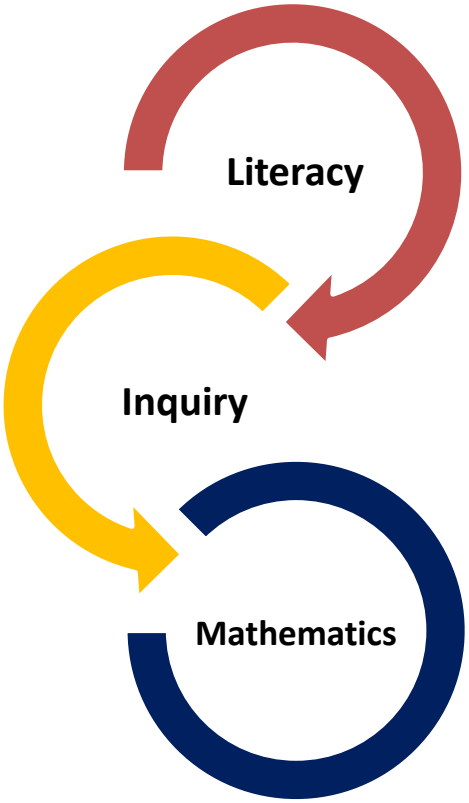
The Vancouver Island Numeracy Network

Presents

The Mathematics Inquiry Template

(2013)



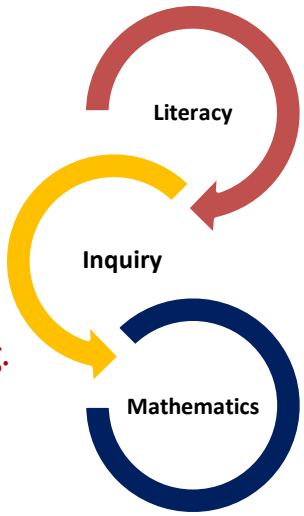
Mathematics Inquiry Template (MIT)

Developed by the Vancouver Island Numeracy Network (2013)

About the MIT

The MIT is a tool to guide math thinking and instruction, with a focus on mathematical inquiry.

MIT weaves together elements of inquiry, literacy and mathematical reasoning.



MIT can be applied to any word problem, any strand and can be adapted for any grade.

MIT is intended to make student thinking explicit which results in deeper understanding and communication of reasoning.

MIT allows all students at differentiated skill levels to address inquiry problems with their own personal strategies and representations, allowing for co-construction of meaning and differentiation.

MIT incorporates math concepts, inquiry, language skills, assessment and a gradual release of responsibility to the students.

Math discussions, in partners, small groups and whole class can easily be facilitated with the MIT, so that learning is supported through collaboration.

This MIT package contains the following resources:

- The Mathematics Inquiry Template
- Information Booklet on the foundations of the MIT
- A sample Inquiry Problem Bank
- Student Friendly rubrics

MATH INQUIRY

Task Title: _____ Date: _____ Name: _____

MATH THINKING

♦ Connections ♦ Visualizations ♦ Determining Importance ♦ Asking Questions

Important Math Information:	What I need to find out:	Smart Estimation:	Math ideas I will use:

Explore and Solve:

Solving Strategies Used:

- ❑ Make a model or diagram
- ❑ Make a list or table
- ❑ Look for a pattern
- ❑ Guess and check
- ❑ Use easier numbers

Other: _____

COMMUNICATION

What strategies did my partner use?	How were our strategies the same and different?	Was my estimate close? Why? / Why not?	What would I do differently next time?

New Mathematics Learned:

