
Numeracy and the Needs of Society: The case of Singapore

Lim-Teo Suat Khoh
National Institute of Education
Nanyang Technological University
Singapore

Organisation of Talk

1. Introduction: Working definition of Numeracy
2. Numeracy and living in the 21st Century (special reference to Singapore) 
3. Balancing basic skills and knowledge with problem solving 
4. Conclusion

What is Numeracy?

Edge (2001)

- Ability to use “mathematics facts, skills, processes and applications essential to daily living and working”
- *Numeracy* does not seem to include geometry nor statistics
- *Mathematical Literacy*
- *Mathematical Proficiency* – competence in knowledge of mathematics and in thinking mathematically

Numeracy vs Mathematics

“Numeracy is not the same as mathematics, nor is it an alternative to mathematics.”

“Students need to have quantitative literacy (numeracy) They also need to master the established discipline of mathematics.”

(Steen, (2001), *Mathematics and Numeracy: Two literacies, One language*)

Comparison between Mathematics and Numeracy

Discipline of Mathematics

- Absolute
- Ideal
- Abstract
- Pure

Numeracy or quantitative literacy

- Messy
- Contextual
- Concrete
- Practical

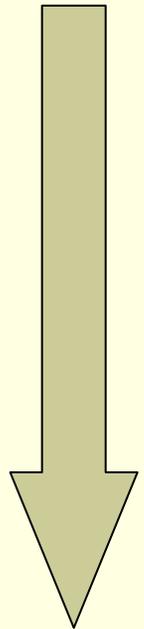
School Mathematics

Classical
categorisations
such as
arithmetic,
algebra,
geometry,
trigonometry
and calculus

Progression is from
simple to advanced

Builds on previous
concepts

Keeps pace with
students' readiness



Acquisition of Numeracy

- Assumption: Learning school mathematics up to certain level allows the citizen to use school mathematics in his daily living.
- Basic arithmetic skills are very necessary and often learnt at primary schools.
- Secondary school mathematics (arithmetic, algebra, geometry and some statistics) is often meant to prepare students for further education, to be grounded in the concepts and processes of mathematics
- Does numeracy only refer to arithmetic at primary level?
- Is such numeracy enough for the modern world?



Numeracy in the 21st Century

- Survival, daily living (basic arithmetic, measurement of space, weight, etc.)
- Understanding data (percentages, rates, data organisation and inferences)
- Decision making and risk taking (rates vs changes in rates, systematic organisation and processing skills, combinatorics, probability)

Example: Number sense



Example: Simple Financial Transactions and Percentages

Tiffany 5ft Bedroom Set (Complete Set)
(Available in both natural and walnut colour)

NOW \$599
U.P. \$1,000 (\$55 a month)

FREE
Sliding Door
Wardrobe

48 Months
Instalment
Plan
(For non-credit card holders)
Terms & conditions apply

0% Interest-Free
Easy Payment
Scheme
Terms & conditions apply

2.18 %
p.a.*

Only UOB pays you 2.18%p.a.* for your 3-month S\$ Fixed Deposit of S\$100,000. To enjoy this special rate, all you need is to place S\$5,000 in selected Unit Trusts. Offer is for a limited period only. Visit any UOB Group branch today. For more details, please call 1800 22 22 121.

