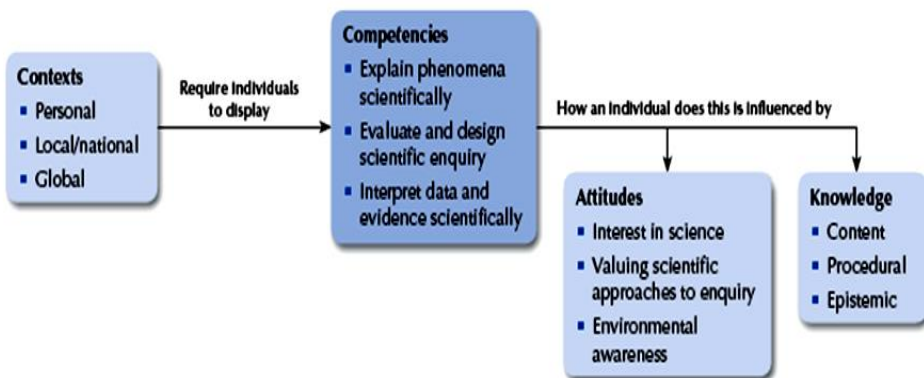# SCIENCE PERFORMANCE OF HONG KONG STUDENTS IN

PISA 2015

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FRAMEWORK OF SCIENTIFIC LITERACY IN PISA 2015

Source: Adapted from *PISA 2015 Draft Science framework* (OECD, 2013, p.12), Figure 1

COMPETENCY
EXPLAIN PHENOMENA SCIENTIFICALLY

Recognise, offer and evaluate explanations for a range of natural and technological phenomena

- Recall and apply appropriate scientific knowledge;
- Identify, use, and generate explanatory models and representations;
- Make and justify appropriate predictions;
- Offer explanatory hypotheses;
- Explain the potential implications of scientific knowledge for society.

COMPETENCY
EVALUATE AND DESIGN SCIENTIFIC ENQUIRY

Describe and appraise scientific enquiries and propose ways of addressing questions scientifically

- Identify the question explored in a given scientific study;
- Distinguish questions that are possible to investigate scientifically;
- Propose a way of exploring a given question scientifically;
- Evaluate ways of exploring a given question scientifically;
- Describe and evaluate a range of ways that scientists use to ensure the reliability of data and the objectivity and generalisability of explanations

COMPETENCY
INTERPRET DATA AND EVIDENCE SCIENTIFICALLY

Analyse and evaluate scientific information, claims and arguments in a variety of representations and draw appropriate conclusions

- Transform data from one representation to another;
- Analyse and interpret data and draw appropriate conclusions;
- Identify the assumptions, evidence and reasoning in science-related texts;
- Distinguish between arguments which are based on scientific evidence and theory and those based on other considerations;
- Evaluate scientific arguments and evidence from different sources (e.g., newspaper, Internet, journals).

COMPETENCY AND KNOWLEDGE

Competency	knowledge
Explain Phenomena Scientifically	Content
Evaluate and Design Scientific Enquiry	Procedural
Interpret Data and Evidence Scientifically	Epistemic

3

MEAN PERFORMANCE IN SCIENTIFIC LITERACY IN PISA 2015

Country/Region	Mean	S.E.	Significance
Singapore	556	(1.2)	▲
Japan	538	(3.0)	▲
Estonia	534	(2.1)	▲
Chinese Taipei	532	(2.7)	▲
Finland	531	(2.4)	▲
Macao-China	529	(1.1)	O
Canada	528	(2.1)	O
Viet Nam	525	(3.9)	O
Hong Kong-China	523	(2.5)	--
China	518	(4.6)	O
Korea	516	(3.1)	O
New Zealand	513	(2.4)	▼
Slovenia	513	(1.3)	▼
Australia	510	(1.5)	▼
United Kingdom	509	(2.6)	▼
Germany	509	(2.7)	▼

