Programme for International Student Assessment
PISA 2015

Hong Kong Students' Performance in Mathematical Literacy

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Mathematical Literacy in PISA

Definition and its distinctive features

"an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain, and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgements and decisions needed by constructive, engaged and reflective citizens." (OECD, 2016, p.65)

Mathematical Literacy in PISA

Mathematical literacy is related to wider, functional use of mathematics. ***Engagement with mathematics*** includes the ability to recognise and formulate mathematical problems in various situations.

Knowledge Domain (Content)	Clusters of relevant mathematical areas and concepts: ▪ ***Quantity*** ▪ ***Space and shape*** ▪ ***Change and relationships*** ▪ ***Uncertainty and data***
Processes	▪ ***formulate*** ▪ ***employ*** ▪ ***interpret***
Context	Various areas of application of mathematics: ▪ ***Occupational*** ▪ ***Personal*** ▪ ***Scientific*** ▪ ***Societal***

Mathematical Literacy in PISA

Challenge in real world context

Mathematical content categories:
Quantity; Uncertainty and data; Change and relationships; Space and shape

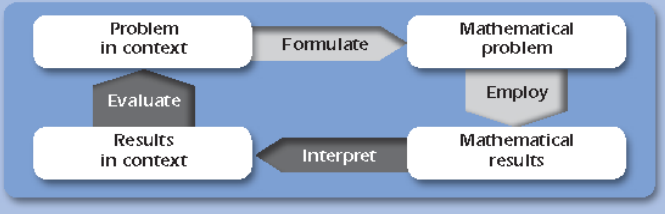
Real world context categories: Personal; Societal; Occupational; Scientific

Mathematical thought and action

Mathematical concepts, knowledge and skills

Fundamental mathematical capabilities:
Communication; Representation; Devising strategies; Mathematisation; Reasoning and argument; Using symbolic, formal and technical language and operations; Using mathematical tools

Processes: Formulate; Employ; Interpret/Evaluate



Hong Kong Students' Performance in Mathematics, Science and Reading from PISA 2000+ to 2015

	Mathematics		Science		Reading	
Cycle	Mean	S.E.	Mean	S.E.	Mean	S.E.
2000+	560	3.3	541	3.0	525	2.9
2003	550	4.5	539	4.3	(510)	3.7
2006	547	2.7	(542)	2.5	536	2.4
2009	555	2.7	(549)	2.8	533	2.1
2012	(561)	3.2	(555)	2.6	(545)	2.8
2015	548	3.0	523	2.5	527	2.7

* Values in parentheses are significantly different from the mean scores of PISA 2015.

Performance in Mathematical Literacy of Participating Countries/Economies in PISA 2015

Country/Economy	Mean	S.E.	Significance
Singapore	564	(1.5)	▲
Hong Kong-China	548	(3.0)	--
Macao-China	544	(1.1)	O
Chinese Taipei	542	(3.0)	O
Japan	532	(3.0)	▼
China (B-S-J-G) *	531	(4.9)	▼
Korea	524	(3.7)	▼
Switzerland	521	(2.9)	▼
Estonia	520	(2.0)	▼
Canada	516	(2.3)	▼
Netherlands	512	(2.2)	▼
Denmark	511	(2.2)	▼
…	…	…	
OECD Average	490	(0.4)	▼

Remarks
▼ O ▲ denotes score that is significantly higher than that of Hong Kong
O denotes score that is not significantly different from that of Hong Kong
denotes score that is significantly lower than that of Hong Kong

* Beijing, Shanghai, Jiangsu and Guangdong are collectively identified as "China (B-S-J-G)".

