PISA 2006

(School Seminar)

Hong Kong Students' Mathematical Literacy:

From PISA 2000+ to PISA 2006

WONG Ka Lok

10 December 2007

Mathematical Literacy in PISA 2006

Definition and its distinctive features	The capacity of an individual to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. ***Mathematical literacy*** is related to wider, functional use of mathematics; engagement 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*
Competencies involved (Processes)	Competency clusters define skills needed for mathematics: • *Reproduction* (simple mathematical operations) • *Connections* (bringing together ideas to solve straightforward problems) • *Reflection* (wider mathematical thinking)
Context and situation	The area of application of mathematics, focusing on uses in relation to personal, social and global settings such as: • *Personal* • *Educational and occupational* • *Public* • *Scientific*

Adapted from *PISA 2006 Science Competencies for Tomorrow's World Vol. 1* (OECD 2007)

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

Figure 6.18

Summary descriptions of the six proficiency levels in mathematics

Level	Lower score limit	What students can typically do
6	669.3	At Level 6 students can conceptualise, generalise, and utilise information based on their investigations and modelling of complex problem situations. 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 understandings 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 formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situations.
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 can reflect on their actions and 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 ones, linking them directly to aspects of real-world situations. Students at this level can utilise well-developed skills and reason flexibly, with some insight, in these 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. They can select and apply simple problem solving strategies. Students at this level can interpret and use representations based on different information sources and reason directly from them. They can develop short communications reporting their interpretations, results 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. They are capable of direct reasoning and 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 obvious and follow immediately from the given stimuli.

Details can be found in OECD (2007) *PISA 2006: Science Competencies for Tomorrow's World, Volume 1* (p.312), available at http://www.pisa.oecd.org/.

Comparison of Performance in Science, Mathematics and Reading from PISA2000+, 2003 to 2006

	Science		Mathematics		Reading	
Year	Mean	S.E.	**Mean**	S.E.	Mean	S.E.
2000+	(541)	3.0	(560)	3.3	525	2.9
2003	(539)	4.3	**550**	4.5	510	3.7
2006	542	2.5	**547***	2.7	536**	2.4

* significant difference between 2006 and 2003

Performance in Mathematical Literacy

of Participating Countries/Regions in PISA 2006

Country/Region	Mean	S.E.	Significance
Chinese Taipei	549	(4.1)	O
Finland	548	(2.3)	O
Hong Kong-China	**547**	**(2.7)**	--
Korea	547	(3.8)	O
Netherlands	531	(2.6)	▼
Switzerland	530	(3.2)	▼
Canada	527	(2.0)	▼
Macao-China	525	(1.3)	▼
Liechtenstein	525	(4.2)	▼
Japan	523	(3.3)	▼
……	…	…	…
OECD Average	**498**	**(0.5)**	
France	496	(3.2)	▼
United Kingdom	495	(2.1)	▼
……	…	…	…
Kyrgyzstan	311	(3.4)	▼