Example: Rates and changes in rates

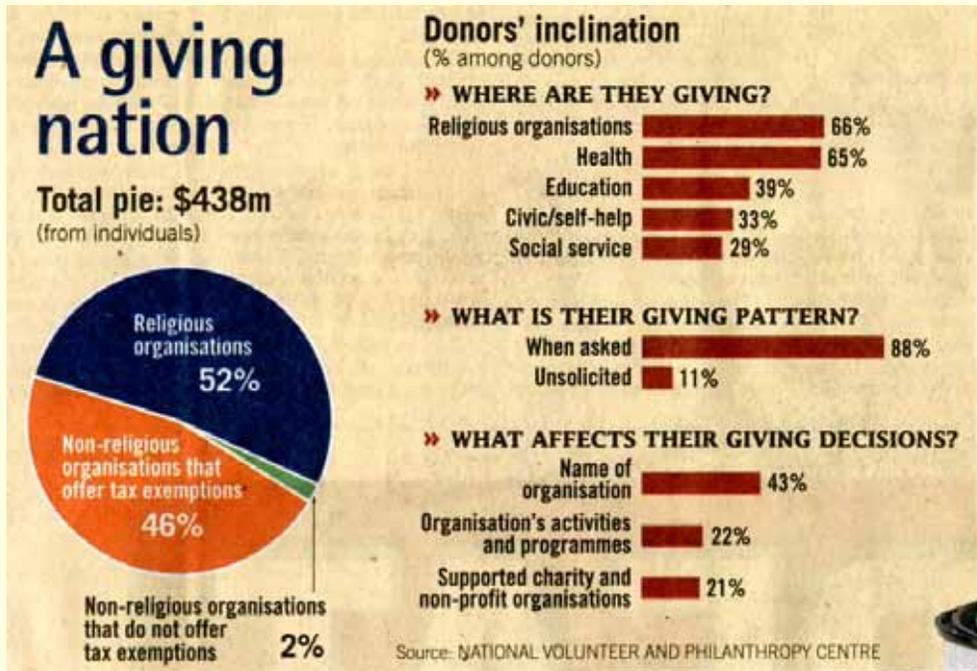


Example: Spatial Skills

Spatial skills are needed for:

- Designing
- Planning furniture arrangements
- Reading maps
- Understanding networks for commuting

Example: Data Inference



Which headline is correct?

More donations go to religious groups

or

More people donate to religious groups

The case of Singapore



- A small island nation
- Land area: 690 sq km
- One city
- Population: 4.17 million
- No natural resources

The case of Singapore- Industries and Services

- Port and shipping
- Airport
- Oil Refining
- Banking
- Tourism
- Electronics
- Telecommunications

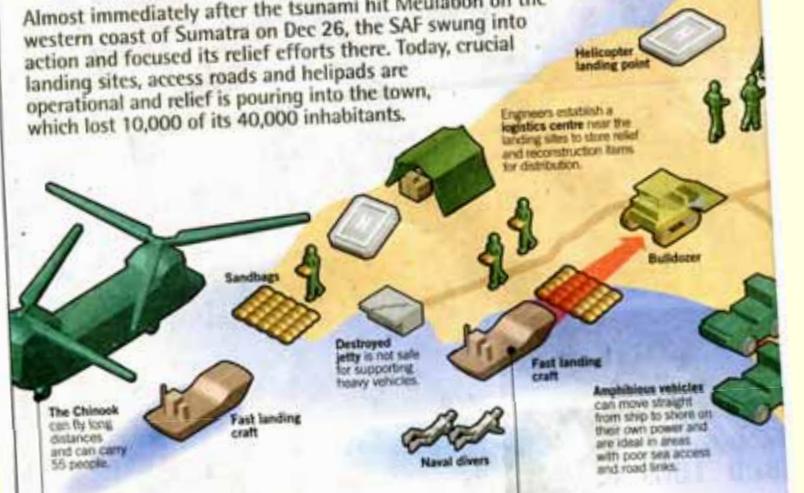
Need for educated population with high level of numeracy

The case of Singapore – an efficient and organised defence force

12 | TSUNAMI AFTERMATH

All systems go

Almost immediately after the tsunami hit Meulaboh on the western coast of Sumatra on Dec 26, the SAF swung into action and focused its relief efforts there. Today, crucial landing sites, access roads and helipads are operational and relief is pouring into the town, which lost 10,000 of its 40,000 inhabitants.



1. Relief flown in

Dec 30
Chinook flies first large food shipment into Meulaboh.

Dec 31

RSS Endurance leaves Singapore for Meulaboh, carrying
- 470 people, including a 33-strong medical team, SCDF members, combat engineers, divers and guardsmen
- 51 vehicles and heavy equipment like bulldozers, forklifts, excavators, dump trucks, mechanical shovels and generators
- 350 pellets and crates of relief supplies

2. Ship arrives

Jan 2

RSS Endurance arrives at Meulaboh. With its arrival, supplies can move into Meulaboh at 20 times the rate before its arrival.