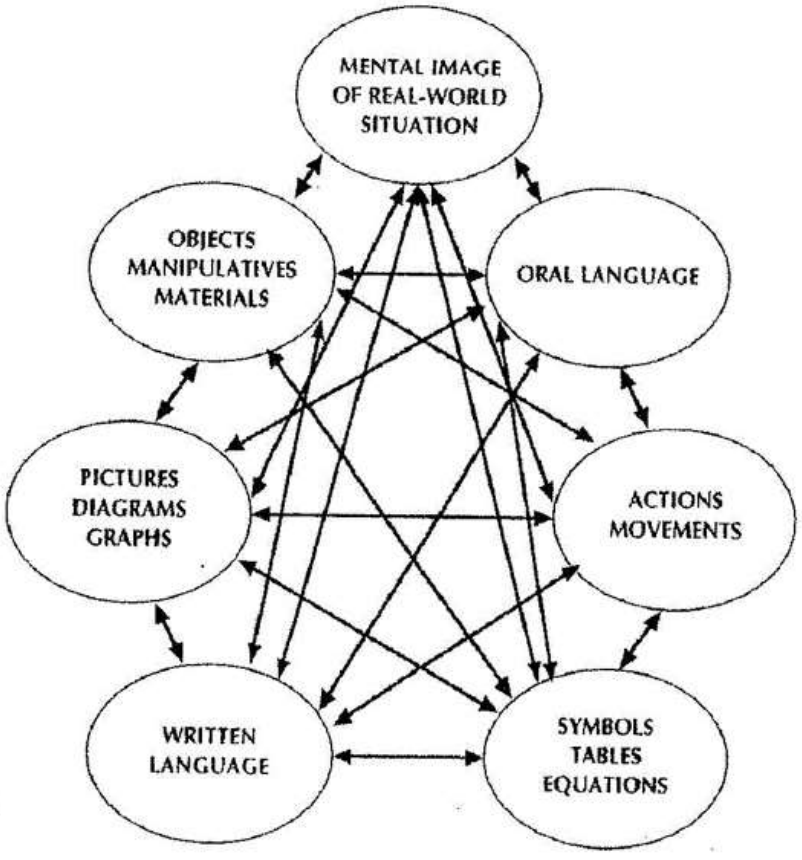
Inferences ♦ Synthesize

Socio-Constructivist Model

The dominant concept in today's learning is socio-constructivist where learning is shaped and actively constructed through social negotiation with others. Learning should be collaborative and self-regulated learning should be fostered.

This is supported by research (Hyde, 2006, p.86) that states that we construct meaning through:

- through math discussions
- by using manipulatives
- by acting it out
- by drawing a picture or graph
- by making a list / table



Implementation of the Mathematical Inquiry

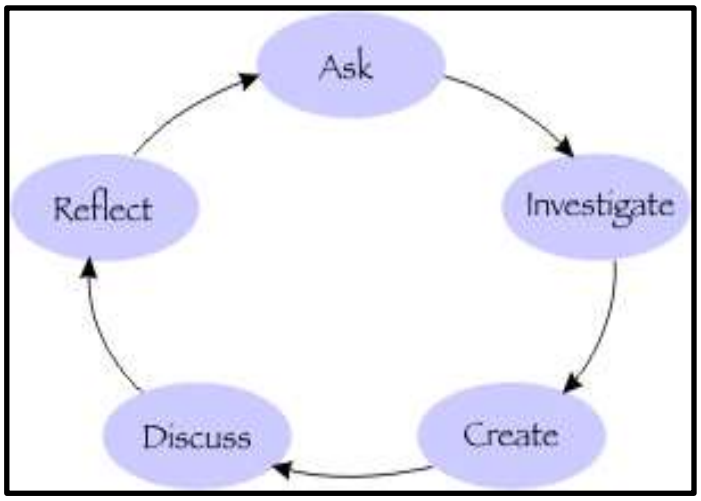
Math is often forgoteen in regard to the inquiry process. However, the MIT allows the inquiry process to reveal and develop deep understandings about math concepts, just inquiry does in language, science or other subject.

"Inquiry provides a planning structure to help students develop thinking strategies that lead to deeper understandings about concepts…Embedded within an inquiry are several thinking skills." (Brownlie, Fullerton & Schnellert, 2011, p.66)

Literacy Connections to the MIT

In mathematics, as in literacy, an understanding of the inquiry cycle and process is important to help lead students through solving mathematics problems:

