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Assessing the Quality and Equality of Hong Kong Basic Education Results from PISA 2000+ to PISA 2006

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Abstract This paper seeks to examine the quality and equality of basic education of Hong Kong based on the first three cycles of the Program for International Student Assessment (PISA). Results from these three assessments suggested that the Hong Kong students have an outstanding performance in mathematics, science and reading. In particular, the performance of reading improves substantially in PISA 2006. As far as equality in education is concerned, the achievement gap of students from different socio-economic backgrounds in Hong Kong is relatively small compared with other countries. However, the academic performance variation between-schools suggest that, there is still academic segregation among secondary schools in Hong Kong although it has been reduced slightly in the PISA 2006.

Keywords Program for International Student Assessment (PISA), quality of education, equality in education, international assessment

Introduction

This article is reporting the performance of 15-year-old students from Hong Kong in the first three cycles of an international study program called the Program for International Student Assessment (PISA). PISA is a collaborative effort among member countries of the Organization for Economic Co-operation and Development (OECD). The primary goal of this international study is to assess how well 15-year-old students approaching the end of compulsory

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education have acquired the knowledge and essential skills in participation for our challenging society. Based on these findings, researchers develop educational indicators to help governmental bodies and policy makers of each participating country/region examine, evaluate, and monitor the quality and equality of the education system at both national and school levels (OECD, 2001, 2004, 2007).

The purpose of this paper is to examine the quality and equality of Hong Kong basic education using the data from the first three cycles of PISA studies. Firstly, an overview of Hong Kong students' performance in mathematical, scientific, and reading literacy will be provided. Secondly, I will examine how Hong Kong students' performance changed over time from PISA 2000+¹ to PISA 2006. In particular, the improvement of reading performance was examined in detail. Thirdly, I will investigate the equality of performance among schools in Hong Kong. How the variations in student performance between schools changed over the past three cycles of PISA studies will be addressed. Finally, I will examine the equality of performance among students with different social background. To what extent has a student's individual economic, social, and cultural background affected his/her performance will be examined.

PISA 2000+ to PISA 2006

PISA is administered every three years starting from 2000. Data are collected through a two-hour literacy test and 30 minutes of responses to questionnaires for students and schools. In the test, students are assessed on their literacy in three subject domains², namely, mathematics, science, and reading. Each of the three domains will in turn be treated as a major domain of the testing year in a cycle, and hence more items in the literacy test as well as the background questionnaires will be focused on it. Reading is the major domain in 2000, mathematics in 2003, and science in 2006 and so on.

In the first cycle, over 200 000 students from over 6 000 schools in 43 countries/regions participated in PISA 2000+ (see Appendix 1). In the second cycle, over 250 000 students from over 10 000 schools in 41 countries/regions participated in PISA 2003 (see Appendix 2). In the third cycle, around 400 000 students from over 14 000 schools in 57 countries/regions participated in PISA 2006 (see Appendix 3). The tables in the appendices show the growth of participating countries/ regions in the first three cycles of PISA.

¹ The assessment of PISA 2000+ was administered in February 2002.

² Nevertheless, in PISA 2003 a new subject domain, "problem solving" has once been introduced to assess students' cross-curricular competencies in solving problems in real-life situations.

Sampling

Sampling Design in PISA

PISA uses an age-based definition for its target population. They are students within the age range between 15 years and three months and 16 years and two months at the beginning of each assessment period and who are enrolled in an educational institution.

Sampling in PISA is a two-stage stratified design. A sample of schools is first selected and then a sample of students is selected within each selected school. In the first-stage of sampling, schools having age-eligible students are sampled systematically with probabilities proportional to the school size, which is a function of the number of eligible students enrolled. A minimum of 150 schools is selected in each country/region. Furthermore, participating countries may introduce stratification in their individual sampling plan to achieve systematic distribution of specific school parameters (e.g., type of curriculum, geographic location, etc.) in the sample. For instance, Hong Kong has used school funding types and the ability of students at intake to define two layers of strata for the school sample. The sampling units of the second stage are students of the sampled schools. 35 students³ are randomly selected from all eligible students (i.e., students satisfying the age definition) in each of the schools.

Sampling Design in Hong Kong Program for International Student Assessment (HKPISA)

The sampling designs of Hong Kong in the three cycles are similar. The 2006 sample is used here for illustration. Schools were stratified according to two criteria, namely, school governance (government, aided and independent/private) and student academic intake (high, medium and low; based on the information provided by the authority). The stratified sampling method ensures the inclusion of the appropriate proportion of each type of schools in the sample (Table 1). The resulting sample represented the target school population well in proportion of students with different ability from different types of schools in Hong Kong.

³ Note that 30 students (30 students $\times$ 150 schools = 4 500 students) have been inflated to 35 to account for an anticipated combined non-response and exclusion rate of 15 % among students within schools.

Table 1 Number of Participating Schools in Each Sampling Stratum in the Hong Kong Sample

School governance	Student academic intake	Total number of schools	Number of schools participated
Government	High ability	17	6
	Medium ability	7	2
	Low ability	10	3
	N/A	2	0
Aided	High ability	128	46
	Medium ability	125	46
	Low ability	126	35
	N/A	1	0
Independent ^a	Local (DSS ^b)	43	7
	International	27	1
Total		486	146

Note: ^a There is no student intake classification for independent schools. ^b DSS refers to schools under the Direct Subsidy Scheme.

