COMPARISON OF K-12 MATH IN THE U.S. & OTHER REGIONS WITH POTENTIAL IMPACT
Presenters

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- **Mytra Groeneveld**, Professor of Mathematics & Coordinator of Developmental Mathematics, Manchester Community College

- **Oiyin Pauline Chow**, M.S., Senior Professor of Mathematics (retired), Central Pennsylvania’s Community College, HACC

- **Shane Tang**, M.S., Associate Professor of Mathematics, Salt Lake Community College
Goals for our presentation

- Identify the uniqueness of math education systems, assessment, and culture in various locations

- Recognize how local cultures, beliefs and perceptions of parents and students can affect individual mindsets on learning mathematics.

- Develop overarching themes based on the comparative findings, and discuss potential impacts for mathematics teaching and learning in the first two years of college.

- Lead a discussion about mathematics teacher preparation for high school and college teachings.
Mathematics content and cognitive domains in Grade 8 based on TIMSS

<table>
<thead>
<tr>
<th>Content domains</th>
<th>% of assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>30</td>
</tr>
<tr>
<td>Algebra</td>
<td>30</td>
</tr>
<tr>
<td>Geometry</td>
<td>20</td>
</tr>
<tr>
<td>Data and chance</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cognitive domains</th>
<th>% of assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing</td>
<td>35</td>
</tr>
<tr>
<td>Applying</td>
<td>40</td>
</tr>
<tr>
<td>Reasoning</td>
<td>25</td>
</tr>
</tbody>
</table>
## Participating countries in TIMSS

<table>
<thead>
<tr>
<th>Australia</th>
<th>France*</th>
<th>Kuwait</th>
<th>Saudi Arabia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahrain</td>
<td>Georgia</td>
<td>Lebanon^</td>
<td>Serbia*</td>
</tr>
<tr>
<td>Belgium (Flemish)*</td>
<td>Germany*</td>
<td>Lithuania</td>
<td>Singapore</td>
</tr>
<tr>
<td>Botswana (9)^</td>
<td>Hong Kong SAR</td>
<td>Malaysia^</td>
<td>Slovak Republic*</td>
</tr>
<tr>
<td>Bulgaria*</td>
<td>Hungary</td>
<td>Malta^</td>
<td>Slovenia</td>
</tr>
<tr>
<td>Canada</td>
<td>Indonesia*</td>
<td>Morocco</td>
<td>South Africa (5, 9)</td>
</tr>
<tr>
<td>Chile</td>
<td>Iran, Islamic</td>
<td>Netherlands*</td>
<td>Spain*</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td>Republic of Ireland, Republic of</td>
<td>New Zealand</td>
<td>Sweden</td>
</tr>
<tr>
<td>Croatia*</td>
<td>Israel^</td>
<td>Northern Ireland*</td>
<td>Thailand^</td>
</tr>
<tr>
<td>Cyprus*</td>
<td>Italy</td>
<td>Norway (5, 9)</td>
<td>Turkey</td>
</tr>
<tr>
<td>Czech Republic*</td>
<td>Japan</td>
<td>Oman</td>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>Denmark*</td>
<td>Jordan</td>
<td>Poland*</td>
<td>United States</td>
</tr>
<tr>
<td>Egypt^</td>
<td>Kazakhstan</td>
<td>Portugal*</td>
<td></td>
</tr>
<tr>
<td>England</td>
<td>Korea, Republic of</td>
<td>Qatar</td>
<td></td>
</tr>
<tr>
<td>Finland*</td>
<td>Russian Federation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PISA Results in 2015 – Mathematics [NEW 10/10 CY]
## International Comparison Among 15-Year-Olds

### Snapshot of Performance in Mathematics

<table>
<thead>
<tr>
<th>Country</th>
<th>Mean Score in PISA 2015</th>
<th>Rank</th>
<th>Score Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD average</td>
<td>493</td>
<td></td>
<td>−1</td>
</tr>
<tr>
<td>Singapore</td>
<td>564</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>548</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
### Snapshot of Performance in Mathematics