Performance in Mathematical Literacy
of Participating Countries/Economies in PISA 2015

Country/Economy	Mean	S.E.	Significance
OECD Average	490	(0.4)	▼
...	...	...	
Lebanon	396	(3.7)	▼
Colombia	390	(2.3)	▼
Peru	387	(2.7)	▼
Indonesia	386	(3.1)	▼
Jordan	380	(2.7)	▼
Brazil	377	(2.9)	▼
Republic of Macedonia	371	(1.3)	▼
Tunisia	367	(3.0)	▼
Kosovo	362	(1.6)	▼
Algeria	360	(3.0)	▼
Dominican Republic	328	(2.7)	▼

Remarks
▲ denotes score that is significantly higher than that of Hong Kong
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Mathematical Proficiency Levels

Score Range of the Mathematical Proficiency Levels

Proficiency Levels	Lower Score Limit
6	669.3
5	607.0
4	544.7
3	482.4
2	420.1
1	357.8
Below 1	Below 357.8

Proficiency Levels 1 – 6

- General ability of an individual in mathematics and related areas, and thus his/her ***prospects and capacity to participate fully in the society***
- Also implications for the role that the country will play in the advancing technological world, i.e. ***the country's competitiveness***

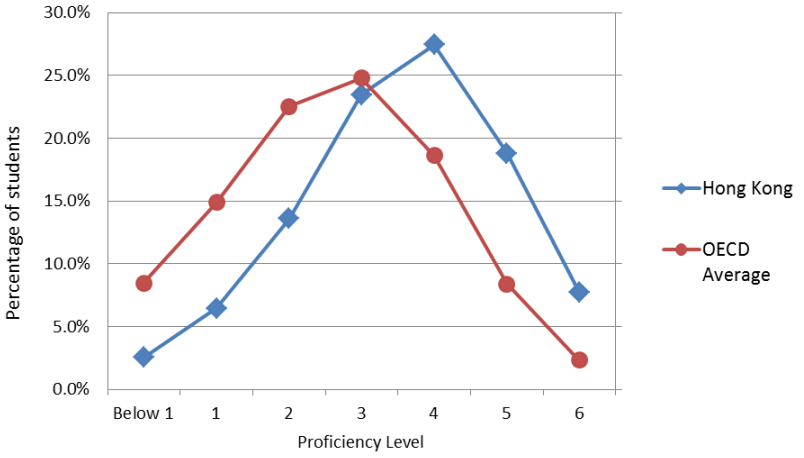
Level	Lower score Limit	What students can typically do at each level
6	669.3	At Level 6, students can conceptualise, generalise and utilise information based on their investigations and modelling of complex problem situations, and can use their knowledge in relatively non-standard contexts. They can link different information sources and representations and flexibly translate among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply this insight and understanding, along with a mastery of symbolic and formal mathematical operations and relationships, to develop new approaches and strategies for attacking novel situations. Students at this level can reflect on their actions, and can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situation.
5	607.0	At Level 5, students can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare and evaluate appropriate problem-solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations, and insight pertaining to these situations. They begin to reflect on their work and can formulate and communicate their interpretations and reasoning.
4	544.7	At Level 4, students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions. They can select and integrate different representations, including symbolic, linking them directly to aspects of real-world situations. Students at this level can utilise their limited range of skills and can reason with some insight, in straightforward contexts. They can construct and communicate explanations and arguments based on their interpretations, arguments and actions.
3	482.4	At Level 3, students can execute clearly described procedures, including those that require sequential decisions. Their interpretations are sufficiently sound to be a base for building a simple model or for selecting and applying simple problem-solving strategies. Students at this level can interpret and use representations based on different information sources and reason directly from them. They typically show some ability to handle percentages, fractions and decimal numbers, and to work with proportional relationships. Their solutions reflect that they have engaged in basic interpretation and reasoning.
2	420.1	At Level 2, students can interpret and recognise situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. Students at this level can employ basic algorithms, formulae, procedures or conventions to solve problems involving whole numbers. They are capable of making literal interpretations of the results.
1	357.8	At Level 1, students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined. They are able to identify information and to carry out routine procedures according to direct instructions in explicit situations. They can perform actions that are almost always obvious and follow immediately from the given stimuli.

