

PISA 2009 Scientific Literacy

Performance of Hong Kong Students

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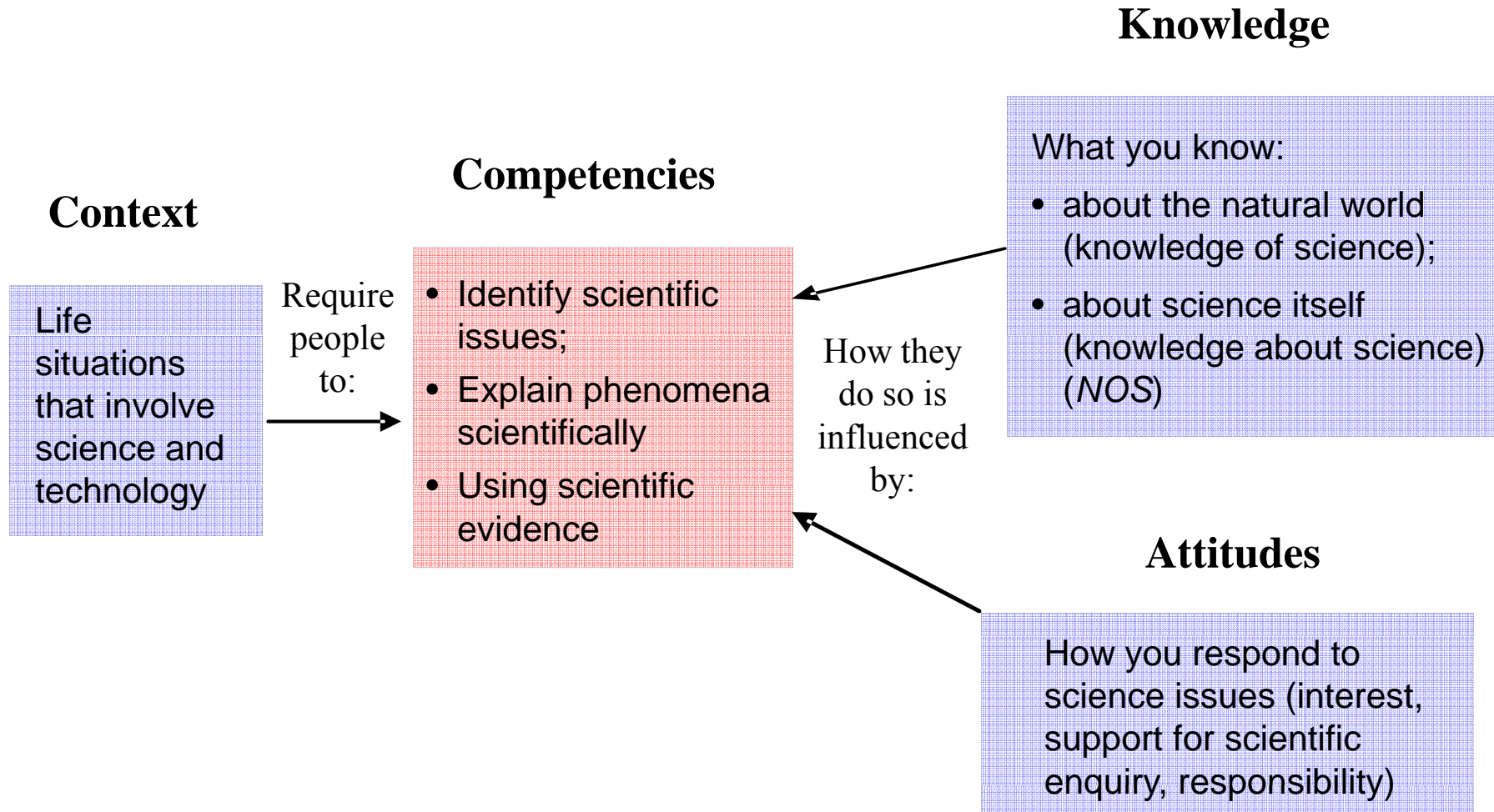
Outline