The RSS Endurance is a 141m-long, 6,000-tonne landing ship tank.

3. Landing sites set up

Jan 3

• **Landing sites** have to be set up first because the shoreline is wrecked. To do this, divers first scout the coastline for possible sites. 45 combat engineers clear the beach of debris and fill 700 sandbags to build landing points. Once landing sites are ready, landing craft ferry bulldozers to shore. Clearing work using bulldozers starts.
• **Field hospital** in Meulaboh set up at the displaced persons camp.

4. Refuelling on ship

Jan 5

Super Pumas and Chinooks can refuel on the Endurance as space is made when vehicles leave the ship's deck.

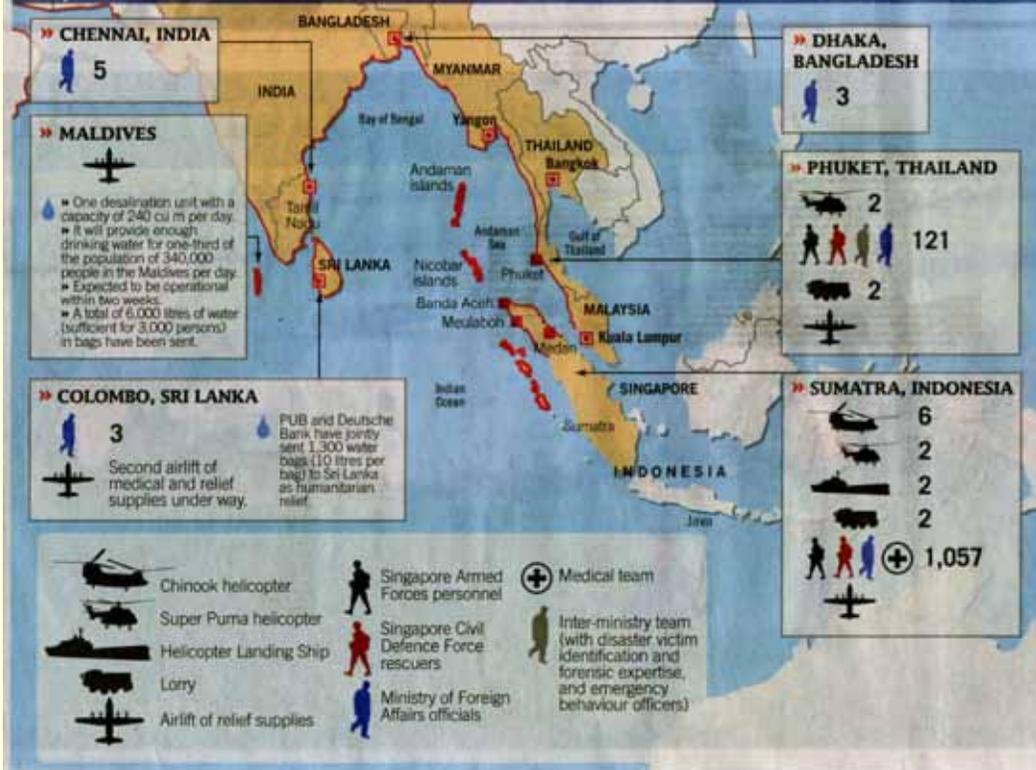
Drawing not to scale
SOURCE: MINDEF

- Singapore's defence force was set up after independence in 1965
- In recent Tsunami disaster, SAF organised relief action to Sumatra.

The case of Singapore

» DISASTER RELIEF

Singapore's efforts to help in the Boxing Day catastrophe extend to six countries, more than 1,000 personnel, and several aircraft and ships. These include:



The case for survival: Water

- Singapore imports most of its water.
- Water technology is thus extremely important.
- Singapore was in position to assist the Tsunami-disaster areas with desalination plants and water dispensers which takes water from the air.



