

School-based Assessment of Chemistry Practical Work: Exploring Some Directions for Improvement

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School-based assessment is widely believed to circumvent some of the disadvantages of external examination. Currently, the push for more school-based assessment in secondary schools continues in Hong Kong. This article looks at the particular situation of the teacher assessment scheme (TAS) for the advanced level practical chemistry. Chemistry teachers' concerns about implementing the TAS were collected by a questionnaire. Based on the top 10 concerns expressed by 372 TAS teachers, some possible directions for improving the internal assessment scheme are discussed. The results of this study indicate that chemistry teachers are most concerned about workload, resources and support, moderation mechanism, student workload, difficulty in motivating students, and teacher collaboration. The root causes of these concerns are the large number of experiments required in Form 6 and Form 7, lack of support from the Hong Kong Examinations and Assessment Authority as well as the Curriculum Development Institute, reliance of theory marks to adjust TAS marks, the limited roles of group coordinators, and the narrow scope of assessment tasks included in the TAS.

Public examinations need to be complemented with information from school-based assessment, but the Hong Kong Examinations and Assessment Authority (HKEAA) has failed to play a leading role in the assessment reform in Hong Kong (IBM Corporation, 2003). School-based assessment can remove many disadvantages of a "one-shot" external examination and cover some learning objectives that are not examinable by means of written theory papers. For science education, the advantages of school-based assessment of practical work

are well documented in the literature (e.g., see Giddings, Hofstein, & Lunetta, 1991; Pang, 1992; Whittaker, 1974). In 1978, a school-based assessment component called Teacher Assessment Scheme (TAS) was incorporated into the Hong Kong Advanced Level (AL) Chemistry Examination to reduce the constraining and undesirable effects of the external practical examination. In the scheme, chemistry teachers are responsible for assessing their students' practical skills over the whole course and the weighting of this teacher-assessed component is 20% of the total marks of the subject. The ideas of TAS for AL chemistry were originally imported from the United Kingdom (Holbrook, 1981). However, the goals and operation of the current TAS have not been adjusted to align with recent curriculum reform efforts in Hong Kong, such as the use of project work and information technologies to facilitate student learning. IBM Corporation (2003) has succinctly criticized the HKEAA as follows:

An acceptable assessment regime is not a static or permanent state, but requires continuous attention and refinement to fit the shifting dynamics of society. In many respects Hong Kong has locked itself into a model of assessment that was acceptable at an earlier stage of its development, but which no longer fits the environment of educational reform. (p. 24)

Actually, the AL chemistry is the first subject that has included TAS in the public examination in Hong Kong. In 1998, the Hong Kong Examinations Authority (later renamed as HKEAA) commissioned a team of consultants from Australia, Hong Kong, and Britain to review the public examination system (Fung et al., 1998). They recommended that TAS should be designed to cater for all subjects at the Certificate of Education (CE) and AL levels. They also recommended that those subjects, which currently have TAS, should review their design and try to incorporate other internal assessment activities that are being undertaken in schools, such as mock examinations, in-class tests, fieldwork activities, and problem-solving investigations. However, the Authority did not adopt these recommendations.

Recently, a consultancy report prepared by the IBM Corporation (2003) reiterated the need for more school-based assessment in Hong Kong. They recommended that school-based assessment should be extended to all CE and AL subjects in the next three years and ultimately the weighting of school-based assessment should be increased to 50% of the total subject marks. They also supported the inclusion of other teacher-assessed coursework as part of the TAS. Obviously, all of these recommendations present an enormous challenge to the HKEAA. While we are generally supportive of these

recommendations, we believe that any changes in the existing TAS must start with an exploration and evaluation of the current practices. What are the major problems of the present scheme of internal assessment for the AL chemistry? How can these problems be solved? This article aims to answer these two important questions. Our intention is to provoke discussion about the possible refinements of the TAS rather than to prescribe an assessment model.

This article is organized in three parts. First, we describe the main technical features of the present TAS for AL chemistry in Hong Kong. Second, we report how we surveyed a sample of chemistry teachers in order to identify their top 10 concerns about implementing the TAS. Finally, results of the survey are presented and discussed, and suggestions are made to address teachers' concerns.

