

# OAME's GUM Project

# ***Growing Up Mathematically***

## Mathematics Learning from Kindergarten to Grade 12

For Primary, Junior, Intermediate, and Secondary Mathematics Educators

### Our Vision for Learning Mathematics

The Ontario Association for Mathematics Education envisions a learning environment where all students do, see, hear, and touch mathematics in a profound and meaningful way. Our association sees the classroom as a community where teachers and students work collaboratively to learn and value mathematics.


presented by
Kathy Kubota-Zarivnij, OAME President
Dan Charbonneau, OAME President-Elect



Growing Up Mathematically


**Growing Up Mathematically**

# Session Learning Goals

During this two hour session, we will:

- investigate the growth of algebraic thinking and reasoning from elementary to secondary grades
- experience one professional development session of OAME's *Growing Up Mathematically* (GUM) project, in context of a specific grade division task
- become familiar with the professional development components of OAME's GUM project

# Setting the Context:
## *OAME - Who Are We?*

- OAME (Ontario Association for Mathematics Education) is a professional, nonprofit association of mathematics educators committed to enhancing the teaching and learning of mathematics in Ontario.
- OAME has a Board of Directors that meets three times annually to discuss issues, to plan events and activities, and to coordinate the work of the larger organization.
- The executive is comprised of a President, a President-elect, a Past President, three Vice-Presidents, and two Executive Directors.
- There are 19 elected directors who serve for a term of three years, as well as an NCTM representative, journal editors, and a website coordinator.
- There are 15 local chapters spread geographically throughout the province.

# Setting the Context:

## *OAME - What Do We Do?*

OAME …

- organizes professional development - local chapter conferences (throughout year), provincial conference (May), Leadership conference (February)
- publishes quarterly a peer-reviewed journal “The Gazette”
- hosts a dynamic website (www.oame.on.ca) featuring current information, resources, and links to other resources (MOE, NCTM, etc.)
- organizes the annual Ontario Mathematics Olympics - grade 7 and 8 student teams (local and provincial)
- produces relevant, tested, and classroom ready resources for use by teachers and leaders of mathematics (most recent – GUM project)

# What Do You See/Hear?



What mathematics teaching and learning do you see/hear across the different grade levels in your school?

- Which aspects are similar? Why?
- Which aspects are different? Why?

What aspects of mathematics teaching and learning need improvement in your school?

How will you know that it improved?

*Leadership should be born out of the understanding of the needs of those who would be affected by it. - Marian Anderson (1897–1993)*

Free Write  Place Mat

# What is Important in Seeing Math Teaching and Learning as a K to 12 Continuum?"

## What are their assumptions?

- Elementary teachers often make assumptions about what they should be "preparing" students for in high school.
- Secondary teachers just as often make assumptions about what kinds of experiences students have had in elementary schools.

- Students must experience learning mathematics as being interconnected.
- Teachers can only make this happen if they understand the mathematics learning before and after their grade level.
- *Growing Up Mathematically* brings to life the continuum of learning mathematical processes through glimpses into real classrooms in video. You will see how technology, manipulatives, communication, reasoning and problem solving becomes more sophisticated as students grow up through the years. The classroom tasks incorporate the development of mathematical skills, knowledge, and processes.


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# Exploring K to 12 Algebraic Thinking

## *Sorting and Classifying Grade Specific Expectations*

How does the algebra curriculum change from elementary to secondary, in terms of:

- concepts and procedures
- models of representation
- relationship to other math strands

Share one idea from your analysis.

– identify, describe, and extend, through investigation, geometric repeating patterns involving one attribute (e.g., colour, size, shape, thickness, orientation);

– determine, through investigation, the inverse relationship between multiplication and division (e.g., since $4 \times 5 = 20$, then $20 \div 5 = 4$; since $35 \div 5 = 7$, then $7 \times 5 = 35$);

– model real-life relationships involving constant rates (e.g., speed, heart rate, billing rate), using algebraic equations with variables to represent the changing quantities in the relationship (e.g., the

– derive, through the investigation and examination of patterns, the exponent rules for multiplying and dividing monomials, and apply these rules in expressions involving one and two variables with positive exponents;


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# Exploring K to 12 Algebraic Thinking

## *Using Linking Cubes*

OAME LEADERSHIP CONFERENCE 2006

K-12 Mathematics Linking Cubes

A joint project between SPECTRUM EDUCATIONAL SUPPLIES LIMITED and OAME/AOEM

**Problem:**

How many different 5-cube trains can you make using up to 2 colours of interlocking cubes?

