The effect of curriculum integration on primary pupils’ achievements of science

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Science is no longer taught as a separate primary subject in Hong Kong after the implementation of General Studies (GS), which integrated three disciplines, viz., Primary Science, Social Studies and Health Education. Science achievements of 333 fourth-grade pupils were compared with results of past Hong Kong pupils participating in the Third International Mathematics and Science Study (TIMSS). The findings revealed that the GS Curriculum did not produce better or worse overall results of pupils’ science knowledge than the previous Primary Science Curriculum in Hong Kong.

Keywords: Science achievement, Primary Education, Comparative analysis

綜合課程對小學生科學成績之影響

現行香港的小學常識科課程把科學科、社會科及健康教育科綜合起來。常識科推行後，香港的小學課程中再沒有獨立的科學科科目。本文將 333 位小四學生的科學成績和『第三屆國際數學與科學研究』(TIMSS) 的結果作比較，發現以常識科模式學習科學，學生的科學成績與從前以獨立科學科目學習科學之整體成績相若

關鍵字：科學成績, 小學課程, 比較研究
Introduction

Hong Kong pupils participated in the Third International Mathematics and Science Study (TIMSS) in 1994 when they learned science through the former Primary Science Curriculum (CDC, 1981) at primary schools. TIMSS results (Martin et al., 1997, p.22) indicated that science performance of Hong Kong fourth-grade pupils was at the 10th position while their mathematics achievement was at the fourth place of the 26 participating countries (Law, 1997, p.25). Even though Hong Kong pupils’ science performance was very close to the international average, only a small percentage of pupils reached the top level of science achievement. According to Law (1997), “only 4% of our (Hong Kong) fourth grade pupils (age 10) can reach the top 10% level (90th percentile) and only 17% can reach the top quartile level (75th percentile) in the international comparison” (p.9).

The former school science curricula in Hong Kong emphasized the role of equipping pupils with adequate science knowledge for further studies (CDC, 1981). Contemporary calls for science curriculum reform aim at one more role to provide all citizens with appropriate knowledge and understanding to help them make democratic decisions about science-related issues in our daily lives. As mentioned in the next section, increasing attention has been given to the second role of school science education under the rationale that every citizen should possess appropriate scientific literacy to meet the needs of future society. Hence, a science-technology-society (STS) approach to science education was increasingly adopted in North America in the 1980s. In 1994, General Studies (GS) was introduced as a core primary subject in Hong Kong. This new subject combined related topics of primary science, social studies and health education (EC, 1990). One of the goals of introducing the GS Curriculum is to implement science education in a STS approach (Fung, 1994). As TIMSS was conducted before the implementation of GS, whether pupils studying science through the GS Curriculum would attain better or worse science achievements could not be reflected by TIMSS results. Although a number of researches have been conducted on science education in Hong Kong (e.g. Holbrook, 1990; Law, 1996; Law, 1997, Chan, 1999; Chan, 2002; So, Cheng & Tsang, 1998; So, Tang & Ng, 2000; Tang, So & Ng, 2000), no published references have been found on probing the effect of GS on primary science education. This study set out to provide a picture about Hong Kong pupils’ science achievements before and after the implementation of the GS Curriculum.

Science curricula for Hong Kong primary schools
Traditionally, both primary and junior secondary science curricula in Hong Kong extensively adapted science curriculum innovations from the USA and the UK because these two countries had great political and social influence in the world. This section will firstly provide readers with some information about the development of science curricula in these two counties. Following the tracks of the development of science curricula in the USA and the UK, the development of science curricula or science-related curricula for Hong Kong primary schools could be classified into two stages which will also be presented in this section.

**Science curriculum development in the USA and in the UK**

In the 1950s, large-scale science curriculum reform activities were initiated in the USA and the UK. Van der Akker (1997) regarded the Soviet launching of Sputnik as a “serious blow for American pride” (p.424) resulting in approximately two billion US dollars being invested in many science curriculum development projects in the USA in the 1960s. Aiming at preparing students to enter discipline-based science courses in the universities, these curriculum projects emphasized the modernization of science content, learning objectives, the structure of science disciplines and processes of scientific inquiry. At the same time, science curriculum development efforts also took place in the UK between 1960 and 1980. Well-known examples were the Nuffield Science Courses for both primary and secondary schools and the Science 5-13 Project. These projects emphasized academic upgrading at secondary levels and process skills in primary school education (Van der Akker, 1997). One major feature of the UK reform in the 1960s was an open, child-oriented teaching approach, with much room for discovery learning.

