Daily-life phenomena — Scientific explanation

Awardees

TSO Siu-man, Simon (Years of teaching: 20 years)
CHAN Chung-leung (Years of teaching: 16 years)
SHU Ching-yee, Gloria (Years of teaching: 5 years)

School

St. Stephen´s College

Teaching Targets

Form 3 (Biology)

The Beliefs of Teaching

"When we study Biology or Science, we have to learn from our experience, particularly starting from incidents and objects around us in our daily lives. Besides, we deeply believe that students can understand the extent to which they can master what they have learnt through continuous assessments."

▲ ► **During the experiment, the teacher would, from time to time, remind students to be observant and should not neglect any details.**

Interview with the teachers

When we find some bread becoming mouldy, or ants gathering on a table stained with syrup, we often think these are only common phenomena. A few Biology teachers of St. Stephen´s College, however, make use of similar daily-life phenomena and turn them into the starting points for stimulating students´ investigative spirit. They also help develop students´ interest in scientific investigation, with the help of a school-based Biology curriculum for Form Three and the implementation of cross-subject project learning. A solid foundation is thus laid for future study.

The Biology teachers of St. Stephen´s College realise that Form One and Form Two students only come into contact with scientific knowledge through the subject of Integrated Science. Biology, Physics and Chemistry are taught as individual subjects starting from Form Three, when students formally come into contact with Biology. In order to avoid frightening off the "new comers" to Biology lessons, when the teachers design the school–based Biology curriculum, they try as far as possible not to use any difficult words and concepts in the early stage. Instead, they teach students some basic concepts of science, e.g. What is Biology? What is an organism? They also make use of learning activities to help students understand the relationship between science and daily life.

Mastering the skills step by step

In order to conduct a scientific investigation, we have to be able to master the necessary skills. A systematic method is used for developing the scientific investigation skills of the students. As pointed out by Ms Shu Ching–yee, in the first term, the curriculum focuses on helping students develop some basic scientific investigation skills through three separate tasks. The first task aims at helping the students understand and familiarise themselves with observation skills; the second is a task on how to handle data; the last one requires students to apply what they have learnt to prepare a simple experimental design in a scientific investigation.

In order to familiarize students with the relevant skills, a solid foundation can be laid with frequent training. Ms Shu said that it normally took about one month to finish one task. When all the basic skills have been taught, the first term would nearly come to an end. More emphasis would be put on the teaching of theories in the second term, during which students would be guided to carry out cross–subject project learning in groups. During this time, students would be divided into groups and would start conducting investigations in their own projects.

Life experience – Thinking and observation

The teachers have adopted an investigative approach in their lessons. They guide students to extend the scope and the depth of their study by constantly quoting daily life examples. For example, a slice of ordinary bread becomes the focus of a teaching point.

"Mouldy bread is something very common. We first discuss the phenomenon of how mould grows on bread. Then we ask students to observe, raise questions and construct a hypothetical concept, giving them guidance along the way. We would guide them to extend the hypothesis and design an experiment. In the course of the experiment, students collect data through observation and learn how to handle and analyze them. We would also include everyday

▲ **Students are divided into groups to conduct an experiment cooperatively to unveil a bit of the mystery of science.**

Teachers´ Sharing

Experiential Learning, School–based F.3 Biology Curriculum in St. Stephen´s College

1. Our ideas

Teachers in the Biology Department of St. Stephen´s College are concerned about not only the delivery of subject knowledge but also the training of presentation skill, planning ability, analytical power, reasoning process and the use of scientific method. We believe that simply imparting knowledge and facts to students is not an effective way in helping them to learn science as these things will be easily forgotten. It is important to internalize some basic ideas and concepts in the mind of students and to cultivate them as life–long learners. We also believe that every student has the instinct to learn if he/she is provided with some basic skills and encouraged to establish his/her motivation.