- Assessment framework
- Sample questions
- Findings and “implications”

Scientific Literacy Defined in PISA

- scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues
- understanding of the characteristic features of science as a form of human knowledge and enquiry
- awareness of how science and technology shape our material, intellectual and cultural environments
- willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen

Framework



Competencies

Identifying scientific issues:

- Recognising issues that are possible to investigate scientifically
- Identifying keywords to search for scientific information
- Recognising the key features of a scientific investigation

Competencies

Explaining phenomena scientifically

- Applying knowledge of science in a given situation
- Describing or interpreting phenomena scientifically and predicting changes
- Identifying appropriate descriptions, explanations and predictions

Competencies

Using scientific evidence

- Interpreting scientific evidence and making and communicating conclusions
- Identifying the assumptions, evidence and reasoning behind conclusions
- Reflecting on the societal implications of science and technological development

Knowledge of/about science

Knowledge of science

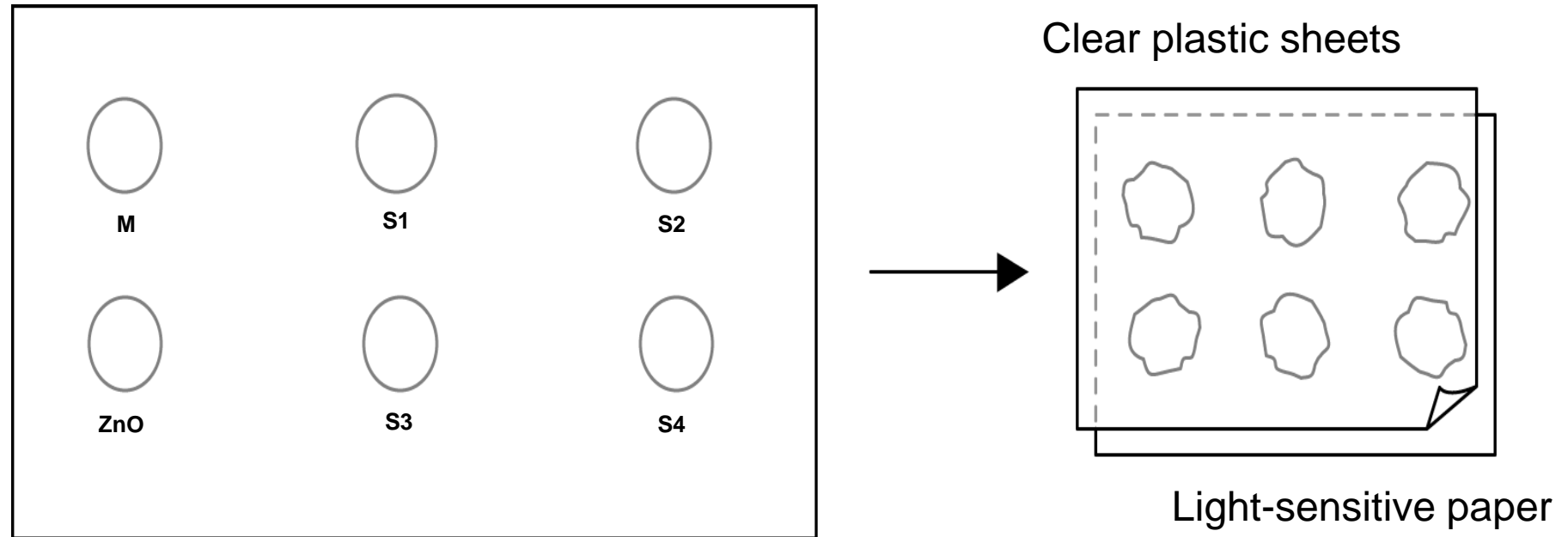
- knowledge about the natural world
- understanding fundamental scientific concepts and theories

Knowledge about science

- knowledge about science itself
- understanding the nature of science as a human activity and the power and limitations of scientific knowledge

Sample items (from PISA 2006)

Mimi and Dean wondered which sunscreen product (S1-S4) provides the best protection for their skin.