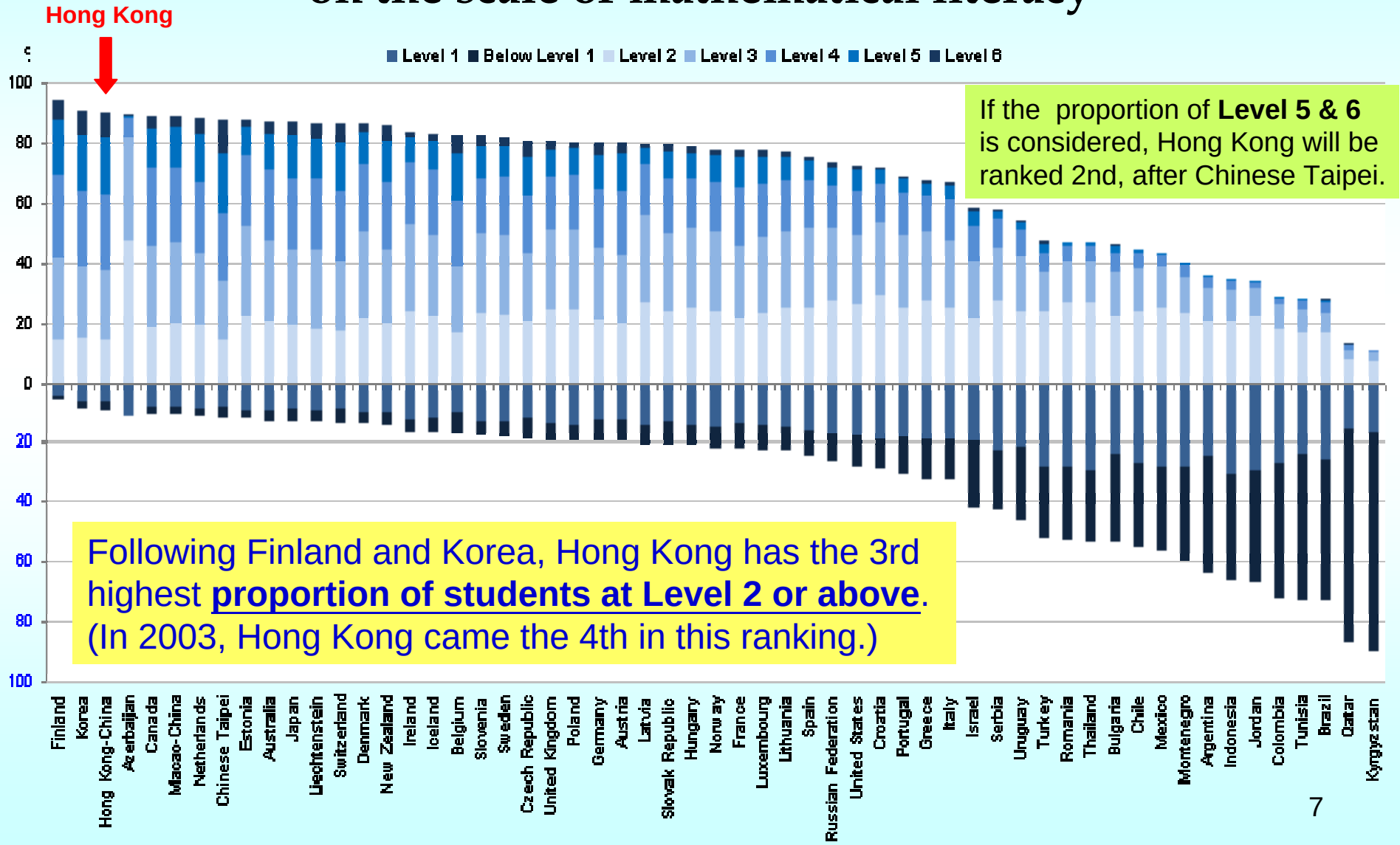
Note: O denotes score that is not significantly different from that of Hong Kong.
▼ denotes score that is significantly lower than that of Hong Kong.

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

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



If the proportion of **Level 5 & 6** is considered, Hong Kong will be ranked 2nd, after Chinese Taipei.

Following Finland and Korea, Hong Kong has the 3rd highest **proportion of students at Level 2 or above**. (In 2003, Hong Kong came the 4th in this ranking.)

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	9.0%	3.3%	**5.7% ****
Level 5	18.7%	10.0%	**8.7% ****
Level 4	25.6%	19.1%	**6.5% ****
Level 3	22.7%	24.3%	–1.6%
Level 2	14.4%	21.9%	– 7.5% **
Level 1	6.6%	13.6%	– 7.0% **
Below Level 1	2.9%	7.7%	– 4.8% **

** Difference is significant at the 0.01 level.

Percentage of Correct Answers (1)

Hong Kong and the OECD Average

Distribution of Items …	Number of items	Percent Correct: Hong Kong	Percent Correct: OECD Average
by Mathematical Strand (content)			
Algebra	1	**22**	7
Discrete Mathematics	2	**59**	43
Functions	5	**65**	59
Geometry	11	**54**	43
Number	14	**65**	55
Probability	3	**58**	52
Statistics	12	**57**	44
by "overarching ideas"			
Change and relationships	13	**58**	48
Quantity	13	**66**	55
Space and Shape	11	**54**	43
Uncertainty	11	**56**	45

Percentage of Correct Answers (2)

Hong Kong and the OECD Average

Distribution of Items …	Number of items	Percent Correct: Hong Kong	Percent Correct: OECD Average
by Competency Class (process)			
Reproduction	11	**75**	68
Connection	24	**58**	47
Reflection	13	**47**	34
by Situation (context)			
Educational	7	**58**	46
Intra-Mathematical	1	**16**	12
Occupational	1	**34**	30
Personal	9	**67**	59
Public	18	**62**	49
Scientific	12	**54**	44

Percentage of Correct Answers (3)

Hong Kong and the OECD Average

Distribution of Items …	Number of items	Percent Correct: Hong Kong	Percent Correct: OECD Average
by Item Format			
Multiple-Choice	12	**68**	58
Complex Multiple-Choice	9	**51**	43
Closed-Constructed Response	6	**73**	65
Open-Constructed Response	11	**47**	32
Short Response	10	**59**	49

For ***whatever*** **dimensions/categories**, the percentages of correct answers of Hong Kong 15-year-old students are **HIGHER** than the OECD Average.