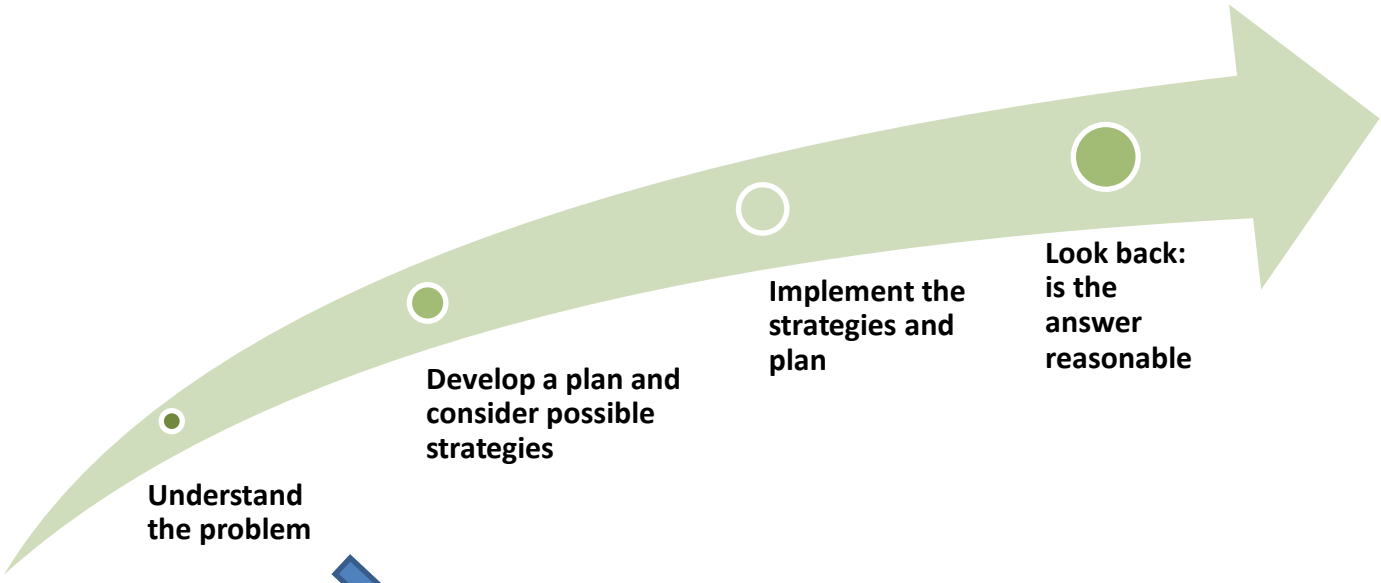
The Inquiry Process

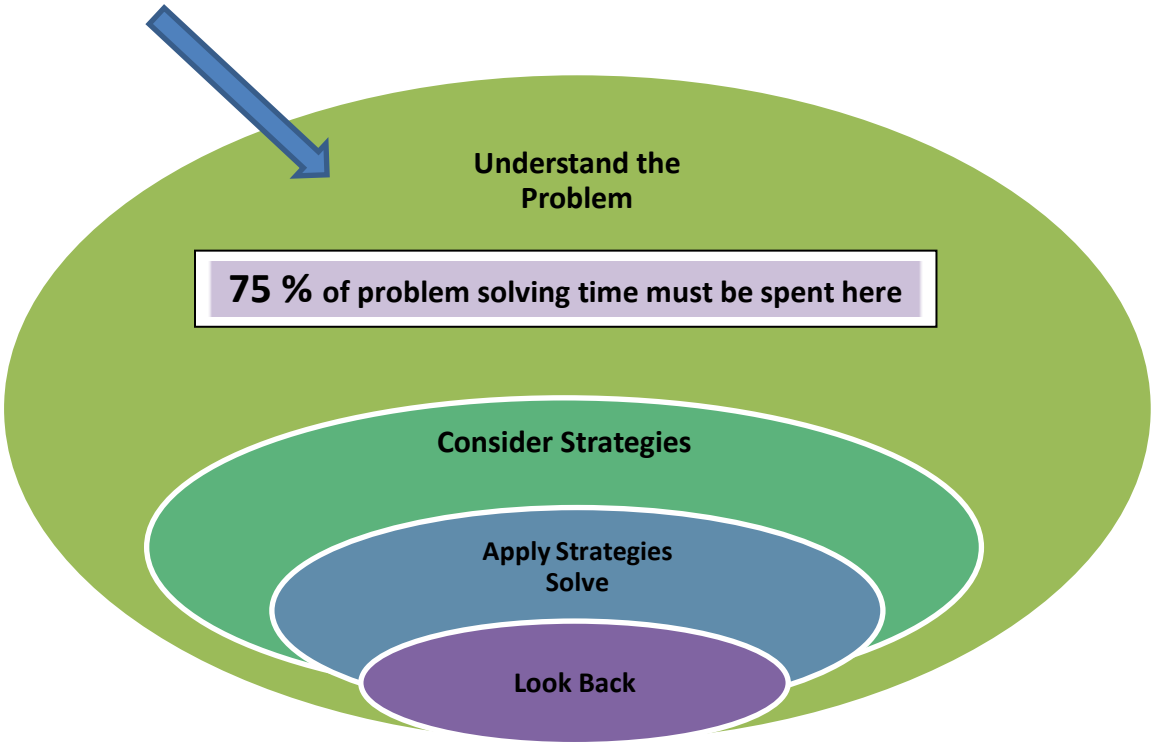


The KWHL Chart guides students through inquiry

K (What do I know?)	W (What do I want to know?)	H (How will I find out?)	L (What have I learnt?)