<table>
<thead>
<tr>
<th>Country</th>
<th>Mean Score in PISA 2015</th>
<th>Rank</th>
<th>Score Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>511</td>
<td>13</td>
<td>-10</td>
</tr>
<tr>
<td>Australia</td>
<td>494</td>
<td>25</td>
<td>-8</td>
</tr>
<tr>
<td>United States</td>
<td>470</td>
<td>41</td>
<td>-2</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>378</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Background of our Study

Past research has shown that high failure rates exist, from 35% to over 50%, in entry-level U.S. college mathematics courses (Attewell et al., 2006; Stevenson & Zweier, 2011; Shakerdge, 2016).

To address this issue, Nagle of Penn State Behrend currently conducts and leads an NSF project, involving high school teachers and college professors. These participants are engaging in a longitudinal dialog about how to best transition high school students to college setting.

Also, based on the PISA study (2012 and 2015), Hong Kong was ranked above average (3rd in 2012 and 2nd in 2015), followed by Canada (13th in 2012 and 10th in 2015), and below average for the U.S. (36th in 2012 and 27th in 2015) in mathematics achievement among high school students.
## Education System

<table>
<thead>
<tr>
<th>Hong Kong</th>
<th>Singapore</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Secondary School (F.1-F.6): Six years of compulsory math</td>
<td>- Primary Math Grades 1-6</td>
</tr>
<tr>
<td>- Extended math classes (Module 1 or 2) for STEM students in addition to compulsory math (F.4-F.6)</td>
<td>- Lower Secondary Math Grades 7-8</td>
</tr>
<tr>
<td></td>
<td>- Secondary Math Grades 1-4</td>
</tr>
<tr>
<td>British Columbia, <strong>Canada</strong></td>
<td><strong>U.S.</strong></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>- Elementary School (7 years)</td>
<td>- High School (8&lt;sup&gt;th&lt;/sup&gt; to 12&lt;sup&gt;th&lt;/sup&gt; grade): Min. two years of math</td>
</tr>
<tr>
<td>- Secondary School (6 years)</td>
<td>- Options for advanced / honors classes for all students</td>
</tr>
<tr>
<td>- Students must earn the following to graduate:</td>
<td>- Students are assigned to the math classes based on their ability</td>
</tr>
<tr>
<td>- a Math 10 (4 credits)</td>
<td></td>
</tr>
<tr>
<td>- a Math 11 OR 12 (4 credits)</td>
<td></td>
</tr>
</tbody>
</table>
## Education System

<table>
<thead>
<tr>
<th>Australia</th>
<th>Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Primary School – 7 or 8 years</td>
<td>- 10 years of compulsory school starting at the age of seven</td>
</tr>
<tr>
<td>- Secondary School – 3 or 4 years</td>
<td>- 3 years of upper secondary school preparing for the Matriculation Test, or</td>
</tr>
<tr>
<td>- Senior Secondary School – 2 years</td>
<td>- 3 years of vocational education, or</td>
</tr>
<tr>
<td></td>
<td>- Enter the workforce</td>
</tr>
</tbody>
</table>
Education System

Puerto Rico

- Based on American Model with Spanish as teaching language at public schools
- Primary School – 1 to 6 grades
- Secondary School – 7 years
- Vocational Education or Tertiary Education
## Curriculum

### Hong Kong

**Grades 7 - 12 Compulsory Math** with three strands:
- Number and Algebra
- Measures, Shapes, and Space
- Data Handling

**Grades 10 – 12 Extended Math** (by choice):
- Module 1 (Calculus and Statistics) – for disciplines or careers requiring mathematical application
- Module 2 (Algebra and Calculus) – for math-related fields and careers

### U.S.

**Grades 8 - 12**:
- Algebra I, Algebra II, PreCalculus, Trigonometry, Calculus I, Statistics
Curriculum

Hong Kong

Grades 7 - 9 Junior Secondary
Compulsory Math

5 class periods per week
40 minutes per period
480 periods available for the three years
320 hours of lesson time
Curriculum