Years before the initiation of the recent education reforms, we had already worked in collaboration in developing a school–based and student–centred curriculum in F.3 level. Our reform in the F.3 Biology curriculum was initiated and planned in 1995 and was first implemented in September 1996. Much emphasis was put on training our students to be active learners and be able to handle scientific investigations. It is hoped that, through the completion of this foundation course, our students can

examples in the class work and the worksheets. For example, when the table is stained with syrup, there would be ants gathering shortly afterwards," said Mr Tso Siu–man when he displayed a brief computer report. "The teaching progresses step by step, and it would not be too difficult for students to follow. As this starts with the daily life, students can easily find many examples. In the process, students gradually learn to master the basic skills in scientific investigation."

If the lessons are dull and dry, even if the topics are closely related to their daily lives, students would not enjoy them. Before teaching each new concept, the three teachers have to set the scene first. They then raise questions and ask students to answer them. This can stimulate students´ desire to learn and enhance their concentration and participation. Meanwhile, the teachers would arrange for students to carry out group activities and discussions. There are generally 3 to 4 students in a group. There was an occasion in which Mr Tso gave two grasshoppers to each group and asked students to observe them carefully. After some time, the groups were asked to exchange the findings of their observations. "In the course of the exchange, students found that they did not notice some of the things that other classmates had noted. Apart from observation skills, the teacher may take the chance to introduce more skills through the activity."

Compilation of a teaching resource kit

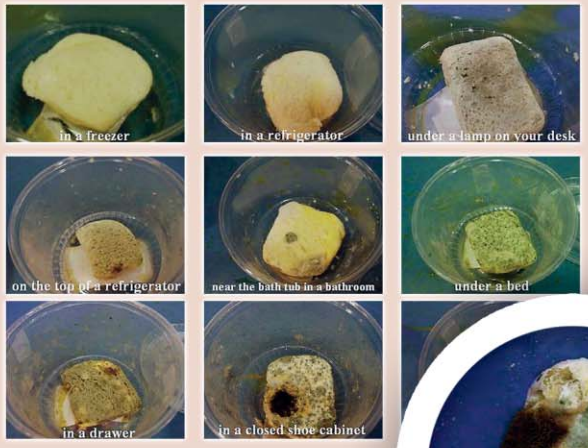
To date, the school-based curriculum designed by the three teachers has been fully developed. Some of the teaching materials have been compiled and included in the "Biology Learning and Teaching Resource Kit" published by the Education and Manpower Bureau and distributed to all secondary schools in the territory as teaching resources. The three teachers have also been invited by the Education and Manpower Bureau to share their teaching experience with teachers in other schools.

In recent years, the three teachers have been promoting the use of the teaching approach they have designed for other science subjects. Mr. Tso said, "Last year, we cooperated with the colleagues of Chemistry and Computer Literacy." In the current academic year, the three teachers have again cooperated with teachers of Physics, Chemistry and Computer Literacy to develop cross-subject project learning. Hence, the development of curriculum has moved a step forward and the students´ choices are more diversified.

be much better prepared for their future studies in various science disciplines.

In order to train our students to be active learners, we lead them to engage in a more independent learning process in which they need to go through systematic and creative planning, critical reasoning and rational decision–making. Moreover we also provide formative evaluations in the form of diversified modes of assessments, such as student–teacher interview, peer–evaluation, evaluation through check–lists etc., so that students can learn scientific concepts in a progressive and constructive way. Another important element to foster students´ learning is the provision of experience to cultivate their curiosity and this could be achieved through life–wide learning processes. Hence, we introduce many laboratory activities and home activities for students to experience and many of these activities are related to their daily lives.