Percentage of Students
at each Level of Proficiency
on the scale of mathematical literacy
Hong Kong vs OECD Average

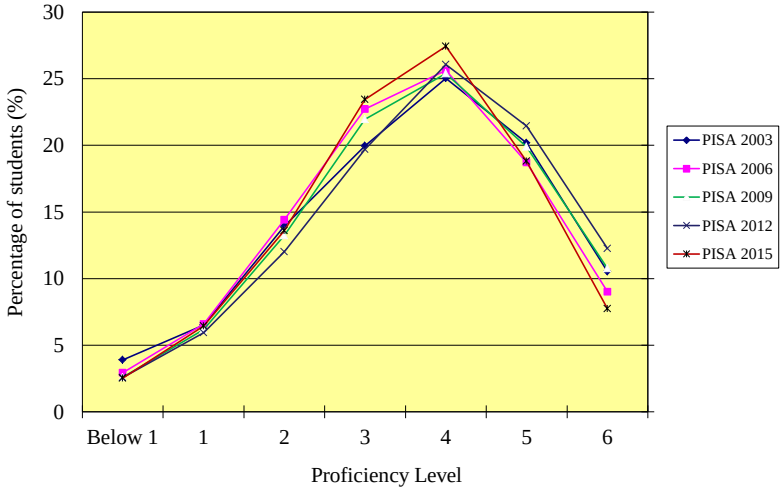
	Hong Kong	OECD Average	Difference (HK – OECD)
Level 6	7.7%	2.3%	**+5.4% *****
Level 5	18.8%	8.4%	**+10.4% *****
Level 4	27.4%	18.6%	**+8.8% *****
Level 3	23.4%	24.8%	-1.4%
Level 2	13.6%	22.5%	**-9.0% *****
Level 1	6.4%	14.9%	**-8.4% *****
Below Level 1	2.5%	8.5%	**-5.9% *****

*** Difference is significant at 0.001 level.

Percentage of Students
at each Level of Proficiency
on the scale of mathematical literacy in PISA 2015
Hong Kong vs OECD Average



Percentage of Students
at each Level of Proficiency
on the scale of mathematical literacy in PISA in Hong Kong



Percentage of Hong Kong Students
at each Level of Proficiency
on the scale of mathematical literacy

	PISA 2003	PISA 2006		PISA 2009		PISA 2012		PISA 2015	
Level 6	10.5	9.0	(–1.5)	10.8	(+1.8)	12.3	(+1.5)	**7.7**	**(-4.5 ***)**
Level 5	20.2	18.7	(–1.4)	19.9	(+1.2)	21.4	(+1.5)	**18.8**	**(-2.6 *)**
Level 4	25.0	25.6	(+0.6)	25.4	(–0.2)	26.1	(+0.7)	27.4	(+1.4)
Level 3	20.0	22.7	(+2.8)	21.9	(–0.8)	19.7	(-2.3)	**23.4**	**(+3.8 **)**
Level 2	13.9	14.4	(+0.5)	13.2	(–1.2)	12.0	(-1.2)	**13.6**	**(+1.6)**
Level 1	6.5	6.6	(+0.1)	6.2	(–0.4)	5.9	(-0.2)	6.4	(+0.5)
Below Level 1	3.9	2.9	(–1.0)	2.6	(–0.4)	2.6	(0.0)	2.5	(0.0)

Numbers in brackets are DIFFERENCES (expressed by percentage points) from the corresponding percentages in the *previous* PISA cycle.

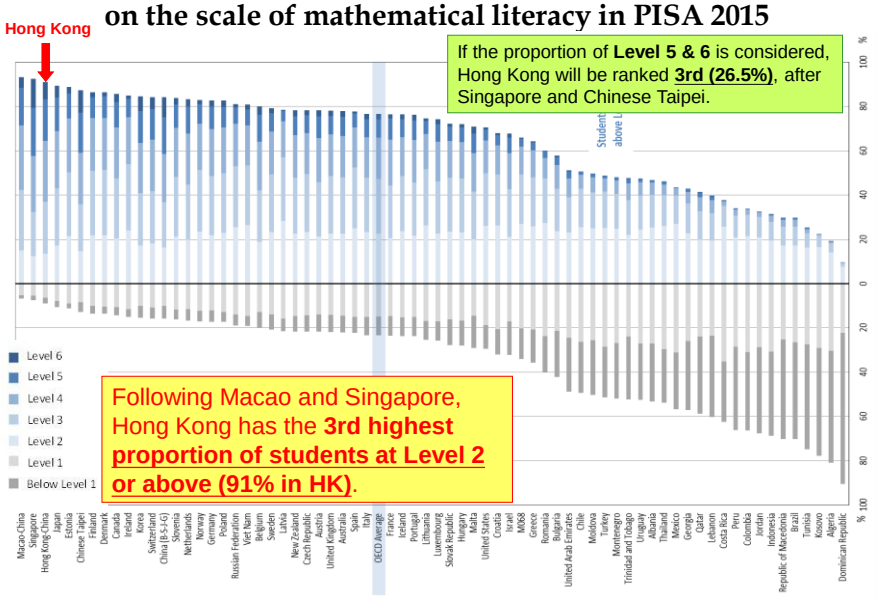
* Difference is significant at the 0.05 level. ** Difference is significant at the 0.01 level.
*** Difference is significant at the 0.001 level.

