C has a better value for your money because it has a greater mass than bag F but costs less than bag F. (Point C is further right than point F which means bag C's mass is greater than bag F's mass. Point C is lower down than point F which means bag C *costs* less than bag F.)
6. Bag B has a better value for your money because although its mass is about half the mass of bag D, its cost is less than half the cost of bag D. (The cost/mass ratio for bag B is less than bag D's.)
7. Bags B and C give about the same value for your money. (The cost/mass ratio for the two bags is the same. If a line is drawn from origin to point B and extended past point B, the line goes through point C. The cost/mass ratio is the same for any two points on this line.)

Consider asking students to pose additional questions for this graph e.g., How would the information about bag A change if point A was moved lower but not left or right?

Sample Explanation for the Graph, "An Afternoon Drive"

The car begins from home with a fairly constant acceleration to a reasonable city/town street speed. It travels at this speed for a time before stopping at a traffic light/stop sign. The car then continues on the trip, entering a highway/expressway to travel at a greater speed for a time. The car slows down as it exits the highway then speeds up again as it travels along another city/town street. Finally, the car slows down before turning and driving slowly up a long driveway to its destination.

Consider asking students to pose additional questions for this graph e.g., How would you describe the afternoon drive if the vertical axis was labeled "Distance" instead of "Speed"?

Reading Different Text Forms: Following Instructions

MATHEMATICS

Students are expected to read and follow instructions in every subject area. This strategy asks students to examine different types of instructions, their features, and elements, and how the features, language and organizational patterns can be used to help the reader understand and complete a task.

Purpose

- Provide students with strategies for reading, interpreting and following instructions to complete a specific task.
- Learn how instructions are organized.

Payoff

Students will:

- identify purposes for reading instructions.
- develop a process for reading and following instructions.

Tips and Resources

- Instructions give detailed step-by-step information about a process or procedure.
- When learning mathematics, students read instructions in a variety of contexts such as playing a math game, reading the sequence in a sample solution, or instructions for using Geometers' Sketchpad to complete a task. It is helpful for students to compare and analyse the organizational patterns, language, and features e.g., What is the difference between using bullets for instructions and instructions that are numbered? (Numbers imply a prescribed sequence.)
- Students are more successful with reading instructions when they have had opportunities to develop sequencing skills orally and then pictorially (e.g., "barrier games" in which pairs of students use a textbook to create a visual "barrier" and then take turns giving and following instructions for completing math tasks such as completing a drawing on a grid or using tangrams to make a shape).
- Graphic organizers such as flow charts and story boards can be used to sequence the instructions through pictures (e.g., the sequence in building a tangram shape) or words (e.g., the explanation for solving a problem) or symbols (e.g., the solution to a sample problem).
- Ensuring that students have previous experience with the content will improve their comprehension when reading instructions (e.g., students will be able to follow instructions for using algebra tiles if they have previous experience in using the manipulative).
- Student/Teacher Resources provide sample materials for grade 7, 8 and 9 for using the Following Instructions strategy.
- **See Student/Teacher Resource, *Following Instructions – Sample.***

Further Support

- When students become overly concerned about accurately following instructions they may lose their focus on the math skills and concepts that they are learning in the task. Students can work in groups and take turns reading the instructions.
- Provide students with a list of typical signal words and task prompts and suggestions/strategies for responding to them (e.g., explain, list, compare, give reasons, select, choose, show your work, solve, simplify, graph, illustrate, show, evaluate, substitute).
- Provide students with opportunities to follow oral instructions, and discuss how they were able to complete the instructions and what was challenging, confusing or frustrating.

Reading Different Text Forms: Following Instructions

MATHEMATICS

What teachers do	What students do
Before Asking Questions • Provide each student with a photocopy of the instructions. Model the strategy for asking questions. Orally identify a question and record it on an overhead copy of the instructions e.g., The name of the game is "Green is Go", I wonder if the other traffic light colours of red and orange will be used in this game? Ask students to continue reading the instructions and recording their questions.	• Students work in pairs. One student has a copy of the instructions and reads them to his/her partner. The second student asks questions for clarification. In this strategy students learn to refer to the text while they are reading in order to answer questions.
Revising for Clarity • Model the technique of revising for clarity on an overhead copy of the instructions. Cross out and simplify the vocabulary. Rewrite longer sentences by using shorter sentences with fewer clauses and phrases. • Have the students select a problem or a set of task instructions and then direct students to revise it for clarity.	• Choose a problem or instructions for a task from TIPS or a textbook. Revise the text and record the revised version in a notebook. Compare the two versions for clarity of communication.
Sequencing • Make copies of game instructions or samples of student responses from a text book or exemplar. Cut them into steps. Ask students to order them in a sequence. • Identify strategies used to make decisions about the order (e.g., the use of signal words such as first, next, then or numbers).	• Put instructions for a game, or samples of students responses, in sequence. • Compare sequences with other students, pairs of students, or groups of students. • Identify text features that support sequencing and ordering such as signal words and numbering.
During • When students ask questions, model returning to the text to find answers to their questions. • While circulating around the room, ask students questions about the instructions and observe the strategies used to answer the questions (e.g., referring to the text).	• Refer to the text to check for answers to questions about "what to do next".
After • Ask students to identify which instructions were most helpful and which were most confusing. • Identify the strategies that students used to make sense of the instructions e.g., "I had to slow down and read the instructions again." • Summarize the strategies that were used.	• Compare personal choice of reading strategies with the strategies used by classmates. • Reflect on reading strategies used to make sense of instructions.

Notes

Following Instructions – Sample (Grade 7)

Adapted from: GSP V4 Instructions from the TIPS Section 3: Grade 7 Summative Task: The Gazebo
http://www.curriculum.org/occ/tips/index.shtml

Constructing a Hexagon by Rotating Diagonals

Set Distance Units
• Under the Edit menu choose Preferences.
• Set distance units to cm.
• Set precision to hundredths.

Saving Files
• Establish classroom procedures.

Printing Sketches
• Use the text tool to create a text box with your name and date.
• Under the File menu choose Print Preview – then select Scale to Fit Page – then choose Print.

Construct a Hexagon
1. Construct a line segment.
2. Under Construct choose Point at Midpoint.
3. Under Transform choose Mark Center.
4. Select the line segment and its endpoints.
5. Under Transform choose Rotate.
6. Enter 60o for the angle of rotation.
7. Under Transform choose Rotate.
8. Deselect, then choose the segment tool to construct the sides of the hexagon.
9. Do a drag test.

Take Measurements
1. Select the two endpoints of one side of the hexagon.
2. Under Measure choose Distance. (The measurement appears in the sketch.)
3. Select the two endpoints of one diagonal of the hexagon.
4. Under Measure choose Distance.

Make Calculations
Calculate the Perimeter
1. Under Measure choose Calculate.
2. Select 6, select *, select the measurement of the side length, then press OK.

Calculate the Ratio of Perimeter to Diagonal
1. Under Measure choose Calculate.
2. Select the Perimeter measurement, select ÷, select the measurement of the side length, then press OK.
3. Do a drag test and watch the measurements change.

Create a Table
1. Select all of the following measurements and calculations: side length, diagonal length, perimeter, ratio.
2. Under Graph choose Tabulate.

New Table Entry
1. Change the side length of your hexagon by dragging a point in the diagram.
2. Place the arrow on one of the table entries.
3. Double click and a new entry will be added.

Repeat steps 1-3 to add more entries.

Student/Teacher Resource

Following Instructions – Sample (Grade 8)

Adapted from: TIPS Section 3: Grade 8 Lessons 17 –23, Task: Green is a Go
http://www.curriculum.org/occ/tips/index.shtml

20.1: Green is a Go

Names:
Date:

With a partner, play a simple game involving six tiles in a bag, e.g., three red and three green tiles. Take two tiles from the bag during your "turn."

Rules
You may not look in the bag. Draw one tile from the bag and place it on the table. Draw a second tile from the bag and place it on the table. Return the tiles to the bag. You win if the two tiles drawn during your turn are both green.

Predict the number of wins if you play the game 40 times. Record and explain your prediction.

Play the Game

1. Take turns drawing two tiles from the bag, following the rules above. Record your wins and losses on the tally chart. Continue this until you have played a total of 40 times.