M – mineral oil which lets most of the sunlight through
ZnO – almost completely blocks sunlight

Which one of these statements is a scientific description of the role of the mineral oil and the zinc oxide in comparing the effectiveness of the sunscreens?

- A. Mineral oil and zinc oxide are both factors being tested.
- B. Mineral oil is a factor being tested and zinc oxide is a reference substance.
- C. Mineral oil is a reference substance and zinc oxide is a factor being tested.
- D. Mineral oil and zinc oxide are both reference substances.

Competency: Identifying scientific issues

Knowledge: Knowledge about science - scientific enquiry

Student Response

Hong Kong

(%)

A	15.7
B	16.7
C	19.9
D	46.0

% Correct

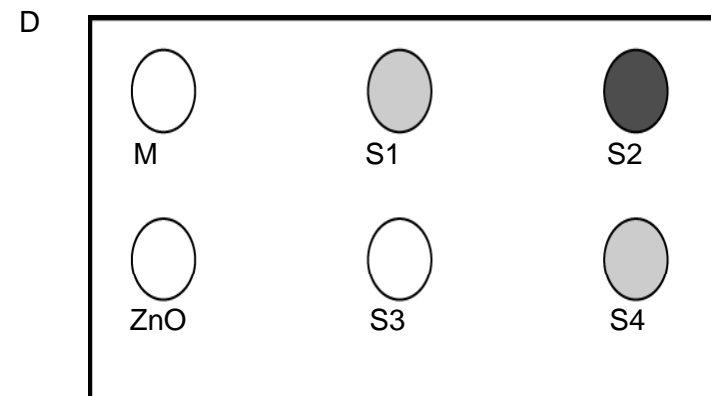
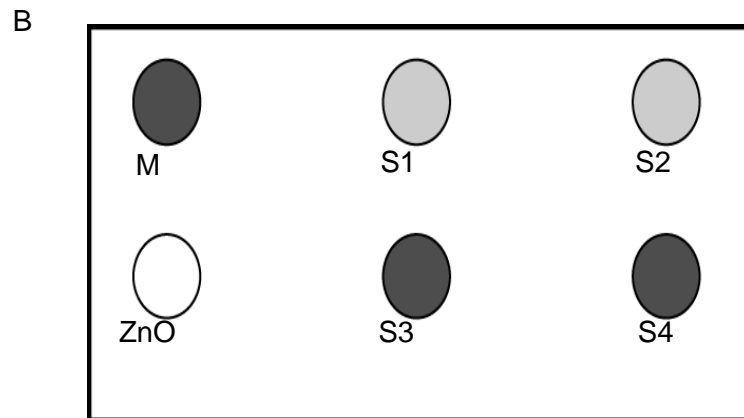
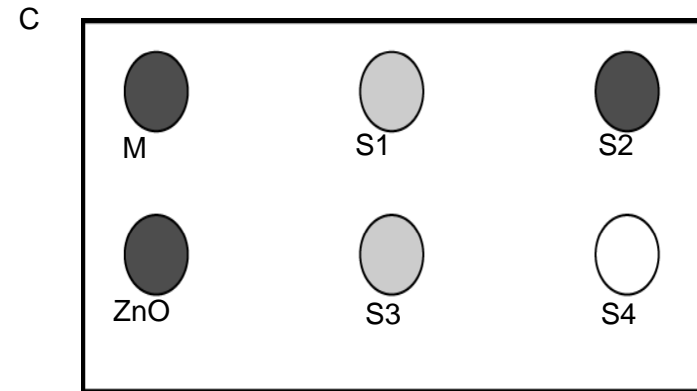
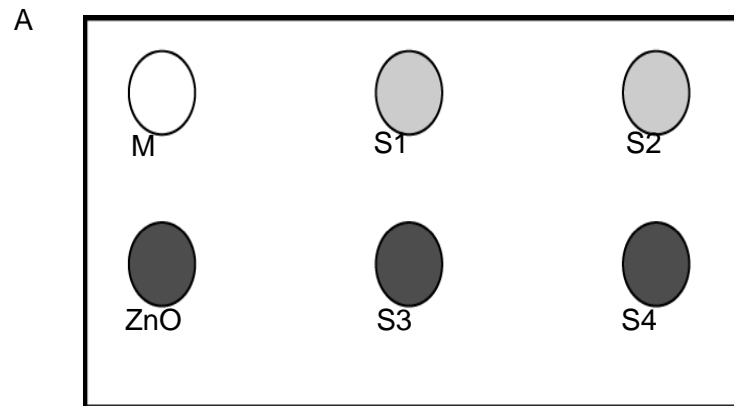
Hong Kong	OECD mean
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46