Teacher Assessment Scheme for Chemistry

The TAS for AL chemistry was introduced in 1978 as an alternative to the traditional external practical examination. Commencing from 1997, TAS has become a compulsory component of the AL chemistry examination. Assessments in the TAS focus on students' performance in practical work and account for 20% of the total mark in the examination. Teachers are asked to assess their own students continually over the entire period of the AL course. According to the TAS requirements (HKEAA, 2002), students should carry out a minimum of 18 and 10 experiments in Form 6 and Form 7 respectively. Internal assessments should cover the following three ability areas:

- Ability area A (40%) — manipulative skills, skill in observation, and general bench performance.
- Ability area B (40%) — presentation of data, interpretation of results, and planning of experiments and project work.
- Ability area C (20%) — attitude toward practical chemistry.

Each student should be assessed by the teacher on at least five occasions for ability area A, five occasions for ability area B, and two occasions for ability area C. It is not necessary for all students to be assessed on the same occasion or on the same practical. Ability areas A and B may be assessed together, but not every experiment needs to produce assessments of both areas. The TAS provides teachers with great flexibility. They are free to select their methods of assessment, and to decide the number of students to be assessed in a practical session and the types of practical skills to be assessed. However, assessments should not be done under examination conditions. For example,

teachers may unobtrusively observe students during normal laboratory activities to make assessments in ability area A. Students' performance in ability area B can be assessed by written laboratory reports, questioning, oral reports, or quizzes. For ability area C, students are only rated at the end of Form 6 and Form 7 by teacher impression.

In addition, the HKEAA (2002) suggests that the scope of chemistry experiments done by a class should cover four areas: changes in substances and patterns of these changes, equilibria, kinetics, and energetics. Three types of experimental work are also recommended: preparative, quantitative, and qualitative. Teachers can structure the frequency, duration, and focus of their practicals to fit in with their teaching schedule. During practical work, teachers should not deny help to students. In other words, teachers should treat a TAS assessment practical firstly as a teaching situation and secondly as an assessment occasion.

Teachers are allowed to choose experiments from any topics as long as those experiments cover the required scopes and types of work. As a result, teacher-assessed tasks vary from teacher to teacher and from school to school. For each ability area, teachers are asked to award marks using a 10-point assessment scale, with 1 being very weak and 10 very good. However, there is no other standardization policy (e.g., a common set of mark descriptors, cross marking of students' reports of practical work, standardization meetings). The HKEAA uses a statistical moderation procedure to adjust the raw TAS marks submitted by schools. The two AL chemistry theory papers serve as the moderating instruments, but they do not contain any questions specifically designed to assess experimental practical skills. The HKEAA assumes that there is a positive correlation between the raw TAS and theory marks. Moderation of TAS marks is done on a teacher basis; the mean mark of students within a class may be moved up or down. Thus, moderation may involve increasing or decreasing the marks awarded to the entire class of students rather than rearranging the order or marks of individual students.

Data Collection and Analysis

Research by Cheung and his colleagues (Cheung, 2001, 2002; Cheung, Hattie, & Ng, 2001; Cheung & Yip, in press) has revealed that teachers' concerns about an educational innovation can be classified into five categories: evaluation, information, management, consequence, and refocusing. Table 1 summarizes the characteristics of these five types of teachers' concerns in relation to the TAS.

Table 1 Five Categories of Teachers' Concerns About School-based Assessment

Category	Teachers' concern
Evaluation	Teachers feel uncertain about the worth and fairness of the TAS as well as the feasibility of putting the TAS into practice in school.
Information	Teachers are concerned about some general aspects of the TAS, such as its rationale, requirements for use, and moderation mechanism. They are uncertain about the demands of the TAS, the types of support provided, and their roles with the innovation.
Management	Teachers raise a number of questions about the tasks and processes of implementing the TAS. The focus is on efficiency and time demands. They are worried about issues such as the marking of laboratory reports and planning of assessment tasks.
Consequence	Teachers are concerned about the impact of the TAS on student learning and their professional development. They want to know how the use of the TAS is affecting students. Teachers are eager to develop working relationships with other TAS teachers and collaborate with them so as to enhance the effects of the TAS.
Refocusing	Teachers are concerned about the further developments of the TAS. They are keen to explore the possibility of refining the operation of the present TAS by changing some of its features or by replacing it with a more powerful alternative.