	Green, Green (win)	Red, Red (loss)	Red, Green (loss)
Totals			

2. After you have played 40 times, use your results to find the experimental probability of winning. (Remember that probability is the number of wins divided by the total number of times the game was played.)
3. How does this compare with your predictions? Explain.
4. Find the theoretical probability of winning. (Hint: Use a tree diagram to show all possible draws).
5. Write a paragraph to compare the theoretical probability you just calculated to the experimental probability you found earlier. Are these results different or the same? Why do you think they are the same/different?

Following Instructions – Sample (Grade 9)

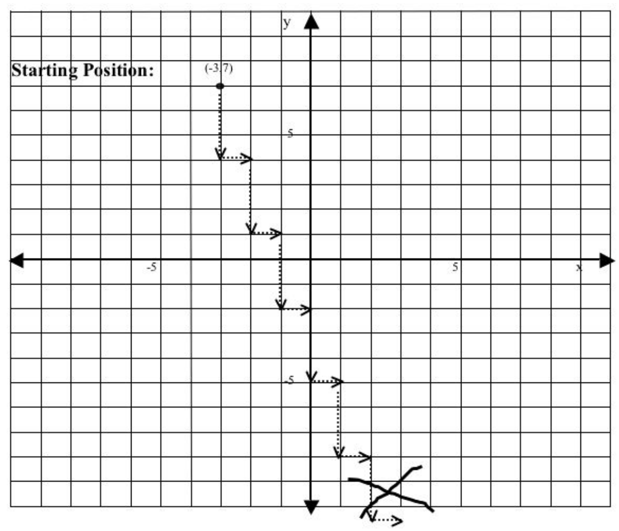
Adapted from: TIPS Section 3: Grade 9 Introductory Unit: Task: Grid Walking Game
http://www.curriculum.org/occ/tips/index.shtml

1.2: Grid Walking

1. You and your partner need a Grid Walking game board and a score sheet.
2. Each of you chooses one 'Starting Position' and one pair of Grid Walk directions. Record these on the score sheet.
3. On the grid, mark your starting position and move across the grid following the Grid Walk directions.
4. Keep moving following the Grid Walk directions until you get to an edge or a corner of the grid.
5. Collect 1 point for each complete "step." No points are given for partial steps!
6. The next player chooses a new starting position and new Grid Walk directions.
7. Use a different colour to mark each turn on the grid.

Example:
The starting position is (-3 ,7).
The Grid Walk directions are: Down 3, Right 1.

This play has 5 complete "steps" and earns 5 points.



Starting Position Choices		Grid Walk Choices			
(2, –4)	(−–4, –1)	Up 0	Down 0	Right 0	Left 0
(–2, 0)	(1, 1)	Up 1	Down 1	Right 1	Left 1
(–3, 7)	(0, 0)	Up 2	Down 2	Right 2	Left 2
(5, –4)	(–6, 1)	Up 3	Down 3	Right 3	Left 3
(0, 2)	(4, –3)	Up 4	Down 4	Right 4	Left 4
(4, 2)	(–2, –3)	Up 5	Down 5	Right 5	Left 5

Developing and Organizing Ideas: Webbing, Mapping and More

MATHEMATICS Grades 7, 8, and 9

Effective thinkers use different strategies to sort the ideas and information they have gathered in order to make connections, identify relationships, and determine possible directions and forms for their thinking and writing. This strategy gives students the opportunity to reorganize, regroup, sort, categorize, classify and cluster their notes.

Purpose

- Identify relationships and make connections among ideas and information.
- Select ideas and information for possible topics and subtopics.

Payoff

Students will:

- model critical and creative thinking strategies.
- learn a variety of strategies that can be used throughout the writing process.
- reread notes, gathered information and writing that are related to a specific task.
- organize ideas and information to focus thinking.

Tips and Resources

- Strategies for webbing and mapping include:
    - *Clustering* – looking for similarities among ideas, information or things, and grouping them according to characteristics.
    - *Comparing* – identifying similarities among ideas, information, or things.
    - *Generalizing* – describing the overall picture based on the ideas and information presented.
    - *Outlining* – organizing main ideas, information, and supporting details based on their relationship to each other.
    - *Relating* – showing how events, situations, ideas and information are connected.
    - *Sorting* – arranging or separating into types, kinds, sizes, etc
    - *Trend-spotting* – identifying things that generally look or behave the same.

- See Student/Teacher Resource, *Webbing Ideas and Information*.
- See Student/Teacher Resource, *Webbing, Mapping and More – Sample.*
- *Info Tasks for Successful Learning*, pp. 23-32, 87, 90, 98

Further Support

- Provide students with sample graphic organizers that guide them in sorting and organizing their information and notes e.g., cluster (webs), sequence (flow charts), compare (Venn diagram).
- Have students create a variety of graphic organizers that they have successfully used for different tasks. Create a class collection for students to refer to and use.
- Provide students with access to markers, highlighters, scissors, and glue for making and manipulating their gathered ideas and information.
- Select a familiar topic (perhaps a topic for review). Have students form discussion groups. Ask about the topic. Taking turns, students record one idea or question on a stick-on note and place it in the middle of the table. Encourage students to build on the ideas of others. After students have contributed everything they can recall about the topic, groups sort and organize their stick-on notes into meaningful clusters on chart paper. Ask students to discuss connections and relationships, and identify possible category labels. Provide groups with markers or highlighters to make links among the stick-on notes. Display the groups' thinking.