Polya's Four Phases of Problem Solving:



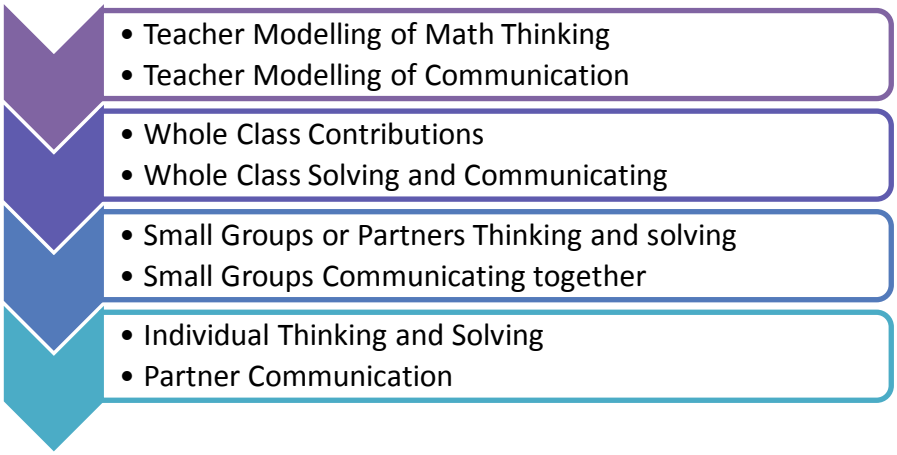


The most difficult part of solving a math problem is understanding what the problem is asking. Students need to read the entire question before beginning to solve. They need to figure out which math information is given and what is missing. At that point they can progress to considering the strategies needed to find the solution.

The importance of understanding a problem must be valued and nurtured in mathematics students.

Model of Gradual Release

In order to scaffold learning, the gradual release of student responsibility must be used where the MIT is modelled in a whole-class setting to facilitate effective math vocabulary and exchanges.
Eventually, students may be able to complete the Math Thinking Section independently before discussing their reasoning and proof in the Communication section of the template.



MIT Word Problem Bank

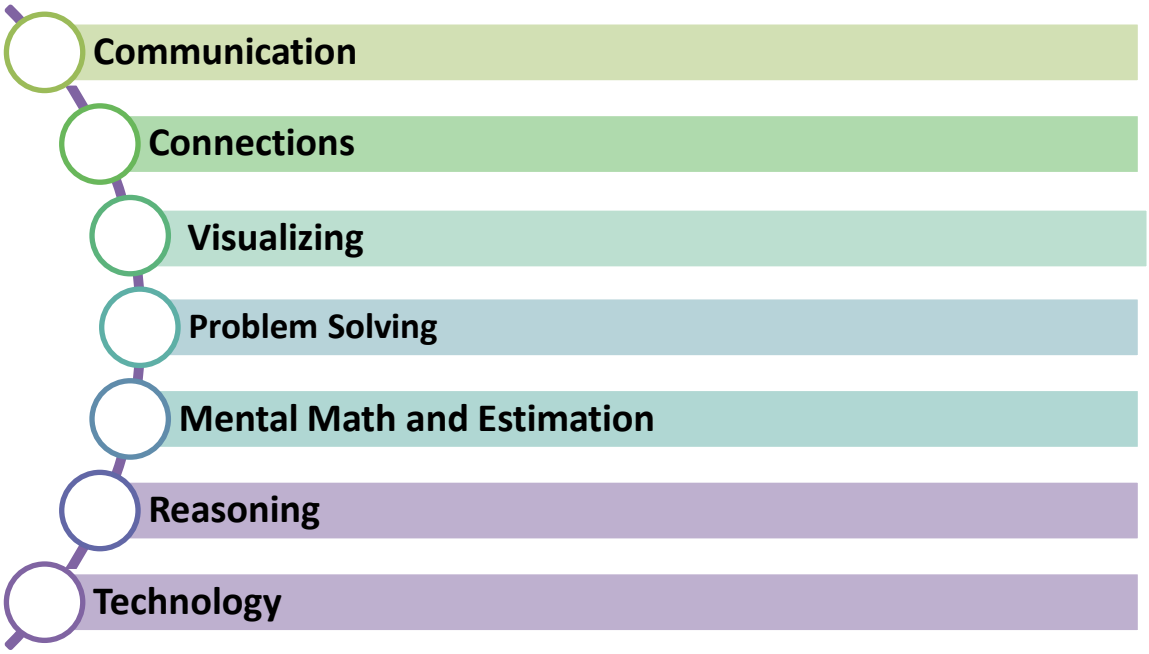
Math problems have been selected and included as introductory problems that work well with the MIT. These problems have familiar and engaging contexts that encourage critical thinking. They are ordered in level of difficulty from primary to late middle school math problems.

