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Scientific Literacy of Hong Kong Students in PISA 2000: An Analysis of Performance on the Released Items

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The general performance of Hong Kong students in scientific literacy in PISA 2000 has been reported in a previous article. With reference to the released items, this article focuses on a more elaborate analysis of Hong Kong's performance in comparison with that of OECD countries. Hong Kong students were relatively good in "using scientific knowledge" and "drawing conclusions," satisfactory in "evaluating evidence" and "communicating explanations and conclusions," but rather weak in "recognizing scientific questions." These results suggest that Hong Kong students possess adequate scientific knowledge and are able to apply it in everyday life contexts, but lack a good understanding of the nature of scientific knowledge. To account for the relatively poor performance of Hong Kong students on certain items, it is proposed that these items made a high demand on reading skills while the students were used to follow detailed laboratory instruction and had little opportunities to develop their reading and communication skills in science lessons.

The Programme for International Student Assessment (PISA) is an international survey of student achievement conducted by the Organisation for Economic Co-operation and Development (OECD). This project aims to assess how well young people, who are approaching the end of compulsory education, are prepared to meet real-life challenges. It therefore focuses on the achievement of literacy in reading, mathematics, and science by 15-year-old students across

countries/regions. The first survey, PISA 2000, was conducted in 32 countries (including 28 OECD countries) in 2000. Nine additional countries or regions, including Hong Kong, conducted the survey in 2002.

In the PISA 2000 study, Hong Kong students' performance ranks third among the 41 participating countries/regions in scientific literacy, with a mean score of 541 and a standard error of 3.01 (OECD & UNESCO, 2003, pp. 108–109). The Hong Kong score is slightly below that of Korea (score = 552 points) and Japan (score = 550 points), but the differences between the scores of these three countries/regions are not statistically significant. Thus Hong Kong is among the top tier of countries/regions in the scientific literacy assessment, scoring well above the OECD mean of 500 points. The OECD mean is computed from the scores of the 28 OECD countries participating in PISA 2000, excluding the 13 non-OECD countries/regions which mostly show much lower performance. The overall strengths and weaknesses of Hong Kong students in various areas of scientific literacy have been reported in a previous article by Yip and Ho (2003/2004).

In order to illustrate the nature of science items used in PISA 2000 and the specific responses of Hong Kong students, this article reports the performance of Hong Kong students on items that have been released by OECD to the public.

The Scientific Literacy Framework of PISA 2000

A central aim of science education for all citizens emphasizes the development of a general understanding of scientific knowledge and skills that are useful for future life in society. This general ability is usually referred to as "scientific literacy." This term, however, may carry different meanings according to the views of different educators (Gräber & Bolte, 1997; Shamos, 1995). For example, the International Forum on Scientific and Technological Literacy for All defines scientific literacy as "the capability to function with understanding and confidence, and at appropriate levels, in ways that bring about empowerment in the made world and in the world of scientific and technological ideas" (UNESCO, 1993). Bybee (1997), on the other hand, has proposed several levels for scientific literacy, such as "nominal literacy" (consisting of knowledge of names and terms),

"functional literacy" (being able to use scientific vocabulary in limited contexts), and "conceptual and procedural scientific literacy" (capable of using scientific knowledge and methods in real-life contexts).

In the PISA study, OECD (2001) defines scientific literacy as "the capacity to use scientific knowledge, to identify questions, and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (p. 23). This definition of scientific literacy is compatible with the aim of the PISA study to assess how well young people are prepared to meet the challenges of real life. According to this view of scientific literacy, assessment tasks are designed to assess the following attributes of scientific literacy (OECD, 2001, p. 83):

1. Understanding and using scientific knowledge,
2. Recognizing scientific questions,
3. Identifying and evaluating evidence,
4. Drawing and evaluating conclusions, and
5. Communicating scientific explanations and conclusions.

Released Science Items and Student Performance

The test items used to assess scientific literacy in PISA 2000 are wide-ranging in terms of types of abilities and levels of difficulty. As PISA 2000 aims at assessing students' scientific literacy rather than their ability to recall correct information, the test items are set in real-life situations that demand the application of scientific concepts and skills. Since most of these items may be used again in later studies, only a small number of items have been released to the public. These released items can be used to illustrate the contexts and range of abilities to be assessed in the scientific literacy framework. Some of these items are assessed by two-digit codes, which indicate the scores awarded as well as the nature of the answers provided by the students. The data thus obtained may reveal the types and frequencies of alternative conceptions held by students. The design and use of the two-digit codes will be illustrated in subsequent sections by referring to the marking of specific items.