Need for numeracy in daily living - even recreation

REVIEW

THE STRAITS TIMES FRIDAY JA

Casino debate: Laying out all the cards

BY GILLIAN KOH
OF THE STRAITS TIMES

Singapore Government spelled out social safeguards and parameters within which a proposed casino must operate, and will give it to private operators if they can work them within their feasibility plans for a targeted resort.

The targeted group of investors seems to be the large resort operators based in the United States — the likes of Hurrah's Entertainment and Kerzner International.

As we understand it, the resort industry in the region is seeking opportunities for expansion in Asia, an undeveloped yet promising market given the rising affluence in China and India. Singapore is attractive because it is a jurisdiction where the rules of corporate governance are strong and enforced. The largest casino operators are those based on Wall Street and in Nevada, under the jurisdiction of the Nevada Gaming Control Board, which will not jeopardise its listing and licences in countries which cannot assure them that their stringent standards of governance will be upheld there.

The casino is integral to the business model of this targeted group of resort operators. It is a revenue and amenity centre that

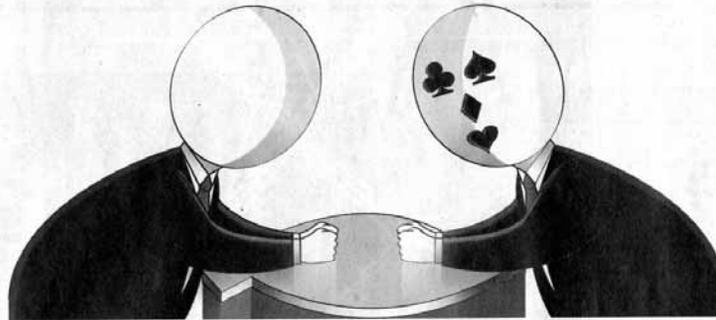


ILLUSTRATION: LUDWIG ILIO

attract tourists. Operators will seek to recoup their investments. They might try to channel some of their clients in other locations to the new venture.

Given that the casino will be the key money spinner, we can count on the operators to market it aggressively. It will certainly not be some poky little den or a low-key, subtle attraction in the resort.

The Government has announced that it will set an upper limit of 15,000 sq m for a casino, and up to 2,500 slot machines, which is more than what some of the largest resorts in Las Vegas have. If the casino cross-subsidises the resort's non-gaming amenities and activities, it will

be a more attractive tourism product which it knows poses some level of social risk.

However, the proposed safeguards are not without economic costs or constraints. Already, the Government will allow the casino to pay a preferential tax rate on gross gambling revenue of 15 per cent, significantly lower than the 40 per cent applied in Macau.

With increasing competition from potentially less regulated casinos, there is the danger of pressure to lower the tax rate to keep the resort viable. The Government must ensure that sufficiently high consumer protection standards would be non-negotiable.

The prevalence of problem and pathological (P&P) gambling, or gambling addiction, can range from one per cent to 8 per cent of the adult population, depending on the location and design of the study.

Two major US government research groups — the National Research Council and the National Opinion Research Centre — estimated in a 1999 report that there were 7.5 million P&P gamblers. Assuming a base of 217,766 million resident adults (over 18 years old) in the US, this would translate to a 3.44 per cent incidence level.

The National Productivity Commission of Australia

affect eight to 15 significant others — be they spouses, children, extended family or close friends. Taking a conservative estimate of eight, the circle of misery widens to an extra 290,400 people.

Another factor to consider is the marginal impact of expanded opportunities to gamble. Among the findings of the American report mentioned above is that the presence of a gambling facility within 80km doubles the prevalence of P&P gamblers.

If we translate that finding to Singapore, we could be looking at an increase from 38,300 to 76,000 P&P gamblers, with an additional 580,800 people affected.

The bill for treatment costs alone would double to \$384 million, with total costs reaching an estimated \$1.7 billion.