40.4

The light sensitive paper is dark grey and fades to a lighter grey when it is exposed to some sunlight, and to white when exposed to a lot of sunlight.

Which one of these diagrams shows a pattern that might occur? Explain why you chose it.



Competency: Using scientific evidence

Knowledge: Knowledge about science - scientific explanation

Code 2 : A; correct explanations for both spots

Sample: *A. ZnO has blocked the sunlight as it should and M has let it through.*

Code 1 : A; correct explanation for one spot and does not give an incorrect explanation for the other spot.

Sample: *A. Zinc oxide absorbs practically all rays and the diagram shows this.*

Code	Hong Kong (%)
2	44.1
1	1.5
0	42.3
9	9.1

酸雨

以下是超過**2500**年前、建造於雅典衛城名爲女像柱的雕像照片。這些雕像是用一種名爲大理石的岩石製造。大理石是由碳酸鈣組成。



在**1980**年，原始的雕像被遷移到衛城博物館內，並由複製品取代。原始的雕像受到酸雨的侵蝕。

酸雨 – Qu(1)

正常的雨水略帶酸性，因為它已經從空氣中吸收了一些二氧化碳。酸雨比正常的雨水更酸，因為它已經同時吸收如硫氧化物和氮氧化物之類的氣體。

空氣中的硫氧化物和氮氧化物是從哪裡來的？

- Explaining Phenomena Scientifically
- Knowledge of science
- Physical systems

酸雨 – Qu(2)

酸雨對大理石的作用可以被模擬，方法是將大理石薄片放置在醋裡一整夜。醋和酸雨的酸度是差不多的。當一片大理石薄片被放置在醋裡時，氣泡便會產生。在實驗之前和之後可以測量乾燥大理石薄片的質量。

一片大理石薄片在被浸泡在醋裡一整夜之前的質量是**2.0**克。隔天大理石薄片被取出並且使之乾燥。乾燥後大理石薄片的質量將會是多少？

- A 少於**2.0**克
- B 精確的**2.0**克
- C 在**2.0**克至**2.4**克之間
- D 多於**2.4**克

- Using scientific evidence
- Knowledge of science

酸雨 – Qu(3)

- 進行這項實驗的學生們也放置一些大理石薄片在純淨（蒸餾）水裡一整夜。
- 請解釋學生們為什麼在他們的實驗中包含了這個步驟。
- Identifying scientific issues
- Knowledge about science - scientific enquiry