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

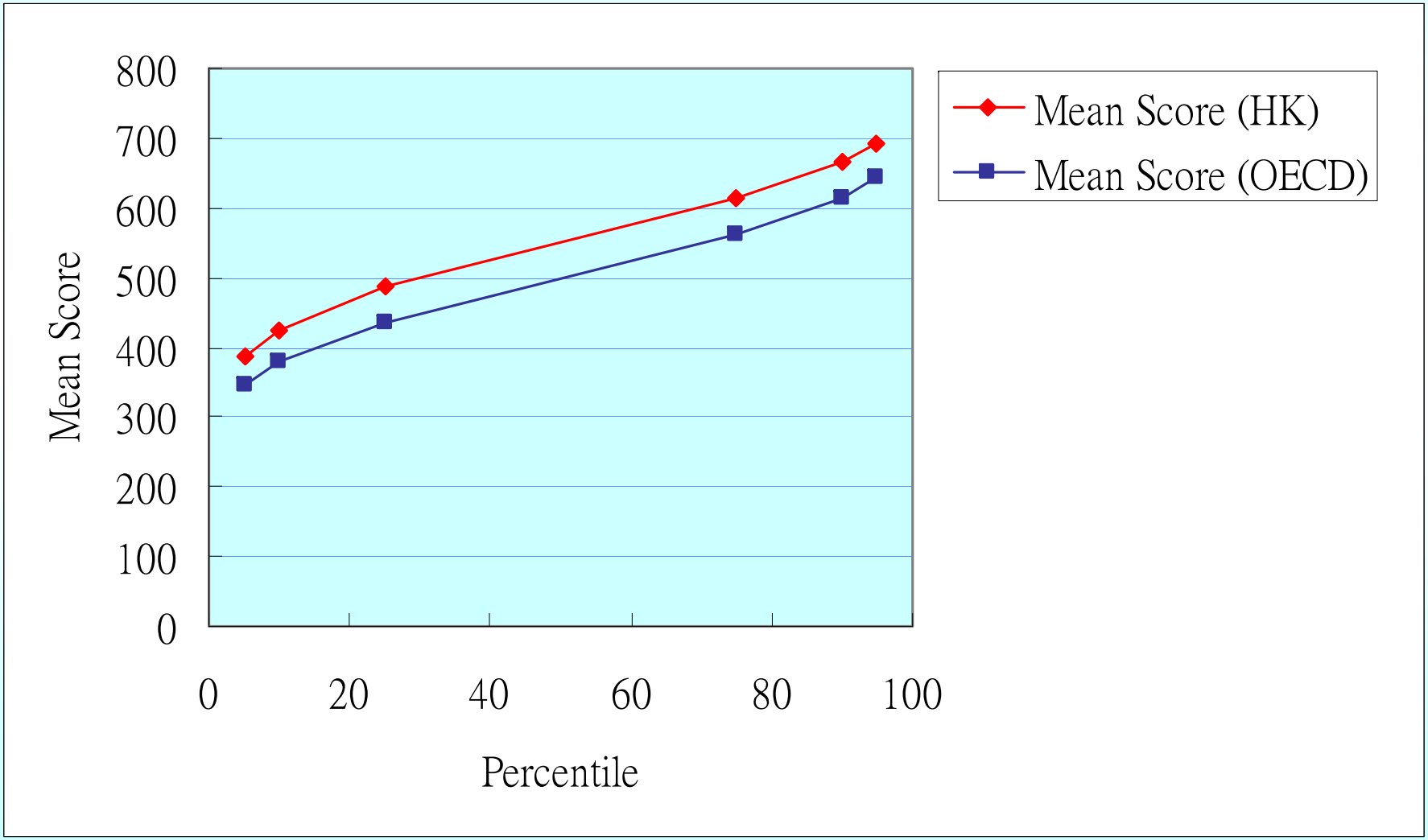
at Different Percentiles

Percentile	Hong Kong		OECD		Difference in Mean Scores (HK - OECD)
	Average	S.E.	Average	S.E.	
5th	386	(6.1)	346	(1.1)	40 ***
10th	423	(6.4)	379	(0.9)	43 ***
25th	486	(4.5)	436	(0.7)	50 ***
75th	614	(3.1)	561	(0.6)	53 ***
90th	665	(3.5)	615	(0.8)	50 ***
95th	692	(4.8)	645	(0.9)	47 ***