Some might feel that the marginal increase would be lower than in the US study, because a casino in Singapore could simply divert some of those Singaporean gamblers now going to Batam or Genting. Singaporean gamblers now going to Batam or Genting would incur an average of eight research studies in the US, each P&P gambler incurred US\$13,586 (S\$22,160) per annum in direct social cost in so far as these costs could be imputed. These would be the combined impact from productivity loss, bankruptcy, crime, suicide, illness, abuse, divorce and separation, social service and treatment costs.

Even if we use a conservative estimate of \$5,000 per annum in direct social cost for a P&P gambler, this would translate to a total bill of \$384 million. If we took the US

thorough review of the problem's size and scope.

At a recent forum organised by the Institute of Social Studies on the casino, views were split in the middle. Participants were opinion leaders and stakeholder groups divided between, on the one hand, such a resort, and on the other, but with all the critical safeguards.

There were those who thought Singapore would not be able to introduce and enforce the right social safeguards and rules of corporate governance to arrive at a level where Singaporean gamblers were others who had been convicted that the introduction of a casino on Singapore would open the door to a social implosion. N. spoke up and wanted to pursue more "in ideas to boost tourism."

If the resort was however, 83.3 per cent of the participants were at least prepared to accept the presence of a casino. The remaining 16.7 per cent were

Better understanding of chance and probability



Balancing Basic Skills and Knowledge with Problem Solving and Creativity

Misconception (about 10 years ago)

- East Asian school mathematics emphasised rote learning and drills in mechanical computation
- Western school mathematics emphasised conceptual understanding and constructivist approaches

Some argue that East Asian nations did well in TIMSS because TIMSS tested computations rather than creativity and problem solving.

Balancing Basic Skills and Knowledge with Problem Solving and Creativity

- True: Confucian Heritage cultures (Japan, China, Korea, Singapore) accept that the ability to perform routine computations and procedures is a **necessary** condition for understanding and doing mathematics.
- This ability is also regarded as important **foundation** for mathematical problem solving.
- Not true: East Asian countries concentrate on computation drills.

Case 1: Japan

- TIMSS video study showed that in Japan, highest amount of engagement in mathematical problem solving was undertaken.
- Japanese mathematics lessons had students doing extended problem-solving (open problems) and learning new concepts through problem-solving.
- Level of mathematics expected of students was very high.

Case 2: China

- The two basics (basic knowledge and basic skills) provide the foundation.
- Four dimensions are:
 - (a) Calculation speed (leading to efficiency)
 - (b) Memorisation of procedures (even if there is no understanding initially)
 - (c) Accuracy in expression (based on logical analysis)
 - (d) Practising with variations (exposure to different variations of the same concept or process)