The Main Study of PISA 2006 was conducted in Hong Kong between May and June 2006. A two-stage stratified sampling design was used. In the first stage, schools were stratified based on school governance (government, aided, and independent–international and DSS) and achievement level of student intake (high, medium, and low)⁴. This stratified sampling method ensures that schools of different background are appropriately represented in the sample. In the second stage, 35 15-year-old students were randomly selected from each sample school. A total of 4 645 students from 146 schools were accepted for final analysis according to OECD sampling standard.

Main Findings

Overview of Performance in Mathematical, Scientific, and Reading Literacy

The mean performances in each of the three domains for the 57 participating countries/regions are shown in Table 2. The OECD average of PISA 2006 is 500 in science; 498 in mathematics, and 492 in reading. The overall performance of Hong Kong students is above the OECD average in all three domains (Ho, Chun, Yip, et al., 2003; Ho, Wong, Yip, & et al., 2005; Ho, Yip, Cheung, & et al., 2008).

⁴ The stratifying criterion is based on the achievement level of the incoming Secondary 1 students of the academic year that the assessment takes place. The achievement level of each student is represented by the Academic Achievement Index (AAI) associated with the student, which is derived by combining the student's school performance and his or her performance in territory-wide assessment.

Table 2 Performance of 15-Year-Old Students in Scientific, Reading, and Mathematical Literacy in PISA 2006

Science			Reading			Mathematics		
	<i>M</i>	<i>S. E.</i>		<i>M</i>	<i>S. E.</i>		<i>M</i>	<i>S. E.</i>
Finland	563	(2.0)	Korea	556	(3.8)	Taiwan-China	549	(4.1)
Hong Kong-China	542	(2.5)	Finland	547	(2.1)	Finland	548	(2.3)
Canada	534	(2.0)	Hong Kong-China	536	(2.4)	Hong Kong-China	547	(2.7)
Taiwan-China	532	(3.6)	Canada	527	(2.4)	Korea	547	(3.8)
Estonia	531	(2.5)	New Zealand	521	(3.0)	Netherlands	531	(2.6)
Japan	531	(3.4)	Ireland	517	(3.5)	Switzerland	530	(3.2)
New Zealand	530	(2.7)	Australia	513	(2.1)	Canada	527	(2.0)
Australia	527	(2.3)	Liechtenstein	510	(3.9)	Macao-China	525	(1.3)
Netherlands	525	(2.7)	Poland	508	(2.8)	Liechtenstein	525	(4.2)
Liechtenstein	522	(4.1)	Sweden	507	(3.4)	Japan	523	(3.3)
Korea	522	(3.4)	Netherlands	507	(2.9)	New Zealand	522	(2.4)
Slovenia	519	(1.1)	Belgium	501	(3.0)	Belgium	520	(3.0)
Germany	516	(3.8)	Estonia	501	(2.9)	Australia	520	(2.2)
United Kingdom	515	(2.3)	Switzerland	499	(3.1)	Estonia	515	(2.7)
Czech Republic	513	(3.5)	Japan	498	(3.6)	Denmark	513	(2.6)
Switzerland	512	(3.2)	Taiwan-China	496	(3.4)	Czech Republic	510	(3.6)
Macao-China	511	(1.1)	United Kingdom	495	(2.3)	Iceland	506	(1.8)
Austria	511	(3.9)	Germany	495	(4.4)	Austria	505	(3.7)
Belgium	510	(2.5)	Denmark	494	(3.2)	Slovenia	504	(1.0)
Ireland	508	(3.2)	Slovenia	494	(1.0)	Germany	504	(3.9)
Hungary	504	(2.7)	Macao-China	492	(1.1)	Sweden	502	(2.4)
Sweden	503	(2.4)	OECD average	492	(0.6)	Ireland	501	(2.8)
OECD average	500	(0.5)	Austria	490	(4.1)	OECD average	498	(0.5)
Poland	498	(2.3)	France	488	(4.1)	France	496	(3.2)
Denmark	496	(3.1)	Iceland	484	(1.9)	United Kingdom	495	(2.1)
France	495	(3.4)	Norway	484	(3.2)	Poland	495	(2.4)
Croatia	493	(2.4)	Czech Republic	483	(4.2)	Slovak Republic	492	(2.8)
Iceland	491	(1.6)	Hungary	482	(3.3)	Hungary	491	(2.9)
Latvia	490	(3.0)	Latvia	479	(3.7)	Luxembourg	490	(1.1)
United States	489	(4.2)	Luxembourg	479	(1.3)	Norway	490	(2.6)
Slovak Republic	488	(2.6)	Croatia	477	(2.8)	Lithuania	486	(2.9)
Spain	488	(2.6)	Portugal	472	(3.6)	Latvia	486	(3.0)
Lithuania	488	(2.8)	Lithuania	470	(3.0)	Spain	480	(2.3)
Norway	487	(3.1)	Italy	469	(2.4)	Azerbaijan	476	(2.3)
Luxembourg	486	(1.1)	Slovak Republic	466	(3.1)	Russian Federation	476	(3.9)