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

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

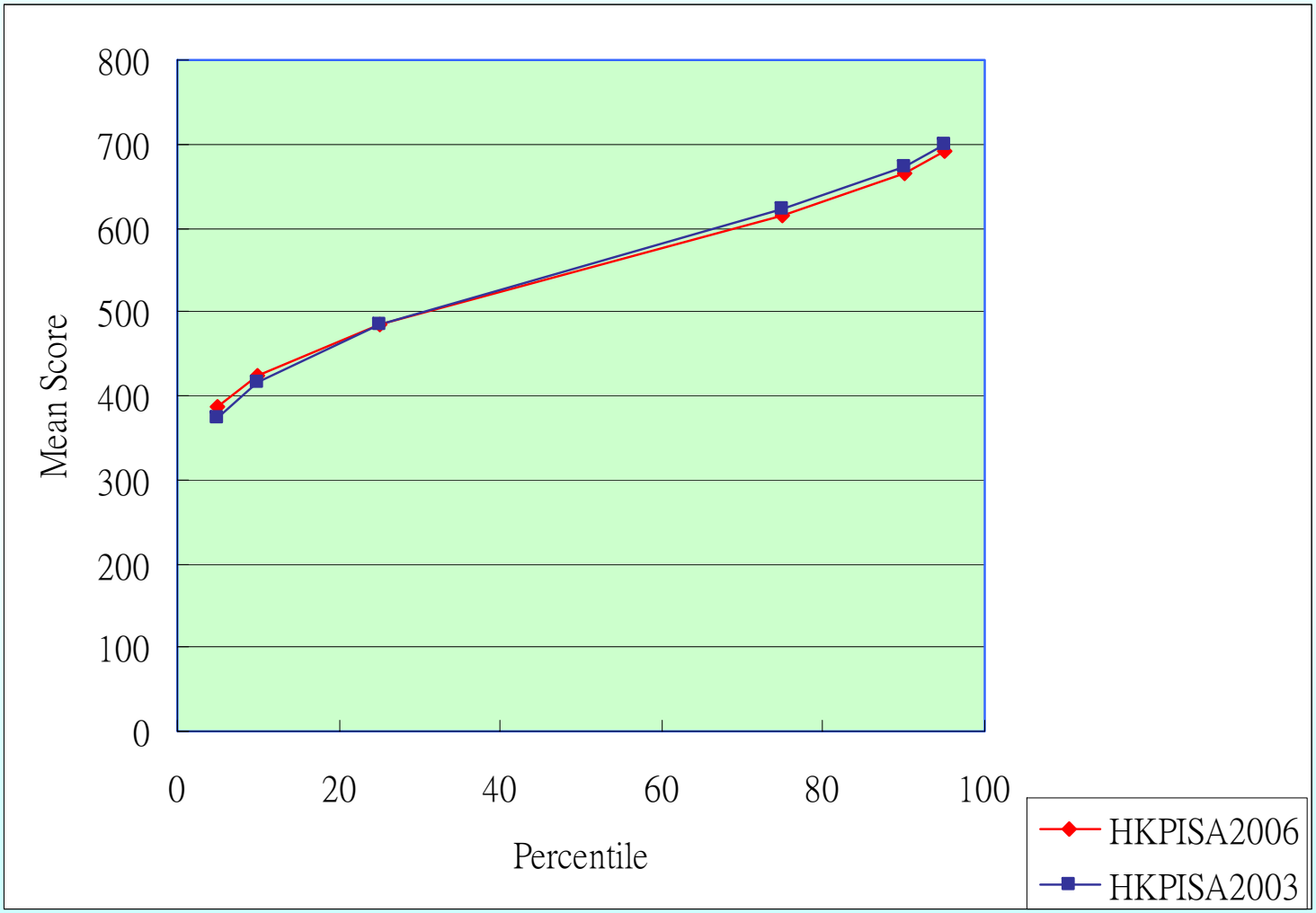
at Different Percentiles



Mean Scores from 2003 to 2006

in Mathematical Literacy

at Different Percentiles



Percentage of Students

at each Level of Proficiency

on the scale of mathematical literacy

HKPISA 2003 and 2006

	PISA 2006	PISA 2003	Difference 2006 – 2003
Level 6	9.0%	10.5%	**–1.5%**
Level 5	18.7%	20.2%	**–1.4%**
Level 4	25.6%	25.0%	**0.6%**
Level 3	22.7%	20.0%	**2.8%**
Level 2	14.4%	13.9%	**0.5%**
Level 1	6.6%	6.5%	**0.1%**
Below Level 1	2.9%	3.9%	**–1.0%**

