The Assessment of Science Learning in Schools in Hong Kong: the status quo and future directions

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Abstract

The findings reported in this paper is part of an international project "Schools Around the World"[1] (SAW) that aims to enhance teacher development in the area of assessing students' work in science. The aim of this paper is to review the current assessment practices that teachers adopt in science at both the primary and secondary levels. This review helps researchers and science educators to identify the needs of the teachers and chart out possible directions to improve the assessment of students' science learning in future. Moreover, drawing on the findings, the SAW project team may also identify ways of facilitating such changes.

Teachers teaching primary four General Studies, secondary teachers teaching secondary two Science and secondary four Biology were interviewed. The interview questions focused on revealing their current practices in assigning students' work; factors influencing the assignment of students' work; performance criteria they set on students' work, feedback they provided for students, their views about science assessment and their opinions on alternative forms of science assessment. In this paper, students' work include all different forms of tasks that the teachers assign to students which may be formative or summative assessment tasks conducted during or after lessons.

Findings reveal that homework in the form of written assignments, laboratory reports, workbooks and tests are at present the major forms of students' work, though the teachers realized the importance of project work and experimental work in science learning. Results also show that the teachers are ready for a change from the current practice to give more emphasis on project work and formative assessment tasks. In the SAW project, teachers are encouraged to attempt the use of alternative forms of students' work in assessing students' science learning and engage in professional discussion with teachers from other countries participating in the project.

Introduction

The recent reform proposal in education in Hong Kong (Education Commission, 2000) has called for a full utilization of alternative methods of

[1] This is a project funded by the Quality Education Fund.

assessment that may comprehensively assess students' performance and abilities. The consultation document released by the Curriculum Development Council (2000) also points out the importance of life-long learning and personal development. The emphasis on the development of nine types of generic skills including: collaborative skills, communication skills, creativity, critical thinking skills, information technology skills, numeracy skills, problem solving skills, self-management skills and study skills were explicit. While teachers and students are long adapted to the teaching and learning methods preparing for examinations, the current reform direction means a change in the conceptions and beliefs about assessment for teachers. As teaching and assessment are closely tied together, teachers have to be aware of the alternative methods of teaching as well as assessment. The focus of assessment is shifted and so is the purpose. This paper aims at examining the current practices of science assessment and identify possible future directions of changes. Teachers' conceptions on students' work in science were collected through interviews. Students' work is the focus of the international Schools Around the World project, and it is defined to include both assessment and learning tasks that teachers assign to students before, during and after their teaching. The paper concludes with recommendations on how such changes may be facilitated through the international project "Schools Around the World".

Current trends in science assessment

Two major forms of assessment, formative and summative assessment, are commonly employed by teachers. Bloom, Hastings and Madhaus (1971) defined "summative assessment" by including evaluation tests conducted at the end of units or course to judge the extent of students' learning. The purpose is to grade or certify students, evaluate their progress or to find out the effectiveness of a curriculum. This form of assessment mainly reflects students' school performance and may have important consequence on students' future. The term formative assessment is used to describe a number of different assessment activities. Formative assessment may include continuous or on-going summative assessment where a number of tests or tasks were given to students and the scores were accumulated to determine students' performance at the end of a course or year. This practice is regarded as a formative assessment for summative purpose. Another way of using the term formative assessment is referring to a variety of tasks that aim at promoting students' learning and informing teachers about their own teaching. Bell and Cowie (1997) defined the purpose of formative assessment in promoting student learning as:

> "To give feedback as to whether the students had scientifically acceptable ideas and skills; to give legitimacy to the students' scientifically acceptable ideas; to monitor whether the learning activities were working; to monitor students' progress in learning; to give feedback on what is valued as learning outcome in the classroom; and to give feedback on the students' social and personal learning."

The gist of formative assessment is thus to improve students' learning and teachers need to take action after they collected information about students' learning through the assessment tasks. By this definition, "on-going summative" assessment can only be considered as formative assessment when teachers take action to improve learning. For example, after having learnt that a student has an alternative concept in science through an assessment task, the teacher may involve in providing opportunities for students to explore their own ideas, to present to them the scientific view, to modify their own ideas and to apply the new ideas confidently (Driver, 1989). Bell and Cowie (1997) further propose the planned and interactive formative assessment. The former involves tasks conducted at the beginning of teaching and aims at eliciting students' prior conceptions. The teacher will then need to interpret and act on the formative assessment information. The latter or interactive formative assessment refers to interactions between students and the teacher during teaching or practical activities. Teachers in Hong Kong are long adapted to the use of tests and examinations for summative purposes, the awareness of formative assessment is only beginning to grow. To be congruent with this situation, the definition of formative assessment is extended to include all different possibilities: tasks which may be used for on-going summative purpose but are directed to improve students' learning as well as planned and interactive formative assessment. The purpose of formative assessment is twofold: improve students' learning as well as teaching.