Since the 1990s, increasing attention has been given to providing every citizen with appropriate scientific literacy to meet the needs of future society in the USA and the UK. Carin (1993) reported that US school science programmes generally adopted more approaches with everyday examples, social and ethical issues, and integrated modes across disciplines. In the UK, there were several national projects or studies (e.g. DES, 1978; APU, 1983; DES, 1985) that could help teachers identify the weaknesses of current situations in science education and recognize the importance of science particularly at primary levels. The Education Reform Act 1988 further introduced science as a core subject of the National Curriculum (DES, 1989). The science curriculum reform efforts at the USA and later at the UK shared a common feature of the “science for all” approach characterized as “scientific literacy” which emerges to cater for all students rather than future scientists or engineers. With the rapid expansion of pupil population as a result of compulsory education policy, a majority of pupils
generally found traditional programmes and materials of science curricula difficult and boring (Hurd, 1986; Walberg, 1991). Preparing students for further studies in science or engineering disciplines was no longer the exclusive aim of science education, especially at junior secondary and primary levels. Scientific literacy for all students then came more to the foreground (Fensham, 1985). School science curricula in many countries, such as the USA, increasingly adopt integrated (thematic or issue-based) and modular approaches together with the traditional discipline-based science curricular fashion although debates about the merits of integrated and subject-based curricula were not conclusive (Gehrke, 1998).

Primary science curricula in Hong Kong (1967-1994)

In Hong Kong, the first central common-core science curriculum, Nature Study (ED, 1967), was introduced in 1967. By providing children with first-hand experiences, this primary science curriculum aimed at helping students live in a full life through the acquisition of knowledge and understanding of natural world and the environment being expanded. It was emphasized in the official curriculum document that “whenever possible, direct observation is to be used” (ED, 1967, p.1). Apart from the development of pupils’ power of observation, skills of collecting, preserving, and recording specimens were emphasized in the teaching and learning activities recommended by the curriculum documents. For the affective domain, the curriculum also stressed cultivating pupils’ curiosity and positive attitude towards nature and their appreciation of natural phenomena. Analysis of the topics of Nature Study found that this was not a broad and balanced curriculum. About 72% of the content of the Nature Study Curriculum (ED, 1967) was biology while physical science and earth science respectively carried 13% and 11%, and the other area of science and technology had a total about 4% of the whole curriculum. This biology emphasis curriculum was structured to deliver biological topics in a spiral approach. Sometimes, the biological content in the Nature Study Curriculum were too difficult for primary students and were taught repeatedly at secondary levels. Holbrook (1990) found that the overall curriculum coverage of the Nature Study was low as compared with the international average in Physics and Earth Science and reflected the little emphasis given to science teaching in primary schools. He further expressed that “even the coverage for Biological aspects (which was the main emphasis in the syllabus) of the curriculum is inferior to that of the international average” (Holbrook, 1990, p.60). In fact, the Nature Study syllabus was very content driven and did not include hands-on skills. Tang, So and Ng (2000) commented that “this predominately academic orientation contrasted sharply with the suggested child-centered pedagogy” (p.530). From the 1960s to the 1970s, the
implementation of the Nature Study curriculum did not differ much from the teaching of other subjects in primary schools. Fixed teaching syllabuses and teacher-centered classroom processes were the most common scenario in classroom practices. Didactic teaching method was extensively adopted in science lessons at the expense of scientific inquiry. Students seldom had chances to do experiments, to use library resources, and to conduct any investigative projects in science. Holbrook (1990) attributed the low achievement of Hong Kong primary 4 students in the Second International Science Study (SISS) to the fact that the teaching at primary levels was neither experimental science nor science processes.