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Science			Reading			Mathematics		
	<i>M</i>	<i>S. E.</i>		<i>M</i>	<i>S. E.</i>		<i>M</i>	<i>S. E.</i>
Russian Federation	479	(3.7)	Spain	461	(2.2)	United States	474	(4.0)
Italy	475	(2.0)	Greece	460	(4.0)	Croatia	467	(2.4)
Portugal	474	(3.0)	Turkey	447	(4.2)	Portugal	466	(3.1)
Greece	473	(3.2)	Chile	442	(5.0)	Italy	462	(2.3)
Israel	454	(3.7)	Russian Federation	440	(4.3)	Greece	459	(3.0)
Chile	438	(4.3)	Israel	439	(4.6)	Israel	442	(4.3)
Serbia	436	(3.0)	Thailand	417	(2.6)	Serbia	435	(3.5)
Bulgaria	434	(6.1)	Uruguay	413	(3.4)	Uruguay	427	(2.6)
Uruguay	428	(2.7)	Mexico	410	(3.1)	Turkey	424	(4.9)
Turkey	424	(3.8)	Bulgaria	402	(6.9)	Thailand	417	(2.3)
Jordan	422	(2.8)	Serbia	401	(3.5)	Romania	415	(4.2)
Thailand	421	(2.1)	Jordan	401	(3.3)	Bulgaria	413	(6.1)
Romania	418	(4.2)	Romania	396	(4.7)	Chile	411	(4.6)
Montenegro	412	(1.1)	Indonesia	393	(5.9)	Mexico	406	(2.9)
Mexico	410	(2.7)	Brazil	393	(3.7)	Montenegro	399	(1.4)
Indonesia	393	(5.7)	Montenegro	392	(1.2)	Indonesia	391	(5.6)
Argentina	391	(6.1)	Colombia	385	(5.1)	Jordan	384	(3.3)
Brazil	390	(2.8)	Tunisia	380	(4.0)	Argentina	381	(6.2)
Colombia	388	(3.4)	Argentina	374	(7.2)	Colombia	370	(3.8)
Tunisia	386	(3.0)	Azerbaijan	353	(3.1)	Brazil	370	(2.9)
Azerbaijan	382	(2.8)	Qatar	312	(1.2)	Tunisia	365	(4.0)
Qatar	349	(0.9)	Kyrgyzstan	285	(3.5)	Qatar	318	(1.0)
Kyrgyzstan	322	(2.9)	United States	m	m	Kyrgyzstan	311	(3.4)

Note: “m” represents missing data. Shaded area indicates scores significantly different from those of Hong Kong.

In science, Hong Kong gets a mean score of 542 and ranks second among the participating countries/regions. The average science score of Hong Kong students is statistically lower than Finland, but higher than all other participating countries/regions. In reading, Hong Kong ranks third with a mean score of 536, which is significantly lower than Finland's (547) and Korea's (556), but higher than all other participating countries/regions'. In mathematics, Hong Kong gets a mean score of 547 and ranks in the top four; there is no statistical difference in the figures for Hong Kong, Korea (547), Finland (548), and Taiwan-China (549).

Comparing the Performances in PISA 2000+, PISA 2003, and PISA 2006

In scientific literacy, there are no significant differences between the

performances across the three cycles. Although the mean score of 542 in PISA 2006 is slightly higher than those of PISA 2003 (539) and PISA 2000+ (541), these differences are not significant (see Table 3) (Ho et al., 2003; Ho et al., 2005).

Table 3 Comparison of Hong Kong Students' Performance in Science, Mathematics, and Reading in PISA 2000+, PISA 2003, and PISA 2006

Year	Science		Mathematics		Reading	
	<i>M</i>	<i>S. E.</i>	<i>M</i>	<i>S. E.</i>	<i>M</i>	<i>S. E.</i>
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

Note: * indicates significant differences in mathematics performance between 2006 vs. 2000+.

** indicates significant differences in reading performance between 2006 vs. 2003 and 2006 vs. 2000+.

In mathematical literacy, Hong Kong continues to rank top in all three cycles of PISA with mean scores of 547, 550 and 560 in PISA 2006, PISA 2003 and PISA 2000+ respectively. There is also no significant difference between PISA 2006 and PISA 2003, but the mean score in PISA 2006 is significantly lower than that of the first cycle of PISA 2000+.

In reading literacy, the mean score for Hong Kong is 536 in PISA 2006, which is significantly higher than those of PISA 2003 (510) and PISA 2000+ (525). The higher reading performance in PISA 2006 can be explained by the improved performance among all percentiles, especially among the low achievers at the 5th percentile and high achievers at the 95th percentile.

The substantial improvement in reading performance is further analyzed by the percentiles comparison in Table 4. Comparing the performance scores between PISA 2000+ and PISA 2006 at the 5th percentile shows an increase of 21 points (from 369 to 390) which is statistically significant. In other words, the low achievers improved substantially from the first to the third cycle of PISA. Similarly, the high achievers at the 90th and 95th percentiles also gained 12 (from 624 to 636) and 14 (from 646 to 660) points respectively, which are also statistically significant. Furthermore, all percentile scores of PISA 2006 are significantly higher than those of PISA 2003. The highest growth (35 points) is at the 5th percentile (i.e., the low achievers), followed by a 30 points' increase at the 10th and also at the 95th percentiles. This evidence suggests that the whole cohort shows improvement in reading performance, while both the high and the low achiever groups exhibit the greatest improvement.

Table 4 Comparison of Hong Kong's Percentile Scores in Reading Literacy at Different Percentiles in PISA 2000+, PISA 2003, and PISA 2006

Percentile	2000+		2003		2006		Difference	
	Score	<i>S. E.</i>	Score	<i>S. E.</i>	Score	<i>S. E.</i>	2006– 2000+	2006– 2003
5th	369	(8.9)	355	(9.8)	390	(6.0)	21*	35*
10th	413	(7.2)	396	(7.0)	426	(5.7)	13	30*
25th	477	(3.6)	461	(5.2)	484	(3.8)	7	23*
50th	534	(2.7)	519	(3.4)	543	(2.6)	9	24*
75th	584	(2.8)	569	(2.7)	594	(2.4)	10	25*
90th	624	(3.1)	608	(2.8)	636	(2.7)	12*	28*
95th	646	(4.1)	630	(3.0)	660	(2.5)	14*	30*

Note: * Difference is significant at the 0.05 level.