To identify the top 10 concerns of chemistry teachers about the TAS, the instrument used by Cheung (2002) was revised to form a 25-item questionnaire so that it was appropriate for school-based assessment of chemistry. For each of the five categories of teachers' concerns about TAS, five items were constructed. Sample items are shown in Table 2. All items were written in Chinese and were rated along an 8-point rating scale that ranged from 0 (not true of me now) to 7 (very true of me now). Thus, small numbers indicated low concerns whereas large numbers reflected high concerns. The 25 items were randomly arranged in the questionnaire. An open-ended question was also included at the end of the questionnaire to invite teachers' further comments on the TAS.

Table 2 Sample Items from the Teacher Questionnaire

Category	Sample item
Evaluation	<ul style="list-style-type: none"> I am concerned about the fairness of the TAS. I doubt the need for including the TAS in the chemistry examination.
Information	<ul style="list-style-type: none"> I would like to know how TAS marks are moderated by the HKEAA. I would like to know how my role should change in the teaching-learning process when I am implementing the TAS.
Management	<ul style="list-style-type: none"> I am concerned about not having enough time to prepare assessment tasks for the TAS. I am concerned about how TAS assessments can be completed efficiently.
Consequence	<ul style="list-style-type: none"> I am concerned about the effects of the TAS on students, such as interest in learning and capability to solve problems. I would like to know how other teachers are implementing the TAS and thus I can learn from their experiences.
Refocusing	<ul style="list-style-type: none"> I would like to modify the implementation of the TAS based on my experience gained in recent years. I would like to determine how to refine or replace the TAS.

The 25 items were trialed by 26 chemistry teachers who attended courses in the authors' university. The wording of only two items needed to be modified in light of teachers' feedback. In the academic year 2001–2002, a total of 393 secondary schools participated in the TAS for AL chemistry. Two copies of the final version of the questionnaire were sent to each of these schools, inviting the AL chemistry teachers to answer the questionnaire. All participation in the survey was voluntary.

Teachers' responses to the 25 items were first coded on a scale of 0 to 7. By using the SPSS computer program, descriptive statistics such as mean and standard deviation were then calculated for each item. The top 10 concerns of teachers about the TAS were identified on the basis of the mean scores.

Results and Discussion

A total of 372 TAS teachers returned their completed questionnaires. The distribution of their experience with the TAS is: 1–3 years (14%); 4–6 years (25%); 7–9 years (25%); 10–12 years (13%); 13–15 years (9%); more than

15 years (13%). The means (which were calculated on the basis of a scale of 0 to 7) of the 25 questionnaire items ranged from 1.98 to 5.82. Table 3 lists the 10 items with the largest means. The top 10 concerns are now discussed in some detail and illustrated with comments which the chemistry teachers themselves provided in the “open response” section of the questionnaire.

Excessive Workloads

Serious concern with workloads in the TAS was clearly experienced as a problem by many chemistry teachers (Items 1 and 6 in Table 3). According to the regulations of the TAS, chemistry teachers are required to organize a minimum of 18 experiments in Form 6 and 10 experiments in Form 7. By the end of the AL course, all students’ laboratory reports should be ready for inspection by the HKEAA. High workloads permeated teachers’ responses to the open-ended question:

The number of laboratory reports to be marked is too many.... I have lost a lot of valuable time for preparing my lessons. (290)¹

TAS increases the time spent on marking. This increase in workload is unnecessary and is not good for the TAS. The time needed to score laboratory reports is much longer than that spent on scoring other classwork, exams or tests. Is it necessary to reconsider the workloads involved? (300)

There are too many experiments. Marking of laboratory reports is too time-consuming, but the school principal does not know the workloads involved in the TAS. (327)

The school administration does not regard TAS laboratory reports as student homework, but I always need to spend a whole day to mark the laboratory reports for a practical. Consequently, I could not finish other teaching duties and there were a lot of pressures. Is there a really effective way to help TAS teachers reduce their workloads? (334)

The above quotations indicate that high workloads remain a significant issue in the existing TAS even though students are expected to write only five detailed laboratory reports during the AL course (HKEAA, 2002). More importantly, teachers’ high workload pressures have interfered with their normal teaching and resulted in adverse effects on student learning. As a supervisor for the TAS in the academic years 2001–2003, the first author had opportunities