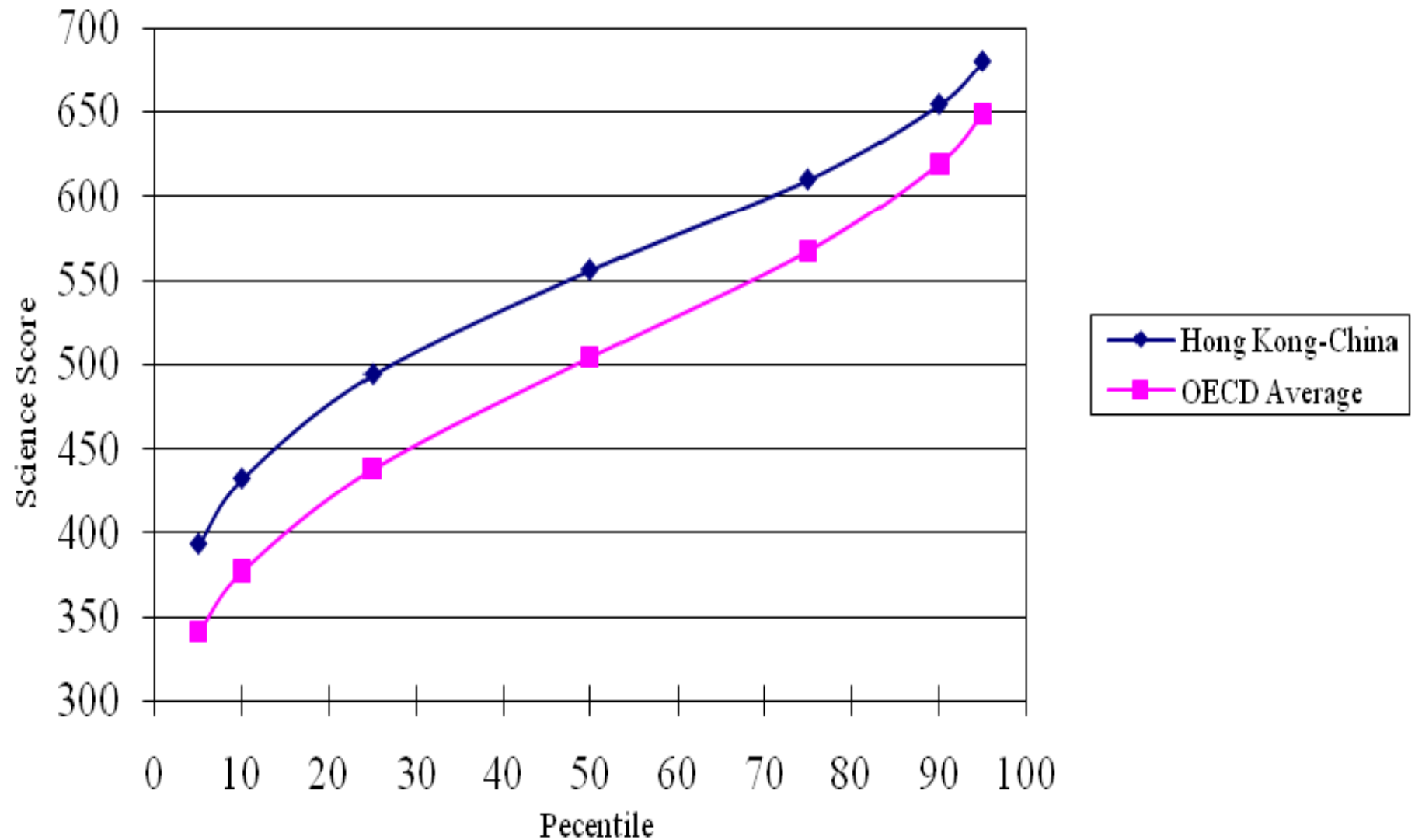
Distribution of science items by competency in PISA 2009

	Closed items	Open items	Total
Explaining phenomena scientifically	16	6	22
Identifying scientific issues	10	3	13
Using scientific evidence	10	8	18
Overall	36	17	53

Mean Performance in scientific literacy of participating countries/regions in PISA 2009

Country/Region	Mean	S.E.	Significance
Shanghai-China	575	(2.3)	▲
Finland	554	(2.3)	○
Hong Kong-China	549	(2.8)	--
Singapore	542	(1.4)	▼
Japan	539	(3.4)	▼
Korea	538	(3.4)	▼
New Zealand	532	(2.6)	▼
Canada	529	(1.6)	▼
Estonia	528	(2.7)	▼
Australia	527	(2.5)	▼
Netherlands	522	(5.4)	▼
Chinese Taipei	520	(2.6)	▼
Germany	520	(2.8)	▼
OECD	501	(0.5)	▼

Comparison of percentile scores between Hong Kong and OECE average in scientific literacy at different percentiles



Comparison of proportion of students at each proficiency level between Hong Kong and OECD countries

Proficiency Level	Hong Kong (%)	OECD (%)	Difference (%) (HK - OECD)
6	2.0	1.1	0.9 **
5	14.2	7.4	6.8 ***
<i>(Levels 5 and 6)</i>	16.2	8.5	
4	32.7	20.6	12.1 ***
3	29.4	28.6	0.8
2	15.1	24.4	-9.3 ***
<i>(Levels 2 and above)</i>	93.4	82.0	
1	5.2	13.0	-7.8 ***
Below 1	1.4	5.0	-3.6 ***

** Difference is significant at the 0.01 level.

*** Difference is significant at the 0.001 level.

Proficiency Level 2

Lower score limit: 409.5

- have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations
- are capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving.