By the end of the 1970s, the Nature Study Curriculum was reviewed. The Hong Kong Curriculum Development Committee introduced the Primary Science Curriculum (CDC, 1981) in 1981. The official document of the Primary Science Curriculum emphasized the teaching of science process which was the procedure for pupils to get their scientific knowledge through hands-on experiments and a problem-solving approach. Examples of teaching methods, suggested experiments and guidelines for homemade apparatus were included in the curriculum document (CDC, 1981). Even though the curriculum developers advocated that experiments should be carried out with simplest apparatus, equipment needed for some suggested experiments were not appropriate for primary classroom settings in terms of complexity and safety. For example, the suggested experiments of expansion of a solid, a liquid and a gas under heating included many laboratory-type glass-wares which were not suitably done in primary classrooms. Therefore, the suggested process approach had hardly been translated into classroom practices since the official implementation of the primary Science Curriculum in 1984. The findings of the third International Mathematics and Science Study (TIMSS) revealed that “teaching in (primary) science classrooms tends to be teachers-centered and didactic” (Leung & Law, 1997, p.167).

Nevertheless, more diversified science topics were included in the Primary Science Curriculum than that in the Nature Study syllabus. Life science topics were reduced to about 45% in the Primary Science Curriculum while about 11% of the content was allocated to environmental science which was not included the Nature Study. By counting the content listed in official syllabi of both the Nature Study Curriculum (ED, 1967) and the Primary Science Curriculum (CDC, 1981), Table 1 shows the content distribution of these two science syllabi for Hong Kong primary schools one after another. The wider range of content in the primary science curriculum resulted in a better average score of Hong Kong primary 4 students achieved in the TIMSS than that in the SISS. “Since the SISS, science achievement of Hong Kong mid-primary pupils relative to the developed countries has remained low. However, compared with the SISS results, there seems to be a more significant contribution of the
opportunity to learn on pupils’ performance” (Law, 1997, p.24). In spite of some problems in promoting the process approach of science learning, the Primary Science Curriculum could be regarded as a credit to the improvement of primary pupils’ achievements in the TIMSS.

Table 1: Content distribution of the Nature Study and the Primary Science curricula

<table>
<thead>
<tr>
<th>Content</th>
<th>Nature Study</th>
<th>Primary Science Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life science</td>
<td>72%</td>
<td>45%</td>
</tr>
<tr>
<td>Physical science</td>
<td>13%</td>
<td>19%</td>
</tr>
<tr>
<td>Earth science</td>
<td>11%</td>
<td>14%</td>
</tr>
<tr>
<td>Science and technology</td>
<td>4%</td>
<td>11%</td>
</tr>
<tr>
<td>Environmental science</td>
<td>0%</td>
<td>11%</td>
</tr>
</tbody>
</table>

**General Studies: an integrated primary curriculum in Hong Kong**

So far, science is still a core subject in the primary curriculum in many countries while some other countries combine science with other disciplines such as social or environmental studies at primary levels. According to the Third International Mathematics and Science Study (TIMSS) in 1994 (Martin et al., 1997, p.135), a majority of primary students in 15 countries out of 22 studied science through an independent science subject. Some countries, such as Israel, Japan, Korea, Kuwait and Singapore, even had 100% of fourth-grade students studying science as an independent subject. Meanwhile, only seven countries participating in the TIMSS implemented science within integrated curricula, viz., Iceland, Ireland, New Zealand, Norway, Portugal, Scotland, and Thailand. In 2000, eighteen countries participated in the International Review of Curriculum and Assessment Frameworks Project (INCA). The review of curriculum structures of these countries also found that the majority (13 out of 18) of these countries had a compulsory subject of science or “science and technology” for primary years while the remaining five countries taught science in interdisciplinary forms (O’Donnell & Micklethwaite, 2000; O’Donnell, 2002). Although TIMSS and INCA projects did not include all countries in the world, the sample taken did represent quite significantly the situations of most developed and developing countries worldwide particularly for those countries adopting educational systems similar to the USA or the UK. Throughout the world, there was a variety of science curricula implemented at primary levels due to different emphases on primary education held by politicians or curriculum developers in different countries.