Percentage of Students at Proficiency Level 5 or Above in Countries / Economies with a Total of More Than 20%

Country/Economy	Percentage at Level 5 (606.99 – 669.30)	Percentage at Level 6 (above 669.30)	Total Percentage at Level 5 or Above
Singapore	21.7%	13.1%	34.8%
Chinese Taipei	18.0%	10.1%	28.1%
Hong Kong	**18.8%**	**7.7%**	**26.5%**
China (B-S-J-G)	16.6%	9.0%	25.6%
Macao-China	16.9%	5.0%	21.9%
Korea	14.3%	6.6%	20.9%
Japan	15.0%	5.3%	20.3%
OECD countries	*8.4%*	*2.3%*	*10.7%*

* Beijing, Shanghai, Jiangsu and Guangdong are collectively identified as “China (B-S-J-G)”.

Percentage of students
at each LEVEL OF PROFICIENCY
on the scale of mathematical literacy in PISA 2015



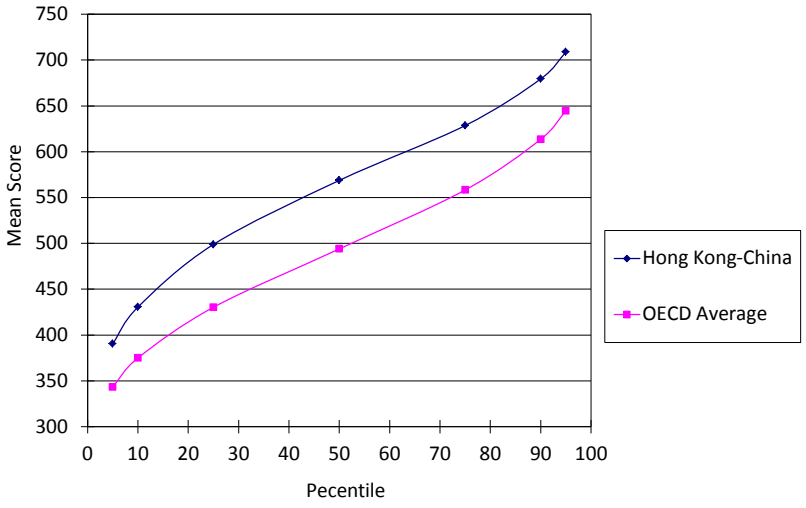
Comparison of Percentile Scores between Hong Kong and OECD Average in Mathematical Literacy
at Different Percentiles

Percentile	Hong Kong		OECD		Difference in Scores (HK - OECD)
	Score	S.E.	Score	S.E.	
5th	389	(5.8)	340	(0.8)	49 ***
10th	426	(5.0)	373	(0.7)	54 ***
25th	490	(4.3)	428	(0.6)	62 ***
50th	554	(3.3)	492	(0.5)	61 ***
75th	611	(2.8)	553	(0.5)	57 ***
90th	659	(3.5)	605	(0.6)	54 ***
95th	687	(4.6)	634	(0.7)	53 ***