The curriculum includes two parts. Half of the course time is spent in acquiring scientific skills including observation, experimental design, data handling and conclusion drawing. The students are then given a chance to demonstrate their abilities in handling an investigatory project of their own choice of topics. They are also encouraged to work in small groups of two to three members. The essence of our school–based curriculum is found to match very well with the recent development encouraged by



▲ **The groups have put the bread samples in different places. The surface of the bread is covered with mould after a period of time. The amounts of mould on the pieces of bread are different.**

the Curriculum Development Council (November 2000). In the consultation document "Learning to learn, the way forward in curriculum development", the following rationales are stated and are found to be consistent with our beliefs:

(1) Emphasizing scientific thinking;
(2) Nurturing interest in science;
(3) Developing students to become active learners in science;
(4) Helping students to make informed judgements based on scientific evidence; and
(5) Catering for students with strong interest and talent in science.

2. Brief Description of the F.3 Biology Curriculum

A. Strategies

(1) Provision of a theoretical background concerning the components of scientific method;
(2) Provision of many related activities to arouse the interest of students;
(3) Provision of opportunities for students to evaluate their own work (building upon their own foundation);
(4) Provision of an opportunity for students to apply their concepts in a real situation;

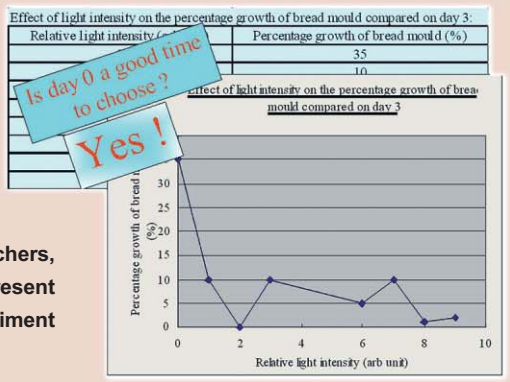
▲ **Mouldy bread is nothing special in the eyes of ordinary people and it is not worth mentioning. However, with the guidance of the teachers, it becomes an interesting subject of study for the students.**

(5) Provision of an opportunity for students to present their ideas in front of a large group of audience; and
(6) Reinforcement of concepts about scientific investigatory skills by referring to two theory topics especially suitable for this purpose.

B. Components

(1) Theoretical background of scientific method:
–Observation & recording;
–Hypothesis making;
–Experimental design;
–Data treatment; and
–Drawing of conclusion.

The project includes 4 lab activities:
–Estimating the length, volume & weight;
–Observing & describing a piece of compound leaf;
–Finding out the surface area of a leaf; and
–Comparing two grasshoppers.



► **With the guidance of the teachers, the students learn how to present the findings of the experiment clearly and systematically.**

It also includes 2 related home activities: on growth of bread mould & subsequent class discussion on presentation of observation/recording.

The activities on the growth of bread mould are conducted in two stages:

(i) A piece of fresh bread sealed in a transparent plastic container is kept by each group of students at home for a week. Different groups will leave their bread in different places. Observation on the growth of bread mould is made and recorded. The records are then presented and students generalize the conditions that may likely have affected the growth of bread mould; and

(ii) Based on the experience and discussion at the first stage, students then focus on one factor for more systematic investigation.

(2) Two theory chapters selected from the Biology Curriculum and Assessment Guide (Secondary 4–5):

The use of the topic "Diversity of Organisms" facilitates the reinforcement of concepts learnt in the topic "Observation & Recording" and the topic "Nutrition in Green Plants" facilitates the reinforcement of concepts learnt in the topics "Dealing with Data" & "Scientific Method".

(3) Conducting self–directed investigatory projects in small groups of about 3 students. There are seven stages:

(i) Grouping of students, determination of a specific topic and submission of a proposal;

(ii) Interview with the teacher to evaluate the proposal;

(iii) Revision of the original proposal and dividing jobs among group members;

(iv) Presentation of project plan to receive comments from classmates;

(v) Conduct of experiment to collect data;

(vi) Presentation of findings to share experience; and

(vii) Submission of a written report with self–reflections.