Place the 5-cube train on the left side of the balance scale.

**Materials:**

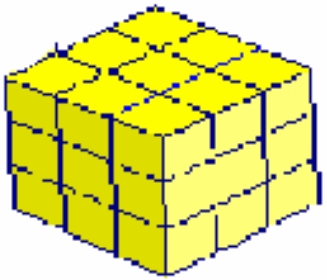
10 interlocking cubes in 2 colours for a total of 20 per pair

1 5-cube train in one colour per pair



**Problem**

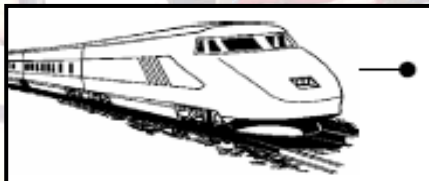
Lin wants to show that she can model this growing pattern in different ways. The pattern rule is add 2 and start at 1. She predicts that she will need about 30 interlocking cubes if she shows the pattern to the $10^{th}$ term. Investigate her hypothesis. Model your different solutions using interlocking cubes.



A 3 by 3 cube made up of small cubes is dipped into a bucket of red paint and removed. Once the paint dries the cube is taken apart into its 27 smaller cubes.

How many small cubes will have 3 faces painted?

How many small cubes will have 2 faces painted?



**K to 12 Mathematics – Using Interlocking Cubes**

**Building Trains with Long Cars and Short Cars**

**Introduction**

In this activity you will consider the types of trains that can be built using two different kinds of cars. These trains can be made from double cars or single cars, or a combination of each. Double cars are made of two single cars joined together. You can use linking cubes to model these trains. Remember that each train has a front and a back. When you build your cube train, place it in front of you and designate either the right or the left as the front of the train

Double cars can be modelled by 2 attached cubes. Choose one colour of cubes to make the long cars. Single cars can be represented by 1 cube. Choose a different colour for short cars.

Suppose double cars are represented by green cubes, and single cars are represented by red cubes.

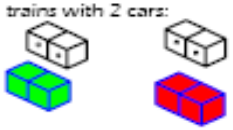
Double Cars

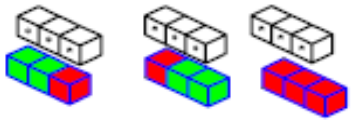


Single Cars



Here are the possible trains with 2 cars:





Here are the possible trains with 3 cars



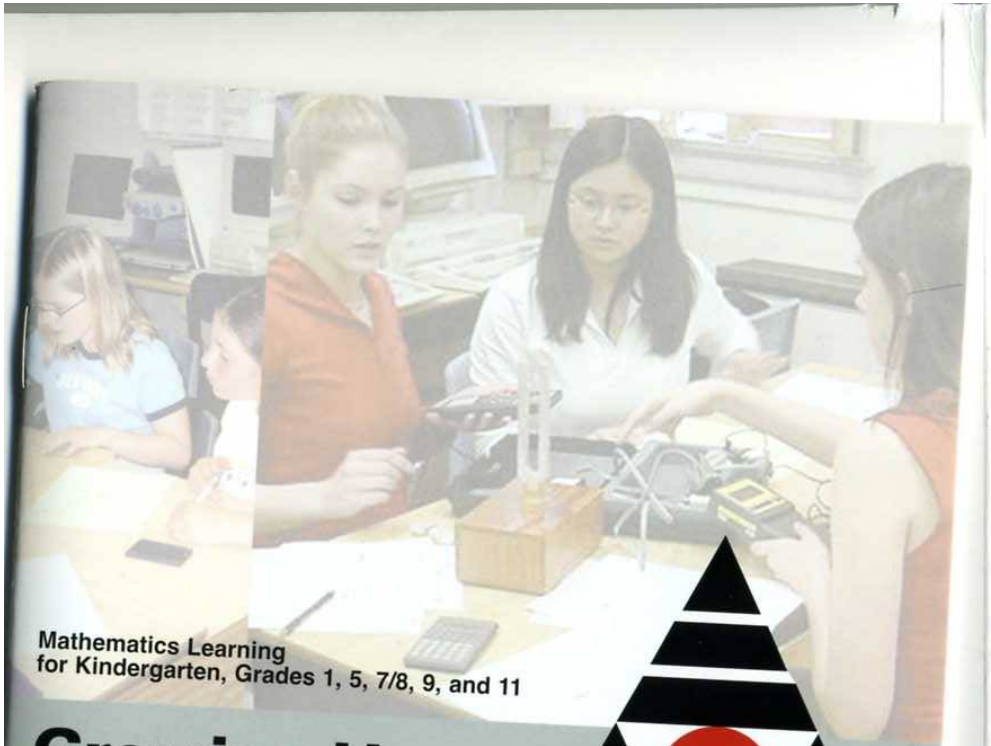
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# OAME Vision Statement *(Student Look-Fors)*