The advantages of formative assessment are further elaborated by a number of science educators. Daws and Singh (1996) summarize that formative assessment strategies can deepen learning by encouraging pupils to:

> Reflect on their learning in a structured and systematic fashion;
> Discuss their progress with their teachers and focus on what they need to do to improve;
> Develop greater confidence in their knowledge of science.

Apart from this, Black (1998a) reviewed the evidences that support the effectiveness of formative assessment. He concluded based on at least 20 studies that formative assessment helps the "low attainers" in improving

their learning whilst raising the overall level of achievement. He also found a number of common characteristics among the research reports. These include: the involvement of new modes of pedagogy that calls for significant changes in classroom practices; the active involvement of pupils in the assessment process; the results of the assessment practices have to be used in adjustment of teaching and learning strategies; formative assessment can affect the motivation and self-esteem of pupils with obvious benefits in engaging pupils in self-assessment.

Having identified the advantages of formative assessment, it is not surprising that in science education, the form of assessment has been shifted from the dominant paper tests to the use of other varieties including diagram drawing and experimental operations. The once prevailing summative assessment strategies have been replaced by such diversified alternatives as formative assessments. The aim of assessment becomes multi-purpose instead of giving only a summation on students' performance (Lloyd-Jones, 1986). The traditional one-off summative science assessment aims at assessing students' understanding on facts and theories, but now teaching objectives, learning processes, nature of scientific knowledge and its relation to the society become the prior aims. According to Lloyd-Jones (1986), assessments have also lifted from low level cognitive domain to high level cognitive domains covering analytical ability, ability of appreciation and sense of creativity, the affective domain like attitude, interests and value; as well as the skills domain. To help teachers to conduct formative assessments that cover the various domains, standardized tests and a variety of students' works are suggested in the literature.

Examples of alternative forms and timing of science assessment

In order to promote the use of formative assessment in science teaching, Black (1998b) suggested that providing a variety of feasible implementation examples is important. With this suggestion in mind, a review on the possible variety of assessment tasks is made. The science teachers may then consider to implement any of the tasks with a formative purpose of improving learning and teaching.

Ten items that may illustrate the variety of forms of science assessment are summarized. While items (1) to (5) may be more commonly employed, teachers in Hong Kong may less frequently use items (6) to (10). Although they are specific examples of tasks, it does not mean that they are discrete

in terms of areas of learning each assess and the information about student that each may reflect.

1.	**"Paper test"**	is a test based on the teaching objectives and teaching materials used by the teacher.
2.	**"Oral test"**	requires students to give verbal answers to the questions asked by teachers. For example, a teacher may present a picture of a computer to a selected number of students and ask them whether they consider it to be a living organism so as to obtain students' prior view before teaching the topic living organism.
3.	**"Experiment"**	assesses students' ability in handling practical experimental operations and solving problems.
4.	**"Field study"**	gives students chances to visit places outside school, like collecting data at a mangrove habitat or interviewing technicians at a factory.
5.	**"Data collection"**	shows how students collect, organize, and analyze data as well as apply the knowledge derived from the data collection processes. For example, after teaching a topic on electricity, the teacher may ask students to record data about the usage of electricity in their own homes by reading either the meter or the electricity bill and calculate the amount of current consumed as well as the payments to be made.
6.	**"Report"**	in both oral and written forms, is to evaluate students' reading comprehension, observation, experimentation and investigation.
7.	**"Project"**	aims at assessing students as they were involved in the investigation of a topic from a scientific point of view or the design and production of an object based on their science knowledge, for example, students may design a home for the future. Projects may reveal the students' knowledge, skills and inquiry attitude. While experiment, data collection and report can be taken as independent assessment tasks, they may also constitute part of a project.
8.	**"Portfolio"**	may include a collection of the work done by students. This may include their experimental reports, notes, projects and even letters that explain scientific concepts as suggested in Farrell-Childers and Lowry (1997).
9.	**"Performance"**	refers to assessments based on the acting performance of students. For example, the students may act in the form of

		a story of their science project or investigations.
10.	**"Classroom interaction"**	refers to the dialogue between students and teachers during the lessons. The responses of students may provide information to the teacher about their levels of understandings and form part of the formative assessment. Though there are student-teacher interactions, teachers may not be always aware that this is actually a form of interactive assessment which serves a purpose of improving teaching and learning as referred to Bell and Cowie (1997).