Please note that by simply changing numbers, or a component of the problem can change the target age level.

"Deep learning comes from dealing with the challenge of problematic situations in a safe learning environment…and 'hard fun'." (Brownlie, Fullerton & Schnellert, 2011, p.5).

Assessment

The MIT is based within the 7 processes of the BC curriculum.



Introduction to Mathematics K to 7

Mathematical Processes

There are critical components that students must encounter in a mathematics program in order to achieve the goals of mathematics education and encourage lifelong learning in mathematics.

Students are expected to

- communicate in order to learn and express their understanding
- connect mathematical ideas to other concepts in mathematics, to everyday experiences and to other disciplines
- demonstrate fluency with mental mathematics and estimation
- develop and apply new mathematical knowledge through problem solving
- develop mathematical reasoning
- select and use technologies as tools for learning and solving problems
- develop visualization skills to assist in processing information, making connections, and solving problems

The following seven mathematical processes should be integrated within Mathematics K to 7.

Student-Friendly Rubrics

The following student- friendly rubrics can be used in conjunction with the MIT, depending on your area of focus, or learning intention(s).

The first rubric focuses on the thinking strategies and the second rubric is based on the BC Ministry rubric.

Remember to target specific criteria, co- create the criteria with students, before using the rubric, so that students are not surprised by expectations, enabling them to play an active role in self-assessment and goal setting.

Name_____

Numeracy Rubric	 … a start	 … getting there	 … that's it	 … Wow!
				
Concepts and Connections	• I am building my prior knowledge and I'm starting to understand some of the concepts . • I need a little help to apply the concepts.	• Using my prior knowledge, I recognize some of the concepts to use. • I apply some of the concepts needed.	• Using my prior knowledge, I recognize what concepts to use. • I apply the concepts needed.	• Using my prior knowledge, I recognize many concepts to use. • I apply a variety of concepts.
Problem-Solving Strategies and Thinking	• I try to use before and after estimation strategies and can't always predict and verify. • With a little help I know what strategy to use and can persevere.	• I am beginning to use before and after estimation strategies to predict and verify. • With familiar tasks, I know which strategies to use and can persevere. • I'm beginning to show some flexibility in thinking in order to find strategies.	• I use before and after estimation strategies to predict and verify. • I know which strategies to use. • I persevere and show some flexibility in thinking until I find a strategy that works.	• I use before and after estimation strategies effectively to predict and verify. • I know which strategies to use and can also invent new strategies. • I persevere and think flexibly until I find a strategy that works.
Procedures	• I am just starting to understand some of the math procedures. • I'm not sure if my answers make sense. • I get a few answers correct. • I takes a long time and sometimes I finish.	• I understand some of the math procedures. • I'm not sure if my answers make sense. • Some of my answers are accurate. • I start over and it takes a little longer.	• I understand the math procedures. • My answers make sense. • My answers are mostly accurate. • I work fairly quickly and efficiently.	• I am confident using math procedures. • My answers make sense. • My answers are consistently accurate. • I work quickly and efficiently.
Representation and Communication	• I can explain parts of my thinking using manipulatives or pictures. • I am beginning to use math language.	• I can explain parts of my thinking in words, numbers or pictures. • I can explain parts of my answers and procedures using math language.	• I can clearly explain my thinking in words, numbers and pictures. • I can explain my answers and procedures using math language.	• I can precisely explain my thinking in words, numbers and pictures. • I can explain my answers and procedures precisely using math language.
Snapshot	• With a little help, I can apply some of the concepts. • With a little help, I use a few strategies and start to use estimation to solve problems. • I get a few answers correct. • I can explain parts of my thinking using manipulatives or pictures.	• I apply some of the appropriate concepts. • I use a few strategies and am beginning to use estimation to solve problems. • Some of my answers are accurate. • I can explain parts of my thinking in words, numbers and pictures.	• I apply the appropriate concepts. • I use strategies and estimation to solve problems. • My answers are mostly accurate. • I can explain my thinking in words, numbers and pictures.	• I apply a variety of appropriate concepts. • I use strategies and estimation to solve problems creatively. • My answers are consistently accurate. • I can precisely explain my thinking in words, numbers and pictures.