Hong Kong

Grades 10 – 12

Compulsory Math with the same three strands
250 to 313 hours of lesson time

Extended Math (by choice)
Module 1 (Calculus and Statistics) or
Module 2 (Algebra and Calculus)
125 hours of lesson time
<table>
<thead>
<tr>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Foundations of Mathematics and</td>
<td>● Computer Science 11</td>
<td>● Apprenticeship 12</td>
</tr>
<tr>
<td>Pre-calculus 10</td>
<td>● Computer Science 11 with elaborations</td>
<td></td>
</tr>
<tr>
<td>● Foundations of Mathematics and</td>
<td>● Foundations of Mathematics 11</td>
<td>● Apprenticeship 12 with elaborations</td>
</tr>
<tr>
<td>Pre-calculus 10 with elaborations</td>
<td>● Foundations of Mathematics 11 with</td>
<td></td>
</tr>
<tr>
<td>● Workplace Mathematics 10</td>
<td>elaborations</td>
<td>● Calculus 12</td>
</tr>
<tr>
<td>● Workplace Mathematics 10 with</td>
<td>● History of Mathematics 11</td>
<td>● Computer Science 12</td>
</tr>
<tr>
<td>elaborations</td>
<td>● History of Mathematics 11 with elaborations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Pre-calculus 11</td>
<td>● Foundations of Mathematics 12</td>
</tr>
<tr>
<td></td>
<td>● Pre-calculus 11 with elaborations</td>
<td>● Foundations of Mathematics 12 with</td>
</tr>
<tr>
<td></td>
<td>● Workplace Mathematics 11</td>
<td>elaborations</td>
</tr>
<tr>
<td></td>
<td>● Workplace Mathematics 11 with elaborations</td>
<td>● Geometry 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Geometry 12 with Elaborations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Pre-calculus 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Pre-calculus 12 with elaborations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Statistics 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Statistics 12 with elaborations</td>
</tr>
</tbody>
</table>
Curriculum - Australia

First 10 years, including Foundation Year
1) Number and Algebra
2) Measurement and Geometry
3) Statistics and Probability
At each year level, the achievement standards focus on
Understanding, Fluency, Problem-Solving, and Reasoning
Four senior secondary subjects for Mathematics:
1) Essential Mathematics – focus on use
2) General Mathematics – focus on solving problems
3) Mathematical Methods – focus on development in Calculus and Statistical Analysis
4) Specialist Mathematics – focus on mathematical proofs
Three Content Strands in Primary and Lower Secondary Math Grades 1-8:

- Numbers and Algebra
- Geometry and Measurement
- Statistics and Probability
Three Content Strands and one Process Strand in Secondary Math Grades 1-4:

- Numbers and Algebra
- Geometry and Measurement
- Statistics and Probability
- Mathematical Processes
Singapore Education

- 6th graders take Primary School Leaving Exam
- assigned to a secondary school based on merit and their choice.
- Gifted Education Programme
- "Express", "Normal (Academic)", or "Normal (Technical)"
Curriculum - Finland

- Numbers and Calculations
- Algebra
- Geometry
- Measurement
- Data Processing and Statistics
Grades 1-2: focus on basic mathematical concepts and structures

Grades 3-5: focus on developing mathematical thinking

Grades 6-9: focus on depending understanding of math concepts and modeling skills
Curriculum – Puerto Rico

• Kindergarten – counting, basic number sense
• Grades 1 to 6 – Math progressing at each level
• Grades 7 to 9 – Intermediate School - PreAlgebra
• Grades 10 to 12 – High School – Algebra I and II, Geometry, Trigonometry, Pre-Calculus
Methods and Over-Arching Themes

**Methods:** Each presenters reviewed existing literature for each of the seven locations to find uniqueness from each. We compared and contrasted the findings, and cast them into several over-arching themes as follows:

- An existing space for mathematical inquiry in a creative manner
- Attitude toward Education
- Connectedness of mathematical ideas in curriculum
- Assessment and its access to the Cognitive Domain
### Theme 1:
An existing space for mathematical inquiry in a creative manner

<table>
<thead>
<tr>
<th>AMPLE SPACE</th>
<th>SOME SPACE</th>
<th>LITTLE TO NO SPACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>Hong Kong</td>
<td>United States</td>
</tr>
<tr>
<td>Canada</td>
<td>Australia</td>
<td>Puerto Rico</td>
</tr>
<tr>
<td>Singapore</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2002 Basic Math Exam

11. For which values of $q$ is the polynomial function $f(x) = x^3 + x^2 + qx + 1$ decreasing on some interval? Find this interval.