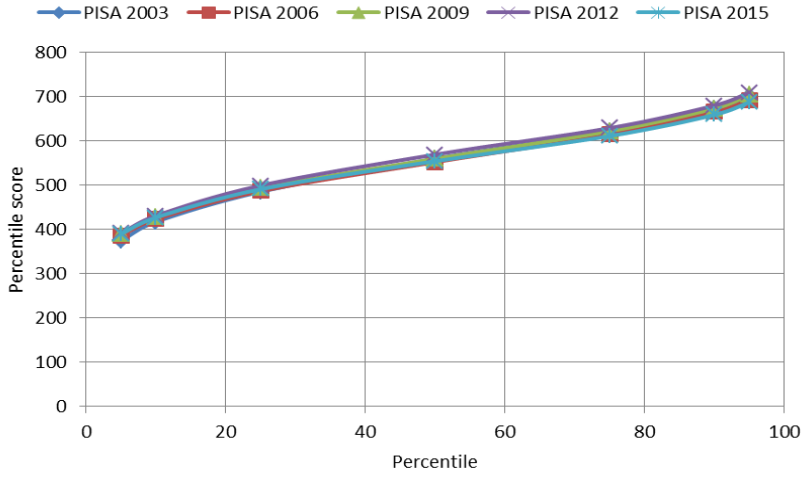
*** Mean difference is significant at the 0.001 level.

Comparison of Percentile Scores between Hong Kong and OECD Average in Mathematical Literacy

at Different Percentiles

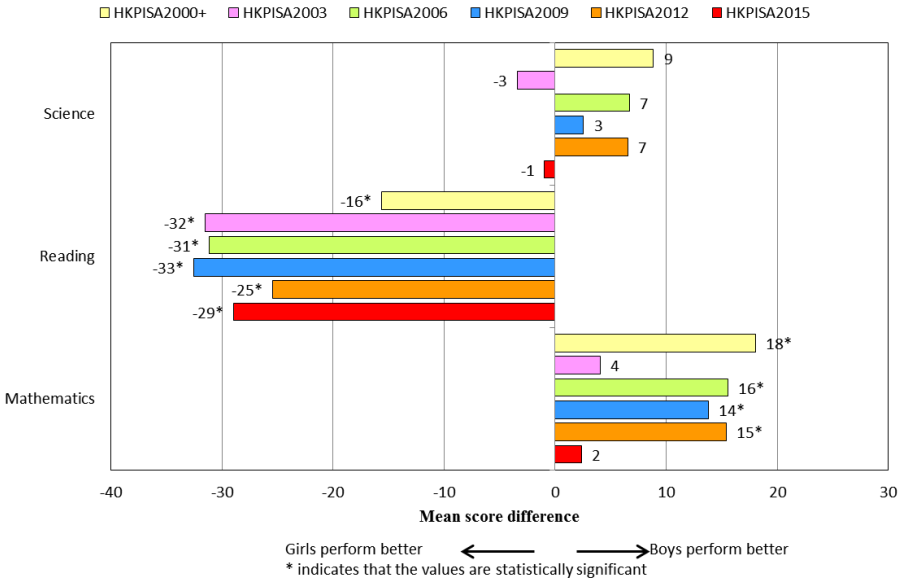


Percentile Scores in Mathematical Literacy from 2003 to 2015



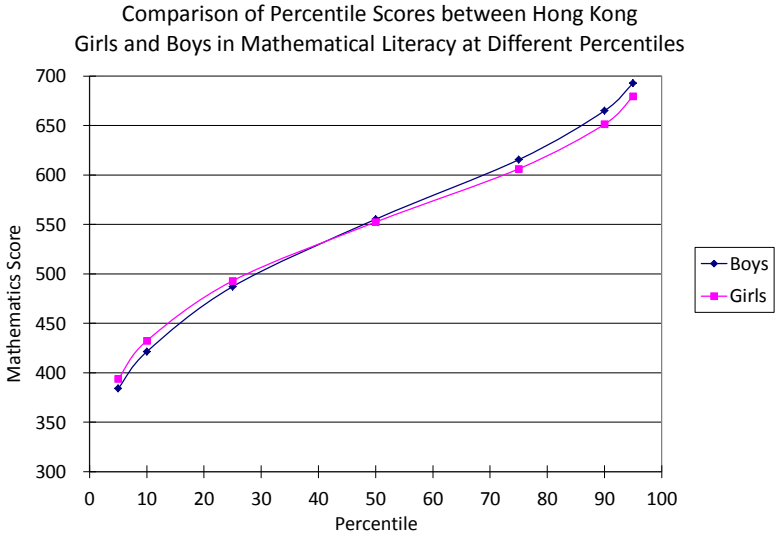
The scores at 50th to 95th percentiles in PISA 2015 are significantly lower than those in PISA 2012.