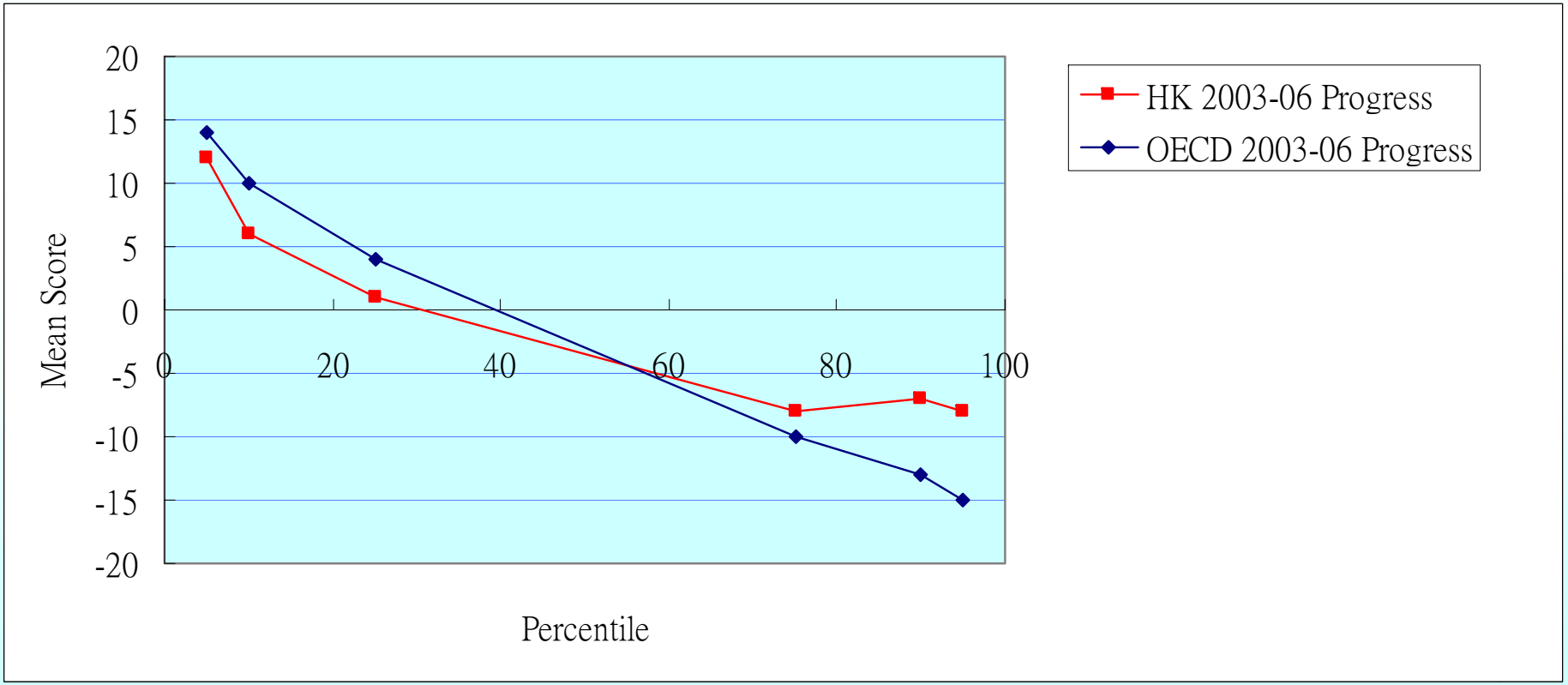
No significant differences at all levels of proficiency between 2006 vs 2003

Progress of Mean Scores from 2003 to 2006

in Mathematical Literacy

at Different Percentiles

(Comparison between HK and OECD Average)



Comparison of the Percentage of Correct Answers (1)
HKPISA 2003 Vs HKPISA 2006
(on the 48 common Mathematics items)

	No. of items	Percent Correct 2006	2003
Distribution of Items by Competency Class (process)			
Reproduction	11	**75**	**75**
Connections	24	**58**	**58**
Reflection	13	**47**	**46**
Distribution of Items by "overarching ideas"			
Change and relationships	13	**58**	**56**
Quantity	13	**66**	**66**
Space and Shape	11	**54**	**56**
Uncertainty	11	**56**	**56**
Distribution of Items by Item Format			
Multiple-Choice	12	**68**	**69**
Complex Multiple-Choice	9	**51**	**51**
Closed-Constructed Response	6	**73**	**71**
Open-Constructed Response	11	**47**	**46**
Short Response	10	**59**	**59**

Comparison of the Percentage of Correct Answers (2)

HKPISA 2003 Vs HKPISA 2006

(on the 48 common Mathematics items)

	Number of items	Percent Correct 2006	Percent Correct 2003
Distribution of Items by Mathematical Strand (content)			
Algebra	1	**22**	**19**
Discrete Mathematics	2	**59**	**60**
Functions	5	**65**	**62**
Geometry	11	**54**	**56**
Number	14	**65**	**65**
Probability	3	**58**	**56**
Statistics	12	**57**	**56**
Distribution of Items by Situation (context)			
Educational	7	**58**	**56**
Intra-Mathematical	1	**16**	**19**
Occupational	1	**34**	**29**
Personal	9	**67**	**68**
Public	18	**62**	**62**
Scientific	12	**54**	**53**