2000 Basic Math Exam

11. Prove that the polynomial $f(x) = x^3 - 4x - 2$ has a zero in the interval $[2,3]$. Find this zero using the bisection method to two correct decimals.
Consider the graphs of the $f(x) = \frac{x^2 - x - 6}{x^2 - 9}$ and $g(x) = \frac{x}{x^2 - 9}$.

Use your knowledge of rational functions to outline the similarities and differences between these two graphs. You will be evaluated on the concepts expressed, the organization and accuracy of your work, and your use of language.
A Sample Question from Canada

\[ f(x) = \frac{x^2 - x - 6}{x^2 - 9} \]

\[ g(x) = \frac{x}{x^2 - 9} \]
A Sample Question from Canada

\[ f(x) = \frac{x^2 - x - 6}{x^2 - 9} = \frac{(x + 2)(x - 3)}{(x + 3)(x - 3)} \]

\[ g(x) = \frac{x}{x^2 - 9} = \frac{x}{(x + 3)(x - 3)} \]

\[ \{ x \in \mathbb{R} : x \neq \pm 3 \} \]

V. A.: \( x = -3 \)

H.A.: \( y = 1 \)

A hole at \( (3, \frac{5}{6}) \).

No symmetry.

\[ \{ x \in \mathbb{R} : x \neq \pm 3 \} \]

V. A.: \( x = \pm 3 \)

H.A.: \( y = 0 \)

No hole.

Symmetric w.r.t. the origin.
Sample Questions from New York, United States

When the expression $x^2 - 3x - 18$ is factored completely,

which is one of its factors?

a) $(x - 2)$  

b) $(x - 3)$

c) $(x - 6)$  

d) $(x - 9)$

21 The function $f(x) = 3x^2 + 12x + 11$ can be written in vertex form as

(1) $f(x) = (3x + 6)^2 - 25$  
(2) $f(x) = 3(x + 6)^2 - 25$  
(3) $f(x) = 3(x + 2)^2 - 1$  
(4) $f(x) = 3(x + 2)^2 + 7$
# Theme 2: Attitude toward Education

<table>
<thead>
<tr>
<th></th>
<th>GENERALLY POSITIVE</th>
<th>GENERALLY NEUTRAL</th>
<th>GENERALLY NEGATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td></td>
<td>Canada</td>
<td>United States</td>
</tr>
<tr>
<td>Hong Kong</td>
<td></td>
<td></td>
<td>Puerto Rico</td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td></td>
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</tbody>
</table>
Cultural Beliefs About One’s Abilities to Learn Mathematics

Schoenfeld (1989) and Tang (2007) both characterized how learners perceive math abilities: Nature versus Nurture

**Nature:** the belief of the abilities in learning math comes from natural endowment and born talent.

**Nurture:** the belief that sufficient facilitation and the learner’s own effort can overcome difficulties in learning mathematics.
Manifestation of the Cultural Beliefs (U.S.)

An examination of the attitude toward homework at the high school level:

Method: Focus group discussion with six PA HS math teachers in September 2016.

Findings:
• Homework given to students is largely procedural, similar to Schoenfeld’s (1989) description.
• Minimal opportunities for learners to experience disequilibrium when doing homework.
Findings: (Continued)

- Learners tend to resist HW when confronted with disequilibrium.
- Parents also tend to resist when they observe their children “stuck” on homework problems.
- School administrators do not generally support the math teachers when learners and parents are pushing back.

Interpretation:

The findings are consistent with the belief of natural endowment of math abilities for many U.S. students.
Manifestation of the Cultural Beliefs (Hong Kong)

- There exists evidence that many learners believe in nurturing as a means to learning. Stay tuned in the later portion of the presentation about the tutoring practice in Hong Kong.