In 1990, the Hong Kong Education Commission raised the problem that “the range of discrete subjects offered (by the common core curriculum) is too wide resulting in fragmentation and compartmentalization of the curriculum” (EC, 1990, p.13). The
A test was administered to collect information about current Hong Kong fourth-graders’ science achievements. To establish a representative sample of Hong Kong fourth-grade pupils, this study adopted a strategy to select pupils who covered a wide spectrum of academic ability. Before 2001, all final-year primary pupils in Hong Kong sat for an Attainment Test which ranked pupils into five bands, namely, Band 1 (top 20%), Band 2 (60th - 80th percentile), Band 3 (40th - 60th percentile), Band 4 (20th - 
40 the percentile) and Band 5 (bottom 20%) for secondary school placement purpose a few year ago. At the beginning of this study, 30 primary schools were chosen randomly from a list of 807 primary schools in Hong Kong (ED, 1997). As the information about the distribution of pupils’ banding of the schools was restricted by the government due to the sensitivity of such information, the author visited each of the 30 sampled schools and met the school principals to explain the intention of this study. Principals from 16 schools were interested in this study and willing to provide unofficial information of their pupils’ achievements in the Secondary School Placement Tests in the past few years. Finally, two schools in each banding were selected as the sample in this study. Readers should bear in mind that the banding information of the school was an approximation reported by the principal since there was no official data released due to the sensitivity of such information. Usually, the author and the principal had to use their own judgement to classify the banding category of the school. For example, a principal said that her school had a majority of Band 2 graduates, a few pupils in Band 1 and Band 4, as well as some in Band 3. This school was finally classified into the Band 2 category. With the consent of the principals, one fourth-grade (10 years old) class was randomly selected from each of the ten schools selected. Fourth-grade pupils were chosen in order to make comparison with the TIMSS which drew data from fourth-graders in 1994. Finally, a total of 333 fourth-grade pupils from ten schools took part in the test.

In the development of the instrument, TIMSS items used in 1994 were selected and adopted so that students’ achievements could be compared by using identical questions. TIMSS released items were downloaded from the Internet (International Study Centre, 1999) and five primary teachers were asked to choose which of these items were appropriate for using in the GS context. Those items chosen by less than three teachers were discarded. Only 26 items out of 36 were retained and translated into Chinese under such selection criteria. To establish the content validity, the draft of the questionnaire was reviewed by a primary teacher who helped the author further modify the items according to the appropriateness of the items in the GS context. To establish the face validity of the instrument, the test items were translated backward into English. The two English versions were compared to see any discrepancy in the meaning. The wording of the Chinese version was refined accordingly. Then, 20 fourth-grade pupils were invited to participate in a pilot test for identifying difficulties in administering the test as well as the average time required. Six pupils were also interviewed probing difficulties they had in understanding and answering the items in the pilot test. Based on the information collected from the respondents in the pilot test, refinement of wordings in the questionnaire was made. Finally, 16 questions (9 multiple-choice questions and 7 open-response questions) were chosen for the questionnaire (see Appendix) in the main
study in order to limit the test time to 30 minutes because most school principals advised that the test should be finished within a normal lesson (35 minutes).

TIMSS items were well-constructed with high reliability. The Cronbach’s Alpha Reliability Coefficients of the science test of the TIMSS for fourth-graders in 1994 ranged from 0.70 to 0.83 (Martin et al., 1997, p.A23). In this study, a procedure was also established to train the author and a second marker to mark the scripts. A marking scheme was adapted from the coding guide of TIMSS items (International Study Centre, 1999) and two markers, the author and a primary teacher, separately marked an identical batch of five scripts taken from the pilot test according to the first draft of the marking scheme. The marks of the five scripts by the two markers were found to have a consistency of 80% (four out of the total five scripts) and a meeting was held between the two markers to refine the marking scheme. Then, the two markers marked the remaining 15 pilot scripts according to the revised marking scheme. It was found the marks given by the two markers in 14 out of a total of 15 scripts were identical. In other words, the mark consistency was up to 93% (i.e. marks of 14 out of the 15 scripts by both markers were identical). In the main test, the author marked all 333 scripts and the other marker marked a random sample of 75 scripts according to the marking scheme established. A consistency of 95% (i.e. marks of 71 out of 75 scripts by both markers were identical) of marks was obtained. The consistency of marks in both pilot and main studies was able to demonstrate the reliability of the marks of the pupil questionnaire survey.

Results

The average marks (in percentages) scored by pupils participating in this study were compared with TIMSS results of the 16 items selected for this test (see Appendix) as shown in Table 2.