Gender Differences in Mathematical, Scientific & Reading Literacy from HKPISA 2000+ to HKPISA 2015



Boys perform as well as Girls (1)

Percentile Scores on the scale of mathematical literacy



Boys perform as well as Girls (1)

Percentile Scores on the scale of mathematical literacy

Percentile Scores of Hong Kong Girls and Boys

Percentile	Boys		Girls		Differences
	Score	S.E.	Score	S.E.	(Boys - Girls)
5th	384	(8.0)	394	(7.9)	-10
10th	421	(6.2)	432	(6.9)	-11
25th	487	(5.6)	493	(5.9)	-6
50th	555	(4.0)	552	(4.5)	3
75th	615	(3.7)	606	(4.4)	9
90th	665	(4.2)	651	(4.7)	14 *
95th	693	(5.7)	679	(6.7)	13
Whole Population	549	(3.6)	547	(4.3)	2

* Score difference is significant at the 0.05 level.

Boys perform as well as Girls (2)

at most of the Proficiency Levels of mathematical literacy

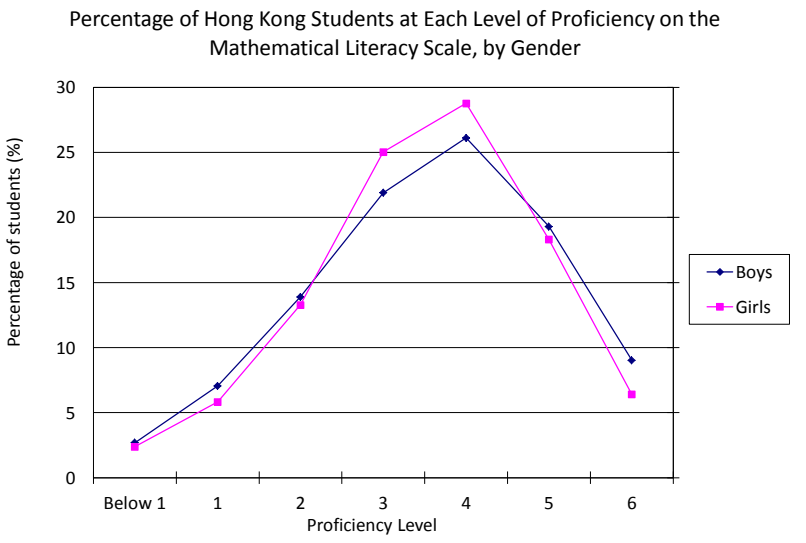
Proportion of HK students at each level of proficiency by gender

Proficiency Level	Boys		Girls		Difference in Percentage Points (Boys - Girls)
	%	S.E.	%	S.E.	
6	9.0	(0.8)	6.4	(1.0)	**2.6 ***
5	19.3	(1.3)	18.3	(1.3)	1.0
4	26.1	(1.3)	28.8	(1.4)	-2.7
3	21.9	(1.1)	25.0	(1.4)	-3.1
2	13.9	(1.0)	13.3	(1.3)	0.6
1	7.1	(0.7)	5.8	(0.7)	1.2
Below 1	2.7	(0.6)	2.4	(0.5)	0.3