Developing and Organizing Ideas: Webbing, Mapping and More

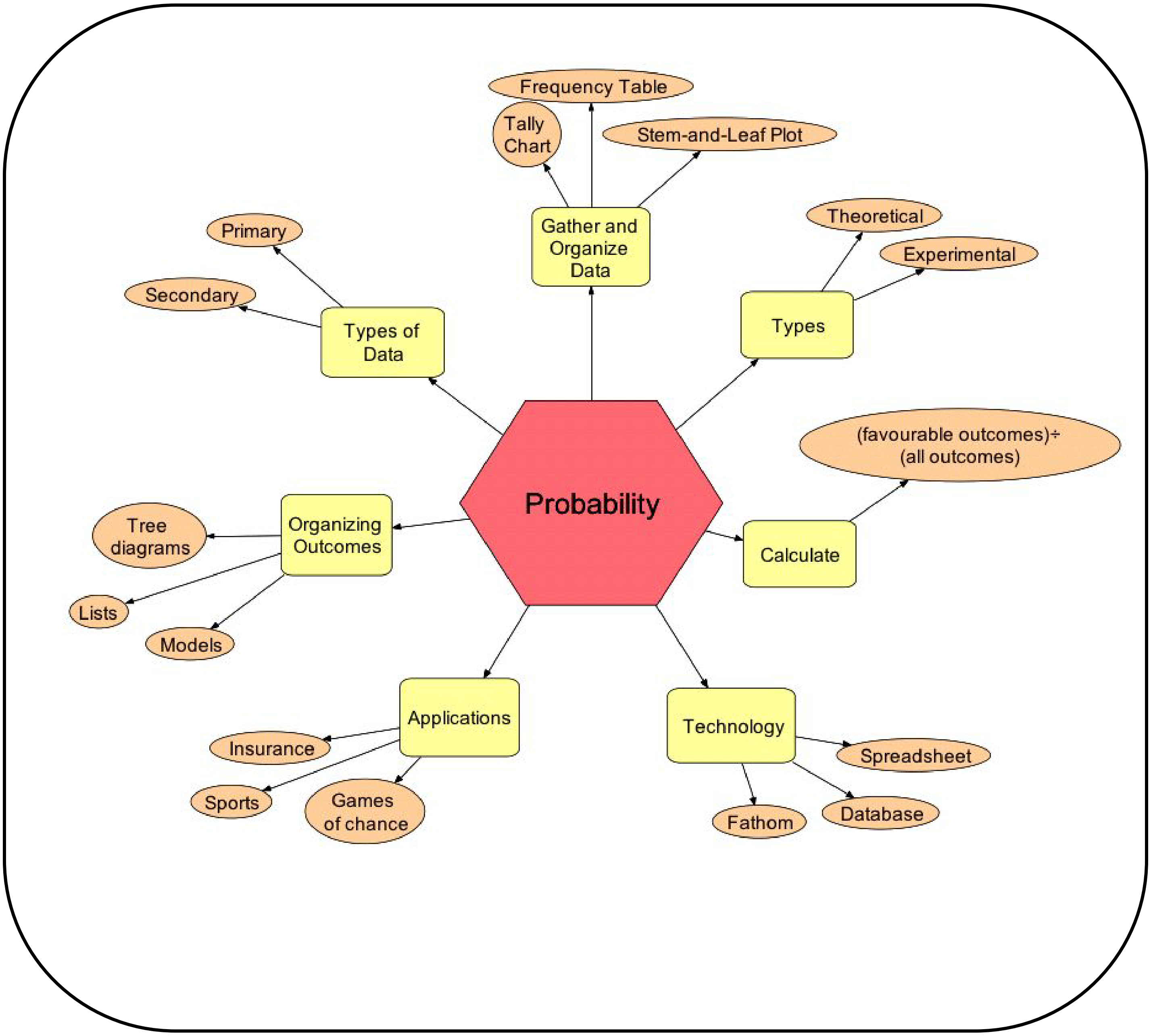
MATHEMATICS Grades 7,8, and 9

What teachers do	What students do
Before • Select a unit/topic for review. • Prepare an overhead transparency with some of the concepts listed. • Model for students how to make connections among the ideas and information (e.g., number, circle, colour-code, draw arrows). • Model the process of rereading notes and arranging key points to show the connections and relationships.	• Recall what they already know about the topic. • Bring notes to class. • Make connections to their own notes.
During • Ask students to contribute to the mind map by identifying additional important ideas and key information and by suggesting how to place the points into the mind map. • Ask students questions to clarify the decisions. For example: - What does this mean? - Is this important? Why? - How does this connect to …? - What is the relationship between …? - Does this connect to other parts of the mind map?	• Contribute to the discussion. • Look for connections and relationships between the mapping concepts. • Look for important information and ideas in their notes and textbooks.
After • Ask students to find examples for the concepts in the mind map. • Ask students to create a mind map for a different topic or a sub-topic by organizing their ideas and information. • Discuss how students can use their mind maps for review before an assessment. • Ask students to reread their mind maps and use them for review.	• Contribute examples. • Create a mind map. • Share and compare mind maps. • Use the mind maps for review.

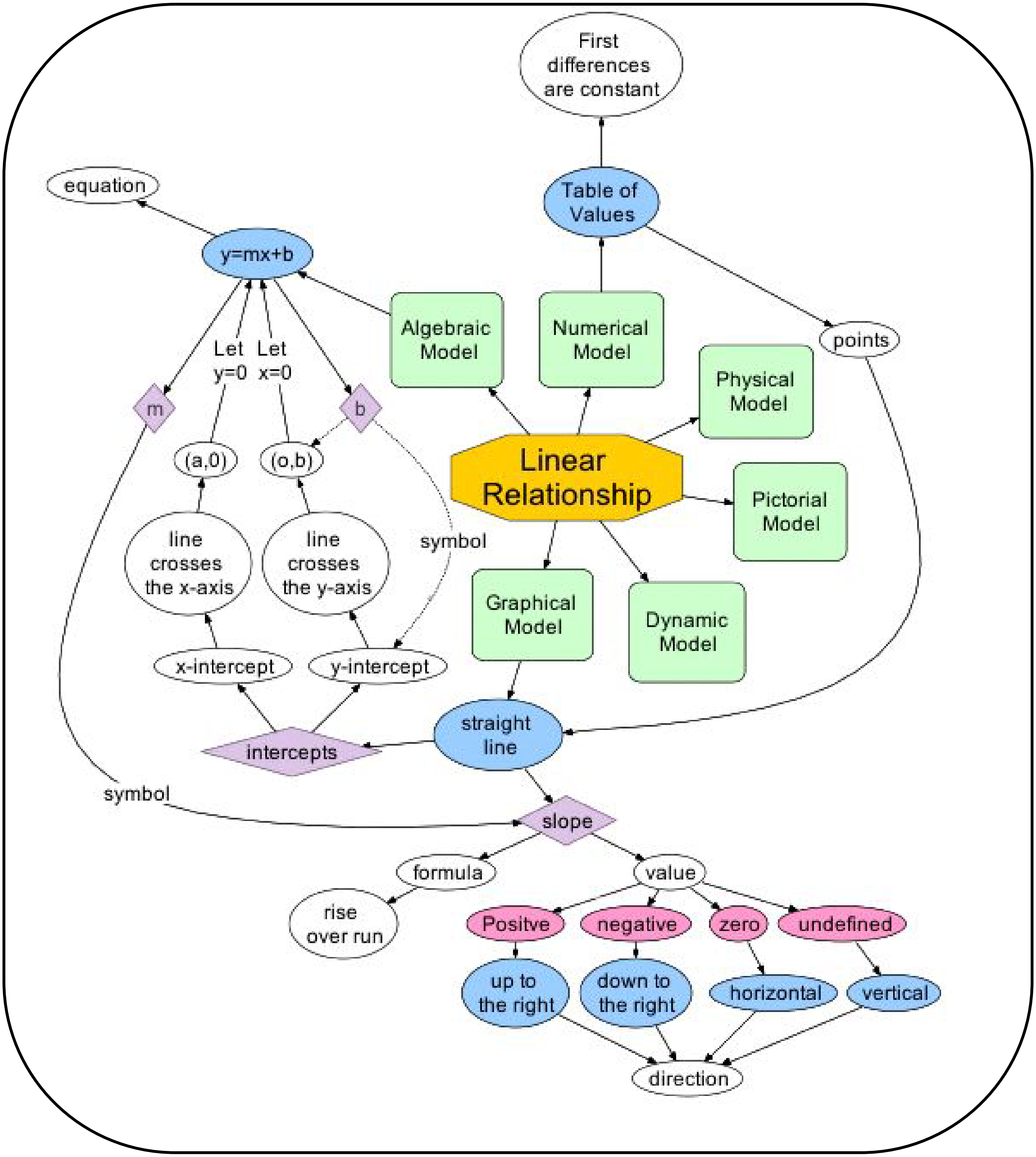
Notes

Student/Teacher Resource

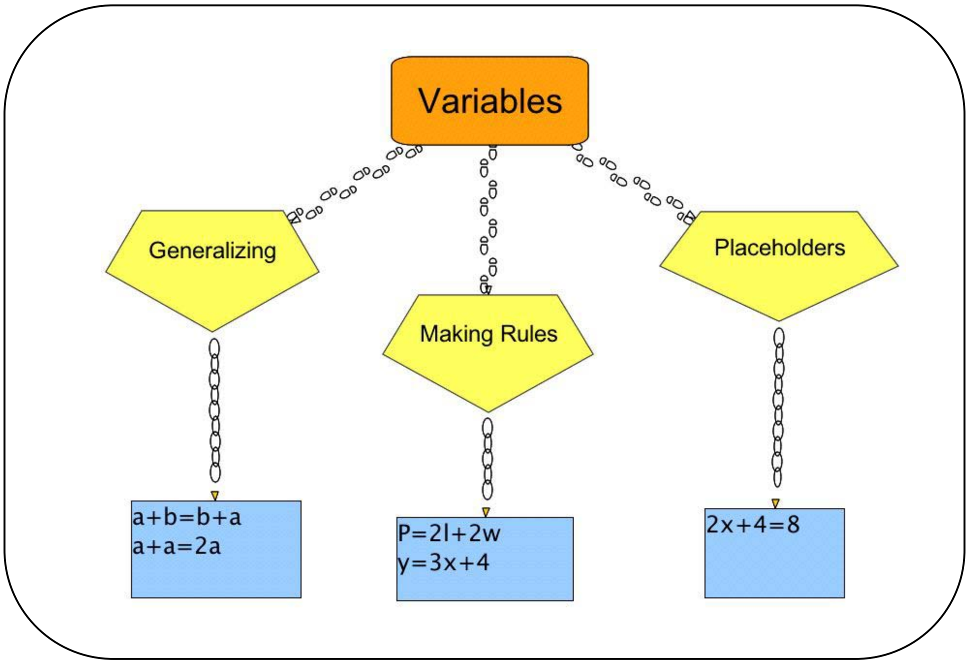
Webbing, Mapping and More – Sample (Grade 7)