The above items may be assessed by the teacher, and may also be self assessed by students. Students may look into their own learning, achievements and behaviours. Moreover, these items can also be peer assessed meaning that students exchange feedback and comment among peers of their respective behaviour or pieces of work. These assessments can be carried out at different times for different purposes. Consistent with a constructivist view of learning (Appleton,1997), the teacher needs to assess students continuously in the process of teaching in order to obtain a better understanding of what they learnt and how learning occurred. Eliciting children's questions and explanations at different stages of teaching was found to be informative for the science teacher and has also helped the children to construct their own science understandings (Gibson, 1998). Hence, assessment at different stages of teaching may facilitate both teaching and learning process. First of all, assessment can be done prior to the teaching of a particular topic. Pre-tests that aim at investigating whether students have acquired the basic skills related to the topic may be conducted. These tests can be a form of diagnostic assessment or serve the purpose of helping teachers to have a better understanding of pupils' preconceptions.

Assessment can also be held during the teaching. Assessments conducted when an activity is almost or already completed carried several objectives. They may provide information about whether it is an appropriate time for the activity to terminate. Besides, it is helpful to look into the conceptual development among students and how they solve the problems during their learning process. These belong to formative assessment and provide teachers with the information about students' learning. With this information, teachers may adjust their teaching according to the needs of students and may in turn improve the quality of teaching.

Similarly, it is possible to invite students to carry out self-assessment in between or at the time nearing the end of the teaching of a topic or unit.

Students may complete self-tests so as to get an understanding in accordance with their own strengths, then find out and improve their weaknesses.

Last but not least, science assessment can be held after the teaching. It aims at assessing the academic achievements of students in learning a unit and results are represented by a grade. This is the most common form of summative assessment in Hong Kong at present.

The above review does not preclude summative assessment as a viable strategy in reflecting and facilitating students' achievement in science. This review, however, suggests a shift in the emphasis from summative assessment to the currently widely ignored importance of formative assessment. It is believed that both forms of assessment have a role to play in facilitating students' learning as suggested by Biggs (1998). Formative assessment has a particular close linkage with education purposes that develop self and life-long learning among students. As suggested by Dougherty (1997), in a "5E instructional model", formative assessment is involved in all the stages of engage, explore, explain, elaborate and evaluate. The teacher may assess the three aspects of learning science, namely knowing science, doing science, talking science and acquiring science attitudes and values (Lee and Fradd, 1998) or the content, skills and problem solving ability of the students (Meng, 1990) at each or any of the five stages. In other words, this assessment information will facilitate the teacher to design subsequent teaching strategies and will also help the student to gain constructive information about his/her own learning. The role of summative assessment will be at the last stage of teaching, evaluate, when a picture about how well the student has achieved in a certain topic is obtained.

Supporting teachers to shift their practice from an emphasis on summative to formative assessment

Having identified the possible range of formative assessment activities in science classes and illustrated how both formative and summative assessment activities may contribute to the teaching and learning process in a teaching unit, suggestions on the support needed to facilitate such a shift in the light of assessment have to be considered. In relating teachers' competence towards assessment, Sadler (1998) suggested six aspects, including teachers' knowledge about the subject, attitudes towards learner and learning; skill in devising students' work; knowledge about the criteria and standard; skill and expertise in similar assessment tasks and expertise in providing appropriate and targeted feedback. Concerning formative

assessment, Daws and Singh (1999) related that teachers found it hard to develop formative assessment strategies in face of pressures from summative examinations, were unsure of formative assessment strategies, and would welcome support for developing formative assessment approaches. Moreover, Black (1998a, 1998b) has repeatedly called for policy revisions that support formative assessment with an aim to raise the standards of learning. He also noted that this shift of teachers' practices calls for changes in more fundamental beliefs about learning among the teachers. The assumption that knowledge is to be transmitted and learned and understanding developed later has to be changed. He remarked that this change is social as well as personal. While Hong Kong has taken the first step in policy revision, the second step will be a long process of changing teachers' beliefs and practices which requires much professional support and development (Black, 1998a). This paper is then set out to examine the present scenario and how much teachers' beliefs match the proposed changes in assessment policies ahead.