Manifestation of the Cultural Beliefs (B.C., Canada)

- We will argue that while many Canadian learners believe in the nature’s disposition for math learning, there exists evidence at the policy level that B.C. system attempts to change this belief.
Honoring the ways of knowing from First Peoples (B.C., Canada)

- Collaborate with local First Peoples Elders and knowledge keepers (B.C. Math 12)

- Lesson Episode from Gear (2012)
  - Haida creation story *The Raven and the First People*
  - How many children can fit in a clam shell
  - Parental orientation
Finnish Attitudes toward Education

- Finland felt insecure toward the end of WWII with being sandwiched between two giants, USSR and Germany. This was a motivation for them to overhaul their education system.

- Contrary to the U.S. notion of “No Child Left Behind,” Finland embraces diversity that different individuals have unique talents, and each must be nurtured in a personalized way.

- Play, rest, and stress management are part of the Finnish schooling components. Students enjoy nap time, ample amount of recess in school, and healthy socialization, both in primary and secondary grades.
To be a math teacher in Finland, one must possess at least a master’s degree in mathematics as well as a degree in education. Apprentice teaching lasts approximately two years. Teaching load is generally less than those of the U.S., and prep time is generally more than those of the U.S.

It is a common practice that a teacher “follows” his/her students for three to four years. The teacher is responsible for devising individualized curriculum for his/her students, as opposed to a state prescribing a curriculum for all students in each specific grade.

Those who desire to attend universities receive a more academic oriented curriculum where a large portion up to Calculus is housed. Those who prefer vocational training learn applied math that is relevant to their trade skills.

Finnish matriculation exam is a university entrance exam, and those who want to attend universities elect to take the exam. It is not a requirement to graduate from secondary schools.

Source: Pasi Sahlberg (2014) Finnish Lessons 2.0: What Can the World Learn from Educational Change in Finland?
Australian Attitudes toward the Math Subject

- Wang and Wu (2010) found that Australian students tend to enjoy learning statistics more so than the Chinese counterparts.

- Norton and Rennie (1998) found that male students tend to have a slightly more positive attitude toward the subject than female students. Overall in their findings, positivity declines in both genders as students moving up from grades 8 to 12.

- De Lourdes Mata, Monteiro and Peixoto (2012) also found the attitude declination, particularly more drastic for female students. They linked attitude and achievement with a positive correlation. Interestingly, they found a strong relationship showing the importance of Australian teachers generally do have positive attitudes towards the math subject.

- Pritchard (2004) found that New Zealand parents are generally positive about helping their children in mathematics.
## Differences

<table>
<thead>
<tr>
<th>Hong Kong</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Political uncertainty</td>
<td>- Politically stable</td>
</tr>
<tr>
<td>- Believe that (STEM) education is the key to success.</td>
<td>- Believe that education is one of the ways to success.</td>
</tr>
<tr>
<td>- Believe that learning math trains the brain.</td>
<td>- Believe that learning math is to fulfill the requirement.</td>
</tr>
<tr>
<td>- Parents generally support school teaching.</td>
<td>- Parents generally involve in school teaching.</td>
</tr>
<tr>
<td>- Invest additional resources and time in tutoring.</td>
<td>- Invest additional resources and time in education, sports and music.</td>
</tr>
</tbody>
</table>
Differences

<table>
<thead>
<tr>
<th>British Columbia, Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Politically stable</td>
</tr>
<tr>
<td>- Believe that college and university education is an investment leading to one benefit of increased employability.</td>
</tr>
<tr>
<td>- Many proactive parents send their children to private schools – about 12% in B.C.</td>
</tr>
</tbody>
</table>
Singapore Math

• Covers fewer topics in greater depth
• three-step learning process: concrete, pictorial, and abstract
• Ready for algebra and geometry in middle school
• Learn at different paces
• Develop foundation for further math learning
• No need to reteach
Singapore Math Believe

• U. S.: “Some are born with naturally talented/gifted in math, while others are not.”