PERFORMANCE IN SCIENTIFIC LITERACY IN HONG KONG AND OECD COUNTRIES ACROSS DIFFERENT CYCLES

	PISA 2006		PISA 2009		PISA 2012		PISA 2015	
	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.
Hong Kong	542	(2.5)	549	(2.8)	555	(2.6)	523	(2.5)
OECD Average	500	(0.5)	501	(0.5)	501	(0.5)	493	(0.4)

	Difference[#]					
	2015-2006		2015-2009		2015-2012	
Hong Kong	-19	***	-26	***	-32	***
OECD Average	-7		-8		-8	*

* Statistically significant at the 0.05 level.
*** Statistically significant at the 0.001 level.

PROPORTION OF STUDENTS AT EACH PROFICIENCY LEVEL

Proficiency Level	Hong Kong (%)	OECD (%)	Difference (%) (HK - OECD)	
6	0.4	1.1	-0.6	***
5	6.9	6.7	0.3	
(Levels 5 and 6)	7.4	7.7		
4	27.4	19.0	8.4	***
3	36.1	27.2	8.9	***
2	19.7	24.8	-5.1	***
(Levels 2 and above)	90.6	78.8		
1a	7.8	15.7	-8.0	***
1b	1.6	4.9	-3.4	***
Below 1b	0.1	0.6	-0.5	***

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

PROPORTION OF STUDENTS AT LEVEL 5 AND LEVEL 6 IN HONG KONG AND TOP-PERFORMING COUNTRIES/ECONOMIES

Country / Economy	Level 5 & 6		Level 5		Level 6		Rank by overall mean score
	%	S.E.	%	S.E.	%	S.E.	
Singapore	24.2	(0.6)	18.6	(0.7)	5.6	(0.4)	1
Japan	15.3	(1.0)	12.9	(0.8)	2.4	(0.4)	2
Estonia	13.5	(0.7)	11.6	(0.7)	1.9	(0.3)	3
Chinese Taipei	15.4	(1.1)	12.7	(0.8)	2.7	(0.5)	4
Finland	14.3	(0.6)	11.9	(0.6)	2.4	(0.3)	5
Macao-China	9.2	(0.5)	8.3	(0.5)	0.9	(0.2)	6
Canada	12.4	(0.6)	10.4	(0.5)	2.0	(0.2)	7
Viet Nam	8.3	(1.2)	7.1	(0.8)	1.2	(0.5)	8
Hong Kong-China	7.4	(0.6)	6.9	(0.6)	0.4	(0.1)	9
China (B-S-J-G)	13.6	(1.4)	11.5	(1.1)	2.1	(0.5)	10

PROPORTION OF HONG KONG STUDENTS AT EACH LEVEL OF SCIENCE PROFICIENCY FROM 2006 TO 2015

Proficiency Level	PISA 2006 %	PISA 2009 %	PISA 2012 %	PISA 2015 %	Difference# 2015-2006	Difference# 2015-2009	Difference# 2015-2012
6	2.1	2.0	1.8	0.4	-1.6 ***	-1.6 ***	-1.4 ***
5	13.9	14.2	14.9	6.9	-6.9 ***	-7.2 ***	-8.0 ***
4	29.7	32.7	34.9	27.4	-2.3	-5.3 ***	-7.5 ***
3	28.7	29.4	29.8	36.1	7.4 ***	6.7 ***	6.3 ***
2	16.9	15.1	13.0	19.7	2.8 *	4.6 ***	6.7 ***
1/1a	7.0	5.2	4.4	7.8	0.8	2.6 **	3.4 ***
Below 1/1a	1.7	1.4	1.2	1.6	-0.1	0.2	0.5

* Significant at the 0.05 level.
** Significant at the 0.01 level.
*** Significant at the 0.001 level.
# The minor discrepancy in the difference is due to the rounding of numbers.