Table 3 The Top 10 Concerns Expressed by Chemistry Teachers

Item	Mean	SD
1. It takes me too much time to mark students' TAS laboratory reports.	5.82	1.50
2. I would like to know what resources are available for TAS teachers.	5.22	1.69
3. I would like to know how TAS marks are moderated by the HKEAA.	5.17	2.06
4. I am concerned about the effects of the TAS on students, such as interest in learning and capability to solve problems.	4.76	1.69
5. I would like to know how other teachers are implementing the TAS and thus I can learn from their experiences.	4.60	1.66
6. I am concerned about how TAS assessments can be completed efficiently.	4.55	2.03
7. I am concerned about the fairness of the TAS.	4.41	2.03
8. I want my students to have a deep understanding of how the TAS can facilitate their learning of chemistry.	4.30	1.73
9. I am concerned about whether there is adequate support, such as teacher training.	4.27	1.97
10. I believe that the HKEAA should review the implementation of the TAS for chemistry.	4.25	1.85

Note: Means were calculated on the basis of a scale of 0 to 7. $N = 372$.

to look at the kinds of comments chemistry teachers had made on students' laboratory reports. Most comments were just token ticks, underlinings, or question marks. There were some schools where no preparative experiments were carried out, and a number of teachers did not return the marked laboratory reports to students until long after the practical had been completed. Furthermore, students' development of process skills was limited as many experiments done in schools were "cookbook practicals" designed to reach predetermined outcomes. All theorizing (e.g., identifying the problem to be investigated, planning the inquiry strategies, interpreting the data) was determined by the teacher and the students acted in a predominantly technician's role of carrying out the instructions. The job of the teacher was to give clear laboratory manuals, the job of the students was to follow line-by-line

instructions on what to do, and the role of assessment was to see if students could produce the so-called “correct” answers. Once the laboratory was finished, then one could forget all about the practical work.

It is worth bearing in mind that the number of experiments included in a chemistry course should not be the sole criterion used in evaluating the implementation of the TAS. What is needed is high-quality practical work that can facilitate students to achieve the following three major goals:

- To help students learn science — acquire and develop conceptual and theoretical knowledge;
- To help students learn about science — develop an understanding of the nature and methods of science and an awareness of the complex interactions among science, technology, society, and the environment;
- To enable students to do science — engage in and develop expertise in scientific inquiry and problem-solving. (Hodson, 1998, pp. 629–630)

Students have to experience different types of experimental work in order to learn science, learn about science, and do science. Thus, we are not suggesting that chemistry students should stop carrying out the traditional recipe-type practicals that are well suited to the acquisition of new chemical knowledge. However, teachers need to broaden considerably the range of learning experiences planned for their students. Open-ended and student-centered investigations (Lock, 1990), for example, can effectively enable students to learn about chemistry and to do chemistry.

Therefore, it is not sufficient merely to reduce the number of TAS experiments per year. Hong Kong’s chemistry teachers, the HKEAA and the Curriculum Development Institute (CDI) need to rethink about the goals of practical work in school chemistry. In England, examining boards such as Edexcel (2002), Assessment and Qualifications Alliance (AQA) (1999), and Oxford, Cambridge and RSA Examinations (OCR) (2000) do not require chemistry teachers to organize a minimum number of TAS experiments per year. Internal assessments are made in three or four skill areas (e.g., planning, implementing, analyzing evidence and drawing conclusions, and evaluating evidence and procedures). Teachers are required to award one mark for each of these skill areas. OCR stresses that when a skill has been assessed on more than one occasion, the better or best mark for that skill should be submitted. OCR also recommends teachers not to assess each skill on more than two occasions because this may take up time that might better be devoted to other aspects of the chemistry curriculum. Unlike Hong Kong’s TAS for chemistry, teachers in England are not required to submit students’ non-TAS laboratory

reports for inspection. However, those laboratory reports that have been internally assessed for the public examination must be clearly annotated by the teacher to support the marks awarded to the students. Observation checklists or written notes may be used to show how the marks for manipulative skills have been awarded.