Table 2: Average percent correct of TIMSS items

<table>
<thead>
<tr>
<th>16 items translated from the TIMSS released items, 1994 (International Study Centre, 1999)</th>
<th>Average for fourth-grade pupils in this study (10-year-old) No. of pupils = 333</th>
<th>Average for Hong Kong fourth-grade pupils (10-year-old) in TIMSS No. of pupils = 4411 (Calculated from Martin et al., 1997)</th>
<th>International average for 10-year old pupils for 23 countries in TIMSS No. of pupils = 95219 (Calculated from Martin et al., 1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average for 9 multiple-choice questions</td>
<td>61%</td>
<td>61%</td>
<td>52%</td>
</tr>
<tr>
<td>Average for 7 open-response questions</td>
<td>40%</td>
<td>41%</td>
<td>43%</td>
</tr>
<tr>
<td>Overall for the 16 TIMSS items selected</td>
<td>50%</td>
<td>51%</td>
<td>47%</td>
</tr>
</tbody>
</table>

As Table 2 indicated, the average mark for the all sixteen questions scored by 333 pupils was 50%.
fourth-grade pupils in this study was 50% which was 3% higher than the TIMSS international average of the 16 items of same age group (95219 ten-year-old pupils) tested in 1994. Besides, the average score of the 16 items of 4411 Hong Kong fourth graders in 1994 was 51% (Martin et al., 1997, p.22). These results revealed that the difference of the marks of the 16 items between pupils in this study and those Hong Kong participants in the TIMSS was very small.

To test whether the differences of the marks of the 16 items were statistically significant or not, t-tests were performed by using the average TIMSS scores achieved in 1994 (calculated Martin et al., 1997) as the test values and the results were as shown in Table 3 and Table 4.

Table 3:  One sample t-test on the marks of Hong Kong fourth-grade pupils (N= 333; df = 332) in this study against the TIMSS results of 95219 international fourth-graders (Calculated from Martin et al., 1997):

<table>
<thead>
<tr>
<th>Test</th>
<th>One sample t-tests on</th>
<th>Average of Hong Kong 4th-graders in this study</th>
<th>Standard deviation</th>
<th>Test value (Average of 95219 international 4th-graders in the TIMSS in 1994)</th>
<th>t-value</th>
<th>Sig. (2-tailed)</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9 multiple-choice questions</td>
<td>0.6089</td>
<td>0.1859</td>
<td>0.52</td>
<td>8.732</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>B</td>
<td>7 open-response questions</td>
<td>0.3967</td>
<td>0.2285</td>
<td>0.43</td>
<td>-2.657</td>
<td>0.008</td>
<td>Significant</td>
</tr>
<tr>
<td>C</td>
<td>16 TIMSS questions selected</td>
<td>0.5028</td>
<td>0.1701</td>
<td>0.47</td>
<td>3.523</td>
<td>0.000</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Table 4:  One sample t-test on the marks of Hong Kong fourth-grade pupils (N= 333; df = 332) in this study against the TIMSS results of Hong Kong 4411 fourth-graders (Calculated from Martin et al., 1997):

<table>
<thead>
<tr>
<th>Test</th>
<th>One sample t-tests on</th>
<th>Average of Hong Kong 4th-graders in this study</th>
<th>Standard deviation</th>
<th>Test value (Average of 4411 4th-graders in the TIMSS in 1994)</th>
<th>t-value</th>
<th>Sig. (2-tailed)</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>9 multiple-choice questions</td>
<td>0.6089</td>
<td>0.1859</td>
<td>0.61</td>
<td>-0.104</td>
<td>0.917</td>
<td>Not Significant</td>
</tr>
<tr>
<td>E</td>
<td>7 open-response questions</td>
<td>0.3967</td>
<td>0.2285</td>
<td>0.41</td>
<td>-1.060</td>
<td>0.290</td>
<td>Not Significant</td>
</tr>
<tr>
<td>F</td>
<td>16 TIMSS questions selected</td>
<td>0.5028</td>
<td>0.1701</td>
<td>0.51</td>
<td>-0.769</td>
<td>0.443</td>
<td>Not Significant</td>
</tr>
</tbody>
</table>