Sue Bannister and Cheryl Adebar SD71

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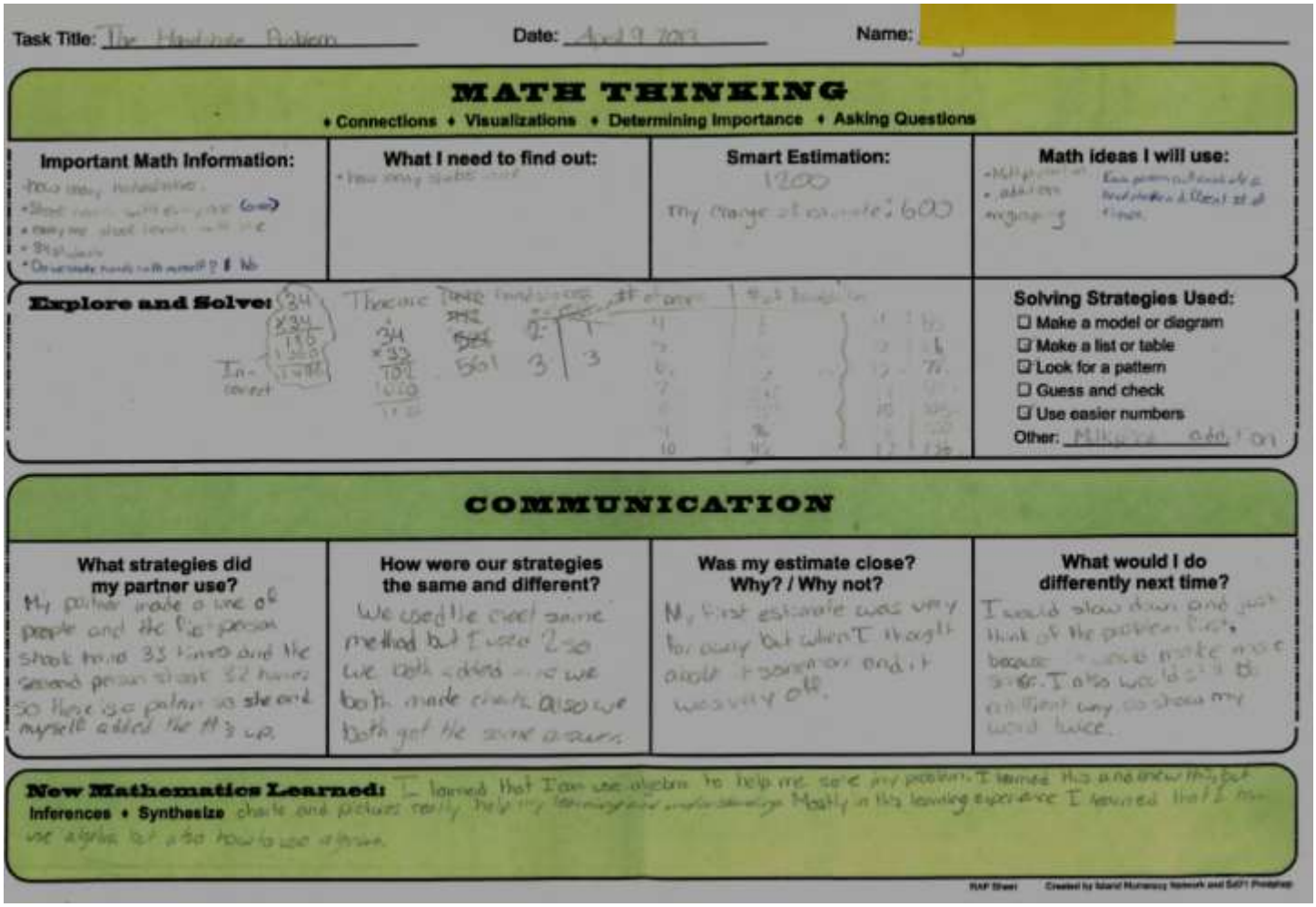
Math Thinking Strategies	 ***... experimenting***	 ***... a start***	 ***... coming along***	 ***... that's it***	 ***... WOW!***
Determining Importance	• may be able to identify some ideas • distracted by details	• identifies main idea and some accurate facts • differentiates details	• identifies most main ideas and accurate facts • includes some details	• identifies all important aspects of main ideas • includes relevant details	• identifies all main ideas and succinctly relates relevant details
Connecting	• makes simple M-S connections with support	• makes simple M-S, M-W and M-M connections	• makes simple M-S, M-W, M-M connections, linking new information to prior knowledge	• makes logical M-S, M-W, M-M connections, linking new information to prior knowledge	• makes M-S, M-W, M-M connections, linking new information to prior knowledge for deep understanding
Asking Questions	• unsure of question to ask to monitor comprehension • responds to some of the KWC questions with support	• asks a few questions to monitor comprehension • responds to some of the KWC questions	• monitors understanding with some questioning • responds to most KWC questions	• Uses relevant questions to monitor understanding • responds accurately to KWC questions	• Uses relevant questions to deepen understanding • responds thoroughly to KWC questions for deep understanding
Visualizing	• creates a mental image of context and reasoning, moving towards understanding • uses one or fewer representations	• creates a few mental images of context and reasoning, moving towards understanding • uses a couple of representations	• creates some mental images of context and reasoning for partial understanding • uses some representations to understand	• creates mental images of context and reasoning for accurate understanding • selects relevant representations to understand and communicate thinking	• creates connected images of context and reasoning for deep understanding • uses multiple representations to clearly communicate thinking
Inferring	• makes a simple inference about the context • accepts inferences when they may not be correct	• makes few relevant inferences about the context • accepts inferences when they may not be correct	• makes some relevant inferences about the context • sometimes detects when inferences may not be correct	• makes many relevant inferences about the context • detects when inferences may not be correct	• makes only relevant inferences about the context • detects when inferences may not be correct and revises them
Synthesizing	• reviews understood thinking • uses a couple of the thinking strategies	• demonstrates some new thinking • uses a couple of the thinking strategies	• demonstrates new, logical thinking • uses some of the thinking strategies	• demonstrates new understandings • uses most thinking strategies	• demonstrates new understandings and has applied this as a pattern • integrates all thinking strategies
Accuracy	• beginning to use thinking strategies with some major errors in thinking	• simple use of thinking strategies with some errors in thinking	• logical use of thinking strategies with occasional errors in thinking	• effectively uses thinking strategies, with few errors	• effective integration of thinking strategies with very few errors