Method

This study involved both primary and secondary teachers. At the primary level, six General Studies[2] teachers from two participating pilot primary schools currently teaching the primary four level were invited to provide information for the present study. At the secondary level, eight teachers teaching biology at secondary four and science at secondary two levels from four secondary schools were interviewed. The interview questions focused on finding out: their current practices in assigning students' work; factors influencing how teachers assign students' work; the performance criteria that they set on students' work, the feedback they provided for the students, their views about science assessment and their opinions on alternative forms of science assessment. These interviews were conducted as part of an international project named Schools Around the World, the aim of which is to enhance teachers' professionalism through the setting of performance standards in science. In order to design workshops and stimulate teachers' professional discussion about science, interviews were conducted in the pilot phase of the project. With the findings of teachers' views about the assessment of science learning, the project team may design teacher development opportunities that are tailor-made to their needs, concerns and present understandings. In this project, the participating teachers were also asked to share their students' works, marking criteria and comments with their colleagues locally and

[2] General Studies is a subject that includes learning in Science, Health Education and Social Studies at the primary level in Hong Kong.

internationally. Students' work to be shared include all different forms of tasks that the teachers assigned, and may be formative or summative assessment tasks conducted during or after the lessons. The teachers were interviewed at their schools and the interviews were translated and transcribed in English.

Results and Discussion

The results were grouped into three areas: the current practices of the teachers; possible changes in future practices; possible factors influencing future changes.

The Status Quo

From the findings, it is apparent that the most common forms of student work among the primary and the two secondary levels are homework after the lessons while pencil and paper tests are most frequently used as a means to reflect students' achievement. The teachers also suggested that these tasks were also mainly concerned with the assessment of science knowledge through recalling. According to the teachers tests and examinations are essential and are the formal forms of assessment that will improve students' performance or make them study hard, such as,

> "...In fact, I also give them quizzes that are small in scale. I ask them one question and they have to put the answer on a sheet of paper. No preparation is allowed because all comes in a sudden. Before starting the lesson, I give them a quiz, but they have ten minutes for revision. Having some time for revision, their performance is much better." (S2T2I1)[3]

> "(Exams) One is held in the first term while there is another in the second term. Tests are held in between. The marks would be an indicator for class promotion which they are all concerned about and they have studied hard for that." (S2T3I1)

Apart from homework and tests, other forms of students' work are not common at the secondary four level biology. The predominant concern among these teachers was to equip the students for the public examination,

[3] The transcriptions were coded as S2 stands for school 2, T1 stands for teacher 1 and I1 stands for interview 1.

> "I would consider whether the assignment could help them in the HKCEE, questions were those that would possibly appear in the HKCEE and that should be manageable for them." (S1T1I1)

Moreover, these teachers were also concerned about providing feedback on students' work that prepare them to provide answers that fulfil the requirements of the public examination though a very different approach is used at the lower secondary levels,

> "My comments for higher form students are referring to their answering skills. It is inevitable for me to put the focus on it. That is reality! In lower forms, I refer them to different source of information despite the textbook or magazine. They may get information via Internet, Environmental Protection Department and Green Power or else. I don't want to narrow down their thinking ability." (S2T1I1)

From these quotations, the public examination has a very strong influence over the teaching, learning and assessment of biology at the secondary four level. Homework and tests are the most commonly students' work employed by teachers of the three levels and there is an emphasis on the assessment of science knowledge by recall. It is apparent that the pressure created by summative assessment exists in all the levels but this accumulates to become the sole purpose of learning at the secondary four level.

Future Directions

Despite the emphasis on tests and recall of science knowledge, teachers did adopt a range of student works for both formative and summative assessment purposes. Though these forms of student works were less frequently employed, .they can become the possible alternative forms of assessment in line with the proposal for the education reform. Hence, a review of the alternative forms of student works currently employed provides a picture of the possible future directions of development.