Proficiency Level 6

Lower score limit: 707.9

- consistently identify, explain and apply scientific knowledge and knowledge about science in a variety of complex life situations.
- link different information sources and explanations and use evidence from those sources to justify decisions.
- clearly and consistently demonstrate advanced scientific thinking and reasoning, and use scientific understanding in support of solutions to unfamiliar scientific and technological situations.
- use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social or global situations.

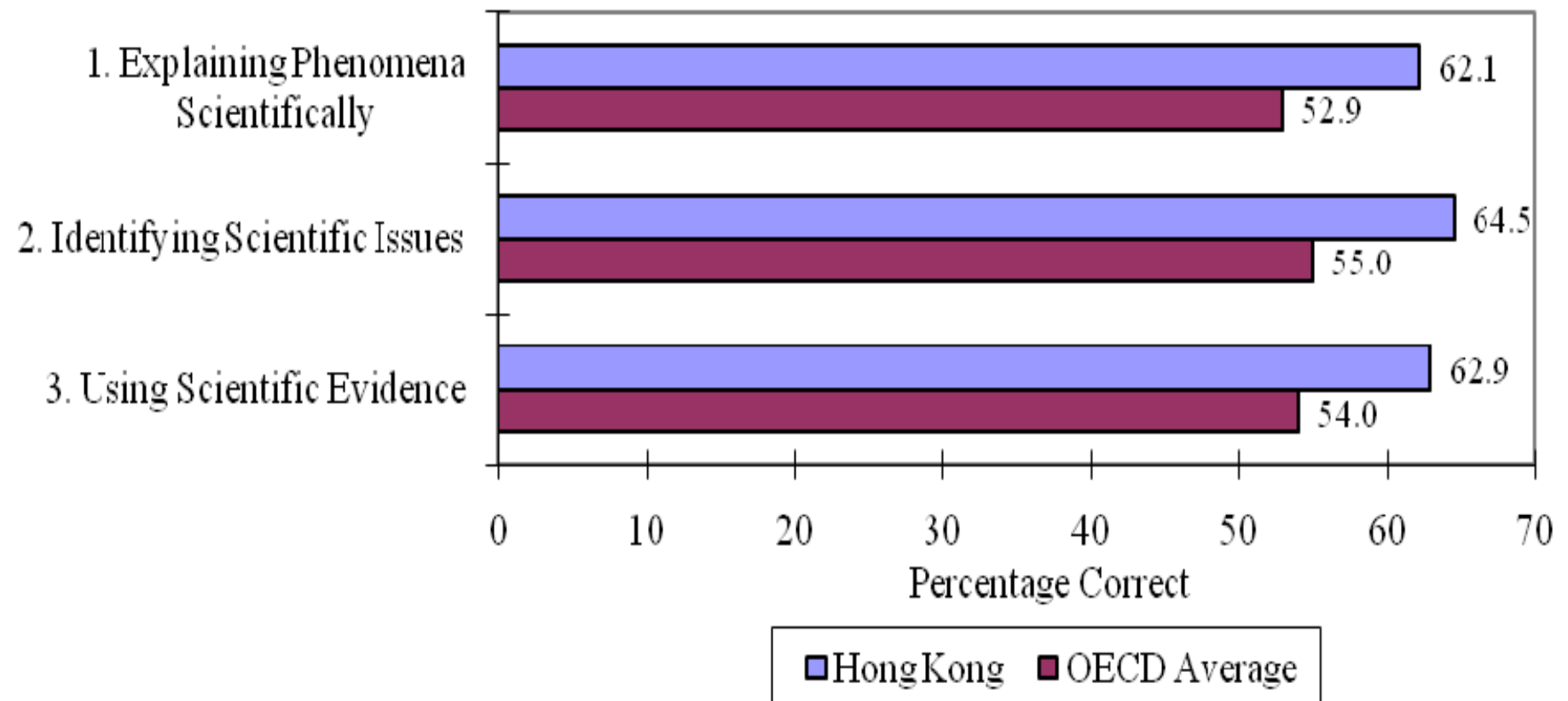
Country or Region	Overall Ranking	Level 6 / % (S.E.)	Diff. with H.K. / %
Shanghai	1	3.9 (0.5)	1.9 ***
Finland	2	3.3 (0.3)	1.3 **
Hong Kong	3	2.0 (0.3)	--
Singapore	4	4.6 (0.5)	2.6 ***
Japan	5	2.6 (0.4)	0.5
Korea	6	1.1 (0.3)	-0.9 *
New Zealand	7	3.6 (0.4)	1.6 ***