A preliminary investigation was conducted to account for the change. Some Reading experts, experienced teachers and textbook editors were interviewed. Some possible contributory factors to this improvement of performance are identified: (1) School-based and wider scale programs that enhance reading climate in general (such as structural time for reading every week or every day; more resources for buying books at the class level and the school level); (2) “Reading to learn” is one of the main concerns in the curriculum reform and therefore more emphasis is put on reading in the school curriculum, e.g., the provision of structured daily reading time in the timetable for enhancing the habit of reading; (3) The new Chinese language curriculum implemented in 2002 shifts from an “essay-based” instruction (which tends to focus on the knowledge and appreciation of selected pieces of classics) to a “competency-based” instruction (which focuses on specific generic skills in the comprehension of a variety of texts). This preliminary exploration has highlighted some themes worthy of further investigation.

Between-School Variation over Time

All countries face formidable challenges to educate a diverse student body and to narrow the performance differences among students. Table 5 shows the percentage of total variance in science performance that lies between schools in science performance in 2006, 2003 and 2000+. The ratio of between-school variance to total variance indicates the heterogeneity of schools in a country. The range in 2006 is from 5.8 % (Finland) to 70.4 % (Hungary).

Table 5 Between-School Variations in Science Performance in PISA 2006, PISA 2003, and PISA 2000+

Country/Region	PISA 2006		PISA 2003		PISA 2000+	
	TVP*	TVBS**	TVP	TVBS	TVP	TVBS
Finland	7 301	5.8	8 209	4.3	7 351	4.9
Iceland	9 263	9.0	9 077	3.9	7 660	7.2
Norway	8 894	9.9	10 717	7.6	8 969	8.9
Sweden	8 635	12.0	11 291	8.9	8 650	7.8
Poland	8 047	13.6	10 472	14.1	9 059	49.1
Spain	8 150	13.9	9 982	16.6	9 042	17.0
Denmark	8 580	15.4	10 263	12.4	10 391	14.5
New Zealand	11 230	15.9	10 658	17.6	9 868	17.1
Ireland	8 871	17.0	8 592	15.5	8 365	14.3
Australia	9 926	17.9	10 283	19.9	8 866	16.8
Latvia	7 056	18.4	8 554	20.3	9 461	29.4
Canada	8 743	18.4	9 845	15.5	7 830	16.1
United Kingdom	11 156	18.9	m	m	m	m
Estonia	6 986	20.5	m	m	m	m
Jordan	7 989	22.1	m	m	m	m
United States	11 186	23.3	10 271	22.1	9 226	32.8
Russian Federation	8 023	27.0	9 945	20.9	9 782	30.8
Macao-China	6 095	28.3	7 724	17.6	m	m
Lithuania	8 082	28.3	m	m	m	m
Montenegro	6 390	28.3	m	m	m	m
Luxembourg	9 356	29.2	10 538	28.8	m	m
Colombia	7 200	31.3	m	m	m	m
Portugal	7 824	31.9	8 687	31.2	7 837	30.4
Israel	12 299	32.4	m	m	m	m
Liechtenstein	9 330	33.6	10 694	32.6	8 806	35.5
Switzerland	9 830	34.2	11 439	28.7	10 018	40.1
Mexico	6 490	35.3	7 524	25.7	5 947	40.5
Korea	8 093	35.3	10 089	38.3	6 508	39.6
Indonesia	4 909	35.5	4 633	34.6	5 520	30.8
Hong Kong-China	8 381	36.5	8 764	44.4	7 135	44.1
Thailand	5 958	38.5	6 622	33.0	5 870	30.2
Kyrgyzstan	6 991	39.4	m	m	m	m
Uruguay	8 887	39.9	11 872	34.3	m	m
Croatia	7 356	41.3	m	m	m	m
Slovak Republic	8 648	42.4	9 496	36.4	m	m
Serbia	7 224	42.6	m	m	m	m

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Country/Region	PISA 2006		PISA 2003		PISA 2000+	
	TVP*	TVBS**	TVP	TVBS	TVP	TVBS
Tunisia	6 768	42.8	7 622	33.5	m	m
Taiwan-China	8 889	46.2	m	m	m	m
Brazil	7 970	46.6	9 702	33.3	8 153	29.9
Argentina	10 197	46.8	m	m	m	m
Romania	6 585	48.3	m	m	m	m
Japan	9 812	48.5	11 892	46.3	m	m
Greece	8 420	51.7	10 069	26.9	9 382	40.3
Azerbaijan	3 106	51.8	m	m	m	m
Italy	9 045	52.1	11 611	48.9	9 569	44.5
Belgium	9 791	52.3	10 308	42.1	10 897	52.3
Turkey	6 928	52.8	9 174	51.6	m	m
Bulgaria	11 352	55.0	m	m	m	m
Chile	8 446	56.3	m	m	m	m
Austria	9 551	57.0	9 146	56.1	8 548	57.8
Czech Republic	9 687	57.8	9 746	40.8	7 968	36.0
Netherlands	9 081	58.9	9 366	55.8	m	m
Germany	9 908	59.9	11 004	50.9	9 791	48.5
Slovenia	9 628	60.4	m	m	m	m
Hungary	7 720	70.4	8 795	41.2	9 871	46.6
Qatar	c	c	m	m	m	m
OECD average	9 009	33.1	10 021	29.5	8 830	30.5

Note: * TVP refers to total variation in performance. ** TVBS refers to total variation between schools expressed as a percentage of the total variation within the country. "m" is for missing in that cycle(s); "c" indicates that there are too few observations to provide reliable estimates.