Though the primary teachers reflected that they seldom conduct experimental work, they have employed other forms of student works like projects, self-evaluations on levels of interest in science and daily habits as the secondary teachers' practices. The secondary two teachers provided the largest variety of students' work including ETV worksheets, newspaper cutting, discussions, short experiments and model making. Unlike teaching the secondary four level, the teachers at the secondary two level found their teaching free from the restrictions of the public examination. They were

aware of arousing students' interest in science, providing opportunities to relate their learning with their daily experience and training them to become independent learners as they related,

> "For example, the Form 2 students would make a model to show different uses of electricity; some of them would make a musical instrument after learning the sound wave concept. We hope that they could apply what they had learnt and be more creative. In short, there was less restriction." (S1T1I1)

> "Tasks are related to their daily experiences, for example, I am teaching them conduction and convection. I use cotton quilt and down as examples. I try to use examples that they are familiar with. This is the approach for junior form students." (S2T1I1)

> "Students need to define experiments and write a lab report right away. Those require them to think. They in fact prefer this way to conducting experiments according to textbooks. They are Form 2 students. They should think more independently than Form 1 students." (S3T1I1)

The teachers at the primary level supported the view that a larger variety of student works should be implemented to reflect student achievement. One of the teachers suggested that the purpose of science assessment should include a number of perspectives, like experimental skills, attitudes and interest in learning science.

> "Assessment should not be confined only to pencil and paper tests or exams. It is good if we can observe their performance in doing experiments within the class. I will find out their level of participation and interest and communication with other members." (P2T1I1)

Apart from the call for science assessment covering more diverse perspectives, the voice for de-emphasis of examinations is strong among the teachers. One of the primary teachers was aware of the fact that tests and examinations may not provide accurate portraits of student achievement as she explained her preference for formative assessment,

> "Tests are very important and I think the results in tests or exams are able to reflect students' abilities. The only problem is that some smart students do not have revisions. Thus, I try to pay more attention to their class performance instead of focusing on tests and exams. Class performance reflects their standard in a more appropriate way.

I am not denying the importance of tests and exams, but they are a game of figures sometimes." (P1T3I1)

Moreover, teachers would like to see balanced and diversified assessment tasks that reflects the creativity as well as other abilities e.g. language,

"Diversified. On the one hand, their basic knowledge and skill could be measured; on the other hand, their creativity and potential could be developed through their own design. But the practice should be balanced so that they would not good at one aspect but weak at the other. Adjustment according to the needs of students is important but not at the expense of their basic written and language skill." (S4T1I1 & T2)

Teachers called for an emphasis on project work, developing students' thinking and independent learning ability as well as an increase in the weighting for project work. Among different forms of student works, project work is highly regarded by the primary teachers, and they found that it helps pupils to develop their self-learning and thinking ability,

"I think the project reflects the learning of students in a clearer way. They are working as a group and they have to organize all the things by themselves. I am sure they will learn something during the process of data collection. This enhances and fosters the self-learning ability among students. Project promotes active learning attitudes of students and it benefits their self-learning. (How about the thinking ability?) Absolutely it will help them to develop their thinking. It requires lots of thinking in doing the project such as the selection of relevant content, where to get the information and they have to embellish the report in a presentable way." (P2T3I1)

The primary teachers also suggested how they could distinguish pupils' achievements through project work,

"Last year I assigned the topic - solar system as their project theme. So I compared their content and presentations on the same topic to decide which the best was. The drawings and the writings were also counted. Content was still considered to be the most important. Some lazy students just copied from the book without providing extra information while some students gathered much information from websites and library reference. I would also add some marks if supplement with extra information." (P2T2I1)

These teachers also reflected that pupils were well involved as they worked on the projects and called for a heavier weighting in the overall assessment. This was related by both primary and secondary two teachers,

> "I am glad we still have a data collection project. It accounts for 10% for the school result. Referring to students' performance in tests and exams, in addition, we also need to refer to their performance in their work. In my own experience, smart students prefer to do something like projects. They are willing to express themselves and show me their abilities. They get involved in doing the data collection project. I have collected and checked their introductory part. I am impressed by their intelligence in presenting their ideas. It is a continuous assessment rather than the discrete assessments. Thus, I think a combination of these two is fair... (Is the project a group work?) No, it is an individual work. That's why it lasts about half a year. The workload is quite heavy. In fact, I know that there are some advantages if we ask them to work in several groups. I only know that 10 marks for the project is under-weighed." (P1T3I1)

