

Hong Kong Biology Olympiad for Secondary Schools

In view of promoting these curriculum emphasis i.e. NOS, SI & STSE, the HKASME has organized Hong Kong Biology Olympiad (2012/13) and tried to study the related learning outcomes from the first cohort of New Senior Secondary Biology students. The competition is a 1-hour test with 60 multiple-choice questions which covers the common syllabuses shared by the HKDSE Biology and the HKDSE Combined Science (Biology). The questions are related to four areas in Biology with equal weight:

1. content knowledge (CK) (25%),
2. nature of science (NOS) (25%),
3. scientific inquiry (SI) (25%) and
4. science, technology, social & environment connection (STSE) (25%).

Each school could nominate at most 2 teams, each consisting of 5 students in maximum. After the enrollment, 275 local secondary schools with 1376 students of Grade 10-12 participated. Table 1 illustrated the general performance of students in the four areas as well as in the overall paper. The performances in CK and STSE are better among the four areas. On the other hand, the results of NOS and SI are much disappointing. Further analysis suggests that there is a moderate correlation between the average scores of content knowledge and the inter-connections between STSE. No other significant correlation was found between other combinations of results from other parts.

Scopes	Mean Mark	Full Mark
Content Knowledge (CK)	7.64	15
Nature of Science (NOS)	3.26	15
Scientific Inquiry (SI)	5.10	15
Science-Technology-Society-Environment (STSE)	9.44	15
Whole Paper	25.44	60

Table 1: The General Performance in the Four Areas and in the Overall Paper

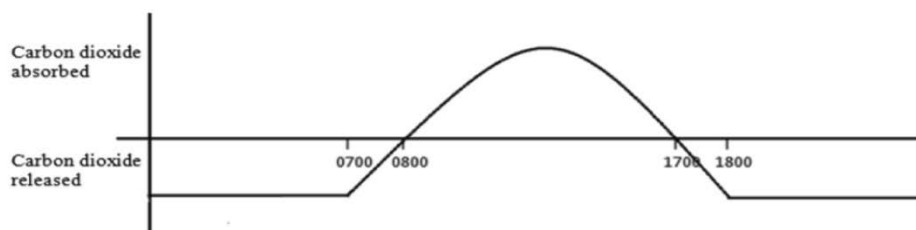
Evaluations on students' performance

In order to make a closer look on the performances of students and their problems encountered, some selected questions are analyzed and discussed in the following section.

Content Knowledge (CK)

Generally, students performed quite well in this scope. Below shows one typical questions with the corresponding response percentage.

Q13 The following diagram shows the carbon dioxide absorbed and released during a day by a plant:



When does the plant have a net gain of dry mass during the day?

- A. at 1300 only B. 0700 – 1800
C. 0800 – 1700 D. 1800 – 0700

Option	No. of students	Percentage
A	54	4%
B	120	9%
C	1150	84%
D	51	4%

Correct Answer: C

In Q13, most of the students (84%) could obtain a correct answer. Yet, in certain questions requiring the application of concepts, students were unable to respond correctly. The following question is one of the examples.

Q1 Membrane proteins are necessary for many nerve functions. Which process in nerves does **not** require a membrane protein?

- A. Diffusion of neurotransmitter
B. Binding of neurotransmitter
C. Active transport of sodium ions
D. Propagation of a nerve impulse

Option	No. of students	Percentage
A	520	38%
B	181	13%
C	163	12%
D	511	37%

Correct Answer: A

Only 38% of students answered the question (Q1) correctly. Most of them seem to have a limited knowledge about the concepts of diffusion, active transport and osmosis, as required by curriculum. However, they cannot explore on their own to further explain the concepts in a new context, e.g. the membrane transport in living organisms, on top of curriculum requirements.

By comparing these two and other questions, the possible reason for such discrepancy in performances may be caused by the examination-driven education system in Hong Kong. Students tend to focus on what to be assessed in the public examination and so, a rote learning style rather than a deep learning approach is generally employed.

Nature of Science (NOS)

As mentioned before, the performances in NOS were not satisfactory. Below are the questions related to this area.

Q24 Scientists cannot single out an explanation for the origin of life. The most possible reason is that

- A. the origin occurred long time ago.
- B. it is difficult to carry out experiments to prove it.
- C. no evidence can be found to validate the origin.
- D. the origin no longer exists.

Correct Answer: C

Option	No. of students	Percentage
A	89	6%
B	538	39%
C	701	51%
D	48	3%

In the above question (Q24), only 51% of students can identify that the availability of evidence is the reason. 39% of students just simply linked to the experimentation. This obviously reflects that one misconception held by the students - experimentation is a must to build up scientific knowledge. They miss a concept that scientific knowledge can be also constructed based on previous evidences. Another question (Q23) shown below also demonstrated this similar problem.