Percentage of Correct Answers in Change and Relationships and Space and Shape

Comparison between PISA+, PISA2003, and 2006

	PISA 2006	PISA 2003	PISA +
Change and Relationships	58	54	57
Space and Shape	54	59	62

	Difference (in Percentage Points)					
	2006-2003	**S.E.**	**2006-2002#**	**S.E.**	**2003-2002#**	**S.E.**
Change & Relationships	**4**	(7.7)	**1**	(8.0)	**-3**	(6.7)
Space & Shape	**-5**	(8.1)	**-8**	(8.3)	**-3**	(7.5)

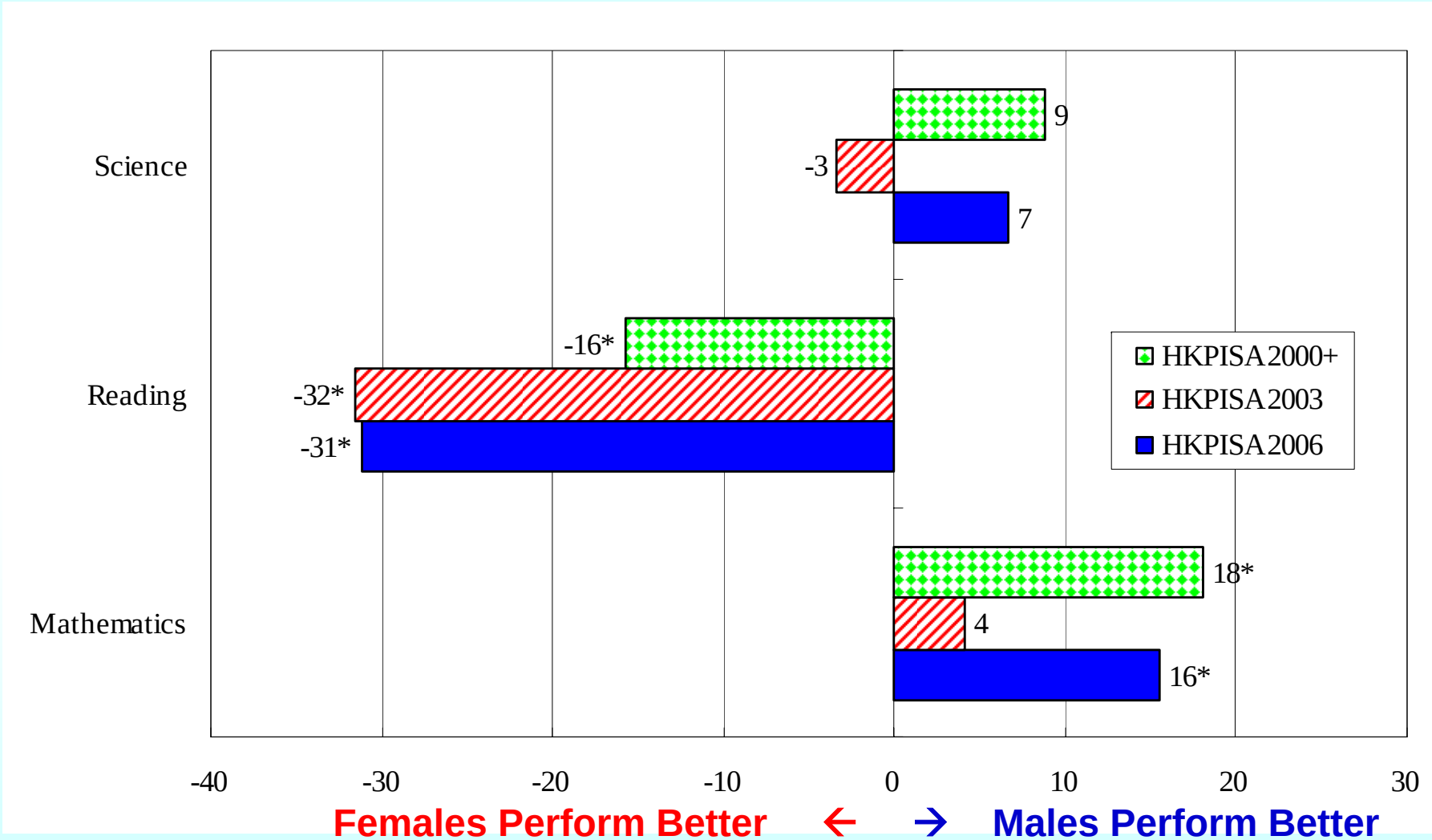
PISA+ was implemented in February 2002.