> "Their school performance is rated by combining four marks - mid-term exam 30%, the general scores in the first term 10%, the second term exam 50%, and the general scores in the second term 10%. The general score is collected from a continuous assessment throughout an academic year including tests, workbooks, newspaper cutting and projects; in other words, all assignments ... like continuous assessment. It is better to adjust the proportion of general scores by reducing the percentage of exam results. I don't think exams could properly assess student performance. Some students might have poor performance in ordinary school days but only outperform during exams." (S3T1I1)

Consistent with the call for diverse forms and perspectives in assessment, teachers at the primary level also preferred to have more contact with pupils such that they can practise continuous and formative assessment,

> "Besides, insufficient time with students is another reason. The cases of some other teachers are different from mine. I teach more than one subject and thus have more lessons with the same class. So my judgement on their performance is more accurate. If a teacher just teaches them one subject, say General Studies, he/she could only meet them four or five lessons per week. It is therefore difficult to give the most accurate general score on their daily performance." (P2T2I1)

The above reveals some infrequent examples of students work as well as teachers' call for a change in the future. The possible directions for development can be summarized as:

- A variety of student works or assessment tasks should be included.
- More diverse perspectives should be developed among students and assessment area should include self-learning and thinking ability.
- Test and examinations should be de-emphasized.
- Project works should be emphasized and they should have a higher weighting in the overall assessment.
- There should be continuous and formative assessment where the teacher has a close relationship with students.

Factors influencing future changes

Having described the possible directions of development as suggested by the teachers, this section relates their concerns and factors that may influence the implementation of new assessment initiatives. At the primary level, the teachers shared two worries. Firstly, they found conducting experiments difficult in the classroom as one described,

> "As I am teaching P4 students, I worry about the safety in the classroom. It is really important to beware of the matter of safety as they are too young and the classroom is crowded. Sometimes, I do the experiment and sometimes I let them work in a group as well. I have to say that we seldom have this chance. As time is insufficient, it is not that easy to allow them to do experiments by themselves. In general, they have the chance to do experiment but that is not so frequent." (P2T1I1)

Secondly, they were worried about providing more freedom for pupils to explore on new topics that were not taught in class and doubted their self-learning ability, for example,

> "We should consider the ability of students once we assign them some student's work. Some of the student work may be below the average level, so they are unable to do them. Let me show you an example. I am teaching them the characteristics of air, but I haven't taught them the function of air. Students may draw conclusion according to their common sense. This wastes an opportunity for them to apply their knowledge. I must give them student work that they are able to do. It is like what I have told you before. I may ask them to do the workbook after my completion of a chapter or ask them to do the worksheet in the middle of their learning. I wouldn't assign

them any work until they have learnt. It is quite dangerous since students may get poor results; or they are frustrated about their poor performance. Students may lose their confidence once they are unable to do the student's work. This will suppress them to raise their own questions. Finally, students will be depressed." (P1T3I1)

"Students must have some understanding on the topic before they do the student's work. They should have prior knowledge to do the work, it means that I give them student work after I taught them. It greatly depends on how much they have acquired. Once they are able to learn the knowledge, I will assign them some student's work. Basically, student's work here means workbook. Needless to say if we talk about exam. I am able to learn how well they have understood the topic from their workbook." (P2T3I1)

These teachers believed that pupils learnt by being told in class and that workbooks or examinations are the best way to tell how much their pupils acquired or understood. Workbooks and examinations provide summative information about student learning at the end of teaching a topic. The belief that students must be taught before a task can be assigned assumes a view of learning that students do not have any prior knowledge on the topic or even if so these knowledge are mostly "incorrect". The teacher's role is then either to help students to discover new knowledge or to correct students' misconceptions. These views of learning are largely different from a constructivist view of learning, which assumes that students held prior concepts before learning. The teacher's role is then to find out what the students think and to change or develop these concepts. With this role, the teacher needs to assess or find out students' conceptions before, during and after the teaching process. Tasks assigned before the learning are important as they provide information to the teacher about how to teach or change students' concepts. Students also take an important part in the learning process, as they have to be actively involved in thinking and developing their science concepts. The concepts cannot be simply discovered or transmitted from the teacher. These responses suggest that fundamental changes in beliefs about teaching and learning are needed if these teachers are to provide opportunities for pupils for self or independent learning. Moreover, these teachers need to develop self-confidence in guiding pupils to self-learning before they may succeed in developing this ability in pupils.