There are altogether 13 assessment tasks in the scientific literacy framework of PISA 2000. However, only two of the tasks, *Semmelweis' Diary* and *Ozone*, have been released. These two tasks consist of eight

items with a score of 11 out of a total score of 38 for the whole scientific framework. In this article, the performance of Hong Kong students on the test items of these two tasks are analyzed to explore in depth the strengths and weaknesses of Hong Kong students in scientific literacy, taking advantage of the information provided by the assessment approach using two-digit codes. The released items, together with the performance of Hong Kong students on them, are described in the following sections.

Semmelweis' Diary

This assessment task refers to a study in the mid-nineteenth century on the causes of puerperal fever. Semmelweis, a Hungarian doctor, was alarmed at the high death rate from this disease in a ward of his hospital. The task presents an extract of *Semmelweis' Diary* (Figure 1) and a graph of deaths in two maternity wards of the hospital over a number of years (Figure 2).

Figure 1. Extract from *Semmelweis' Diary*

July 1846

Next week I will take up a position as "Herr Doktor" at the First Ward of the maternity clinic of the Vienna General Hospital. I was frightened when I heard about the percentage of patients who die in this clinic. This month not less than 36 of the 208 mothers died there, all from puerperal fever. Giving birth to a child is as dangerous as first-degree pneumonia.

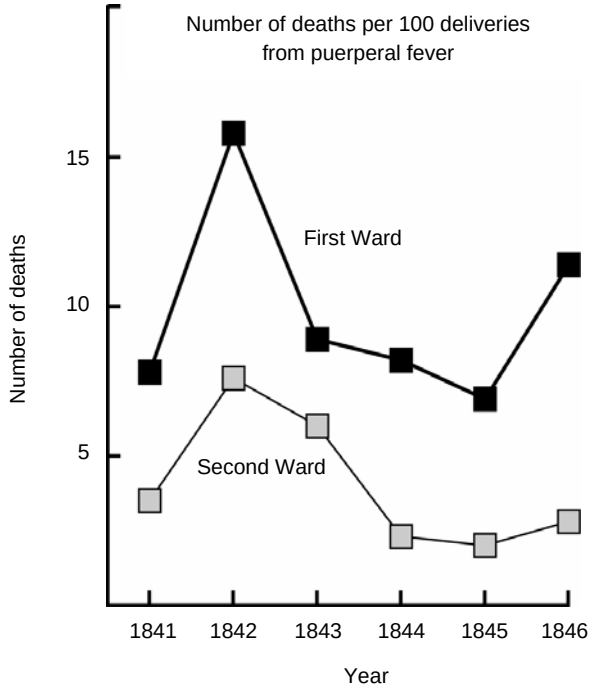
December 1846

Why do so many women die from this fever after giving birth without any problems? For centuries science has told us that it is an invisible epidemic that kills mothers. Causes may be changes in the air or some extraterrestrial influence or a movement of the earth itself, an earthquake.

Question 1

In Question 1, the students are asked to imagine that they are Semmelweis and, referring to the graph, use his data to support the argument that earthquakes are unlikely to be the cause of the disease.

Figure 2. Deaths Caused by Puerperal Fever in the Two Maternity Wards



Question 1 *(Semmelweis' Diary)*

Suppose you were Semmelweis. Give a reason (based on the data Semmelweis collected) why puerperal fever is unlikely to be caused by earthquakes.

This question assesses the ability to evaluate conclusions according to the given information. Two marks are awarded to a fully correct answer and one mark to a partially correct answer. Part of the Marking Guide for this question is presented in Figure 3 to illustrate the marking criteria. It also illustrates the way of marking an item with two-digit codes, the first digit indicating the marks awarded and the second digit the type of response given. The two-digit code facilitates the subsequent analysis of the variety of student answers, particularly with regard to students' alternative conceptions.