(4) Presentations of project design and project findings in the lessons

3. Important Elements of the Curriculum

A. Working within students´ daily experience

In the development of various components of our school–based F.3 Biology curriculum, we have designed a number of learning activities that are related to the daily lives of students. Activities such as "the growth of bread mould", "effect of physical activities on the heart–beat rate", "grasshoppers in grassland" and "ants like sweet solutions" are some examples.

B. Making good use of the school campus

We always make use of our large school campus that has a rich collection of fauna and flora when students learn the topic "diversity of organisms". In such a way, learning of animal and plant groups will not be theoretical but something authentic.

C. Assessment for learning

"Assessment for learning" is a concept that has been widely advocated in recent years. It exists in many instances in our daily teaching. The following two examples serve to illustrate how it is done.

Example 1

Students are guided, but not taught, to learn how to finish a task. We understand that such a kind of problem–solving activity requires students´ high–order thinking skills. Sufficient pastoral care services are essential especially during the early stage of idea formulation and experimental design of an investigatory project. Hence each group of students are required to submit a proposal and are provided with an interview session, typically of 30 to 45 minutes, with their teacher. During the interview, teachers will lead them to evaluate their own original proposals, instead of correcting the mistakes for them. Under such an arrangement, it is believed that students will be more likely to engage in active learning. In the middle and the final stages of the project, each group of students is required to present their plans and findings. This arrangement not only provides more chances to assess students´ understanding but also opportunities for peer assessment and mutual learning.

Example 2

At several stages of the "bread mould

activities", students are required to record their observations and present the results in the forms of tables and graphs. The record sheets are scanned onto the computer and the images projected during the lesson. Students are invited to comment on the presentation of data by suggesting correct practices and areas for improvement. This arrangement has been proved to provide good opportunities for peer assessment and mutual learning.

Way of Access to the Information of the above Teaching Practice

The 2001 version of the course materials may be downloaded from "Biology Learning & Teaching Resource Kit" prepared by the Science Education Section (CDI) of the EMB through the following link:
http://cd1.emb.hkedcity.net/cd/science/biology/resources/content_resources_e.htm
Interested teachers may also contact any one of us for further information.

Preferred Way of Dissemination

Public dissemination and discussion

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▲ Cross-subject project learning provides a good chance for students to put into practice what they have learnt. It also enables teachers to learn about the progress of students' learning and the learning outcome.

Summary of Assessment

Excellent team collaboration and curriculum leadership in developing a school–based Biology curriculum to enable students to become active learners

The nominees have demonstrated excellent team collaboration and curriculum leadership in developing a coherent, systematic and flexible school-based S.3 Biology curriculum, adopting Project-based learning with emphasis on the process skills of scientific investigation. In developing the curriculum, the team has worked together collaboratively to analyse students´ strengths and weaknesses and prepared course materials including comprehensive teaching notes and well-designed worksheets to cater for the students´ learning needs. Some of these materials were incorporated into the "Biology Learning and Teaching Resource Kit" (Curriculum Development Institute 2002) distributed to all local secondary schools as resource materials. This has helped to promote a culture of excellence and collaboration in the profession. The team has persevered with developing the curriculum as they continue to refine the S.3 Biology curriculum.

The S.3 Biology curriculum has been very well received by students. It adopts a scientific investigative approach with focuses on the concept of hypotheses, the ways of verification through investigation, and the appropriate ways of presenting data and drawing conclusions. Students are required to conduct self-directed investigatory projects in small groups. Each project involves 4 laboratory activities, 2 related home activities, follow-up class discussions, presentations and recording. Students need to engage themselves in systematic and creative planning, critical reasoning and rational decision-making. The projects are to be completed towards the end of the school year. According to a survey conducted in the 2004-05 school year on the response of the students who had carried out self-directed investigatory projects in the previous school year, the students´ interest in learning science had increased and their communication skills, critical thinking skills, collaboration skills as well as process skills had also improved. The nominees also pointed out that students were particularly fond of the project on the growth of bread mould.