In Hong Kong, the between-school variance accounts for 36.5 %, 44.4 % and 44.1 % of the science score differences in 2006, 2003 and 2000+ respectively, which are all higher than the OECD average for that particular year (33.1 %, 29.5 %, and 30.5 %) (Ho, 2005; OECD, 2001, 2004). The relatively high proportion of between-school variances can be seen as an indicator of inequality of students' learning outcomes among schools in Hong Kong. In fact, Hong Kong grouped students into five ability levels, or five bands before 2000. After 2000, the tracking system was reduced to three bands with about 33 % of student in each band. This academic segregation in school intake is expected to be a major factor for high proportion of between-school variance. Ho (2005b) conducted further analysis by using multilevel analysis to examine the effect of school's academic intake and social composition on student reading performance. Her findings indicated that over 80 % of the percentage of between-school

variance in reading was explained by the school academic intake and school social composition. Yet the present study found that the degree of between-school inequality improved slightly over time. The between-school variance reduced by about 8 % ($44.1 \% - 36.5 \% = 7.6 \%$) from PISA 2000+ to PISA 2006, which might be related to the change of five-banding system to three-banding system in secondary school enrollment.

Unlike Hong Kong, Finland not only performs very well in the three cycles but also consistently has very low between-school variance (5.8 %, 4.3 %, and 4.9 %), indicating that it provides high quality education to all students, thus achieving high equity learning. This is the ideal type of educational system for which Hong Kong should strive.

Distribution of Literacy Scores by Economic, Social, and Cultural Status (ESCS) Index

An index of economic, social, and cultural status (ESCS) is derived by OECD, based on parents' occupational status, years of schooling that the parents completed as well as the indices of home educational resources and possessions related to classical culture. Table 6 shows the ESCS indices and scientific literacy scores for all participating countries/regions in PISA 2006. This ESCS index is standardized in all OECD countries to have a mean of zero and a standard deviation of one. Greater values represent more advantaged family backgrounds and smaller values represent less advantaged family backgrounds. A negative value implies that the socio-economic and cultural status is below the OECD mean, and a positive value means that it is above the OECD mean.

Table 6 Relationship between Scientific Literacy Performance and the Index of Economic, Social, and Cultural Status (ESCS)

Country/Region	ESCS mean		Unadjusted mean score in Science		Science score (adjusted to mean ESCS of all OECD countries)		Slope of the socio-economic gradient	
	Mean index	S. E.	Mean score	S. E.	Mean score	S. E.	Coef	S. E.
Azerbaijan	-0.45	0.03	382	2.8	388	2.7	11	2
Macao-China	-0.91	0.01	511	1.1	523	1.8	13	1.5
Tunisia	-1.2	0.07	386	3	408	4.4	19	2.2
Indonesia	-1.52	0.05	393	5.7	425	7.5	21	2.6
Colombia	-1	0.05	388	3.4	411	3	23	1.6
Montenegro	-0.02	0.01	412	1.1	412	1.1	24	1.4
Mexico	-0.99	0.04	410	2.7	435	2.4	25	1.3

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Country/Region	ESCS mean		Unadjusted mean score in Science		Science score (adjusted to mean ESCS of all OECD countries)		Slope of the socio-economic gradient	
	Mean index	S. E.	Mean score	S. E.	Mean score	S. E.	Coef	S. E.
Hong Kong-China	-0.67	0.03	542	2.5	560	2.9	26	2.3
Jordan	-0.57	0.03	422	2.8	438	2.8	27	1.8
Kyrgyzstan	-0.66	0.02	322	2.9	340	2.8	27	2.6
Thailand	-1.43	0.03	421	2.1	461	3.3	28	1.6
Portugal	-0.62	0.04	474	3	492	2.3	28	1.4
Iceland	0.77	0.01	491	1.6	470	2.1	29	1.8
Latvia	-0.02	0.02	490	3	491	2.6	29	2.3
Brazil	-1.12	0.03	390	2.8	424	3.6	30	1.9
Italy	-0.07	0.02	475	2	478	1.9	31	1.6
Turkey	-1.28	0.04	424	3.8	463	6.4	31	3.2
Finland	0.26	0.02	563	2	556	1.8	31	1.6
Estonia	0.14	0.02	531	2.5	527	2.4	31	2
Spain	-0.31	0.03	488	2.6	499	1.9	31	1.3
Korea	-0.01	0.02	522	3.4	522	3	32	3.1
Russian Federation	-0.1	0.03	479	3.7	483	3.2	32	2.6
Serbia	-0.14	0.03	436	3	440	2.5	33	1.8
Canada	0.37	0.02	534	2	524	1.8	33	1.4
Uruguay	-0.51	0.03	428	2.7	446	2.5	34	1.4
Croatia	-0.11	0.02	493	2.4	497	2.3	34	1.9
Romania	-0.37	0.04	418	4.2	431	3.9	35	3.4
Norway	0.42	0.02	487	3.1	474	2.8	36	2.5
Greece	-0.15	0.03	473	3.2	479	2.6	37	2.2
Chile	-0.7	0.06	438	4.3	465	3.3	38	1.8
Lithuania	0.04	0.03	488	2.8	487	2.3	38	2
Sweden	0.24	0.02	503	2.4	496	2.2	38	2.1
Argentina	-0.64	0.07	391	6.1	416	4.7	38	2.4
Japan	-0.01	0.02	531	3.4	533	3.1	39	2.7
Denmark	0.31	0.03	496	3.1	485	2.5	39	2
Ireland	-0.02	0.03	508	3.2	510	2.5	39	2.2
Poland	-0.3	0.02	498	2.3	510	2.1	39	1.8
OECD average	0	0	500	0.5	500	0.5	40	0.4