- In such a classroom, students engage in meaningful mathematical experiences through the use of concrete materials and manipulatives, visuals, technology, and other resources.
- Students build on their prior knowledge of key mathematical concepts and connect these concepts to their world. They understand the purpose of their learning through clearly defined expectations, goals, and assessment criteria. Students engage in inquiry, pose questions, and actively discuss their understandings with one another. Students demonstrate their understanding on a regular basis and strive to become independent and collaborative mathematics problem solvers.

# OAME Vision Statement *(Teacher Look-Fors)*

- Teachers use a variety of strategies that accommodate different learning styles and use resources to develop the investigative process in mathematics. They provide multiple opportunities for students to learn and apply mathematics in creative, purposeful ways while assisting and supporting students to help them achieve success in both independent and collaborative tasks.
- To facilitate student learning, teachers provide feedback to students throughout the learning process. Teachers engage in opportunities for professional growth and continuously reflect on their teaching practices and classroom experience.
- The learning of mathematics is supported through the active and ongoing involvement of students, parents, educators, and the community at large.



Mathematics Learning
for Kindergarten, Grades 1, 5, 7/8, 9, and 11

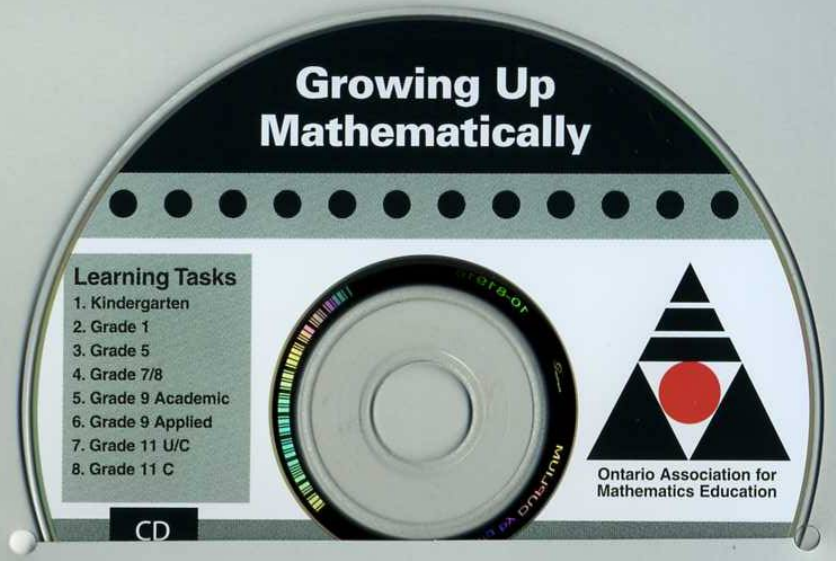
# Growing Up Mathematically

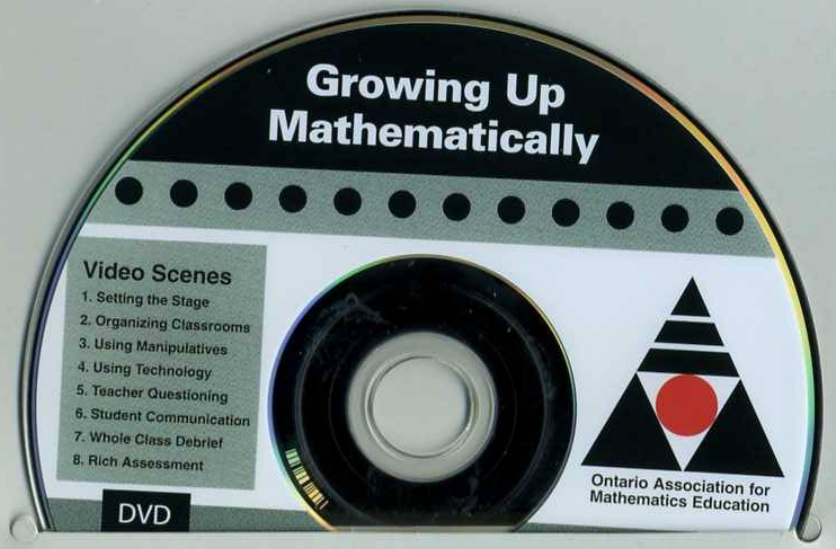
Ontario Association for Mathematics Education