SCIENCE PERFORMANCE IN DIFFERENT AREAS OF COMPETENCY IN HONG KONG AND TOP-PERFORMING COUNTRIES/ECONOMIES

	Mean performance in science (overall science scale)	Mean performance on each science competency subscale			Relative strengths in science: Mean performance on the science competency subscale…		
		Explain phenomena scientifically (EPS)	Evaluate and design scientific enquiry (EDSE)	Interpret data and evidence scientifically (IDES)	… explain phenomena scientifically is higher than on…	… evaluate and design scientific enquiry is higher than on …	… interpret data and evidence scientifically is higher than on…
Singapore	556	553	560	556		EPS IDES	
Japan	538	539	536	541			
Estonia	534	533	535	537			
Chinese Taipei	532	536	525	533	EDSE		EDSE
Finland	531	534	529	529			
Macao-China	529	528	525	532			EPS EDSE
Canada	528	530	530	525			
Hong Kong-China	523	524	524	521			
China (B-S-J-G)	518	520	517	516			
Korea	516	510	515	523			EPS

SCIENCE PERFORMANCE IN DIFFERENT AREAS OF COMPETENCY IN HONG KONG AND TOP-PERFORMING COUNTRIES/ECONOMIES

	Mean performance in science (overall science scale)	Mean performance in each science knowledge subscale		Relative strengths in science: mean performance in the science knowledge subscale…	
		Content knowledge (ck)	Procedural and epistemic knowledge (pe)	… content knowledge (co) is higher than in…	… procedural and epistemic knowledge (pe) is higher than in…
Singapore	556	553	558		co
Japan	538	539	538		
Estonia	534	534	535		
Chinese Taipei	532	538	528	pe	
Finland	531	534	528	pe	
Macao-China	529	527	531		co
Canada	528	528	528		
Hong Kong-China	523	526	521		
China (B-S-J-G)	518	520	516		
Korea	516	513	519		

GENDER DIFFERENCE

PROPORTION OF STUDENTS AT EACH PROFICIENCY LEVEL BETWEEN HONG KONG BOYS AND GIRLS IN PISA 2015

Proficiency Level	Boys (%)	Girls (%)	Difference (%) (Boys-Girls)
6	0.6	0.3	0.2
5	7.9	6.0	1.9
(Levels 5 and 6)	8.4	6.3	
4	26.7	28.1	-1.3
3	34.7	37.5	-2.9
2	19.5	19.9	-0.4
(Levels 2 and above)	89.4	91.8	
1a	9.0	6.6	2.4 *
1b	1.6	1.5	0.1
Below 1b	0.1	0.1	0.0

* Mean difference is significant at the 0.05 level.

PERFORMANCE OF BOYS AND GIRLS IN DIFFERENT AREAS OF SCIENTIFIC LITERACY

	Boys	Girls	Difference[#] (Boys – Girls)
Competency			
1. Explaining phenomena scientifically	529	520	9 *
2. Evaluate and design scientific inquiry	518	530	-13 *
3. Interpret data and evidence scientifically	519	523	-4
Knowledge			
• Content	530	522	8
• Procedural & epistemic	517	526	-8
Knowledge system			
• Physical	524	521	2
• Living	522	524	-2
• Earth & space	523	523	0

**POSSIBLE REASONS FOR CHANGES IN
HONG KONG STUDENTS' SCIENCE PERFORMANCE**

1. Demographic characteristics (similar)

2. Opportunity to learn science:
    Instructional Time for science (Might be)

3. Extensiveness of science learning: Percentage of Students
    Taking 3 Major Science Subjects (Might be)

4. Others

    Further analysis needs to be explored by science educators,
    colleagues from CDI and professional associations of science
    education.