Figure 3. Marking Guide for Question 1 of the *Semmelweis' Diary* Task

Full credit (2 marks)

Code 21: Refers to the difference between the number of deaths (per 100 deliveries) in both wards, e.g.:

- Due to the fact that the first ward had a high rate of women dying compared to women in the second ward, obviously it had nothing to do with earthquakes.
- It is unlikely that earthquakes cause the fever since death rates are so different for the two wards.

Partial credit (1 mark)

Code 11: Refers to the fact that earthquakes don't occur frequently, e.g.: it would be unlikely to be caused by earthquakes because earthquakes wouldn't happen all the time.

Code 12: Refers to the fact that earthquakes also affect people outside, e.g.: if there were an earthquake, women from outside the hospital would have got puerperal fever as well.

Code 13: Refers to the thought that when earthquakes occur, men don't get the fever, e.g.: because girls get it and not men.

No credit

Code 01: States only that earthquakes cannot cause the fever, e.g.: earthquake cannot make a person sick.

Code 02: States that the fever must have another cause, e.g.: earthquake is caused by movement of the plates of the Earth; it has nothing to do with the fever.

Code 03: Answers that are combinations of Codes 01 and 02.

Code 04: Other incorrect answers.

The mean scores of students of OECD countries and Hong Kong for Question 1 are 25% and 38% respectively. The low scores indicate that the question is of high level of difficulty. Table 1 shows the distribution of responses of Hong Kong students who attempted this question. A total of 43% of them got the full credit of 2 marks, 50% scored no mark, and a small portion of students (6%) were awarded with the partial credit of 1 mark. This analysis indicates that students who have the ability to evaluate conclusions could express their views correctly in

Table 1. Distribution of Hong Kong Students' Responses to Question 1 of the *Semmelweis' Dairy* Task

Answer code	*N*	Percentage	Mean %
21	514	43.12	43.12
11	53	4.45	6.46
12	23	1.93	
13	1	0.08	
01	85	7.13	50.42
02	218	18.29	
03	140	11.74	
04	158	13.26	
Total	1,192	100.00	

their answers, as very few of them got penalized by presenting partially correct answers.

Of those who got no credit for this question, most of them simply said that puerperal fever and earthquakes have different causes (Codes 02), or that the fever is not caused by earthquakes (Code 03). These students did not seem to possess the skill for assessing the validity of a conclusion (i.e., puerperal fever is unlikely to be caused by earthquakes) on the basis of available data.

Questions 2 and 3

The task then presents a passage based on the information described in *Semmelweis' Diary* (Figure 4). This is followed by Question 2 which asks students to identify what idea Semmelweis would have come up with from his observations.

This multiple-choice question requires the students to identify an implication that could be made by evaluating the available evidence, such as the different frequencies of puerperal fever in the two wards and the student doctors' behavior. This question is considered to be of medium level of difficulty, and the mean scores of the OECD students and Hong Kong students are 64% and 65% respectively.

Of the Hong Kong students who attempted this question, a majority of them (about 69%) answered correctly by choosing option A (Table 2). These students were able to identify a possible way to control puerperal fever by comparing the situations between the two wards.

Figure 4. A Passage Based on *Semmelweis' Diary*

Part of the research in the hospital was dissection. The body of a deceased person was cut open to find a cause of death. Semmelweis recorded that the students working on the First Ward usually took part in dissections on women who died the previous day, before they examined women who had just given birth. They did not pay much attention to cleaning themselves after the dissections. Some were even proud of the fact that you could tell by their smell that they had been working in the mortuary, as this showed how industrious they were!

One of Semmelweis' friends died after having cut himself during such a dissection. Dissection of his body showed he had the same symptoms as mothers who died from puerperal fever. This gave Semmelweis a new idea.

Question 2 *(Semmelweis' Diary)*

Semmelweis' new idea had to do with the high percentage of women dying in the maternity wards and the students' behaviour.

What was this idea?

A. Having students clean themselves after dissections should lead to a decrease of puerperal fever.

B. Students should not take part in dissections because they may cut themselves.

C. Students smell because they do not clean themselves after a dissection.

D. Students want to show that they are industrious, which makes them careless when they examine the women.

Table 2. Frequencies of Hong Kong Students' Responses to Question 2 of the *Semmelweis' Dairy* Task

Option	*N*	Percentage
A*	942	68.71
B	56	4.08
C	292	21.30
D	81	5.91
Total	1,371	100.00

* indicates the correct response.