## Our Vision for Learning Mathematics

The Ontario Association for Mat... ...visions a ...touch ...ees ...k

**Growing Up Mathematically can be ordered on-line at**





OAME - 70 Chestnut Court
London ON N6K 4J5
EDs@oame.on.ca or www.oame.on.ca

# What is “Growing Up Mathematically?”

- *Growing Up Mathematically* is based upon the simple idea of one student growing up through the years and what her/his experience in mathematics should be over those years.
- *Growing Up Mathematically* is a set of resources including a vision statement, a video, classroom experiences spanning the grades Kindergarten to Grade11, and supporting professional development materials.
- These resources can be used as stand-alone pieces or more powerfully as a set of connected components that depend and build upon each other.
- The classroom experiences and sample student work are intended to be used by teachers and their students as living examples of what mathematics looks like, sounds like, and feels like according to the vision articulated by OAME.

# GUM: Mathematics Learning Tasks

The resource contains classroom ready learning tasks for:

- Kindergarten – Eleven is Eleven
- Grade 1 - Ten Black Dots
- Grade 5 - Who Won?
- Grade 7/8 - Station-to-Station, Exploring Angle Sums in Polygons
- Grade 9 - Bungee Jump, Popcorn: Applied, Popcorn: Academic
- Grade 11U/C - The Hula Hoop Experiment: Going Around in Circles, Pendulum: Performance based Assessment
- Grade 11C - Decisions, Decisions, Decisions: Summative Assessment

# GUM: The Video

- The video focuses on the process components of mathematics and demonstrates the growing sophistication with which learners use materials, technology, vocabulary, and problem solving skills.
- It also provides examples of excellent classroom teaching skills including setting the context, questioning, grouping, and assessing of students.
- All segments in the video were filmed in five Ontario classrooms spanning the grades from Kindergarten to Grade 11.

# GUM: Professional Development

- It is hoped that the vision statement, the video, the classroom learning tasks and the assessment ideas will promote many rich conversations between teachers.
- The professional development component of this resource is intended to inspire and focus those conversations.
- It might be used by a principal, a coordinator, a consultant, a department head, or by a group of teachers interested in professional growth.



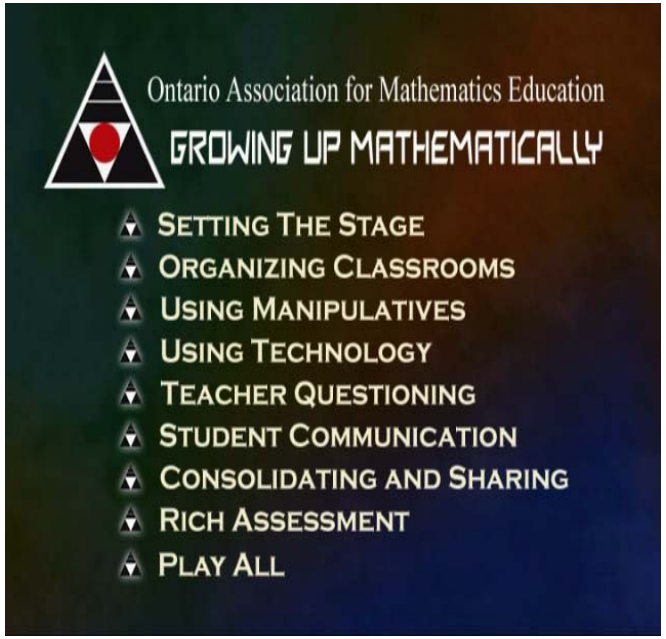
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# GUM: Professional Development