(Continued)

(Continued)

Country/Region	ESCS mean		Unadjusted mean score in Science		Science score (adjusted to mean ESCS of all OECD countries)		Slope of the socio-economic gradient	
	Mean index	<i>S. E.</i>	Mean score	<i>S. E.</i>	Mean score	<i>S. E.</i>	<i>Coef</i>	<i>S. E.</i>
Luxembourg	0.09	0.01	486	1.1	483	1.1	41	1.2
Taiwan-China	-0.31	0.02	532	3.6	546	2.8	42	2.1
Israel	0.22	0.02	454	3.7	448	3.5	43	2.7
Australia	0.21	0.01	527	2.3	519	1.7	43	1.5
Netherlands	0.25	0.03	525	2.7	515	2.4	44	2.2
Hungary	-0.09	0.03	504	2.7	508	2.2	44	1.8
Switzerland	0.09	0.02	512	3.2	508	2.6	44	1.8
Slovak Republic	-0.15	0.02	488	2.6	495	2.2	45	2.6
Slovenia	0.13	0.01	519	1.1	513	1.2	46	1.6
Austria	0.2	0.02	511	3.9	502	3.7	46	3.1
Germany	0.29	0.03	516	3.8	505	3.1	46	2.1
Belgium	0.17	0.02	510	2.5	503	2.2	48	1.9
United Kingdom	0.19	0.01	515	2.3	508	1.9	48	1.9
Liechtenstein	0.19	0.05	522	4.1	513	4.3	49	5.5
United States	0.14	0.04	489	4.2	483	3	49	2.5
Czech Republic	0.03	0.02	513	3.5	512	3.2	51	2.6
Bulgaria	-0.21	0.05	434	6.1	446	4.4	52	3.6
New Zealand	0.1	0.02	530	2.7	528	2.3	52	1.8
France	-0.09	0.03	495	3.4	502	2.7	54	2.5

The second column of Table 6 shows the average ESCS indices for each of the participating countries/regions. The ESCS index of Hong Kong is -0.67 which is far below the OECD average. The major reason for this negative value is that the education levels of parents in Hong Kong are comparatively lower than many OECD countries. The pattern indicates that students perform very well despite the low ESCS in Hong Kong.

The third column shows the unadjusted mean scores in science, while the fourth column displays the adjusted mean of each country/region after the ESCS of each country were set to the OECD average. We can see that the adjusted score of Hong Kong is 560, which is even higher than the unadjusted mean. This result indicates that the overall quality of Hong Kong schooling is even higher after the socio-economic and cultural status has been taken into account.

The final column of Table 6 shows the relationship between ESCS and

students' mathematical achievement for each participating country/region. This relationship can be understood as the "socio-economic gradient," which is a useful index for analyzing the equality or distribution of educational outcomes for students from different socioeconomic status. The results suggest that socio-economic gradient varied substantially across the participating countries/regions in 2006. The average slope for OECD countries is 40 in 2006 which is slightly lower than that in 2003 (45). It means that a unit change in the ECSC corresponds with a change of 40 points on the scientific scale. The impact of ESCS appears to be smaller than that in 2003 (OECD, 2004). The average socio-economic gradient of Hong Kong is down to 26 in 2006, which is also smaller than that in 2003 (31) (Ho et al., 2005). These results suggest that Hong Kong has continued to succeed in achieving high overall performance (attaining an unadjusted mean of 542 in scientific literacy) with low socio-economic gradient (26). In other words, students from various socio-economic backgrounds perform consistently well in Hong Kong.

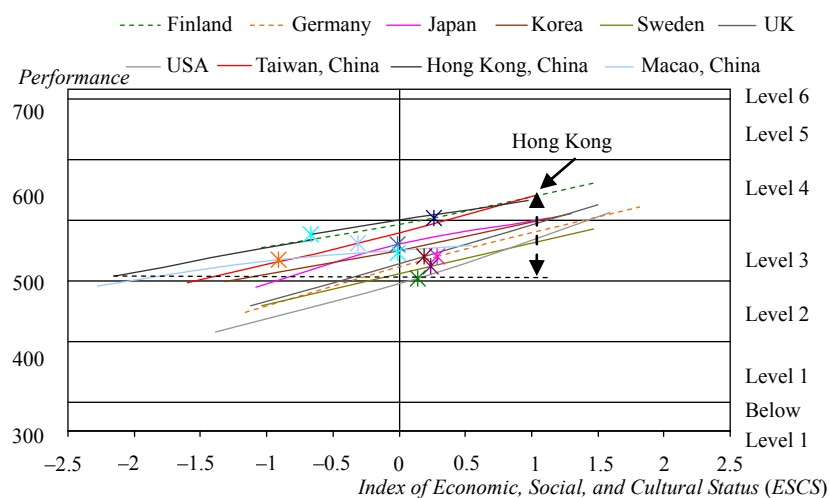


Fig. 1 Relationship between Student Performance in Science and ESCS in Ten Participating Countries/Regions

Note: The ESCS index for PISA 2006 is derived from three variables related to family background: Highest parental education, highest parental occupation and number of home possessions related to classical culture.