As compared to other top performing countries, Hong Kong has slightly less proportion of top performing students.

Country or Region	Overall Ranking	Below Level 2 / % (S.E.)	Diff. with H.K. / %
Shanghai	1	3.2 (0.4)	-3.5 ***
Finland	2	6.0 (0.5)	-0.6
Hong Kong	3	6.6 (0.7)	--
Singapore	4	11.5 (0.5)	4.9 ***
Japan	5	10.7 (1.0)	4.1 **
Korea	6	6.3 (0.8)	-0.3
New Zealand	7	13.4 (0.7)	6.7 ***

Performance in different competencies

Comparison of the percentage of correct answer between Hong Kong and OECD average in different competencies of scientific literacy



Performance in different types of knowledge

Types of knowledge	Hong Kong (% of correct answer)	OECD average (% of correct answer)	Korea (% of correct answer)
Knowledge of science	63.2	54.5	59.5
Earth and space systems	61.1	56.0	65.6
Living systems	58.7	45.8	46.8
Physical systems	68.6	60.0	62.9
Technology systems	68.8	63.3	72.3
Knowledge about science	62.8	53.2	61.9
Scientific enquiry	62.1	53.3	60.1
Scientific explanations	63.5	53.1	63.8

Any Gender Differences ?

No significant difference in overall scores

Comparison of performance of girls and boys in different areas of competencies of scientific literacy in PISA 2009

Competency	Boys		Girls		Difference
	% Correct	S.E.	% Correct	S.E.	Boys - Girls
1. Explaining phenomena scientifically	63.4%	(0.641)	60.7%	(0.786)	2.7% **
2. Identifying scientific issues	61.9%	(0.893)	64.5%	(0.807)	-2.6% *
3. Using scientific evidence	62.1%	(0.835)	60.8%	(0.806)	1.3%

* Difference is significant at 0.05 level.

** Difference is significant at 0.01 level.

Why are boys better in explaining phenomena?

Boys have good performance in some items in which the contexts *may be* more related to the life experiences and interests of boys e.g. dinosaurs, fossils, energy sources and burning

Why are girls better in *identifying scientific issues*?

- These items tend to draw on minimum amount of knowledge of science but rely more on reading and writing skills of students
- Girls tend to have better language literacy than boys