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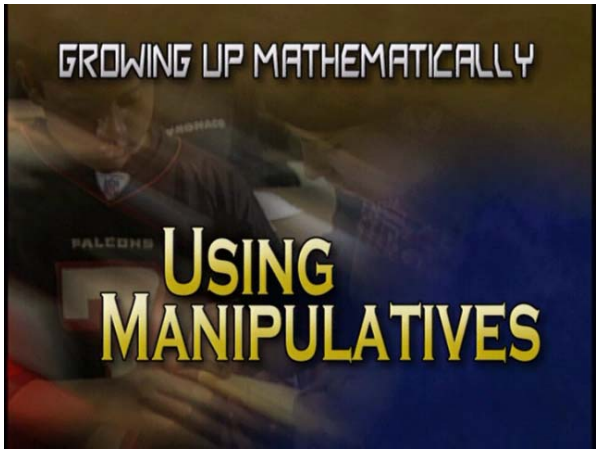
Session 1 - Engaging Students in Learning Mathematics
(Video Scenes – Setting the Stage, Organizing Classrooms)
Session 2 - Developing Mathematical Understanding
(Video Scenes – Using Manipulatives, Using Technology)
Session 3 - Developing Mathematical Communication
(Video Scenes – Teaching Questioning, Student Communication)
Session 4 - Consolidating and Sharing
(Video Scene – Whole Class Debrief)
Session 5 - Conversations About Student Work
(Video Scene - Rich Assessment)

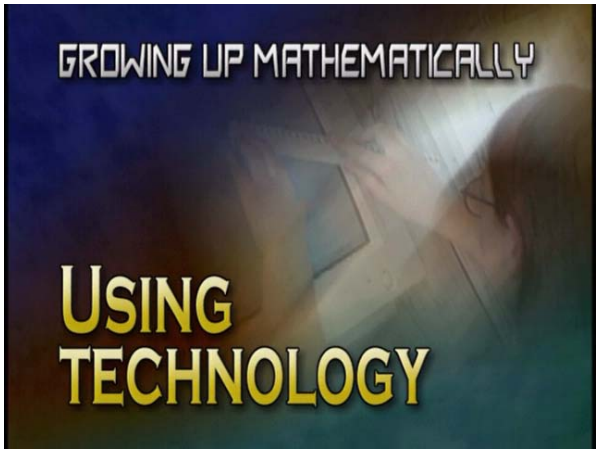




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# Session 2:
# Developing Mathematical Understanding





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# Let's Do the Mathematics Tasks

**Kindergarten** — **Eleven Is Eleven**

Five 10-minute lessons plus Centre time

**Task Description**

Kindergarten students will explore the number 11 and w… be represented in many different ways.

**Grade 5** — **Who Won?**

1 hour

**Task Description**

In this task, students will explore bias in data by developing strategies to collect, organize, and represent data (e.g., choosing intervals that reflect the … a biased way), and will analyze the effect of those strategies in game-… contexts.

**Grade 9 Applied**
**MFM1P** — **The Popcorn Box Problem**

180 minutes

**Task Description**

This task will address the expectations dealing with relations, measurement, and optimizing volume. Students will use a piece of paper of a given size to design a box with the greatest … this volume problem using con… spreadsheet. Students will the… relationship between length an… volume occurs.

**Grade 11U/C**
**(MCF3M/MCR3U)** — **Modelling Periodic Functions: The Pendulum Task**

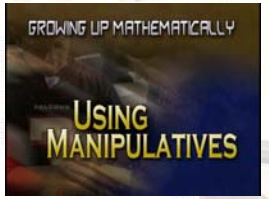
2.5 hours

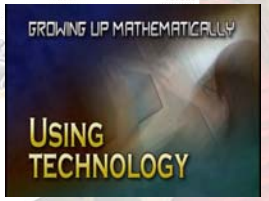
**Task Description**

In this summative task, students will develop a trigonometric model of the periodic motion of a pendulum. In Part 1, students will collaborate to identify the physical characteristics of the pendulum, as modelled by a sinusoidal function. In Part 2, each student will investigate and analyze the effect(s) of changing one of the characteristics of the pendulum. The students will then extend their results to an application involving a grandfather clock.


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# Session 2: Developing Mathematical Understanding



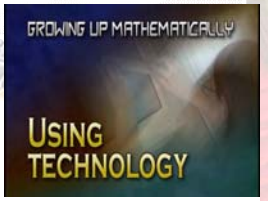




- As a student develops mathematical understanding, he or she begins to comprehend how a concept is connected to other ideas, why the concept is important, and when it is useful in different problem-solving contexts.
- If we think of students' understanding as a continuum, we see concepts, procedures, and/or experiences that are generally isolated at one end of the continuum and a rich set of interconnected mathematical concepts, procedures, and experiences at the other end.
- Mathematical learning tools, such as manipulatives and technology, help students construct these conceptual connections.