Option C is a powerful distractor as it attracts over 21% of the students. It simply describes the conditions of the student doctors in the First Ward without any reference to the possible cause of puerperal fever as based on Semmelweis' observation. Choosing this option reflects that these students did not comprehend the meaning of Question 2. Options B and D were poor distractors as they were chosen by a much smaller percentage of students, probably because the statements are not based on the content of the given passage.

In comparison with Question 1, the higher score on Question 2 can be accounted for in several ways. Question 2 is less difficult in the sense that it is a multiple-choice item, which provides strong hints to the answer and does not require the students to communicate their ideas in words as in the case of an open-response question. The better performance on Question 2 may also suggest that students are more competent in drawing implications from given information than in providing justifications for a certain conclusion, which makes a higher demand on logical thinking and communication skills. This is consistent with the nature of learning experiences emphasized in the local science curriculum. Hong Kong students are provided with ample opportunities to draw conclusions from experimental results, but are seldom required to justify or evaluate conclusions with reference to available evidence.

Question 3 assesses the ability to use common scientific knowledge to explain why washing sheets at high temperatures can help to control the spread of puerperal fever in a hospital. A total of 68% of the students from the OECD countries got this item correct, indicating that this item is of low to medium level of difficulty, while 82% of Hong Kong students answered it correctly.

Question 3 *(Semmelweis' Diary)*

Semmelweis succeeded in his attempts to reduce the number of deaths due to puerperal fever. But puerperal fever even today remains a disease that is difficult to eliminate.

Fevers that are difficult to cure are still a problem in hospitals. Many routine measures serve to control this problem. Among those measures are washing sheets at high temperatures.

Explain why high temperature (while washing sheets) helps to reduce the risk that patients will contract a fever.

The following examples illustrate the different types of acceptable answers for this item. The first digit of the marking code indicates the mark awarded, and the second digit the nature of the answer:

Full credit

Code 11: Refers to killing of bacteria, e.g.: bacteria will not stand the high temperature.

Code 12: Refers to killing of micro-organisms or germs, e.g.: it's too hot for germs to live.

Code 13: Refers to the removal of bacteria, e.g.: the number of bacteria will decrease.

Code 14: Refers to the removal of micro-organisms or germs, e.g.: you won't have the germ on your body.

Code 15: Refers to sterilization of the sheets, e.g.: the sheets will be sterilized.

No credit

Code 01: Refers to killing of disease, e.g.: the high temperature kills the fever on the sheets.

Code 02: Other incorrect answers, e.g.: they don't get sick from the cold; washing removes the germs.

Of those who attempted this question, nearly 92% of them got it correct (Table 3). Most of them, however, refer to the effect of high temperature on bacteria (Code 11: over 55%) rather than on germs (Code 12: about 26%). Although the fever is now found to be caused by a virus, answers coded as 11 are accepted as correct because students have only learned in their science course that infectious diseases are

Table 3. Frequencies of Hong Kong Students' Responses to Question 3 of the *Semmelweis' Dairy* Task

Answer code	*N*	Percentage	Mean %
11	708	55.27	
12	334	26.07	
13	65	5.07	91.96
14	22	1.72	
15	49	3.83	
01	14	1.09	8.04
02	89	6.95	
Total	1,281	100.00	

usually caused by bacteria. Although answers coded as 13, 14, and 15 are also acceptable, they are less precise and accurate than those coded as 11 and 12. The relatively small percentage of answers coded as 13, 14, and 15 indicates that the students in general have a rather accurate concept of the effect of heat on microorganisms and how this idea can be applied to controlling the spread of the disease. On the whole, Hong Kong students possess the concept that high temperature treatment would kill the causative agents of a disease rather than the disease itself.

Question 4

Question 4 is a multiple-choice item that assesses students' understanding of the consequence of the uncontrolled use of antibiotics. This item is of medium level of difficulty, with the OECD mean at 60% and Hong Kong mean at 76%.

Question 4 *(Semmelweis' Diary)*

Many diseases may be cured by using antibiotics. However, the success of some antibiotics against puerperal fever has diminished in recent years.

What is the reason for this?