Lack of Resources and Support for Teachers

Many teachers were concerned about the resources and support provided by the HKEAA and CDI (Items 2 and 9 in Table 3). The following quotations can illustrate the nature of their concerns:

The CDI and HKEAA have provided teachers with little support during the implementation process of the TAS. Teachers are like mechanics carrying out other people's orders. (288)

I think the HKEAA has shifted part of its responsibilities to TAS teachers without providing adequate support for them. (327)

Support for teachers is inadequate because the HKEAA has seen its main task as organizing public examinations rather than dealing with teacher training, whereas the CDI has viewed the TAS as a matter of the public examination and thus has merely participated in half-day "hit and run" in-service workshops for new TAS teachers on an ad hoc basis. However, workshops of one-time nature are ineffective to help novice teachers grow beyond the traumas of the first few years. Sound assessment techniques cannot be mastered in a half-day's course! Help over time is necessary to work the kinks out.

In the 1980s, a few chemistry educators and teachers contributed about 35 experiments to serve as examples of practical work for the TAS. At that time, the focus was on the experimental procedures as chemistry teachers had difficulties in finding suitable practical work. Now, one of the most common requests by teachers is the provision of exemplar teacher-assessed laboratory reports for reference:

Since the TAS was initiated, the HKEAA has provided teachers with little support, especially the assessment criteria for TAS experiments. Exemplars of laboratory reports are badly needed. (296)

I hope the HKEAA can provide the assessment criteria for some typical experiments (e.g., determination of the enthalpy of formation of calcium carbonate). Even better, a computer-based item bank of TAS assessments may be developed. (336)

According to the TAS handbook (HKEAA, 2002), teachers should assess students on a 10-point scale: 10–9 (very good), 8–7 (good), 6–5 (average), 4–3 (weak), and 2–1 (very weak). Unfortunately, the HKEAA has not prepared any annotated work samples to illustrate, for example, what “good” performance means. Teachers are unclear about what is required. No clear indicators of performance are provided for them to judge at what level a student is performing. This assessment issue must be addressed by the HKEAA rather than simply transferred to the teaching profession to be resolved under the umbrella of “teachers’ professional judgment.”

Actually, the teacher as an assessor in school is nothing new. All teachers are assessors and spend a large part of their instructional time assessing their students in their everyday teaching. What is new is the responsibility of making internal assessments for examinations that are externally certificated. Hong Kong’s teachers are used to norm-referenced assessment, but school-based assessment is incompatible with norm-referenced assessment. Therefore, adequate provision of resources is critically important to help chemistry teachers take up the new role. Exemplars of laboratory reports have been prepared for the AL Biology TAS (Hong Kong Examinations Authority, 2001). There appears no reason why similar exemplars cannot be produced for chemistry teachers.

Furthermore, to promote inquiry-based learning, a few exemplars of well-tried open-ended investigations are essential because most Hong Kong’s chemistry teachers have little experience in implementing this type of practical work.² The TAS handbook needs to be further developed to incorporate more explicit guidance to teachers on matters of assessment of planning skills. Recently, the IBM Corporation (2003) also recommended that the development of exemplars of valid and reliable internal assessments should be given a top priority.

Faulty Moderation System

Many teachers responded that they wanted to know how TAS marks are moderated by the HKEAA (Item 3 in Table 3). The scarcity of information regarding moderation was deliberately caused by the HKEAA. Since the TAS was initiated in the 1970s, the TAS handbook has provided less and less information about the moderation mechanism. The moderation procedures must be made known to everyone involved in the TAS:

I don’t understand how TAS marks are moderated. Students in my school performed very well in the exam, but the adjusted marks were quite close to those of mediocre schools. I don’t know why! (331)

The HKEAA will adjust TAS marks.... How does the HKEAA determine the adjusted marks? (291)

In contrast, detailed information about moderation is usually provided by examining boards in other countries (e.g., Board of Studies, 1999); teachers are not only informed of the rationale for moderation but also the procedures used to scale the raw marks. Furthermore, the current moderation mechanism was seen as invalid and unfair (Item 7 in Table 3) and demotivating for chemistry teachers:

I feel doubtful about the use of exam marks to adjust TAS marks. Those students with high exam marks may not have good practical skills. The TAS is not fair to students! (296)