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# Session 2: Developing Mathematical Understanding



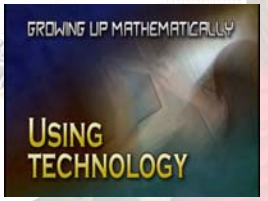




The teacher's role is to:

- understand and anticipate students' existing knowledge and ideas
- plan learning tasks that are developmentally appropriate and that involve suitable materials
- use different instructional approaches, ranging from direct instruction to inquiry-based learning, that are appropriate for the type of mathematics (i.e., concepts, procedures) the students are learning

# Session 2: Developing Mathematical Understanding

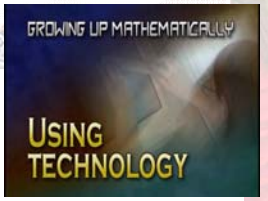



The vignettes in this session illustrate ways in which manipulatives and technology can be used to help students develop their mathematical understanding.

# Session 2: Developing Mathematical Understanding




## Activating Your Prior Knowledge

- Which manipulatives and what forms of technology are available for use at your school?
- Why do you think that manipulatives and technology are important tools in the learning of mathematics?

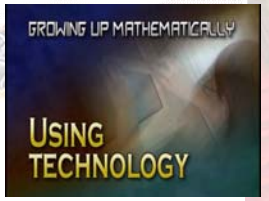
## While watching the video…

- What kinds of manipulatives and forms of technology are shown in the video?
- Why are the students using manipulatives and technology to learn mathematics?


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# Session 2: Developing Mathematical Understanding

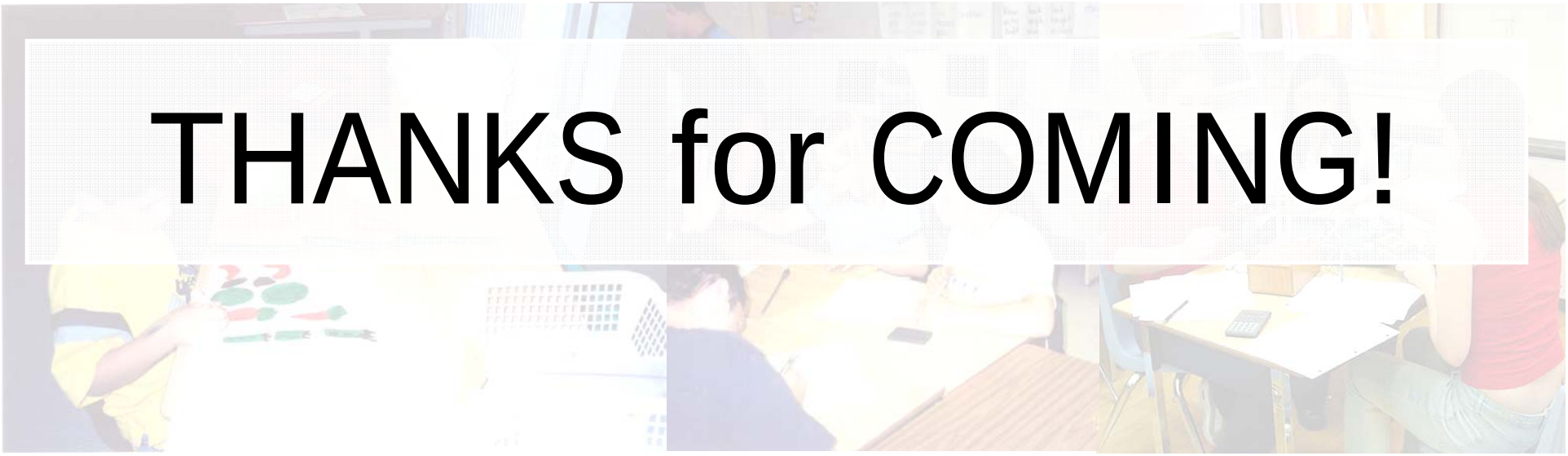



## Points for Discussion

- What other found materials (e.g., cereal boxes, pop-can tabs, toothpicks) might be used as manipulatives?
- Under what circumstances might manipulatives *not* help students develop mathematical understanding?
- What are some ways of sharing and storing manipulatives in the school?
- How can the Internet help us find additional ideas for the use of manipulatives and technology?


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# THANKS for COMING!

Copies of this resource package can be ordered from:


OAME

70 Chestnut Court

London ON  N6K 4J5

Phone/Fax: 519-471-6324

EDs@oame.on.ca or www.oame.on.ca