The teachers at the secondary level related concerns about the tight teaching schedule, the availability of teaching resources in school other than textbooks and the ability of students. Teachers at the secondary two

level found that they were under the pressure of a tight teaching schedule and hence found themselves loosing precious teaching time as they conduct project work with their students,

> "For those project-based topics, it is possible for us to produce a great project like one of the examples shown in the workshop. However, it really takes time to do this by both teachers and students. As a result, we are in a hurry to meet the schedule to compensate the time we lost." (S4T1I1 & T2I1)

Resources that are available in school would be another factor that teachers considered when designing tasks for students.

> "In the present situation, there are limited lessons for science teaching. Project-based learning is a hot topic among the educational investigation... However, we just base on the textbook to teach as it is the main teaching resources we are using..." (S4T1I1 & T2)

Moreover, teachers at the secondary levels doubted the ability of students in engaging in self-learning tasks,

> "If students have good learning bureaucracy and have good preparation, it is possible to do more projects with them. On the contrary, it is no good to give too many projects for students with poor quality." (S4T1I1 & T2)

The teachers also shared concerns on how the alternative forms of assessment can fairly reflect students' performance,

> "Our school is discussing the possibility of swapping one or two exams with two projects. But the premise is that students should first have basic knowledge." (S4TII1)

> "It is difficult to put into practice since there is no effective science evaluation practice established so far. Students would ask why I give him 58 and give the other 59 ...Not applicable to use grading for Form 3 since their marks would be decisive in their allocation. Parents would argue with you point to point." (S4T2I1)

These comments suggest that a change in the curriculum content or a re-definition of topics to be covered is needed. Besides, supporting materials for science learning and teaching that suggest alternative student work or assessment practices are essential. Furthermore, like the primary level, the students have to be equipped with basic skills for self-learning

before they can embark on meaningful projects independently. A number of self-learning skills which may correspond to the generic skills depicted by the Curriculum Development Council (2000) like using the library, information technology skills, self-management skills, study skills as well as other ways to foster self-learning ability as exemplified by the PEEL project (Baird and Northfield, 1987) may be developed. Teachers would need support on setting criteria in formative assessment tasks and information on how these tasks may reflect students' learning.

Conclusion

The findings reveal the emphasis on tests and homework as well as the assessment of science knowledge by recall at present. The pressure for the public examination accumulates to an enormous power that it directs the teaching, learning and assessment of Biology at secondary four level. Despite this, teachers at the primary and the lower secondary level did attempt a number of alternative strategies in the assignment of students work. From these practices, possible directions of change in future are charted. These include: the implementation of a variety of assessment tasks that cover more diverse perspectives, the de-emphasis of examinations, the re-emphasis on project work and formative assessment tasks. However, to make these changes possible, support for teachers at both primary and secondary levels are essential. These support include: changes in the basic beliefs about pupils' capability in self-learning; reviewing the present teaching schedule; provision of resources materials on alternative assessments and student work; introducing ways of developing students to become independent learners and introducing ways of setting criteria in formative assessment tasks.

In face of the possible changes ahead, the international project SAW may support the teachers in a number of ways. Firstly, there can be introductions on theories of science teaching and learning which emphasis on developing students to become independent and active learners. This may help to convince the teachers that students can learn actively by themselves. Moreover, introduction on the ways of developing in students a self-learning ability is essential. Secondly, teacher development workshops that introduce alternative forms of science assessment and ways of setting criteria in formative assessment tasks as well as project work are helpful. Thirdly, teachers may share with each other resources materials on alternative assessment and their student works. Mutual support and encouragement are important in supporting the change process. The project provides a forum for local teachers at different levels to share their experience in conducting different forms of assessment in school and

marking students' project work. Teachers who have attempted alternative forms of assessment, for example the secondary two teachers, may share their experience with teachers teaching at other levels The project also provides an opportunity for local teachers to share and discuss student works with teachers in other countries through the Internet or CD-ROM. It is the aim of the SAW project that discussions among teachers locally and internationally may enhance teachers' professional development leading to improvement of pupils' science learning.

The project team is aware that the SAW project may not provide all the answers to how alternative science assessment methods should be designed and related to the present curriculum. Other developments in the curriculum and assessment have to be in-place to match with the recent proposal for education reform. A few of the possible initiatives may include: trimming down the topics to be taught or allowing more freedom for teachers to choose their topics, de-emphasis on the use of textbook and reconceptualizing the assessment process in schools. To achieve these initiatives will involve the participation of different parties in the education arena namely, curriculum developers, school administrators, teachers and teacher educators.

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