A. Once produced, antibiotics gradually lose their activity.

B. Bacteria become resistant to antibiotics.

C. These antibiotics only help against puerperal fever, but not against other diseases.

D. The need for these antibiotics has been reduced because public health conditions have improved considerably in recent years.

Among the Hong Kong students that attempted this question, nearly 80% of them got it correct (Table 4). The high performance on this item indicates that Hong Kong students in general know that bacteria can develop resistance to antibiotics. Although this topic is not covered explicitly in the science curriculum, it appears occasionally in local newspapers and TV programs. It is very likely that the students may have acquired the idea of antibiotic resistance through the mass media.

Table 4. Frequencies of Hong Kong Students' Responses to Question 4 of the *Semmelweis' Dairy* Task

Option	*N*	Percentage
A	95	6.95
B*	1,091	79.87
C	51	3.73
D	129	9.44
Total	1,366	100.00

* indicates the correct response.

Figure 5. Passage on the *Ozone* Task

Read the following section of an article about the ozone layer.

The atmosphere is an ocean of air and a precious natural resource for sustaining life on the Earth. Unfortunately, human activities based on national/personal interests are causing harm to this common resource, notably by depleting the fragile ozone layer, which acts as a protective shield for life on the Earth.

Ozone molecules consist of three oxygen atoms, as opposed to oxygen molecules which consist of two oxygen atoms. Ozone molecules are exceedingly rare: fewer than ten in every million molecules of air. However, for nearly a billion years, their presence in the atmosphere has played a vital role in safeguarding life on Earth. Depending on where it is located, ozone can either protect or harm life on Earth. The ozone in the troposphere (up to 10 kilometres above the Earth's surface) is "bad" ozone which can damage lung tissues and plants. But about 90 percent of ozone found in the stratosphere (between 10 and 40 kilometres above the Earth's surface) is "good" ozone which plays a beneficial role by absorbing dangerous ultraviolet (UV-B) radiation from the Sun.

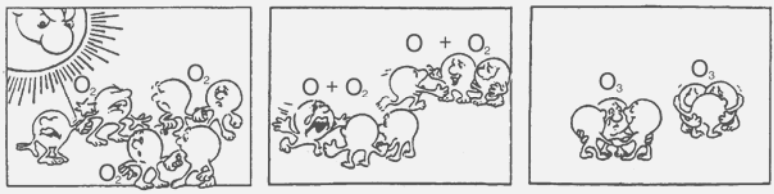
Without this beneficial ozone layer, humans would be more susceptible to certain diseases due to the increased incidence of ultraviolet rays from the Sun. In the last decades the amount of ozone has decreased. In 1974 it was hypothesised that chlorofluorocarbons (CFCs) could be a cause for this. Until 1987, scientific assessment of the cause-effect relationship was not convincing enough to implicate CFCs. However, in September 1987, diplomats from around the world met in Montreal (Canada) and agreed to set sharp limits to the use of CFCs.

Ozone

The *Ozone* task is made up of four items of different levels of difficulty, different literacy abilities, and different item types (closed and open questions). The context is based on a short article from a UNESCO Newsletter (Figure 5).

Question 1 requires the students to explain the formation of ozone based on the information provided in the passage and a cartoon. This question assesses the ability to understand scientific information presented in different forms, and communicate the ideas to people with limited scientific knowledge.

Question 1 *(Ozone)*



In the text above nothing is mentioned about the way ozone is formed in the atmosphere. In fact each day some ozone is formed and some other ozone disappears. The way ozone is formed is illustrated in the following comic strip.

Suppose you have an uncle who tries to understand the meaning of this strip. However, he did not get any science education at school and he doesn't understand what the author of the strip is explaining. He knows that there are no little fellows in the atmosphere but he wonders what those little fellows in the strip stand for, what those strange notations O_2 and O_3 mean and which processes the strip represents. He asks you to explain the strip. Assume that your uncle knows:

- that O is the symbol for oxygen;
- what atoms and molecules are.

Write an explanation of the comic strip for your uncle.

In your explanation, use the words atoms and molecules in the way they are used in lines 6 and 7.