TAS marks are moderated against theory marks. This will “encourage” students to focus on theories but ignore practical work.... Being a Band 1 school has an advantage. (320)

I think the concept of TAS is very good, but the way to adjust marks is unreasonable. Moderation is an important issue in the TAS. We need to review the method seriously. (325)

There are several possible forms of moderation, but the limitations of statistical moderation are well known. We concur with Holbrook (1980) that statistical moderation against the theory marks “is certainly much easier to effect, but could also turn out to be more damaging than no moderation at all” (p. 16). He pointed out that if teachers are awarding TAS marks that differ little from the theory examinations, then the justification for the time, effort, and money spent on the internal assessment scheme seems hardly worthwhile. Wood (1991) also reminded us: “If instrument Y exists to measure things other than instrument X manages, how can it be right to use X to scale Y?” (p. 77) The HKEAA should explore other forms of moderation. Holbrook (1980) suggested that moderation by inspection is the best method for Hong Kong.

Clearly, the current reliance on statistical moderation undermines the potential contribution of chemistry teachers and may deprive some students of grades that they may well have earned. Although the ideas of TAS for the AL chemistry were originally imported from the United Kingdom, statistical moderation is no longer used by examining boards such as AQA, OCR, and Edexcel. The experiences of these examining boards are very useful to the HKEAA. Our moderation could be revised along the following lines:

- Chemistry teachers define assessment standards for themselves through group meetings on a regional basis. Samples of student work are trial marked. Emphasis is placed upon consensus of teachers' judgments.
- Samples of student work are sent by post from a school to the group coordinator. Following the re-marking of the samples, the coordinator's marks are compared with the teacher's marks to determine whether any adjustment is needed.
- Mark adjustments will normally preserve the rank order of students submitted by a teacher. However, if the group coordinator has found major discrepancies, he or she may call for the work of other students and rearrange the rank order.
- Samples from each local group are sent to the TAS supervisors to ensure "regional" equality.

No moderating procedure is without disadvantages. The most important is the role of the group coordinators in this new form of moderation. The moderation process will be time-consuming and will require a lot of managerial skills. However, we believe that moderation of this form can enhance the quality of school-based assessment, the professionalism of teachers, and the credibility of the TAS.

Negative Impact on Students

There are two important issues to consider with respect to the impact of the TAS on students. Firstly, some chemistry teachers wanted to make use of practical work to motivate students (Items 4 and 8 in Table 3) but were sadly constrained by the requirements of the current TAS:

More and more students didn't complete their practical work and laboratory reports with care. To arouse their interest in practical work, a wide range of methods should be used. Although some experiments are interesting, they cannot be easily assessed for the TAS. What a pity! (328)

My students have become less interested in practical chemistry. Actually, students are important users of the TAS. The HKEAA should provide students with details regarding the importance of the TAS and the abilities that are to be assessed. (321)

The use of practical work in chemistry instruction should not be solely driven by assessment. A practical is useless if it is not motivating for students. Careful consideration needs to be given to the design of practical work so that

students can have a wide range of learning experiences, including open-ended investigations and computer-based practical work. However, the existing TAS requirements are too rigid (e.g., students should carry out at least 18 experiments in Form 6) and thus discourage teachers to try innovative chemistry practical work.

Secondly, assessing students' practical work by means of written reports is very common. The inclusion of TAS in the AL chemistry has increased student workload:

Students spent too much time on laboratory reports. (289)

Students spent a lot of time on writing their laboratory reports. As a result, there was little room for reading chemistry reference books. (290)

Experiences in New South Wales of Australia have confirmed that students are often overburdened with multiple school-based assessment tasks at a particular time (Board of Studies, 1998). If the TAS extends to more AL subjects in Hong Kong, then our students will certainly face heavier workloads. The crucial questions are: Should practicals always be written up? What is the role of the written report of labwork? Many chemistry teachers require their students to write detailed laboratory reports on every practical. This is unnecessary. It is worth remembering that written reports cannot provide direct evidence of a student's practical skills as demonstrated in the laboratory. Also, some students may be good at speaking and doing chemistry labwork but poor at writing laboratory reports. Therefore, other methods of assessment and reporting (e.g., oral presentation, direct observation) may have to be used. Teachers' concern about student workload can further be alleviated, of course, if students are not required to carry out at least 18 experiments in Form 6 and 10 experiments in Form 7.