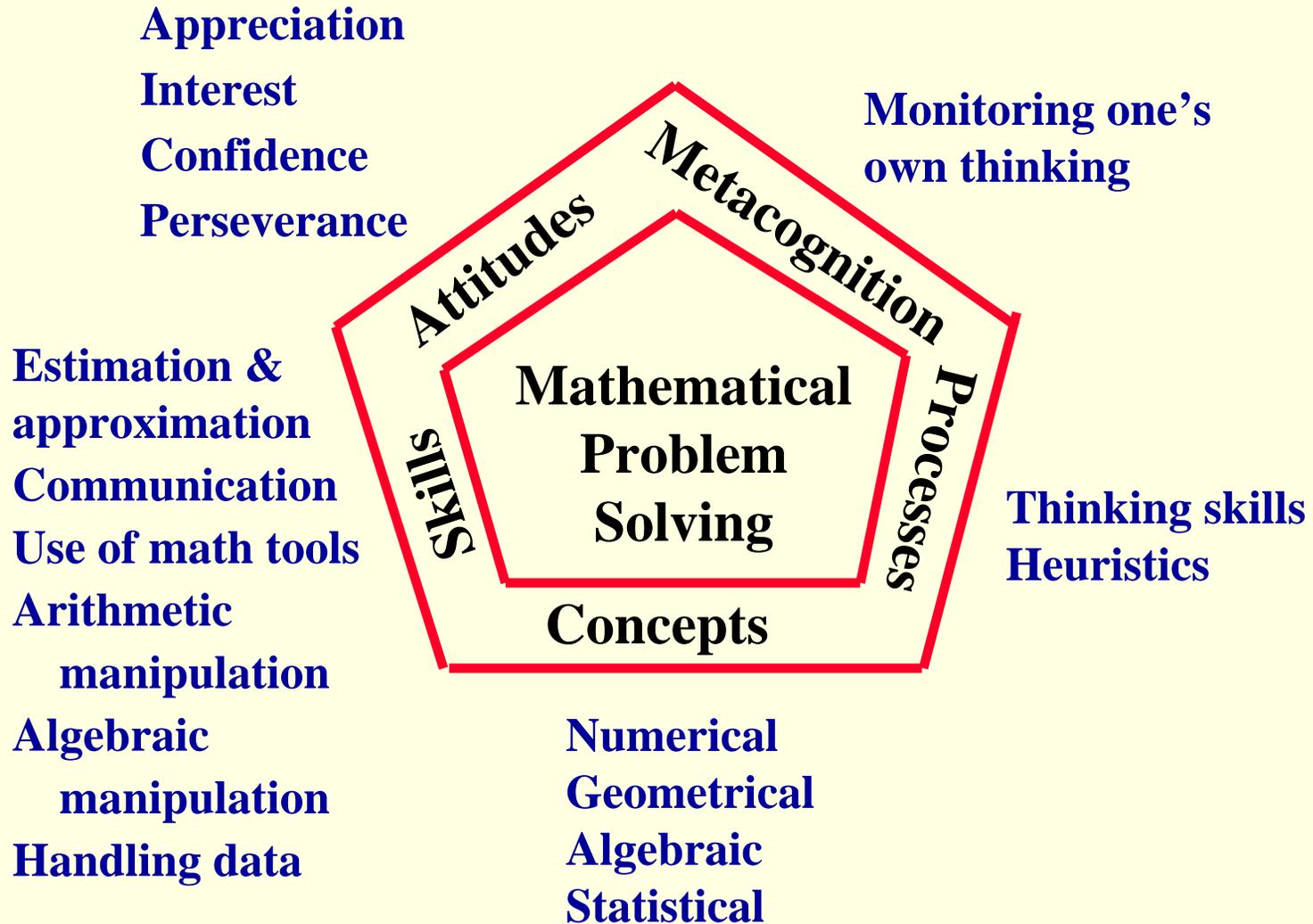
Case 2: China

- In China, students are expected to be highly proficient in computation and manipulation skills.
- In the 1990s, following Japan's example, more and more open-ended problems were used in mathematics teaching
- Students were encouraged to find many acceptable and justifiable answers – thus developing creativity.

Case 3: Singapore

- Singapore has a centrally controlled education system.
- All schools follow common syllabus set by the Ministry of Education
- There are nation-wide common examinations at end of primary school (6 years), secondary schools (4 years) and junior college (2 years) before university entrance
- Since 1990s, mathematical problem solving has been the central theme of the mathematics syllabus

Framework of Singapore Mathematics Curriculum



Case 3: Singapore

- Concepts and procedures/skills are considered basic and very important.
- Students are expected to practice many variation of the same processes with increasing levels of difficulties and they are regularly tested on these.

Case 3: Singapore

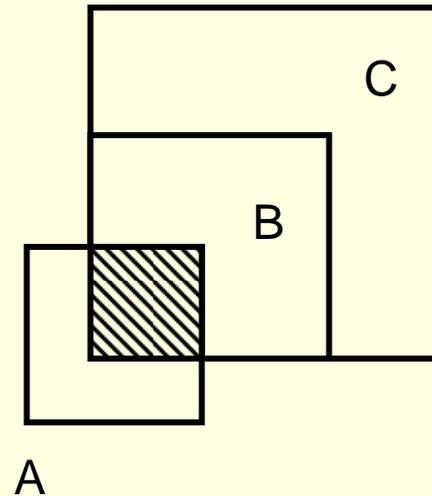
- Singapore students are also taught problem-solving heuristics and thinking skills explicitly at primary levels.
- Students are exposed to problems which need combination of maths concepts such as ratios and percentages.
- High stakes exam at end of primary schools – families put great stress on children to do such types of problems intensively throughout that year.