1. DEMOGRAPHIC CHARACTERISTICS

	PISA 2006	PISA 2009	PISA 2012	PISA 2015
S1	2.3	1.8	1.1	1.1
S2	9.1	7.3	6.4	5.3
S3	24.4	25	25.8	25.8
S4	64.1	65.8	66.1	67.4
S5	0.1	0.1	0.6	0.3
M:F	49.4:50.6	52.9:47.1	53.7:46.3	49.9:50.1

2. OPPORTUNITY TO LEARN: INSTRUCTIONAL TIME

Periods per week		Science			Math			Reading		
ST001D01T		2009	2012	2015	2009	2012	2015	2009	2012	2015
S1	Mean	4.96	3.74	4.78	6.18	6.06	6.33	6.79	6.75	6.82
	S.D.	2.102	4.038	2.227	1.483	1.671	2.274	1.585	1.784	2.216
S2	Mean	4.43	4.41	5.39	6.04	6.14	6.59	6.56	6.57	7.14
	S.D.	1.752	2.665	3.566	1.589	1.457	2.070	1.637	1.442	2.150
S3	Mean	5.09	5.01	5.79	6.14	6.32	6.58	6.64	6.70	7.21
	S.D.	1.901	2.341	3.011	1.550	1.484	1.891	1.598	1.530	1.891
S4	Mean	**9.51**	**5.18**	**5.47**	6.72	6.55	7.12	6.65	6.77	7.47
	S.D.	3.742	4.315	4.967	1.972	1.575	1.827	1.607	1.524	1.806
S5	Mean	**7.25**	**7.48**	**3.85**	5.75	7.08	7.03	4.00	6.31	7.45
	S.D.	.838	2.793	3.690	1.658	1.551	1.734	.715	1.043	1.425
Total	Mean	**7.22**	**5.11**	**5.53**	6.52	6.47	6.94	6.64	6.73	7.38
	S.D.	3.727	3.803	4.442	1.862	1.553	1.881	1.608	1.518	1.857

3. PERCENTAGE OF STUDENTS TAKING 3 MAJOR SCIENCE SUBJECTS

2008/09 S5 students (HKCEE 2009 participants)		2011/12 S4 students		2014/15 S4 students	
All three	40%	**3 science subjects**	5.68%	**3 science subjects**	4.41%
Chemistry	40.62%	**2 science subjects**	24.76%	**2 science subjects**	24.07%
Physics	41.44%	**1 science subject**	23.71%	**1 science subject**	20.97%
Biology	41.8%	**Total**	54.15%	**Total**	49.45%

But if this is the direct and main cause of declined science performance, the effect should have been shown in 2012 rather than until 2015.

CONCLUDING REMARKS

- Hong Kong students rank ninth among the 72 participating countries/economies, with a mean score of 523.

- The Hong Kong score is statistically lower than that of Singapore, Japan, Estonia, Chinese Taipei and Finland, no different from that of Macao-China, Canada, Viet Nam, China (B-S-J-G) and Korea statistically.

- A majority of Hong Kong students (90.6%) have a baseline level of proficiency in science (Level 2 or above) relative to the OECD counterparts.

CONCLUDING REMARKS

- Hong Kong performs equally well in the three scientific competencies and the two knowledge areas in PISA 2015.

- Gender difference in the overall scientific literacy score is not statistically significant.

- However, similar to PISA 2006, boys perform better than girls in *explaining phenomena scientifically*, but poorer than girls in *interpreting data and evidence scientifically* in PISA 2015.

CONCLUDING REMARKS

- Hong Kong students' performance dropped in PISA 2015 as compared to the previous cycles

- Hong Kong has nurtured a smaller proportion of students (i.e. 7.4%) at Levels 5 and 6 as compared to other top performing countries/economies. These students have the potential to develop into talented scientists, given the opportunities for higher education and a labour-market of science-related jobs.

IMPLICATIONS FOR SCIENCE EDUCATION IN HONG KONG

- Science curriculum and instruction need to take fuller account of the changes brought about by the NSS.

- More concerted efforts should be paid to nurturing students having high interest and abilities in science.

- The teaching and learning of scientific inquiry and nature of science need to be further enhanced.