Ineffective Coordinator System

The coordinator system has failed to set the tone for teacher collaboration (Item 5 in Table 3). In each academic year, the HKEAA divides TAS chemistry teachers into about 15 regional groups and appoints a coordinator to guide each group of teachers. Holbrook (1980) believed that "This coordinator system is particularly enhanced by the closeness of schools to one another, and the ease with which teachers can get together" (p. 18). Unfortunately, only one annual meeting is organized for each group of teachers and the agenda usually

focuses on logistic matters rather than reflection upon their assessment practices. A number of coordinators seldom visited the schools in their groups and had no idea of the quality of laboratory reports written by students. TAS teachers still work largely alone:

The coordinator should provide teachers with more opportunities to exchange information and ideas, and share their experiences of the TAS in action. (335)

TAS teachers work as solo practitioners, isolated from other teachers in the group. I rarely had a chance to compare the implementation of the TAS in different schools. It is vital to maintain good communications within the group. (337)

It is important that the TAS should build in opportunities for teachers to meet regularly in small groups. Even after participation in the TAS for several years, teachers will vary in their understanding of the purposes of the TAS, their assessment methods, and their attitudes toward internal assessment of public examination. Forums for discussion need to be set in place.

Furthermore, the HKEAA should offer workshops to TAS supervisors and coordinators to broaden their thinking about the purposes and implementation of school-based assessment and to dialogue with assessment specialists. The planning and implementation of in-service development programs for both new and experienced TAS teachers should also involve TAS supervisors and coordinators. It is also important that supervisors and coordinators keep abreast of the existing school-based assessment policies and practices in other countries so as to explore ways to remedy the ills of our TAS.

Narrowness of the scope of the TAS

A lot of teachers wanted the HKEAA to review the implementation of the TAS (Item 10 in Table 3). Some of these teachers valued the assessment of scientific investigations and recognized that school-based assessments are not confined just to experimental practical work:

The TAS should be reviewed... Project-based experiments may be included in the TAS. Presentations by groups of students should be encouraged. (293)

The current TAS requirements need to be reviewed. The scheme should facilitate students to experience the “wholeness” of a scientific investigation. (137)

It is necessary to review the chemistry syllabus. If I was not so hard pressed to cover the content, perhaps I could let students try a few investigative practicals. (097)

TAS may include oral presentation ... once a year. (326)

The scope of the TAS may be expanded a bit. Theory papers cannot adequately assess students' communication skills, self-learning skills, and the use of information technology. (015)

According to Hodson (1992), the most effective vehicles for learning to do science in the school curriculum are investigational problem-solving exercises, directed holistic investigations, and project work under full student control. Jenkins (1999) has also argued that all science students should be involved in some kind of scientific investigation. Although project work is included in the ability area B in the current TAS for AL chemistry, it is not a compulsory component. Sometimes teachers complain that students cannot apply skills learned in previous practicals when doing a new experiment, but they provide few opportunities for them to practice. Practically based whole investigations are still underused today. Along with many other science educators, we think that sustained inquiry should be a key element in the chemistry practical work. In England, for example, the practical assessment designed by OCR (2000) requires teacher assessments in the first year to focus on four separate skill areas (i.e., planning, implementing, analyzing evidence and drawing conclusions, and evaluating evidence and procedures). But in the second year, individual students must conduct one complete student-directed investigation to experience the "wholeness" of a scientific investigation (Denby, 1998). Through the process of carrying out scientific investigation, students are also given opportunities to apply and develop their capability to use various information communication technologies (e.g., spreadsheets, data-loggers, graphical analysis software, the Internet).