Example 1

- Father gave Jason 50 stamps. 16% of them were from Australia. After Mary gave Jason more stamps from Australia, the percentage of his stamps which were from Australia increased to 30%. How many stamps did Mary give Jason?

Example 2

- The figure is made up of overlapping squares A, B and C. The ratio of the areas of A to that of B to that of C is $2 : 4 : 7$. If $\frac{3}{8}$ of B is shaded, what percentage of the figure is not shaded?



Singapore: Contributing Factors for High TIMSS Performance

- One of the contributing factors of Singapore's high performance in TIMSS is that Singapore students regarded doing well in studies as important. They had high aspirations "to finish university".
- Private tuition and tuition schools (juku) are a large (unofficial) education industry.
- Schools and homes are well-resourced. Singapore had the highest Index of Availability of School Resources (86 – 88%) compared to International Average of (26 – 33%)

Seeking a balance

- Both China and Singapore are seeking a balance between developing basic skills/knowledge and developing deeper thinking skills/processes.
- Both are necessary for effective problem solving.

Seeking a balance

- Using the idea of foundation may imply that we develop basic skills and knowledge first and leave the understanding and real life problem solving processes to later on.
- However, to have better connections to the real world, we need to move on to encourage real problem solving through the processes soon after we teach various computation and manipulative skills.
- Using the analogy of a pair of chopsticks, we need both chopsticks to be balanced for our society to have good problem-solvers.



Concluding Point 1

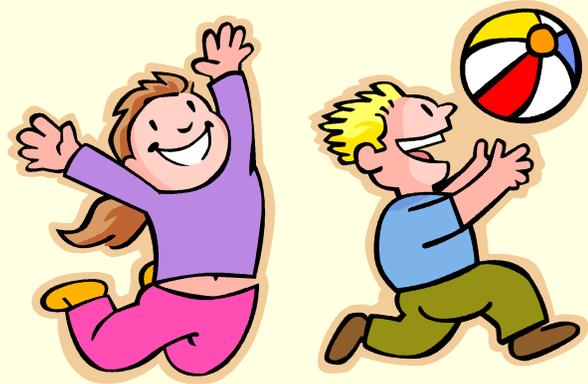
- In TIMSS 1995, although East Asian countries (Japan, Hong Kong, Chinese Taipei, Korea and Singapore) topped the mathematics performance, the students did not enjoy mathematics as much as the students from the western countries.
- Is enjoyment and achievement correlated?
- Do students have to be encouraged to do “hard” mathematics?

Concluding Point 1

- Is the East Asian culture of giving priority to common good against individual rights means that society can influence students to work at their studies.



But this is slowly changing.
Students will not learn if the
lessons are not motivating.



Concluding Point 1

- Again a balance
- Learning must be meaningful and in context and enjoyable if possible. In TIMSS 2003, Singapore students' enjoyment of mathematics improved significantly over TIMSS 1995 and 1999.
- But learning to sacrifice and to work hard and persevere to learn difficult concepts and solve difficult problems is also good value to cultivate.