Student Work Sample



Task Title: The Handshake Problem Date: April 9 2013 Name: [redacted]

MATH THINKING

• Connections • Visualizations • Determining Importance • Asking Questions

Important Math Information:	What I need to find out:	Smart Estimation:	Math ideas I will use:
• How many handshakes. • Short cuts with easy way • easy way short cuts with me • 34 players • Do we shake hands with myself? & No	• how many shakes	1200 My range of estimate: 600	• Multiplication • addition ongoing

Explore and Solve:

Solving Strategies Used:

- ☐ Make a model or diagram
- ☑ Make a list or table
- ☑ Look for a pattern
- ☐ Guess and check
- ☑ Use easier numbers

Other: Multiple add 1 on

COMMUNICATION

What strategies did my partner use?	How were our strategies the same and different?	Was my estimate close? Why? / Why not?	What would I do differently next time?
My partner made a line of people and the 1st person shook hands 33 times and the second person shook 32 hands so there is a pattern so she and myself added the #'s up.	We used the exact same method but I used 2-3 we both added - we both made charts also we both got the same answer.	My first estimate was very far away but when I thought about it some more and it was very off.	I would slow down and just think of the problem first, because I also would try to be different way to show my work twice.

New Mathematics Learned: I learned that I can use algebra to help me solve my problem. I learned this and new things but mostly in this learning experience I learned that I can use algebra but also how to use algebra.

Inferences • Synthesize charts and pictures really help my learning and understanding

RAF Sheet Created by Island Numeracy Network and SAFI Project