Student Performance on the Mathematics Literacy Scale:

Difference between High & Low Achievers

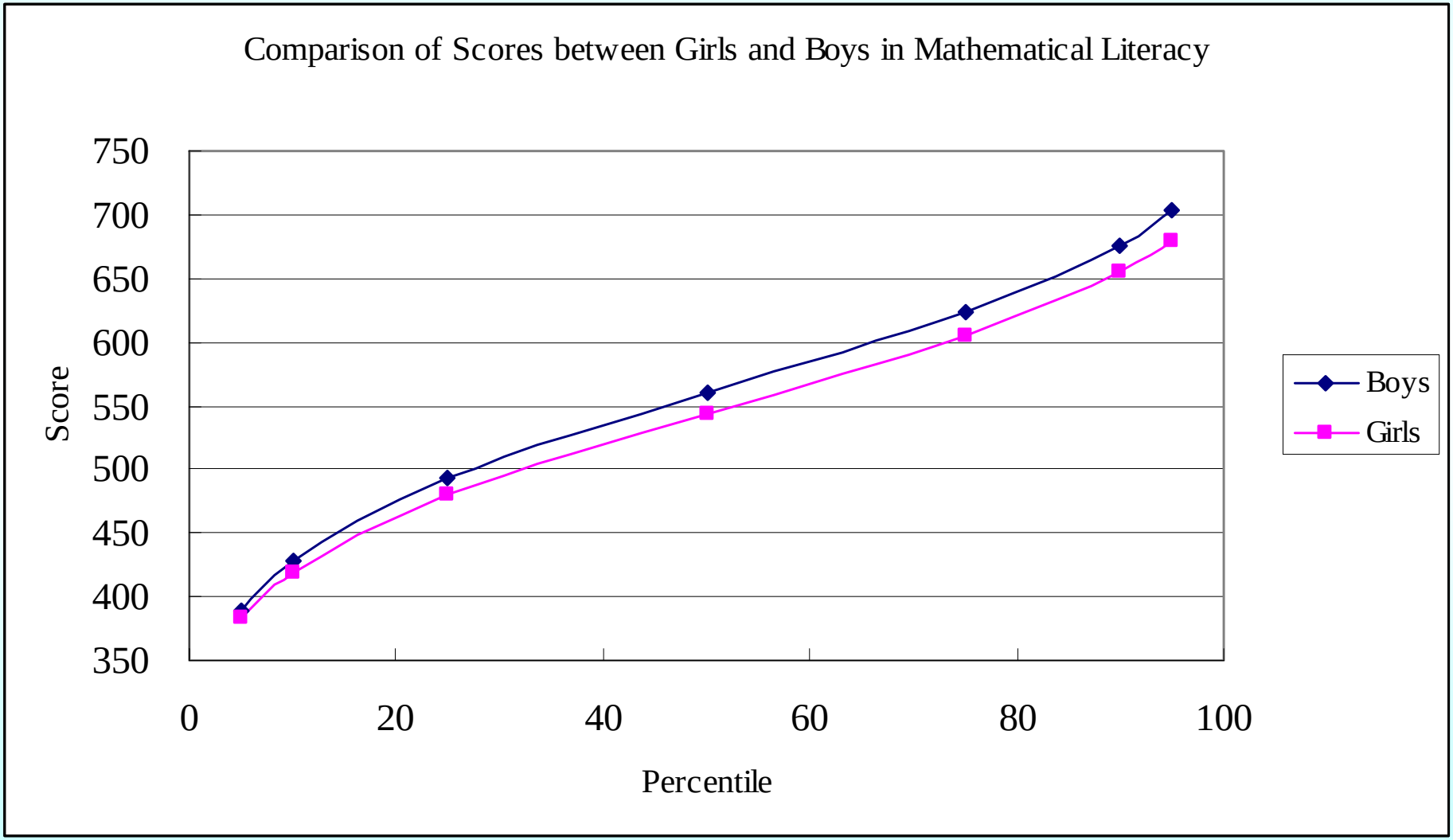
	Mean Score	S.E.	5th Percentile Score	S.E.	95th Percentile Score	S.E.	Difference (95th-5th)
...	...	...	...	...	...	...	...
Chinese Taipei	549	(4.1)	373	(7.2)	707	(3.9)	333
...	...	...	...	...	...	...	...
Hong Kong-China	547	(2.7)	386	(6.1)	692	(4.8)	306
...	...	...	...	...	...	...	...
Korea	547	(3.8)	392	(7.1)	694	(8.2)	302
...	...	...	...	...	...	...	...
OECD average	498	(0.5)	346	(1.1)	645	(0.9)	300
...	...	...	...	...	...	...	...
Japan	523	(3.3)	370	(6.4)	668	(4.2)	298
...	...	...	...	...	...	...	...
Macao-China	525	(1.3)	384	(3.6)	660	(3.3)	276
...	...	...	...	...	...	...	...
Finland	548	(2.3)	411	(5.0)	678	(3.0)	266
...	...	...	...	...	...	...	...