The difference in overall test marks of the 16 items between fourth-graders in this study and Hong Kong fourth-graders in the TIMSS was statistically insignificant (Test F
of Table 4: \( t = -0.769; \) d.f. = 332; \( P = 0.443 > 0.05 \). There was insufficient evidence to reject the null hypothesis that science achievements of the fourth-graders studying science through the GS Curriculum were the same as the fourth-graders taking Primary Science Curriculum in 1994. When the scores of the 16 items of the pupils in this study were compared with the international average of fourth-graders in the TIMSS, the difference in the average marks was statistically significant (Test C of Table 3: \( t = 3.523; \) d.f. = 332; \( P < 0.05 \)). Based on the results of the 16 items selected in this study, science achievements of current Hong Kong fourth-graders were higher than the international average scored in the TIMSS. Similar results were found from the cohort of Hong Kong fourth-graders in 1994 (Martin et al., 1997).

When looking at performances in two different question types (multiple-choice and open-response questions) achieved by fourth-graders in this study, the pattern was the same as past Hong Kong fourth-graders did in the TIMSS. Even though the marks of these two cohorts varied from one question to another, pupils of both cohorts scored the same average mark for the 9 multiple-choice questions selected (61%) while the difference in the average scores for the 7 open-response questions was merely 1% (41% against 40%). The results of t-tests also indicated that there were no differences in the marks of both the 9 multiple-choice questions and the 7 open-response questions scored by current and past fourth-graders in Hong Kong (Test D and Test E of Table 4). Results of tests A and B shown in Table 3 also confirmed that current Hong Kong fourth-graders achieved better results in the 9 multiple-choice questions than TIMSS international pupils who did better in the 7 open-response questions.

### Discussion and Conclusions

The results in Tables 2 and 3 indicated that the GS Curriculum appeared to have no extra, neither positive nor negative, effects on pupils’ science knowledge as compared with the past Primary Science Curriculum. Achievements in science knowledge of the two cohorts of fourth-graders were higher than the international average. Statistically, Hong Kong pupils studying science through the GS Curriculum scored the same average mark of the 16 questions as that scored by past fourth-graders in 1994 when the GS Curriculum had not been implemented. Given the problem of science being no longer a separated subject in the primary curriculum, one may expect pupils’ science knowledge to get worse over the time. Perhaps it is good to find that pupils’ achievements in science knowledge in this study have not been worse than before. The results also revealed that Hong Kong pupils did better in multiple-choice questions but worse in open-response questions than the international pupils. Although the GS
Curriculum emphasized the development of pupils’ science communication skills (CDC, 1997, p.15), the scores of open-response questions in this study revealed the situation that Hong Kong pupils’ weakness in expressing science ideas in words had not been improved since the implementation of the GS Curriculum.

In sum, the results of this study found that the science achievements of fourth-graders were generally the same for the two cohorts who studied science respectively through the past Primary Science Curriculum or the current GS Curriculum. Such a finding may be due to the reason that the conditions of teaching strategies adopted in GS lessons and teachers’ subject knowledge of science had not changed significantly after the introduction of the GS Curriculum (e.g. So, Cheng & Tsang, 1998; So, Cheng, Leung & Wong, 1999; So, Tang & Ng, 2000; Tang, So & Ng, 2000).

It was an encouraging finding that the scores in the test of science knowledge in this study had not dropped within a few years of implementing GS. However, science educators should still be careful to see whether pupils’ science achievements can be maintained at the current standard in the long-term future due to the abolishment of an independent science subject. In a survey of 900 primary teachers in England, only 33% of teachers felt at all confident about their own knowledge of science and only 14% had confidence in technology (Wragg et al., 1989). The findings of Wragg’s study revealed that science was ranked eighth and technology ranked tenth out of ten subjects in terms of teachers’ confidence. Five years later, a further study on 400 primary teachers in England found that teachers were more confident in science resulting from extra in-service training and resource materials together with the comprehensive map of the science set out in the UK statutory orders of the National Curriculum (Bennett et al, 1992; Carre & Carter, 1993). To a certain extent, the integrated nature of GS may have an added disadvantage to the development of primary science education in Hong Kong even though integration has other educational advantages. There was no one speaking for the area of science in the school. The support potential for science, which exists in other countries - like the UK where science was an acknowledged core subject - does not emerge. It is recommended that further studies should be conducted to probe if the integrated nature of GS would have a positive or negative effect on pupils’ science achievements in the years to come.