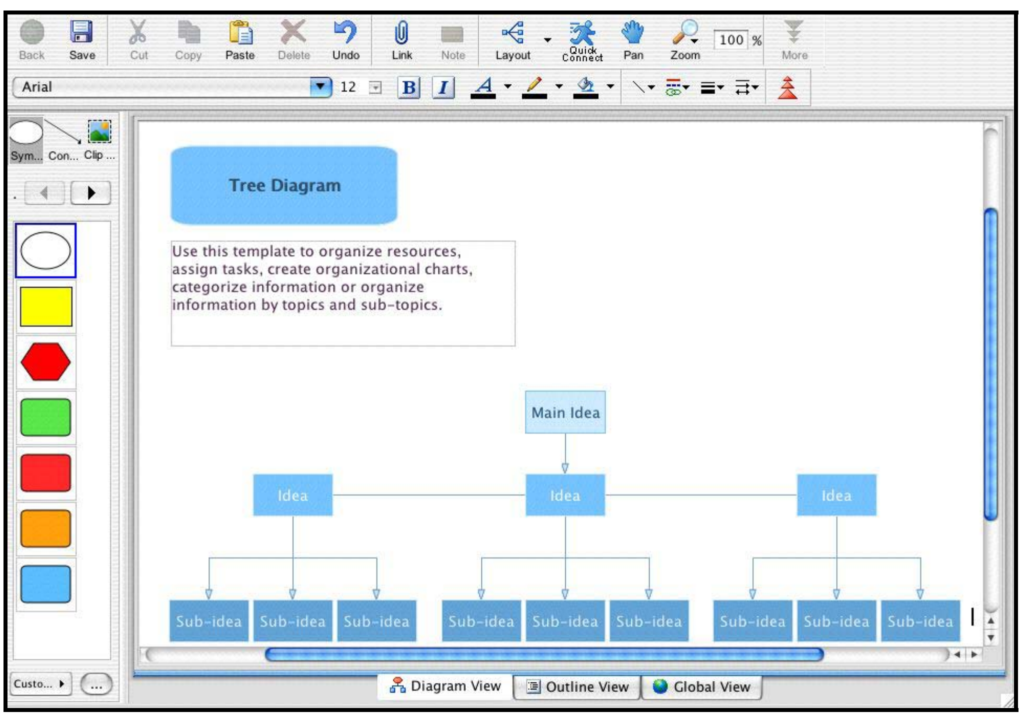
Webbing, Mapping and More – Sample (Grade 9)



Webbing, Mapping and More – Sample (Grades 7 – 9)



SMART Ideas ® is concept mapping software which is Ministry licensed and thus available for students and teachers to use. The sample mind maps in this strategy were created with SMART Ideas ®. Creating concept maps with this software is facilitated by the many templates available like the one shown in the screen capture below.



Revising and Editing: Asking Questions to Revise Writing

MATHEMATICS

Students ask other students questions and provide specific feedback about other students' writing. Students gain a sense of taking responsibility for their writing.

Purpose

- Discuss the ideas in a piece of writing in order to refine and revise the ideas.

Payoff

Students will:

- engage in meaningful discussion and deepen understanding about the subject content.
- develop over time into supportive partners for peers.
- recognize that the writer owns the writing, but that collaboration helps other students to recognize unintended omissions and inconsistencies.

Tips and Resources

- The writer Nancie Atwell explains that "the writer owns the writing." This means that the writer should always be given the first opportunity to amend ideas, form and style rather than having another person suggest them. When other students ask questions or provide open-ended prompts about a problem solution, they give the writer an opportunity to think deeply about his/her solution and to gain a better sense of how to tailor it to make it both a more effective piece of communication and a better solution.
- Revising and Editing a solution to a mathematics problem differs from revising and editing a literary piece in at least two ways: first, it is not the power of words, expressions, or style that convinces the reader but rather the logic – the reasoning must be clear; second, mathematical communication has its own syntax and conventions which must be adhered to if correctness as well as clarity is to be presented.
- See the Mathematics exemplars ("Mathematics: The Ontario Curriculum – Exemplars") for samples of student work at levels 1,2,3, and 4 to use as examples of both good solutions and of solutions needing revising. These are available both on-line at http://www.edu.gov.on.ca/eng/document/curricul/elemcurric.html and in hard-copy form from The Queen's Printer, and should already be in every school.
- See also EQAO Release Materials from the Grade 9 testing for other examples. These are available on-line at http://www.eqao.com/06ede/ed6_1e.asp
- See the handout of suggested prompts and questions, Student Resource, *Asking Questions to Revise Writing –Sample Questions*.

Further Support

- Create groups of three or four that will work together to support each other.

Revising and Editing: Asking Questions to Revise Writing

MATHEMATICS

What teachers do	What students do
Before • Prepare an overhead or a paper copy of two sample solutions to a particular problem - one containing form/logic errors and omissions, the other a model solution. • Have the students read the inappropriate solution, asking them to either note or highlight form/convention/logic errors and omissions. • Ask students to identify the areas of concern or confusion that they discovered. • Model the use of questions and prompts to the problem solver, asking students to consider the purpose of these questions and prompts.	• Look for areas of confusion and form/convention errors and omissions. • Offer suggestions for areas of concern or confusion. • Suggest the purposes of the questions and prompts.
During • Give students the Student Resource, *Asking Questions to Revise Written Solutions*, and take a few minutes to read it over with them. • Put students in conferencing groups of three or four. • Ask students to exchange their solution with another person in their group. • Ask the students to read the solution received and to make notes using one or two of the 'praises' and/or 'questions'. • Have the students return the solutions to then be exchanged with a different student. • Have the students take a minute to read over the notes made on their own draft solution. • Provide 10 to 15 minutes for this exercise.	• Exchange solutions with another group member. • Read the received solution and make notes using the 'praise' and/or 'questions'. • Repeat the exchange with a different group member.
After • Engage students in a whole-class discussion about the process. How helpful was the process in helping them to set direction for revising their draft solution? • Direct students to revise their draft solution.	• Revise own draft solution based on the 'praises' and 'questions' from their partners.

Notes

Student Resource

Asking Questions to Revise Writing – Sample Questions

Your job as a revising partner is a very important one. You can help the writer by:

- giving the writer a sense of how completely the task has been accomplished
- praising proper form, use of required convention and/or reasoning
- identifying poor form
- identifying areas of confusion
- targeting statements that are not relevant
- targeting conclusions that do not address the question
- targeting conclusions that are not supported with evidence.

However, the writer owns the writing, and should not feel that your suggestions or ideas are being imposed as THE solution. The best way to help your revising partner is to phrase your comments as open-ended prompts, as questions, or as a combination of an observation and a question. Some suggestions are below.

- Begin by using any "praise" statements that you can.
- If you can't use the "praise" suggestions, you should use the "questions."

Praise	Questions
• Your solution is complete.	• Your solution doesn't seem to be complete: a) Have you defined the variable? b) Have you included a concluding statement? c) Is your conclusion connected to the numerical values that you worked out? d) Have you shown all of your steps?
• Your solution uses proper form.	• How could you improve the 'form' of your solution? a) Do you have more than one = sign on a line? b) Have you carried all of the expression from line to line? c) Have you used the appropriate units?
• Your conclusion is consistent with the question being asked.	• What conclusion would better connect to the question being asked? • Should the numerical answer you calculated be rounded? If yes, up or down?
• Your work is clearly laid out with your steps outlined.	• What comments could you add to clearly identify the steps you took? • How could you organize/space your solution to help the reader follow your thinking? • Could you include a diagram, chart or graph to support your thinking?
• You have used all the necessary conventions.	• What conventions have to be paid attention to in your solution (e.g., units, = sign position, rounding, labels and scales on graphs / diagrams, symbols, …)?
• You have made good use of mathematical terminology.	• What mathematical terminology and symbols can you use in your solution?
• Your strategy is reasonable.	• Does your strategy produce an answer to the question being asked? • Does your diagram/graph reflect the information given in the problem? • Did you choose appropriate values from the given chart/graph? • Did you choose an appropriate formula?
• You were able to consider more than one possible solution.	• Can this problem have more than one solution?

Revising and Editing: Peer Editing

MATHEMATICS

Peer editing gives students an opportunity to engage in important conversations about how a piece of writing for an assignment in any subject area has been constructed and whether it achieves its purpose, considering the audience. By reading each other's work, asking questions about it, and identifying areas of concern, students learn a great deal about how to put information together and express ideas effectively.