Fig. 1 shows the relationship between ESCS and scientific literacy scores of ten countries/regions including Hong Kong with their mean scores statistically significantly above the OECD average. The relationship is shown in the form of socio-economic gradient lines. The slope of the gradient indicates the extent to which inequality in scientific performance could be attributed to family socio-economic and cultural background. Steeper gradients indicate a greater

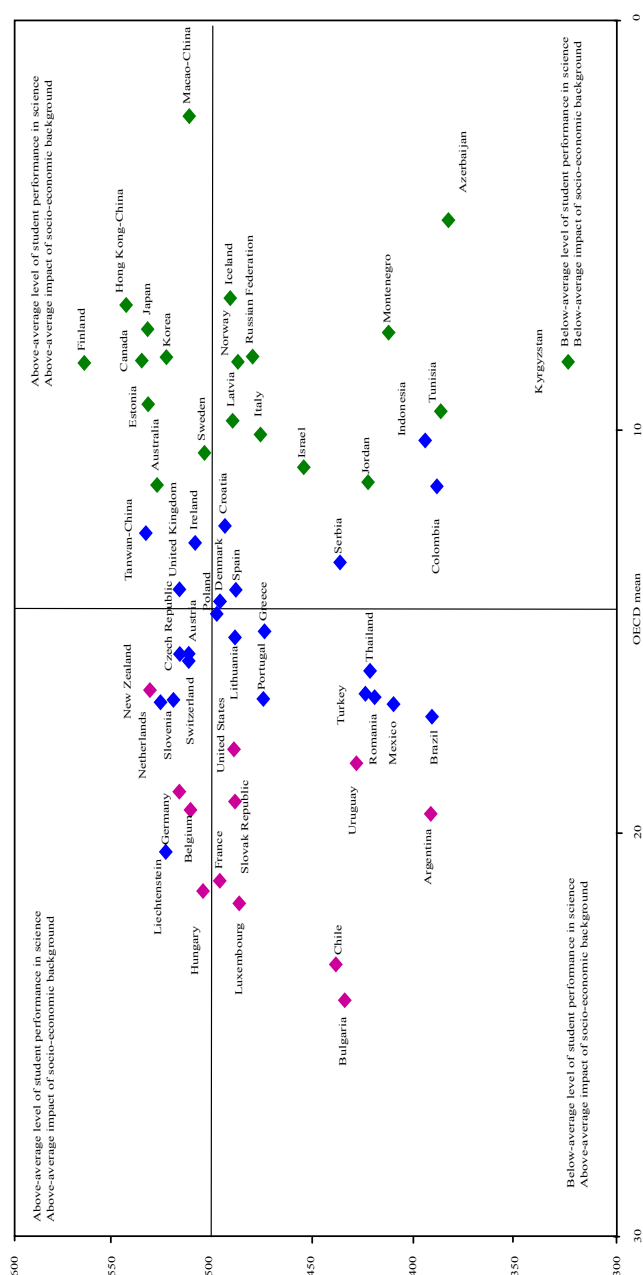
impact of family background on scientific literacy performance, which means more inequality. In contrast, gentler gradients indicate a smaller impact of family background on performance and hence suggest less inequality. As can be seen, the slopes of the socio-economic gradient lines vary widely across the participating countries/regions. Hong Kong being in the top three on the graph with a gentle gradient indicates that Hong Kong's 15-year-olds perform well in science and the impact of SES is modest. We can argue tentatively that Hong Kong is providing education opportunity with relatively high quality and high equity for students regardless of their socio-economic and cultural background.

Fig. 2 further illustrates the relationship between each country/region's mean scores on the combined scientific literacy and the impact of socio-economic and cultural background on science. This figure makes it possible to classify the participating countries/regions into four categories determined by their "overall quality" (in terms of the scientific literacy scores achieved by their students) and their "degree of equity" (in terms of the explaining power of socio-economic and cultural background on scientific literacy performance).

The entire area is divided horizontally by the dotted line at 500, which is the OECD mean in scientific literacy performance. For countries/regions lying above the horizontal line, students on average score more than 500 points. Conversely, in countries/regions lying below the line, students score less than 500 points on average.

The area on the figure is also divided vertically into two parts by a line at 14, which is the percentage of variance in scientific performance explained by the ESCS for all OECD countries. For countries/regions located on the right-hand side of the figure, the percentage of variance explained by the ESCS is statistically less than 14 % in the combined scientific literacy performance. In other words, family socio-economic and cultural status tends to play a less important role in these countries/regions than in OECD countries as a whole. Hong Kong is located in this area. The strength of relationship between science performance and the ESCS for Hong Kong is 6.9 (in other words, 6.9 % of variance in science performance explained by the ESCS). In contrast, for countries on the left-hand side of the vertical line, the gaps in scientific literacy performance between students from families of lower socio-economic and cultural status and those from higher status tend to be greater than the OECD average.

Thus, the four sections in Fig. 2 represent different possible scenarios for a country/region in terms of its overall mean scientific performance and inequity related to family socio-economic and cultural status. The upper right part represents the most desirable scenario for education policy makers, where a country/region has high mean scores, and the gaps in literacy performance among students from different socio-economic and cultural backgrounds are relatively small. Hong Kong falls into this category. High performing countries include five Asian societies (Taiwan, Hong Kong, Korea, Japan, and Macao) and seven Western countries (Australia, Canada, Estonia, Finland, Ireland, Sweden and United Kingdom).