• Singapore: “Effort” is the key!

hands-on group activities
pictorial phase
abstract equations.
“Throughout much of Asia, education is seen as the only path to success. Parental demands, fear of failure, competition and pride are fueling Asia’s academic ascension. Simply put, children in Asia study with a purpose. …typical Asian Student: committed, diligent, competitive, passionate, focused and ambitious.”
Attitudes toward Education: Hong Kong

1,016 students from 14 primary and 27 secondary schools were polled in 2015.

- **67.6%** of 4\textsuperscript{th} grade and 5\textsuperscript{th} grade students took tutorial classes after school

- **40.8%** of 10\textsuperscript{th} grade or 11\textsuperscript{th} grade students took tutorial classes after school
Attitudes toward Education: Hong Kong

Private tutoring in 2013:

- 85% of 11th grade students have private tutoring
- CAD 350 million private tutoring industry or cram school
- Top cram schools can have 10,000 students per month
- Most popular tutors can earn at least CAD 528,000 a year
Atitudes toward Education: Hong Kong

- CAD 70 per hour 10 years ago
- Math/Science tutors may charge between CAD 140 per hour 10 years ago
Attitudes toward Education: Hong Kong

1/3 secondary school students spent about CAD 3.32 million per month on private tutoring in 2004-2005

Private Tutoring Industry is worth at least CAD 71 million

Other reports claimed that the industry generated more than CAD 637 million
“In Hong Kong, the Tutor as Celebrity”
Advertisements for star tutors in Hong Kong can be seen all over here: on billboards that loom over highways and on the exteriors of shopping malls. Invariably, the local teaching celebrities are young, attractive and dressed in designer outfits befitting pop stars. But beyond the polished shine, the advertisements also claim that their celebrity tutors can help students ace Hong Kong’s university entrance exam."
Cultural Differences: Tutoring (United States)

“The tutoring market is fragmented. Some online tutoring marketplaces aggregate a large number of private tutors. One site has over 34,000 registered tutors in California. The hourly rate is, in average CAD 62.”

Private tutoring is not as common in the U.S.
Cultural Differences: Tutoring (B.C., Canada)

- In Toronto, 60% of more than 70,000 high school students have private tutors.
- CAD 35-45 per hour for University student tutors
- CAD 50-60 per hour for certified teacher tutors
- CAD 280 for 2 ½ hour sessions a week + CAD 150 registration fee for children ages 3 to 6 at Tutoring Centers
- At least one tutoring business per 10 blocks or 10 minutes walk in Vancouver
Cultural Differences: Tutoring (B.C., Canada)

- Kumon has 330 centers across Canada enrolling students as young as preschool through high school in math and reading with 13% in preschool and 67% in grades 1-5.

- A 2007 study by the Canadian Council on Learning stated that 1/3 of Canadian parents would hire a private tutor or a tutoring company for their children aged 5 to 24.

- The global tutoring market may surpass CAD 138 billion by 2018.
Theme 3: Connectedness of Mathematical Ideas in Curriculum

<table>
<thead>
<tr>
<th>Well-Designed and Tightly Connected</th>
<th>Somewhat Well-Designed Loosely Connected</th>
<th>Generally Fragmented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>Hong Kong</td>
<td>United States</td>
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<tr>
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<td>Singapore</td>
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</tbody>
</table>
Characteristics of B.C. and Quebec Math Curricula, with comparisons to those of U.S.

- American children consistently rank below most other industrialized nations on international mathematics assessments.

- American students, with the spiral curriculum was merely a fragmentation of computationally-oriented content; hence, it lacks focus – highly repetitive – and does not provide … a rigorous math and science education by international standards.
Some evidence of spiraling in B.C.'s curriculum

In B.C., by grade eleven, 60% of instructional time was earmarked for Algebra, with 33% of objectives repeated from prior years. In contrast, under Quebec’s *Data Analysis*, students solved problems using correlation and probabilities.