Concluding Point 2

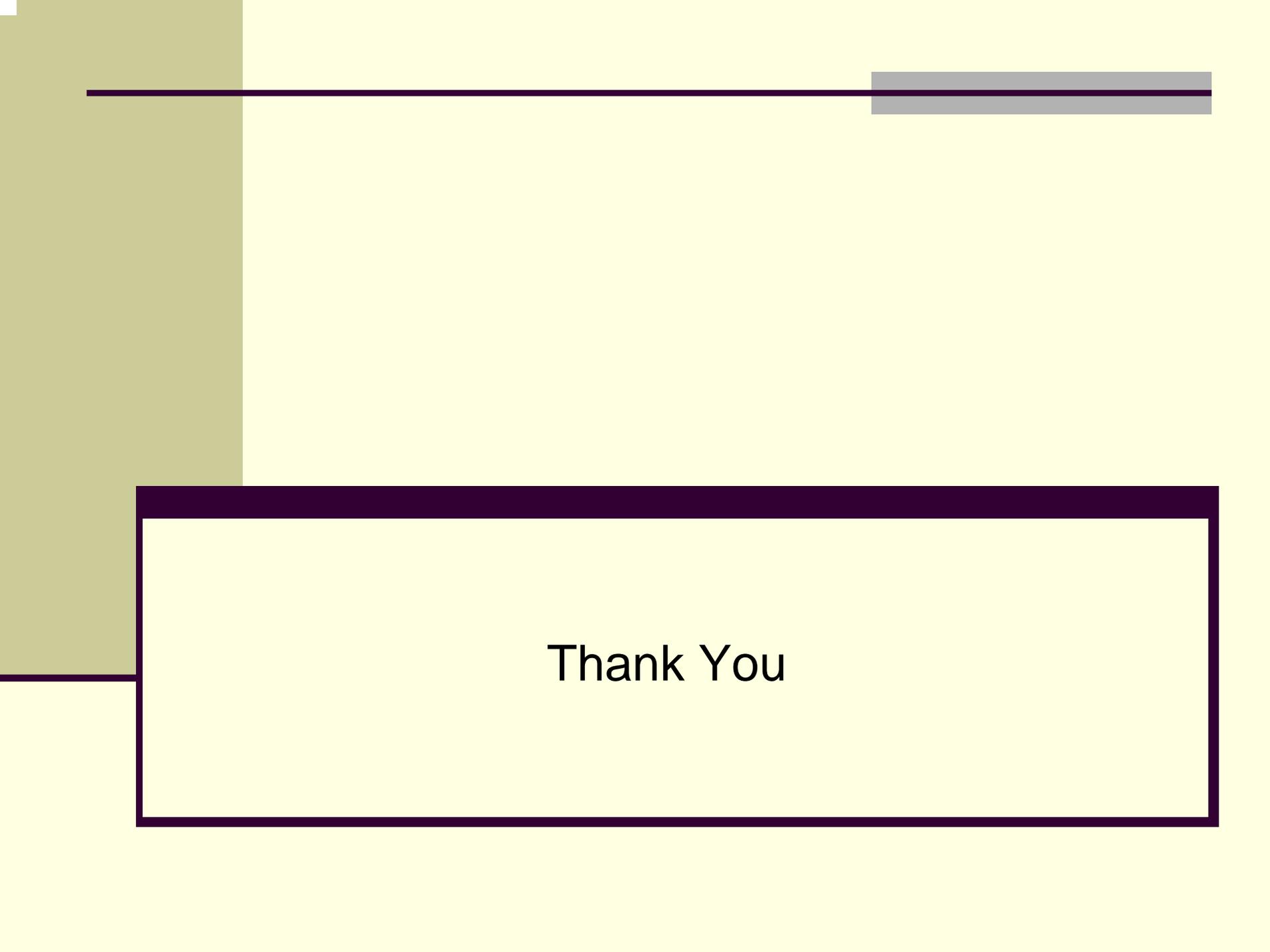
- In Japan and China, the problems used in open problem-solving could be open in solution methods or answers.
- Generally, they are strong in use of mathematics and emphasis may not be in “real-life” problem solving.
- Singapore uses a mixture, not with such high mathematics content as China and Japan. There is move towards using more mathematics in “real-life” situations.

Concluding Point 3

- In East Asian countries, the exam culture is very well established.
- Students are pragmatic and will work towards what counts in high stakes exams.
- Since assessment influences teaching approaches, assessments should move towards being more “real” and influence the teaching approaches towards nurturing the numeracy needed for living in today’s world.

Concluding Point 4

- How should we nurture numeracy (number sense, logical thinking, data interpretation, etc)?
- Should we learn mathematics through traditional topics and in order of difficulty or through the uses of mathematics as in numeracy for living in an informed manner in the 21st century? (Steen, 2001)
- Schools teach mathematics as a discipline through traditional topics and leave it to higher levels (tertiary courses) to use the mathematics concepts in useful applications.
- Is this too late?



Thank You