Average performance of countries on the PISA science scale and the relationship between performance and the index of economic, social and cultural status

◆ Strength of the relationship between performance and ESCS above the OECD average impact

- ◆ Strength of the relationship between performance and ESCS not statistically significantly different from the OECD average impact

- ◆ Strength of the relationship between performance and ESCS below the OECD average impact.

Fig. 2 Performance in Science and the Impact of Socio-Economic and Cultural Background

Fig. 2 Performance in Science and the Impact of Socio-Economic and Cultural Background

Source: OECD PISA 2006 database, Figure 4.10.

Conclusion and Implications

The data collected in PISA sheds light on both the quality and equality of an education system in nurturing 15-year-old' literacy skills and identifies the disparity of literacy performance across students of different socio-economic background and across different schools. This article has given a detailed picture of quality of basic education by measuring Hong Kong students' performance in scientific, reading and mathematical literacy from an international perspective. The equality of student performance among schools and between students with different economic, social and cultural status was also explored.

This paper shows that firstly, Hong Kong continues to rank top among participating countries/regions in science and mathematics. Tremendous improvement in reading performance let Hong Kong rank top not only in science and mathematics but also in reading. These results suggest a high average quality of Hong Kong's basic education.

Secondly, between-school variations remain higher than the OECD average across the three PISA cycles but reduce slightly from PISA 2000+ to PISA 2006. Previous studies indicated that these between-school variations could largely be explained by disparity of students' academic and social input (Ho, 2005a). Ho's previous study found that over 80 percent of the between-school variations in student performance was largely explained by the school's social composition and academic intake in Hong Kong. In other words, schools with larger proportions of students from lower SES and lower academic background are in schools in which educational conditions are relatively less favorable.

Thirdly, the relatively small impact ESCS has on literacy performance suggests that Hong Kong students of all backgrounds access and benefit from the education system fairly equally. Yet, the inequality of student performance among schools is problematic and longitudinal and in-depth case studies are needed to examine to what extent and how the comprehensive school reforms in reducing banding among schools can change this pattern of academic segregation over time.

To conclude, the goal of excellence and equality of education appeared to be incompatible in previous discourse, yet this conflict is not universal or inherent in the education as reflected in the findings of Hong Kong. Readers may be

curious to know under what conditions Hong Kong can bring about relatively high levels of achievement without leaving lower SES students too far behind. Possible reasons could be core curriculum of less differentiation that is equally demanding for all students, high-stake examination system (Ho, 2006), better disciplinary climate and academic press (Ho, 2006), greater demands for students' time in schoolwork and homework, high parent expectation and involvement (Chiu & Ho, 2006; Ho, 2005b); parental investment in private tutoring (Ho, 2009) and so on. Some of these topics had been addressed in other papers and all are important factors to be explored for future studies. As schools' quality and equality are influenced by the interplay of many student, family, school, and system level factors, readers should be cautious when identifying factors as determinants of PISA performance.

From the policy perspective, changing the five-banding system to three-banding system appears to have some impact on the academic segregation as reflected in the decrease of between-school variations from HKPISA 2000+ to HKPISA 2006. It is likely that Hong Kong is moving towards a more homogenous basic education system; however, compensatory policies and special programs for disadvantaged learners are necessary to counter the inequalities that still exist between schools.

Appendices

Appendix 1 Participating Countries/Regions of PISA 2000+

OECD countries			Partner countries
Australia	Hungary	New Zealand	Albania
Austria	Iceland	Norway	Argentina
Belgium	Ireland	Poland	Bulgaria
Brazil	Italy	Portugal	Chile
Canada	Japan	Russian Federation	Hong Kong, China
Czech Republic	Korea	Spain	Indonesia
Denmark	Latvia	Sweden	Israel
Finland	Liechtenstein	Switzerland	Macedonia
France	Luxembourg	United Kingdom	Peru
Germany	Mexico	United States	Romania
Greece	Netherlands		Thailand

Appendix 2 Participating Countries/Regions of PISA 2003

OECD countries			Partner countries	
Australia	Hungary	Norway	Brazil	Russian Federation
Austria	Iceland	Poland	Hong Kong, China	Serbia and Montenegro
Belgium	Ireland	Portugal	Indonesia	Thailand
Canada	Italy	Slovak Republic	Latvia	Tunisia
Czech Republic	Japan	Spain	Liechtenstein	Uruguay
Denmark	Korea	Sweden	Macao, China	
Finland	Luxembourg	Switzerland		
France	Mexico	Turkey		
Germany	Netherlands	United Kingdom		
Greece	New Zealand	United States		

Appendix 3 Participating Countries/Regions of PISA 2006

OECD countries			Partner countries (non-OECD countries/regions)		
Australia	Hungary	Norway	Argentina	Indonesia	Romania
Austria	Iceland	Poland	Azerbaijan	Israel	Russian Federation
Belgium	Ireland	Portugal	Brazil	Jordan	Serbia
Canada	Italy	Slovak Republic	Bulgaria	Kyrgyzstan	Slovenia
Czech Republic	Japan	Spain	Chile	Latvia	Thailand
Denmark	Korea	Sweden	Taiwan, China	Liechtenstein	Tunisia
Finland	Luxembourg	Switzerland	Colombia	Lithuania	Uruguay
France	Mexico	Turkey	Croatia	Macao, China	
Germany	Netherlands	United Kingdom	Estonia	Montenegro	
Greece	New Zealand	United States	Hong Kong, China	Qatar	

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