The OECD and Hong Kong mean scores for Question 1 are 28% and 27% respectively, which indicate that this item is of high level of difficulty. Full credit of three marks (code 31) is awarded to answers that use the terms "atoms" and "molecules" as instructed, and state the following points as illustrated in the comic strip:

(a) an oxygen molecule is split into oxygen atoms,
(b) the splitting occurs under sunlight,
(c) an oxygen atom combines with an oxygen molecule to form an ozone molecule.

Partial credit of two marks is given to answers that contain two of the listed points — code 21 for answers including (a) and (b), code 22 for answers including (a) and (c), and code 23 for answers including (b) and (c). Partial credit of one mark is given to answers that contain only one of the listed points, with codes 11, 12, and 13 given to answers that contain points (a), (b), and (c) respectively. No credit (code 01) is given to answers that does not contain any of the three points. The pattern of responses of Hong Kong students on this item is summarized in Table 5.

Table 5. Frequencies of Hong Kong Students' Responses to Question 1 of the *Ozone* Task

Answer code	*N*	Percentage	Mean %
31	116	15.01	15.01
21	15	1.94	
22	34	4.40	9.96
23	28	3.62	
11	2	0.26	
12	39	5.05	18.89
13	105	13.58	
01	434	56.14	56.14
Total	773	100.00	

Question 1 asks for a description of the process of formation of ozone in the upper atmosphere, which appears to be cognitively undemanding. However, it turns out to be quite difficult as it requires a mastery of chemical concepts that are not explicitly taught in science lessons, as well as adequate organization and communication skills for presenting the answer. These skills are not emphasized in the local science curriculum and students are seldom provided with the learning

experiences that facilitate their development. For those students who score partial credit for the question, only a small number of them (i.e., answers with code 11) could point out that an oxygen molecule is spit into oxygen atoms during the process.

Question 2 is a complex multiple-choice question that assesses the ability to understand the information given in the passage. The OECD and Hong Kong scores for this item are 35% and 38% respectively, indicating that it is of medium to high level of difficulty. The performance on this item is relatively poor compared with other closed questions in the PISA science test.

Question 2 *(Ozone)*

Ozone is also formed during thunderstorms. It causes the typical smell after such a storm. In lines 11–16 the author of the text distinguishes between "bad ozone" and "good ozone."

In terms of the article, is the ozone that is formed during thunderstorms "bad ozone" or "good ozone"?

Choose the answer and the explanation that is supported by the text.

	Bad ozone or good ozone?	*Explanation*
A.	Bad	It is formed during bad weather.
B.	Bad	It is formed in the troposphere.
C.	Good	It is formed in the troposphere.
D.	Good	It smells good.

Examination of the frequencies of responses shows that most students chose options B or C (Table 6). Both options are correct

Table 6. Frequencies of Hong Kong Students' Responses to Question 2 of the *Ozone* Task

Option	*N*	Percentage
A	57	7.63
B*	366	49.00
C	320	42.84
D	4	0.54
Total	747	100.00

* indicates the correct response.

statements in themselves, but to understand that the ozone formed during thunderstorms has harmful effects on humans and plants, students have to comprehend the passage. As this passage is long and complex, and the context is novel to students, it is probable that students that are weak in reading and comprehension would suffer in this item.

Question 3 assesses knowledge on the effects of excessive ultraviolet rays on human health, which is an environmental concern of the local community in recent years. This item is of medium level of difficulty, and the OECD and Hong Kong scores are 55% and 63% respectively. Despite that this topic is not covered in the science curriculum, the majority of Hong Kong students were able to name a specific disease caused by ultraviolet rays. This suggests that these students have acquired the knowledge and awareness in their everyday life exposure, such as through the weather and news reports in the mass media.

Question 3 *(Ozone)*

Lines 17 to 19 state: "Without this beneficial ozone layer, humans would be more susceptible to certain diseases due to the increased incidence of ultraviolet rays from the Sun."

Name one of these specific diseases.

Question 4 consists of two parts that assess the ability to recognize whether a certain problem can be studied scientifically or not. To answer

Question 4 *(Ozone)*

At the end of the text, an international meeting in Montreal is mentioned. At that meeting lots of questions in relation to the possible depletion of the ozone layer were discussed. Two of those questions are shown in the table below.

Can the questions listed below be answered by scientific research?