Other gender differences

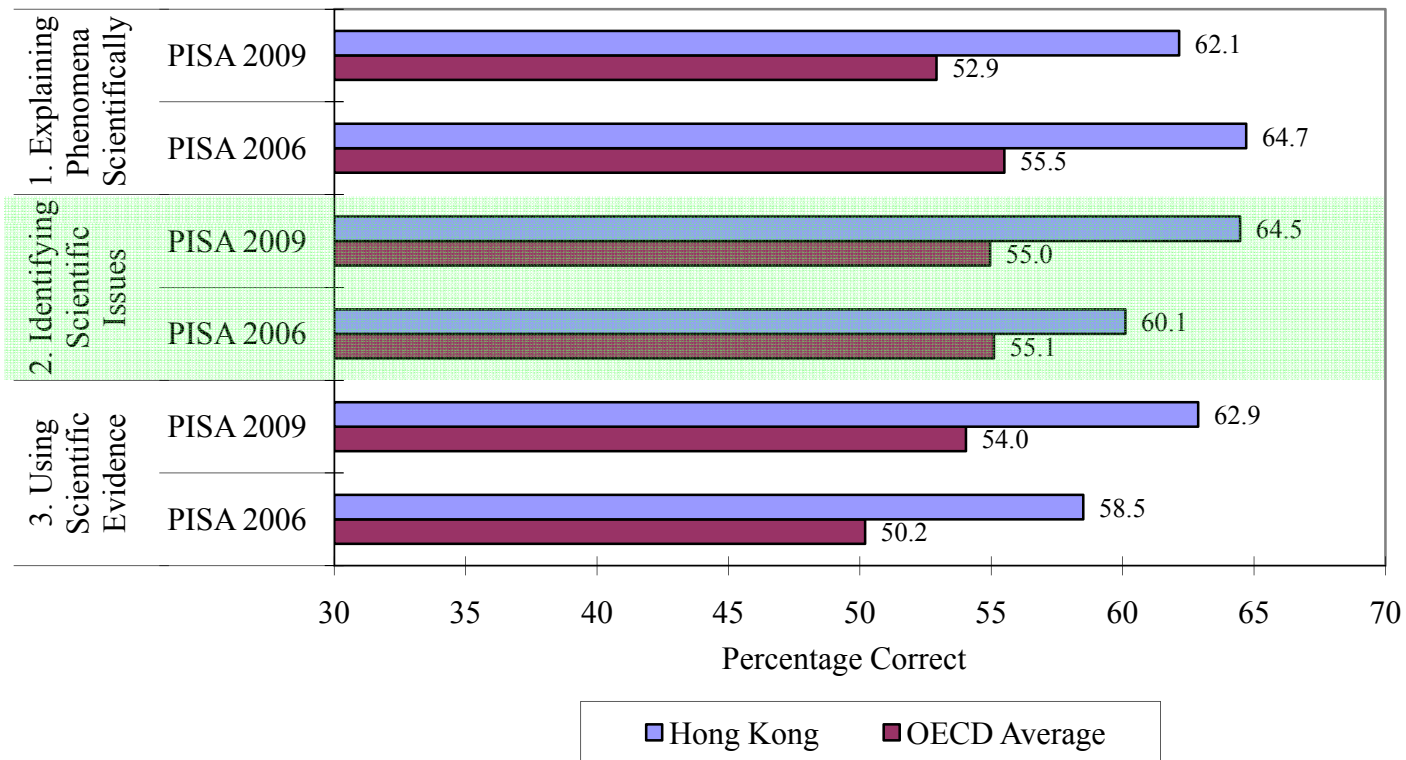
- Boys are favoured by items involving **map reading** because of male superiority in spatial ability
- Boys are favoured by items involving **quantitative reasoning**

Trends of scientific literacy performance

- PISA 2006 and 2009 share the same science assessment framework
- A brief trend could be shown by comparing the performance in 2009 with that in 2006.
- Hong Kong showed no significant change in overall scores from 2006 to 2009.

Performance in different competencies

Comparison of the percentage of correct answer between Hong Kong and OECD average in different competencies of scientific literacy



Findings and “Implications”

1. Hong Kong shows **consistently top performance**.
2. Our education system can take care of students across all ability levels.
3. When compared with some other top countries, Hong Kong still has room for improvement in the development of **high ability students**.

Findings and “Implications”

- Hong Kong *is heading towards* **more balanced goals** of scientific inquiry, nature of science and scientific knowledge as seen by the equally well performances in the three competencies.
- Hong Kong showed **no significant gender difference** in overall science performance, but teachers should still take account of some gender differences in their teaching and assessment, such as **contexts, spatial and quantitative reasoning, and language demands**.

PISA 2012

PISA may be an important lens through which we can evaluate the new senior secondary science curricula.

Thank you!