Q23 The use of fossil record to study evolution involves

- (1) creativity
- (2) evidence-based interpretation
- (3) experimentation

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

Correct Answer: A

Option	No. of students	Percentage
A	315	23%
B	19	1%
C	784	57%
D	257	19%

Once again, many students (77%) believed that experimentation should be involved in studying scientific concepts (Q23). On the other hand, only 23% of students could point out creativity, as one of crucial components of NOS, should be involved. Such response supported the idea that our students were quite weak in certain aspects of NOS.

Scientific Inquiry (SI)

Like the case of NOS, the students were rather weak in SI. A sound and valid conclusion with reference to the existing evidences is important in SI. Nevertheless, from the below question (Q41), only 51% of students made a correct conclusion based on the given observation. Other students seem to recite similar but not precise ideas according to what they have learnt in the lessons or in the textbook. This question mirrors the fact that our students did not realize the construction of a conclusion though they have experienced the learning of conclusion in secondary school science.

Q41 The scientists removed the pancreas of a healthy dog, and it shows signs of diabetes. When they injected extracts of pancreas into the same dog, the signs of diabetes disappeared. What conclusion can be drawn from the above treatments?

- A. A lack of the pancreatic extracts would lead to diabetes.
- B. The secretion of the pancreas can reduce blood glucose level.
- C. Insulin can convert glucose into glycogen in the liver and muscles.
- D. Pancreas can detect the blood glucose level and regulate it.

Correct Answer: A

Option	No. of students	Percentage
A	700	51%
B	470	34%
C	41	3%
D	165	12%

Another idea of SI lacking is the causal relationship in explaining scientific phenomenon. Below is one of the relevant questions.

Q37 4 students (P, Q, R and S) are asked to compare and explain the average body temperatures of people living in Hong Kong and South Pole. Below are their responses:

P: The two body temperatures are very similar because both two groups need a suitable body temperature to facilitate enzymatic reactions in the body.

Q: The two body temperatures are very similar because human are homoeothermic.

R: The two body temperatures should differ for at least 5°C because the two regions have different climates.

S: The two body temperatures should differ for at least 5°C because the people in two regions have different clothing.

Which of the students points out the correct comparison and cause?

- A. P
- B. Q
- C. R
- D. S

Option	No. of students	Percentage
A	679	49%
B	614	45%
C	73	5%
D	10	1%

Correct Answer : B

Almost half of the students wrongly regarded the need as the cause. They could not distinguish between significance and cause. Thus, they misunderstood that same body temperature was caused by the need of enzymatic activity. In fact, they should identify the physiological cause to explain the biological phenomenon, i.e. a constant body temperature, in this question. This indicates that students hold limited understanding on the causal relationship in biology.

Science, Technology, Social & Environment connection (STSE)

The performance of students in STSE is the best among the four areas. Taking the following question (Q55) as an example, many students (63%) could give a correct answer when they were asked to explain the compositions in different cleaning agents. The reason can be linked to the great effort paid on STSE in the local curriculum during the previous decades. However, we shall note that still some students (37%) could not apply the concepts in daily life examples.

Q55 Both washing powder and body cleanser are cleaning products. However, their compositions are different, in which lipase is often added into the washing powder but not into the body cleanser. This is because lipase

- A. is not so effective to help the removal of dirt on the body
- B. can work best when mixed with other enzymes in the washing powder
- C. may cause damage on the skin
- D. is denatured in a hot bath

Correct Answer: C

Option	No. of students	Percentage
A	172	13%
B	78	6%
C	866	63%
D	255	19%

Reflections

From the overall statistics, the performances of students in STSE are better whereas those in NOS and SI are a bit disappointing. We come up with four possible reasons. First, STSE has been established for long and so much have been integrated into questions setting, which are relatively familiar to the students. Second, the local examination system seems to over-emphasize on solid knowledge. This undoubtedly drives the students to fall into the mode of rote learning and focus the concepts written in the textbooks instead of mastering the application of scientific knowledge. Third, the exposure on SI is generally limited. Many practical stressed by the school-based assessment (SBA) in the public exam are done by the students. Yet, students seem like a machine which keeps doing practical but not realize the crucial meaning of SI behind. Lastly, lack of NOS questions reduces the corresponding assessment for learning. This has directly influenced the attention of students on this area.

As science teachers, we hope to attain different goals of science education, just like what is stated in the official curriculum documents. However, it appears still a long way to go with our students. From the recent report of Hong Kong Biology Olympiad, perhaps, it is time for us to rethink, reflect and reform what happens in teaching and learning.

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