- Should the scientific uncertainties about the influence of CFCs on the ozone layer be a reason for governments to take no action?
- What would the concentration of CFCs be in the atmosphere in the year 2002 if the release of CFCs into the atmosphere takes place at the same rate as it does now?

this item correctly, the students need to understand the nature of the problems posed and the processes of scientific enquiry. Credit will be given only when both parts of the question are answered correctly. This item is of medium level of difficulty, and the OECD and Hong Kong scores are 57% and 49% respectively.

The responses of Hong Kong students to this question are summarized in Table 8. Although over 60% of the students answered the individual parts correctly, only 49% got both parts correct, which is significantly below the OECD mean score. This result indicates that while Hong Kong students generally demonstrate mastery of scientific knowledge and are able to apply the knowledge in everyday life contexts, they lack a good understanding of the nature of scientific knowledge, which is essential for one to appreciate the reliability and validity of the type of knowledge generated by science, and the strengths and weaknesses of the processes of scientific inquiry.

Table 8. Frequencies of Hong Kong Students' Responses to Question 4 of the *Ozone* Task

Response	*N*	Percentage
Part (a)		
Yes	352	36.97
No*	600	63.03
Total	*952*	*100.00*
Part (b)		
Yes*	628	66.60
No	315	33.40
Total	*943*	*100.00*

* indicates the correct response.

Conclusions

The mean percentages correct for the OECD countries and for Hong Kong on the released science items are summarized in Table 9. The OECD means show that the items vary widely in difficulty, but basically the performance is good on items that assess "understanding and use of scientific knowledge," and poor on those that assess "drawing conclusions" and "communicating explanations and conclusions."

Table 9. Summary of Performance on the Released Science Items

	OECD mean (%)	Hong Kong mean (%)
Semmelweis' Diary		
Question 1 (Drawing conclusions)	25	38
Question 2 (Evaluating evidence)	64	65
Question 3 (Using scientific knowledge)	68	82
Question 4 (Using scientific knowledge)	60	76
Ozone		
Question 1 (Communicating explanations and conclusions)	28	27
Question 2 (Drawing conclusions)	35	38
Question 3 (Using scientific knowledge)	55	63
Question 4 (Recognizing questions)	57	49

While Hong Kong students show a similar pattern of performance, analysis of their responses to the released items can provide additional information about the strengths and weaknesses of Hong Kong students in various elements of scientific literacy. Comparing with the students in the OECD countries, the results reported in this article show that Hong Kong students are good at "using scientific knowledge" and "drawing conclusions," satisfactory in "evaluating evidence" and "communicating explanations and conclusions," but weak in "recognizing scientific questions."

Among the eight released items, the lowest scores were registered for the items concerned with "drawing conclusions" (i.e., Question 1 of *Semmelweis' Diary* and Question 2 of *Ozone*) and "communicating explanations and conclusions" (i.e., Question 1 of *Ozone*), by Hong Kong students as well as the OECD students. To answer the two questions on "drawing conclusions," students are required to comprehend the given passages and associated information, such as graphs or pictures, which makes a high demand on reading skills. Hong Kong students are seldom provided with learning experiences that develop their reading and comprehension skills in science lessons. When performing experiments, students usually follow detailed instruction given by the teacher and then complete blanks in a worksheet for data interpretation (Yip & Ho, 2003/2004; Yip & Yung, 1998). They do not have to use their own words to discuss the results or draw conclusions. It is therefore understandable that Hong Kong students will have difficulty in understanding a scientific passage, particularly when it is

set in a novel context. Accordingly the students will not be able to develop communicating skills and express their ideas in words. This is reflected in the poor performance on Question 1 of *Ozone* which demands good comprehension of the given passages and power of expression in communicating the ideas in their own words.

The overall performance of Hong Kong students on the science items of the PISA 2000 study has been analyzed in a previous article (Yip & Ho, 2003/2004). Based on the released science items, the findings reported in this article provide some insight on the strengths and weaknesses of Hong Kong students. However, due to the small number of questions analyzed in this article, great caution must be taken in making generalizations about the scientific literacy of Hong Kong students. To account for the characteristics of Hong Kong students, it is necessary to look into the science curriculum, particularly the implemented curriculum that takes place in the science classrooms, and teaching strategies of science teachers in Hong Kong.

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