Purpose
- Have students look at their own and others' writing with a more knowledgeable, critical eye.

Payoff
Students will:
- have an audience for the writing, other than the teacher.
- develop skills in editing and proofreading.
- receive peer input about possible errors and areas of concern, in a "low-risk" process.
- have positive, small-group discussions.

Tips and Resources
- Mathematics peer editors should not be expected to correct all of the writer's errors, since the writer is responsible for the piece's clarity and precision. Rather, the teacher and other students should provide support for the writer to make improvements.
- Peer editing of mathematics written responses is a skill that must be built and practised over time. Begin with a single focus (such as, being precise in the use of mathematics), then add elements one at a time, such as: including sufficient explanatory detail and supporting evidence, having a logical sequence of ideas, using different representational forms (i.e., words, numbers, pictures, symbols), using mathematics terminology and conventions.
- This strategy may be used more intensively where time permits or where the mathematics writing is particularly significant (e.g., lesson focus is on mathematical communication). In these cases, student work may be edited by more than one group, so that each student receives feedback from a larger number of peers. Also, the analysis of the components of effective mathematics writing using student samples of work from EQAO and Ministry of Education Mathematics Exemplars is effective in focusing students on the criteria for effective mathematical communication.
- Each student should have the opportunity to get feedback from two other students about their mathematics writing.
- Peer editors should record their feedback using a Peer Editing Checklist and discuss their ideas face-to-face with the writer so that questions for clarification can be asked and responses can be given. Also, such a shared discussion can include correction of inaccurate mathematics calculations, correction of the application of mathematical procedures, and collaborative revision of the mathematics writing.
- See Student Resource, *Peer Editing – Being an Audience.*
- See Student Resource, *Peer Editing – Sample Checklist.*

Further Support
- Consider balancing each group with students who have varying skills and knowledge to bring to the peer-editing process. More capable peer editors can act as models for the students who haven't yet consolidated the concepts or skills.
- Explain to students that you have designed the triads or groups to include a very creative person, a person with good technical skills, and one or more persons who would provide a very honest audience for the writing.
- Consider turning some of the questions into prompts (e.g., Effective mathematics communication looks like …; I'd like more information about …; I was unsure of what the writer was showing …).

Revising and Editing: Peer Editing

What teachers do	What students do
Before • Ask students to bring a completed draft of a writing assignment to class on a specified date. • Divide students into triads. • Distribute a peer-editing checklist (see Student Resource, *Peer Editing - Sample Checklist*). Discuss the characteristics of effective mathematics writing, modeling questions students may ask. • Make an overhead of the Student/Teacher Resource, *Peer Editing – Being an Audience*, to share the questions with students.	• Bring a completed draft of a mathematics writing assignment to class on the specified date.
During • Give directions for the peer editing process: one student exchanges their mathematics writing piece with another student. Students read the writing pieces making running comments, in terms of strengths, suggestions, and questions. • Once the peer reading and responding is completed, direct the peer editor to pass the mathematics writing to the second peer editor. • Remind students that they are not responsible for correcting all the writer's errors, but that they can underline areas of concern, or circle words that should be checked for spelling or usage. • Monitor and support the group processes by stopping them and having students identify a strength.	• Give their piece of writing to another student. • Individually read and annotate (circling, underlining, and writing questions or comments). • Remember that the writer owns the writing; therefore, the reader is not primarily responsible for correcting all the writer's errors. • Review a different piece of writing. • As a group, discuss each piece and complete a peer-editing checklist arriving at consensus (through discussion) about judgments, suggestions, and comments. • Sign or initial the peer-editing checklists when the group is done, and return the writing pieces to the original owners.
After • Give each student time to look at the peer-editing checklist that accompanies the writing pieces. • Debrief the activity with the class, asking questions such as: – What were the strengths you noticed in the best pieces of writing in various areas (e.g., in the accuracy of the mathematical calculations, supporting details)? – What were some typical areas needing improvement? – What types of things will you have to do to improve your work? • Provide time for each student to engage in a brief conference with a student who peer-edited his/her piece of writing, to get a deeper understanding of the comments and suggestions.	• Read the peer-editing checklist comments that they receive with their work. • Take part in the class debriefing discussion. • Confer with one other student to provide more complete feedback and comments or suggestions. • Complete subsequent draft, if assigned.

Notes

Student Resource

Peer Editing – Being an Audience

Ask yourself (and the writer) these questions as you read a mathematical solution, explanation or justification.

1. How were the ideas in the mathematics explanation or justification connected to the question, problem, problem solving process, and/or problem solving context?

2. How were the mathematical ideas clearly expressed and focused?

3. How were the ideas organized?

4. How clear was the mathematics solution, explanation or justification?

5. How were the examples and/or supporting evidence relevant to the mathematical explanation or justification?

6. How was the mathematical supporting evidence appropriate and varied, in terms of its mathematical forms (i.e., words, numbers, graphic representation, symbols)?

7. Where in the explanation or justification were mathematics terminology and conventions accurately, effectively, and consistently used?

Student Resource

Peer Editing - Sample Checklist

Writer's Name	Mathematics Task		Grade

#		Y	N
1.	… are connected to the mathematics question, problem, problem solving process, and/or problem solving context.		
2.	… are focused, concise, and clear.		
3.	… are mathematically precise.		
4.	… are sufficiently detailed.		
5.	… include logically sequenced, mathematical ideas.		
6.	… include relevant, mathematical supporting evidence.		
7.	… include a variety of mathematical forms if appropriate (e.g., words, numbers, graphic representation, symbols).		
8.	… are persuasive through the effective integration of narrative and mathematical forms.		
9.	… uses mathematics terminology and conventions accurately, effectively, and fluently.		

Running Comments		
Strengths		
Areas for Improvement		
Suggested Next Steps		
Peer Editor Signatures	1.	2.

Writing for a Purpose: Journal Writing

MATHEMATICS

Journal writing in mathematics is a tool that can positively affect attitudes toward the subject, skill development, and concept mastery. Furthermore, journals allow teachers to see into student reasoning, rather than simply testing output. So from these two perspectives, journal writing in mathematics offers students not only a growth opportunity but also the opportunity to receive better-focused teaching strategies. It should be seen both as a learning tool and as a coaching tool.

"When students learn to use language to find out what they think they become better writers and thinkers." (Joan Countryman, 1992)

Purpose

- Provide students with *a safe place* in which they are able to test ideas i.e. to be able to express ideas and be willing to be wrong.
- Provide a vehicle for feedback to students which supports, encourages and challenges rather than judges.
- To inform and focus instruction.

Payoff

Students will:

- become better thinkers and writers
- learn mathematical content and improve problem solving skills.
- overcome math anxiety.
- be given more timely help as teachers become better aware of individual difficulties. ["I realized (more than often) some students were having difficulties – which if it were not for journal writing, I would have overlooked. " (an anonymous Ontario teacher)]

Tips and Resources

- Always have a purpose in mind (something you are truly curious about in terms of student understanding) when assigning journal writing; if you don't, your interest in reading the entries will be low and the benefit to your students will be low.
- Recognize that journals only become vehicles for communication for students. Initial writings may be brief and meaningless to the teacher. [This disappears when writing in math becomes part of the culture of the school.]
- Always use very specific prompts that direct student writing – prompts such as, "What did you learn today?" invite the reply, "Nothing."
- Persistence is required when first introducing writing in the math class: "I am glad that the students are starting to show progress with their math journals." [A teacher from DDSB after 6 weeks of implementing journals.] Many, however, see much quicker progress.
- Do not give in to the temptation to minimize the time spent on modelling (i.e., Class Journals) and practice (i.e., Group Journals).
- To maintain journals as a safe place, consider evaluating the achievement chart category of Communication in writing exercises on paper apart from the journal notebook; use journals for formative assessment.
- Just as a journal is defined to be 'a record of happenings' so teachers should be prepared to read entries that are either a record of happenings in mathematics (learnings) or a record of happenings in the mathematics classroom (e.g., " … my group kept picking on Ritchie; I didn't learn anything").
- See Teacher Resource, Journal Writing – *Developmental Stages.*
- See Teacher Resource, Journal Writing – *Forms and Sample Stems.*

Further Support

- Consider scheduling journal writing for 5 minutes at either end of a class.