Gender Differences in Scientific, Reading & Mathematical Literacy in HKPISA 2000+, HKPISA 2003 and HKPISA 2006

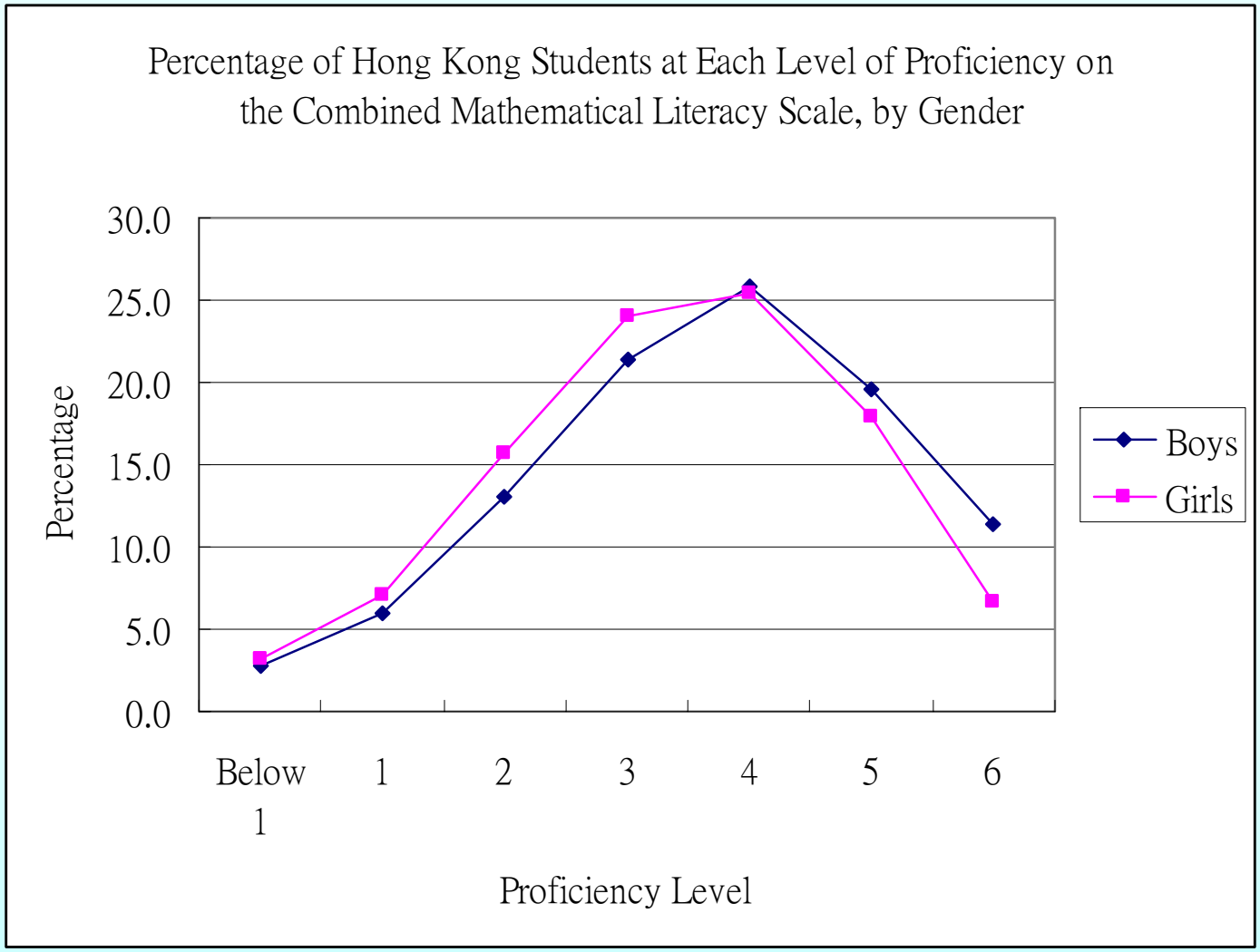


Note: 1. Values that are statistically significant are indicated by an asterisk *.
2. This graph is reproducing Figure 5.6.1 from Preliminary Report (p.24).

Boys are better than **Girls** (1)
on the scale of mathematical literacy



Boys are better than **Girls** (2) on the scale of mathematical literacy



Implications

- Not be concerned too much with the ranking
- Performance in mathematical area still proven to be “strong”
- Getting our students prepared in their “mathematical literacy” in its more general sense adaptable to wide-ranging contexts as well as to both genders