Side note:
Unlike British Columbia’s mathematics curricula, Quebec's also demonstrated substantial dedication to mental calculations.
A grade eleven objective, in Quebec, required that students summon all their knowledge (algebra, geometry, statistics and the sciences) and all the means at their disposal (computers, calculators, instructional materials) to solve problems. This interconnectedness was not evident in B.C.'s curriculum.
Influence of different educational philosophies

Quebec’s curricular documents wove together activities fostering conceptual understanding, calculations, operational applications and problem-solving. Quebec’s objectives directed teachers to assign open-ended problems thereby indicating a cognitivist learning orientation.

By contrast, British Columbia’s curriculum reflected a more behaviorist view of learning. Its mathematics curriculum dealt with problem-solving as a separate topic, unlike Quebec’s where problem-solving was integrated throughout all learning objectives.
Australian Year 8 students

- In 2015, Australian students were outperformed by 12 other countries.
- There was a dip in score in 2007 and a recovery in 2011.
- Australian students scored about the same in 1995 and in 2015.
- 64% met the Intermediate international benchmark – the proficient standard for Australia.
Other Observations about the Grade 8 Australian Students

- Male students performed slightly better.
- Those who had more books at home perform better.
- Non-Indigenous students performed better.
- Other factors: geographic location and language spoken at home
## Theme 4: Assessment and its access to the Cognitive Domain

<table>
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<tr>
<th>Assessing Deep Learning</th>
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<th>Assessing Surface learning</th>
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<tbody>
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<td>Finland</td>
<td>Hong Kong</td>
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<td>Canada</td>
<td>Australia</td>
<td>Puerto Rico</td>
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<td>Singapore</td>
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</tbody>
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## Assessment

<table>
<thead>
<tr>
<th>Hong Kong</th>
<th>U.S.</th>
<th>Canada</th>
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</thead>
<tbody>
<tr>
<td>Hong Kong Diploma of Secondary Education (HKDSE) Examination at 12th Grade (exam results are generally used for local colleges/universities admission after 12th Grade)</td>
<td>▪ Graduation Exam as required by each state ▪ SAT, ACT, AP etc (not necessarily compulsory for students)</td>
<td>▪ Provincial Exams ▪ 12th Grade Research Projects</td>
</tr>
</tbody>
</table>
## Assessment (Cont.)

### Singapore

- PSLE at the end of the final year of primary school, i.e. P.6
- Mathematics Paper 1 (50 minutes)
- Mathematics Paper 2 (100 minutes)
- Foundation Mathematics Paper 1 (60 minutes)
- Foundation Mathematics Paper 2 (75 minutes)

  List of approved science calculator is allowed in paper 2 exams

- GCE N(T), N(A), O, and A level exams at the end of
### Assessment (Cont.)

<table>
<thead>
<tr>
<th>Australia</th>
<th>Puerto Rico</th>
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<tbody>
<tr>
<td>The numeracy components comprise 45 multiple-choice questions.</td>
<td>Fourth- and eighth-grade students participated in NAEP mathematics assessments</td>
</tr>
</tbody>
</table>
Cultural Differences: Calculator Use (Hong Kong)

- Elementary students learn how to perform basic arithmetic operations without using a calculator.

- When students take the Hong Kong Diploma of Secondary Education Examination (HKDSE), they can only bring a calculator from a list of permitted scientific calculators.
Cultural Differences: Calculator Use (Canada)

- Hand-held devices for mathematical computations.
- Students in grades 8-10 may use teacher approved scientific calculators.
- Students in grades 11-12 and the IB Diploma program may use graphing calculators: TI-83/84 or Nspire (non CAS).
- During provincial exams, a calculator inspection will be conducted.
Cultural Differences: Calculator Use (H.K. vs U.S.)

- In 2007, 52% of 4th grade teachers in Hong Kong did not permit calculators and 31% in U.S.
- In 2014, use of graphing calculator is 12% in Hong Kong and 77% in U.S.
- In 2014, use of scientific calculator is 88% in Hong Kong and 23% in U.S.
- Calculators are not allowed in tests for nine- and 11-year-olds in Hong Kong.
QUESTIONS?
THANK YOU!