Writing for a Purpose: Journal Writing

MATHEMATICS

What teachers do	What students do
Before • Develop a journal writing prompt (see Teacher Resource, *Journal Writing – Forms and Sample Stems*). • Model the form of writing to be used if it has not been modelled before. (see Teacher Resource, *Journal Writing – Developmental Stages* and Teacher Resource, *Journal Writing – Forms and Sample Stems*).	• Learn the journal form and the response style.
During • Assign the journal entry in one of three formats: class, group or personal journal. (see Teacher Resource, *Journal Writing – Developmental Stages*).	• Students respond to the journal prompt: as a class to a class journal, as a group (3 or 4 students) in a group journal, or individually in a personal journal.
After • Respond to the journal entry. This **must** initially be done after each journal assignment until such time that the students are confident that the teacher is an interested reader; then journal entries may be responded to after two or three journal assignments: - respond as a comment; marking/grading will often stop students from responding freely. - start the response with a positive comment (on effort, honesty, style, use of terminology …. *something*). - comment on the central concept. - ask a question to help clarify or to further the student's thinking. - do not grade grammar and spelling; this is their opportunity to express themselves freely, on their terms, not the teacher's. - comment on grammar and spelling in a 'coaching' mode, and <u>only after</u> a 'safe place' has been established.	• Read/listen to the response and respond back to it if it included a return question.

Notes

Journal Writing – Developmental Stages

Journals in the mathematics class should be introduced in three stages : Class Journals, Group Journals, and Individual Journals. There are a variety of journal entry forms (see Teacher Resource, *Journal Writing – Forms and Sample Stems*) and students cannot be expected to understand either a journal form or how to respond to a journal prompt without some specific instruction rooted in modeling. Hence, *each form* of journal writing must be introduced through these three stages; the stages are *not* passed through only once.

The first stage is the **Class Journal.** This is where the teacher models both the writing form and the style in which students may respond.

- Tell the students the name of the form of writing e.g., list, personal writing, self-assessment, instructions etc.
- Give the class the journal prompt and ask for individual responses.
- Write their responses, *using their exact words*, on the board, overhead, chart paper, or whatever you've chosen as your journal medium.
- Do not write corrected grammar; it is important to honour the students' responses in order that their ideas be the focus of the exercise, not the syntax carrying them (see Tips and Resources).
- With *Class Journals*, the response is immediate and to the whole class; ideas are discussed, and ideas requiring refinement or correction are addressed through questioning rather than through telling – "pointing to the kitchen rather than feeding intravenously" is an analogy. The teacher's role is to facilitate reasoning and communication, not to evaluate it.

The second stage is the **Group Journal**. This stage affords semi-independent practice of both a writing form and a response style.

- Give the students a larger format notebook in which to write, illustrate and/or figure.
- Students gain confidence in their understanding of both the forms of writing and the acceptable response styles (previously modelled).
- Students get a chance to explain their own understanding as well as to compare and contrast with the understanding of others in an effort to synthesize a common response.
- *Group Journal* entries can be shared among groups or with the whole class. They can be responded to by the teacher, another group, or by the whole class.

The third stage is the **Personal Journal**. At this stage students write journal entries independently and the journal writing reaches its full potential. However (!), there must never be a race to get to this stage just because of that; not until the particular writing form and acceptable response style are well understood should the personal journal be used. After all, it is the thinking that must be free-flowing, unimpeded by a struggle with form or style, if journal writing in the mathematics classroom is to be of benefit to the student.

To reiterate, once the students have passed through the three developmental stages with a particular form of journal writing (e.g., problem design) then all three stages must again be passed through if a new form is introduced. This point cannot be overstated; using individual journal entries too soon takes up more teacher time in the end and frustrates both students and teachers.

"I'm glad that I didn't give up on math journals when I first started a year ago [without instruction]. When I started again [after instruction], I did far more modeling and as a class we did a lot more talking …"
Anonymous Ontario Teacher

Journal Writing – Forms and Sample Stems

Forms	Stems, Starts, Ideas
1. Personal Writing *reflecting on feelings, attitudes, successes, challenges*	- I think I'm good/weak in working with fractions because ... - When I'm asked a question in class I …
2. Summaries *answering the question, "What did you learn?"*	- Create a poster about today's lesson to advertise it. - Brainstorm everything you know about probability; linear relations ; polynomials …
3. Definitions *defining math terms in their own words to show understanding (may be used as part of a personal math dictionary)*	- Explain what is meant by the term 'polygon'. - What is a linear relationship? Give an example.
4. Translations *taking information from one source and having the students put it in their own words*	- Draw a diagram/picture to show what the word problem describes. - What did you learn from your graph in question #3?
5. Reports *after a series of lessons or a unit, bringing understanding together*	- We have looked at mean, median and mode ... Report on how they are the same/different. - Report on the survey that you took (topic, method, results and conclusions).
6. Instructions *writing a series of steps in a procedure*	- How do you find the centroid of a triangle using Geometer's Sketchpad? - How do you use your calculator for linear regression?
7. Lists *making a list (this is the easiest form of writing for students with communication difficulties; it requires no particular syntax)*	- List all the things you still need to do to complete your math project. - List different forms of a linear relation. - Make a list of all the things that can be changed after you press the MATH key on the graphing calculator.

Journal Writing – Forms and Sample Stems (continued)

Forms	Stems, Starts, Ideas
8. Self-assessments *giving feedback or comments about math work, learning experiences*	- The hardest problem was ... - I think I could do better if ...
9. Descriptions *describing procedures, conversations, group work …*	- Our group had trouble agreeing on ... - The two different solutions that we got were ...
10. Arguments/Justifications *persuading others of a point of view, refuting other points of view, justifying a choice …*	- The most efficient way to solve this problem is ... - I assumed a value of ___ for the width because ...
11. Explanations *reasoning, findings, terms, attempts, strategies, answers, procedures, patterns, suggestions*	- A calculator was not necessary to solve this problem because … - If we had to double the volume we would change ... - There was more than one possible solution because …
12. Applications *where this math/lesson could be used*	- How would a person in the field of medicine use mathematics? - How could a surveyor use the Pythagorean theorem? - Could a graph of a linear relation be used at a car rental business? Explain.
13. Problem Design *student creates a problem that has to incorporate specific criteria*	- Create a problem around the given graph. - Create a problem that can be solved by using the equation $2x - 17 = 539$ - Create a problem that requires knowing that the alternate angles between parallel lines are equal.

Pair Work: Think/Pair/Share

MATHEMATICS

In this strategy, students individually consider an issue or problem and then discuss their ideas with a partner.

Purpose

Encourage students to think about a question, issue, or reading, and then refine their understanding through discussion with a partner.

Payoff

Students will:

- reflect on subject content.
- deepen understanding of an issue or topic through clarification and rehearsal with a partner.
- develop skills for small group discussion, such as listening actively, disagreeing respectfully, and rephrasing ideas for clarity.

Tips and Resources

- Use Think/Pair/Share in all math strands for any topic.
- Use it to help students read and understand a problem e.g., direct students to complete a KMWC (Know/Model/Words/Cross out) chart (see **Most/Least Important Idea(s) or Information**) then share their work with a partner.
- Once a problem has been understood, this strategy can be used to help in the problem solving process (see Student/Teacher Resource, *Think/Pair/Share – Sample Starters*).
- This strategy can be used for relatively simple questions and for ones that require more sophisticated thinking skills, such as hypothesizing. Use it at any point during a lesson, for very brief intervals or in a longer time frame.
- Use it to activate prior knowledge, understand a problem, or consolidate learning.
- Take time to ensure that all students understand the stages of the process and what is expected of them.
- Review the skills that student need to participate effectively in think/pair/share, such as good listening, turn-taking, respectful consideration of different points of view, asking for clarification, and rephrasing ideas.
- After students share in pairs, consider switching partners and continuing the exchange of ideas.
- See Student/Teacher Resource, *Think/Pair/Share – Possible Starters.*
- See other strategies, including **Take Five** and **Discussion Web** (Oral Communication strategies in *Think Literacy: Cross-Curricular Approaches, Grades 7-12*) for ways to build on this strategy.

Teaching Reading in Social Studies, Science, and Math, pp. 266-269.
Beyond Monet, pp.94, 105.

Further Support

- Some Students may benefit from a discussion with the teacher to articulate their ideas before moving on to share with a partner.