In addition, the school-based assessment scheme run by OCR (2000) has an externally set and marked open-book paper that accounts for 7.5% of the final mark. There is only one question providing students an opportunity to demonstrate their research skills and communication skills in the context of chemistry. The topics selected in some past papers are shown in Table 4. Students are expected to write a report between 800 and 1,000 words in normal homework time for chemistry during a two-week period. The total amount of time required

Table 4 Open-book Coursework Assessment Used in the Salters Advanced Chemistry

Year	Topic
1992	Air pollution in the lower atmosphere
1993	Recent developments in the design of industrial catalysts
1994	Use of genetic engineering techniques in designing medicines
1995	Chemistry of painting cars and recent development of water-based paints
1996	Discovery of buckminsterfullerene and subsequent research
1997	Link between CFCs and ozone depletion and the search for replacements
1998	Use of cellulose in the manufacture of fibers and plastics, and the development of lyocell fibers such as Tencel
1999	Use of micro-organisms to extract metals from their ores
2000	Spectroscopy and its applications in solar analysis and investigation of interstellar space
2001	How aspirin works and the development of salbutamol

is normally expected to be between 5 and 8 hours. Recently, IBM Corporation (2003) has asked the HKEAA to widen school-based assessment by going beyond the current TAS. Perhaps our conception of chemistry “practical work” may be expanded to include other active-learning activities. However, our present experience of assessment and moderation in non-experimental practical work is scarce. Its weighting should not be too high until Hong Kong’s chemistry teachers have thoroughly explored the difficulties involved.

Conclusion

The TAS for the AL chemistry has remained fundamentally unchanged since it was initiated in the 1970s. As a consequence, the goals of the TAS do not align with recent curriculum reform efforts in Hong Kong. The results of this study indicate that chemistry teachers are most concerned about workload, resources and support, moderation mechanism, student workload, difficulty in motivating students, and teacher collaboration. Our analysis has revealed that the root causes of these teacher concerns are the large number of experiments required in Form 6 and Form 7, lack of support from the HKEAA and CDI, reliance of theory marks to adjust TAS marks, the limited roles of group coordinators, and

the narrow scope of assessment tasks. If the current TAS is to be expanded, as has been recommended by Fung et al. (1998) and IBM Corporation (2003), these major concerns expressed by TAS teachers cannot be neglected.

It is unfortunate that the TAS for chemistry has been used mainly to reduce the unwieldy problems associated with administering external practical examination to many thousands of candidates and to force teachers to organize a minimum number of experiments in the course. The HKEAA has not been very proactive in exploring ways to assess more learning objectives that cannot be validly assessed by means of a year-end external examination. Its responsibilities for funding and implementing in-service training courses in school-based assessment have been close to nil. The HKEAA should reconsider its role in the TAS.

Based on chemistry teachers' major concerns about the TAS, we have proposed some directions for making important changes in the scheme. The most obvious barrier to some of these proposed changes is the fact-bound AL chemistry syllabus, which leaves little space for the time-consuming open-ended investigations and for teachers to give formative feedback to students. The syllabus must be revised to encourage students to experience a wide range of practical work in chemistry. Debate about what content to be cut has begun.³ Actually, school-based assessment and external examination are two sides of the same coin, and it is only when they operate together that the learning outcomes of our AL chemistry students can be adequately assessed.

There is no one best school-based assessment scheme for chemistry. What is good for chemistry students in the United Kingdom or Australia may not be good for our students in Hong Kong. Assessment must serve as a vehicle for improving the quality of learning for every student. As Hodson (1993) told us, "if we are to establish *good* school laboratory practice we need a *good* and rigorous assessment scheme that focuses on the kind of laboratory activities we value" (p. 128 [emphasis original]). Teachers' concerns about the current TAS for chemistry must be addressed. The concerns of other stakeholders such as students, school administrators, and parents should also be considered. How much improvement will occur depends in the end on the leadership of the HKEAA and CDI. As IBM Corporation (2003) pointed out:

The importance of the change to teaching and learning that school-based assessment will bring should not be under-estimated. It demands very active management and very well planned and communicated implementation. (p. 34)

We hope that this article would trigger off a comprehensive review of the TAS for AL chemistry and stimulate debate about what non-experimental work could be assessed through the TAS.

Notes

1. The number inside the parenthesis refers to the coding system for teachers when their responses to the open-ended questionnaire item were analyzed.
2. Some annotated exemplars of laboratory reports can be downloaded from the following two websites:
 - <http://www.tki.org.nz/e/search/>
 - <http://www.york.ac.uk/org/seg/salters/chemistry/>
3. A committee was set up by the Curriculum Development Council and the HKEAA to revise the AL chemistry syllabus in June 2003.

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