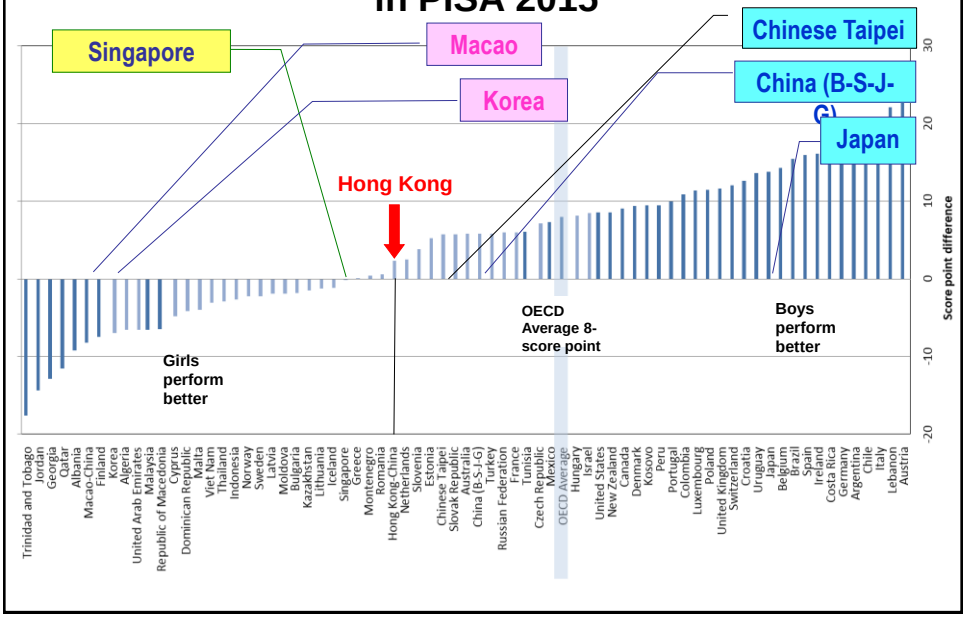
* Difference is significant at the 0.05 level.

Boys perform as well as Girls (2)

at most of the Proficiency Levels of mathematical literacy



Gender Differences in Mathematical Literacy in PISA 2015



Gender Difference
in Science, Reading & Mathematics Performance
(From HKPISA 2006 to 2015)

	Difference #					
	2015 - 2006		2015 – 2009		2015 - 2012	
	Boys	Girls	Boys	Girls	Boys	Girls
Science	-23 ***	-15 *	-27 ***	-24 ***	-35 ***	-28 ***
Reading	-8	-10	-5	-9	-20 **	-17 *
Mathematics	-6	7	-12	0	-19 **	-6

The minor discrepancy in the difference is due to the rounding of numbers.

The performance of both boys and girls dropped in 2015.

But the boys have dropped in performance *more substantially than girls*.

	PISA 2006				PISA 2009				PISA 2012				PISA 2015			
	Boys		Girls		Boys		Girls		Boys		Girls		Boys		Girls	
	Mean score	S.E.	Mean score	S.E.	Mean score	S.E.	Mean score	S.E.	Mean score	S.E.	Mean score	S.E.	Mean score	S.E.	Mean score	S.E.
Science	546	(3.5)	539	(3.5)	550	(3.8)	548	(3.4)	558	(3.6)	551	(3.1)	523	(3.1)	524	(3.4)
Reading	520	(3.5)	551	(3.0)	518	(3.3)	550	(2.8)	533	(3.8)	558	(3.3)	513	(3.4)	541	(3.6)
Mathematics	555	(3.9)	540	(3.7)	561	(4.2)	547	(3.4)	568	(4.6)	553	(3.9)	549	(3.6)	547	(4.3)

Conclusion

- Let's *not* focus only on the ***ranking***.
- Performance of HK students in mathematical area is still ***strong*** – much better than most other countries.
- Performance of HK students in mathematical area is ***stable*** and *consistently gratifying* throughout the years (2003 to 2015).
- With such good grounds, we may target at developing our students in their "**mathematical literacy**" in its more general sense **adaptable to the technological advanced world in wide-ranging contexts**, not only those calling for reproduction of mathematical skills.

Conclusion *(continued)*

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- With such good grounds, we may target at developing our students in their "**mathematical literacy**" in its more general sense **adaptable to the technological advanced world in wide-ranging contexts**, not only those calling for reproduction of mathematical skills.

- The narrowing **gender difference**, now reduced to *statistically insignificant*, may suggest more **equity**.
- The **slight drop** of the 2015 results in most aspects as compared with 2012 (and also previous years) is worth further investigation.