Pair Work: Think/Pair/Share

MATHEMATICS

What teachers do	What students do
Before • Choose a teachable moment during the class where the process of reflection and shared discussion would bring deeper understanding, and insert a brief Think/Pair/Share activity into the lesson at that point. • Consider the social and academic goals for the Think/Pair/Share activity, and plan for pairing of particular learners that would further those goals.	• Read the text, if the Think/Pair/Share is based on information and ideas from a reading selection.
During • Ask students to spend several minutes thinking about and writing down ideas. • Set clear expectations regarding the focus of the thinking and sharing to be done. • • Put students in pairs to share and clarify their ideas and understanding. • Monitor students' dialogue by circulating and listening.	• Formulate thoughts and ideas, writing them down as necessary to prepare for sharing with a partner. • Practise good active listening skills when working in pairs, using techniques such as paraphrasing what the other has said, asking for clarification, and orally clarifying their own ideas.
After • Call upon some pairs to share their learning and ideas with the whole class. • Possibly extend the Think/Pair/Share with a further partner trade, where students swap partners and exchange ideas again. • Consider adding a journal writing activity as a productive follow-up to a Think/Pair/Share activity.	• Pinpoint any information that is still unclear after the pair discussion, and ask the class and teacher for clarification.

Notes

Student/Teacher Resource

Think, Pair, Share – Sample Starters

Sample Starters for Individual Thinking before Pairing:

- Think of three things you know about ___ . (e.g., scientific notation).
- Take about 5 minutes to jot down things you remember about ___ . (e.g., triangles).
- Write a definition for ___ . (e.g., rhombus).
- What is the difference between ___ and ___ ? (e.g., the instructions *solve* and *simplify*)
- What is the same and what is different between ___ and ___ ? (e.g. mean and median)
- Think about different ways that you can ___ . (e.g. model the addition of -7 and +5)
- You are going to look at a diagram on the overhead for a few moments. Then I will cover the diagram and ask you to individually write things that you remember about the diagram.
- Read the set of instructions and highlight any that you don't understand.
- Read the set of instructions and reword them so they would be easier for a Grade __ student to understand.
- Think about the activities we did in class over the last few days. Summarize the mathematics concepts that you learned and state the concepts that are still unclear to you.

Sample Think/Pair/Share Process for Problem Solving:

Step 1: Think 	Individually think about the following (3-5 minutes): • What information do you need to solve the problem? • What information do you already know? • What tools and strategies could you use? • What questions do you need to ask your group?
Step 2: Pair 	With a partner, jot down ideas to help you get started with the problem (2-3 minutes). You may use any of the tools provided in the classroom, including calculators to help with estimating.
Step 3: Share 	Take turns sharing ideas in a larger group (3-4 minutes).
Step 4:	Decide on the first strategy your group would like to apply to solve the problem. Record other possible strategies. You may want to revise your plan as you work through the problem.
Step 5:	The person with ______________________________ shares your favoured strategy with the whole class.

…adapted from TIPS: Section 4 – TIPS for Teachers, page 8

Pair Work: Timed Retell

MATHEMATICS

In this strategy, students practise their listening and speaking skills. Students divide into pairs and take turns speaking, listening, and retelling information in timed steps.

Purpose

- Enhance critical thinking skills.
- Create an argument and be concise in its delivery.
- Develop attentive listening skills while sharing viewpoints on an issue.
- Make connections between written and oral skills.

Payoff

Students will:

- share ideas.
- develop listening skills.
- apply skills in different ways – in pairs, small groups, and with the whole class.

Tips and Resources

- Timed Retell can be informal or more formal, as described here. In the more formal approach, students require more confidence.
- Consider allowing students to make notes during the brief presentations given by their partners.
- It is possible to use this activity with more extensive subject matter. In that case students will need time to properly research the topic and devise their arguments.
- Additional Information is found in the **Peer Editing** strategy.
- Take time to ensure that all students understand the stages of the process and what is expected of them.
- Review the skills that student need to participate effectively in this strategy, such as good listening, turn-taking, respectful consideration of different points of view, asking for clarification, and rephrasing ideas.
- After students share in pairs, consider switching partners and continuing the exchange of ideas.
- A short form of this strategy is "A answer B". In this variation students have pre-assigned partners and each student is either a Partner A or a Partner B. Pose a question that requires a fairly short response then direct Partner A to give an answer to Partner B. After an appropriate length of time ask a Partner B student to volunteer to retell his partner's response to the question. When a question is posed in this way, all students are engaged as either listeners or tellers. Another advantage is that students who normally don't respond individually in front of the whole class will more confidently volunteer to share a response that is not entirely their own.

Further Support

- Some students may benefit from a discussion with the teacher to articulate their ideas before moving on to share with a partner.
- ESL students may benefit from pairing with a partner who speaks the same first language so that they can clarify the concepts in their first language and build more confidently on their prior knowledge.
- As always, consider pairs carefully.

Pair Work: Timed Retell

MATHEMATICS

What teachers do	What students do
Before • Choose a relevant question or topic that might invite debate e.g., "Is it true that all squares are rectangles?" or "Is it true that if the length of each side of a rectangle is doubled then the area of the rectangle is doubled?" or "How is mathematics used in hospitals?" • Make sure the students have the appropriate background knowledge about the topic. • Review active listening skills.	• Individually jot down ideas about the topic.
During • Put students in pairs facing each other. • Direct all partner A students to tell what they know about the topic for 30 seconds. • Direct partner B to retell the talk for about 30 seconds then to respond (e.g., add additional information). • Direct partner A to retell what partner B said.	• Decide who will be partner A and who will be partner B. • Partner A speaks for 30 seconds and tells partner B all they know on the topic while partner B actively listens. • Partner B retells partner A's talk then responds to what partner A said and mentions anything of importance that partner A did not mention on the topic. • Partner A retells what partner B just said.
After • Invite students to write a summary of the discussion. • Share summaries in small groups of four. • Organize the class into a circle to share all ideas and concepts.	• Write a carefully constructed summary of your discussion. • Read the paragraph to the partner to ensure that no important details have been omitted. • Share both summaries with two other students. • Share ideas in a full class circle setting.

Notes

Small Group Discussions: Placemat

MATHEMATICS

In this easy-to-use strategy, students are divided into small groups, gathered around a piece of chart paper. First, students individually think about a question and write down their ideas on their own section of the chart paper. Then students share ideas to discover common elements, which can be written in the centre of the chart paper.

Purpose

- Give all students an opportunity to share ideas and learn from each other in a cooperative small-group discussion.

Payoff

Students will:

- have an opportunity to reflect and participate.
- have fun interacting with others and extending their learning while accomplishing the task.

Tips and Resources

- The strategy can be used with a wide variety of questions and prompts.
- Use the placemat strategy for a wide range of learning goals, for example:
  - to encourage students to share ideas and come to a consensus about a concept/topic
  - to activate the sharing of prior knowledge among students
  - to help students share problem-solving techniques
  - to facilitate peer review and coaching on a particular type of problem or skill
  - to take group notes during a video or oral presentation.
- Groups of 2 to 4 are ideal for placemat, but it can also work with up to 7 students in a group.
- You may choose several questions or issues for simultaneous consideration in a placemat strategy. To start, each group receives a different question or issue to work on. Once they have completed their discussion, the groups rotate through the various questions or issues until all have been explored.
- Placemat also works well as an icebreaker when students are just getting to know each other.
- See Teacher Resource, *Placemat - Template and Sample*.

Beyond Monet, pp.172-173
TIPS: Section 4 – TIPS for Teachers
http://www.curriculum.org/occ/tips/index.shtml

Further Support

- Give careful consideration to the composition of the small groups, and vary the membership according to the students' styles of learning and interaction, subject-matter proficiency, and other characteristics.
- Some students may benefit from being able to "pass" during group sharing.