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Appendix

Test items (Translated from International Study Centre, 1999)

(1) 下表中記錄四個城市在同一天的氣溫和降雨(或雪)量。

<table>
<thead>
<tr>
<th></th>
<th>城市甲</th>
<th>城市乙</th>
<th>城市丙</th>
<th>城市丁</th>
</tr>
</thead>
<tbody>
<tr>
<td>最低氣溫</td>
<td>13°C</td>
<td>-9°C</td>
<td>22°C</td>
<td>-12°C</td>
</tr>
<tr>
<td>最高氣溫</td>
<td>25°C</td>
<td>-1°C</td>
<td>30°C</td>
<td>-4°C</td>
</tr>
<tr>
<td>降雨(雪)量</td>
<td>0 cm</td>
<td>5 cm</td>
<td>2.5 cm</td>
<td>0 cm</td>
</tr>
</tbody>
</table>

哪一個城市曾降雪？

(A) 城市甲。

(B) 城市乙。

(C) 城市丙。

(D) 城市丁。

答案：___________________(1 分)

(2) 下圖顯示木條浮在清水中的情況。

如果用海水去代替清水，請問木條的浮沉情況會有什麼改變呢？

(A) 海水

(B) 海水

(C) 海水

(D) 海水
(3) 圖中大雄在推動他的單車上斜坡。他推動單車所需的能量來自甚麼地方呢？

(A) 從他所吃的食物得來。
(B) 從他早前做運動得來。
(C) 從他行經的地面得來。
(D) 從他推動的單車得來。

答案：___________________(1 分)

(4) 月亮本身是不會發光，但為何它在晚上卻會光亮呢？

(A) 月亮將太陽光反射
(B) 月亮以高速自轉
(C) 月亮表面被一層薄冰所覆蓋
(D) 月亮有很多環形山。

答案：___________________(1 分)

(5) 若要找出種子於光或是暗的環境下會生長得較好，我們可以將種子放在濕紙上並

(A) 置於溫暖而黑暗的環境下
(B) 將一組種子置於光的環境下，而另一組則置於黑暗的環境下
(C) 置於溫暖而光亮的環境下
(D) 置於光亮或黑暗而溫度寒冷的環境下
(6) 種子是由植物哪部份發展而成？

(A) 花
(B) 葉
(C) 根
(D) 莖

答案：______________(1 分)

(7) 以下哪種物件行走的速度最快？

(A) 火車
(B) 飛機
(C) 聲音
(D) 光線

答案：______________(1 分)

(8) 以下哪項理由將蔬果列在均衡飲食的項目內？

(A) 蔬果含有很多水份
(B) 蔬果含有很多蛋白質
(C) 蔬果含有很多維生素和礦物質
(D) 蔬果含有很多碳水化合物

答案：______________(1 分)

(9) 為什麼當我們在陽光猛烈的時候外出，我們要使用太陽油？

(A) 因為太陽油能幫助皮膚抵抗陽光中的有害光線
(B) 因為太陽油令皮膚曬得更黑
(C) 因為太陽油令皮膚變得光滑
(D) 因為太陽油令皮膚感到清涼

答案：______________(1 分)
(10) 很多時候，在山頂仍有積雪的情況下，山下的雪已經融解。試說明此現象的成因。(1 分)

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(11) 當玻璃瓶覆蓋正在燃燒的蠟燭時，瓶內的火卻熄了。

為何會有此現象呢？(1 分)

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(12) 下圖的水壺差不多盛滿了水 (虛線代表水位)。

若慢慢地把水壺傾斜，使水逐滴地從壺口流出，水位會變成怎樣呢？請於下圖的水壺中用虛線畫上水位。(1 分)

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(13) 請寫出一種心臟的功能。(1 分)

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(14) 太陽的體積實際上比月亮大，但從地球上看來，兩者看來卻差不多一樣大小。為什麼呢？ (1 分)

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(15) 請寫出兩種不同的方法去減低空氣污染。 (2 分)

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(16) 動物保護自己的其中一種方法是逃走 (跑開，飛走或游走)。試列出動物其他兩種不同保護自己的方法。 (2 分)

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