Small Group Discussions: Placemat

MATHEMATICS

What teachers do	What students do
Before • Divide students into small groups of 4 or 5. • Decide on a question (or concept or problem) for the centre of the placemat. • Distribute chart paper to each group. • Ask the students to divide the chart paper into sections equal to the number of students in the group, leaving a circle/oval/rectangle in the centre of the chart for the later recording of the group consensus.	
During • Direct each group member to think about, then silently write ideas/information that relate to the question in their personal area of the chart paper. Give students a pre-determined amount of time.	• Gather their thoughts about the chosen question and write silently in their own area of the paper, respecting the space and silence of all members of the group.
After • Give a signal for students in each group to discuss their ideas and information and to agree upon a response to be shared with the entire class. • Call on one member from each placemat group to share their group's response with the whole class. • Assess *for* understanding by listening to student responses. • Use information gained throughout the activity to inform instructional decisions. • Have students post the charts to further share their group's thinking with the class.	• Take turns sharing ideas with the group. • Engage in discussion with all group members to reach consensus on a group response. • Use communication skills, such as active listening and requesting clarification. • Record the group response in the center of the placemat. • Actively listen as each group's placemat is presented. • Post the chart for further sharing with the class.

Adapted from: TIPS: Section 4 – TIPS for Teachers
http://www.curriculum.org/occ/tips/index.shtml

Notes

Placemat – Template and Sample

Template:

Write quietly on your own in your section of the border for several minutes.

Through group sharing, summarize the key ideas and information for the question or concept.

Sample:

Take a few minutes to think about and then individually write down what you know about **scatter plots** (reviewing/summarizing concepts).

Points on a graph
Label axes, write title
Line of best fit
Extend line
Curve of best fit

Ordered pairs on a graph
Shows trends
Interpolate
Extrapolate

Scatter Plots

Graphical model used to determine if a relationship exists between two variables. It is also used to make predictions based on the given data.

Points
2 variables
Used to show data
Can make predictions
Compares 2 sets of data

Graph points
Put line of best fit through points
Make predictions
Strong or weak correlation
Positive or negative correlation

Whole Class Discussions: Four Corners

MATHEMATICS

In this strategy, students individually consider an issue and move to an area in the room where they join others who share their ideas. The beauty of this strategy is that it is flexible and can be used for many topics, questions, and subject areas.

Purpose

- Allow students to make personal decisions on various issues; encourage critical thinking.
- Encourage an exchange of ideas in small groups.
- Facilitate whole-class discussion of these ideas.

Payoff

Students will:

- make up their own minds on an issue.
- speak freely in a relaxed environment.
- think creatively and critically.

Tips and Resources

- Encourage students to make up their own mind concerning the issue.
- Consider using more than four areas for response – even six responses can work well with various questions.
- Vary the approach by creating a value line. Ask students to rank themselves by lining up in a single line of a continuum, from strongly agree to strongly disagree. This will make student exchanges a necessity so that students can discover exactly where they fit on the line.
- This strategy would work well as a forum in which students could share a product they have created. In this case students would take their work to one of the corners to share, compare and discuss with other students. This is a very helpful option for students prior to handing work in to the teacher.
- **Opposite Sides** Variation:
  - This is used when there are only two responses. Divide the room in two and ask students to take one side, depending on their decision.
  - If the class is large, use smaller groups to allow all students a chance to speak. Arguments could be written on chart paper. After a specified time, the groups would share their arguments with the whole class.
- See Teacher Resource, *Opposite Sides - Examples*.
- See Teacher Resource, *Four Corners – Examples.*

Further Support

- The teacher may need to encourage some students and promote equal opportunity responses in groups.

Whole Class Discussions: Four Corners

MATHEMATICS

What teachers do	What students do
Before • Create a statement or question for students to ponder that has the potential for varying degrees of agreement or preference. • Organize the room into four areas (corners) and label with: strongly agree, agree, disagree or strongly disagree or with four descriptors/categories. • Give students ample opportunity to think about the question and take a stance. Students need to be encouraged to make their own choices. • A minute or two should be ample time; ensure that this time is spent quietly so that students make their own choices.	• Fully understand the question posed. • Carefully ponder the question, making a personal decision as to the position they will take.
During • Ask students to move to the corner that best represents their stance on the issue. • Direct students to get into groups of three (if possible) to discuss the reasons for their choices. In cases where the groups are not large enough, pairs may be formed. In cases where only one student is in a group, the teacher could act as the other member of the pair.	• Move to the corner that best describes their personal views on the issue. • Engage in an exchange of ideas with other members of their group, remaining open and communicative. • Ensure that everyone is heard and that everyone in the group shares equally. • Prepare to speak to the class about the group's discussion, noting common reasons and differing opinions.
After • Call upon various groups to share information gathered in small-group discussions with the whole class.	• Highlight their group's main points with the class, pointing out commonalities and discrepancies. • Ensure that each member of the group has something to share with the class.

Notes

Teacher Resource

Four Corners - Examples

Example 1:

1 Strongly agree		2 Agree
	Journal writing in mathematics can help you become a better thinker.	
Disagree 3		Strongly disagree 4

Example 2:

State a relationship that can be modeled in at least three of the different ways listed. Ask students to choose which model they would use and to be prepared to justify why their chosen model is the best choice. Consider directing students to create the model in which case technology or appropriate manipulatives should be placed in corner 4. Other models (e.g. algebraic) may be used instead of those listed below.

1 Pictorial Model		2 Graphical Model
	The sum of the co-interior angles formed by a transversal of parallel lines is 180^{o}.	
Numerical Model 3		Dynamic Model 4

Whole Class Discussions: Four Corners Variation - Opposite Sides

MATHEMATICS

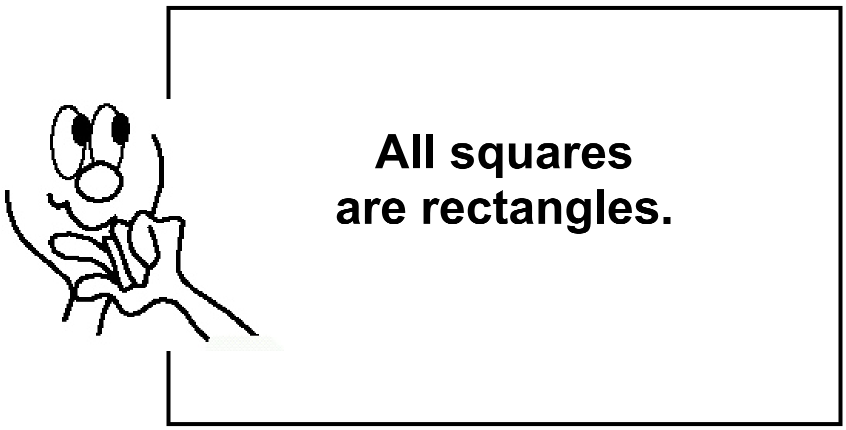
What teachers do	What students do
Before • Create a true/false statement or question for students to ponder. Choose a statement that requires critical thinking. • Assign one side of the room as the "Agree" side, and the opposite side of the room as the "Disagree" side. • Give students a minute or two of quiet time to individually think about the question and take a stance. • A minute or two should be ample time; ensure that this time is spent quietly so that students make their own choices.	• Carefully ponder the statement, making a personal decision as to the position they will take. • Respect other students' quiet thinking time.
During • Ask students to move to the side of the room that represents their stance on the question. • Have some students to justify their choice of sides to the whole class. • Allow students to change sides after another student's explanation. However, when a student chooses to change sides, ask the student to give reasons for the change. • Be prepared to contribute to the "debate" by asking "what if .." questions.	• Move to the side of the room that describes their stance on the statement. • Actively listen to students' justifications. • Be prepared to justify your own choice. • If sufficiently swayed by a justification from the other side, be prepared to justify your move to that side of the room.
After • Debrief the activity by leading a discussion to summarize the justifications and clarify concepts in order to dispel misconceptions.	• Participate in summarizing the justifications.

Notes

Teacher Resource

Whole Class Discussions: Opposite Sides

“Agree” Side



“Disagree” Side

	Sample Statements	Grade		
		7	8	9
1.	All squares are rectangles.	√	√	√
2.	Data can be displayed in any kind of graph you choose.	√	√	√
3.	The product of two numbers is always greater than either of the two numbers.	√	√	√
4.	All structures built with 27 interlocking cubes will have the same volume and the same surface area.	√	√	√
5.	When two different fractions each have a numerator that is one less than the denominator, then the fraction with the larger denominator is bigger.	√	√	
6.	1 is the same as 100%.	√	√	
7.	Two negatives make a positive.		√	√
8.	The largest area that can be enclosed by a rope of any length is a square.	√	√	√
9.	The distance around a can of 3 tennis balls is less than the height of the can.		√	√
10.	The only way you can tell if a relationship is linear is to graph it.			√

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