TEACHER ASSESSMENT OF PRACTICAL SKILLS IN CHEMISTRY AT ADVANCED LEVEL

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Early in 1973 an initial survey was undertaken of the teaching of chemistry in the sixthforms of the 62 schools in Hong Kong which enter candidates for the local Advanced Level examination. This was based on work done earlier by Kerr (1) and Buckley and Kempa (2). Attention was focussed on the role of practical work in the sixth form course, but incidentally covered aspects of facilities within the schools, staffing in the schools, timetabling and budgeting for chemistry teaching. Altogether three questionnaires were used, the first to heads of science departments, the second to all science teachers and the third to a group of nearly 200 first year science students at Hong Kong University who had completed their sixthform courses the previous summer. The detailed findings of this work have been published (3).

Particular attention was paid to the position of practical work in the schools, under the influence of a practical examination externally set and marked which consists of volumetric and observational exercises. The content of school practical courses was predictably dominated by preparation for the examination. The thoroughness of this preparation in many schools was highlighted by the videotaping of the performance of candidates in the examination which showed that the examination was approached as a routine exercise based on similar practicals previously encountered. Teachers were invited to consider a set of objectives for practical work and then later were asked to consider to what extent these objectives could be achieved in a practical examination of existing type. The results of these considerations are given below:

Objectives	% of teachers agreeing they should be present	% of teachers thinking that stated objective was tested by present practical examination
A Development of manipulative skills		
A1. Manipulate apparatus	100	53
A2. Handle chemical substances safely	100	42
A3. Work accurately with reasonable speed	100	90
B Development of observational powers		
B1. Observe accurately	100	94
B2. Record observations correctly	100	87
B3. Read instruments correctly	100	73

Objectives	% of teachers agreeing they should be present	% of teachers thinking that stated objective was tested by present practical examination
C Ability to interpret experimental data		
C1. Interpret observations and experimental data	100	94
C2. Assess and judge the reliability of experimental procedures	94	39
D Ability to plan experiments		
D1. Solve practical problems using standard experimental procedures	95	34
D2. Devise simple procedures to investigate chemical problems	92	10

Teachers showed overwhelming agreement with the objectives of practical work suggested to them, which is perhaps not surprising. They only had significant reservations about whether secondary school students should be expected to consider planning aspects of chemical laboratory investigations. However, when they considered what the practical examination appeared to assess, there was a substantial mis-match between their own agreed objectives and those measured in the practical examination. This clearly gives cause for concern. The practical examination appears to measure students' abilities over a very restricted range of skills. Most candidates do tolerably well in this part of the examination, suggesting thorough preparation in the schools. The question obviously arises as to whether a student's practical work should be judged only over such a limited range of abilities. It is certain that the present practical examination could not assess over the whole range of abilities listed previously. An attempt was made to seek teacher opinion on alternative methods of assessment. Teachers were given three methods of assessment and asked to indicate their order of preference for these. The results are given below in terms of the percentages of teachers choosing a mode of assessment as their first preference:

Type of assessment	Percentage of teachers
1. End-of-course examination such as the present A-level practical	27%
2. Teacher-based assessment over two years, assessing specific abilities and grading to a set scale	21%
3. Teacher-based assessment plus a practical examination	52%

Teachers tended to take a median position in the face of an unknown by choosing the third alternative. Following this work, interviews and discussions with many teachers and examiners, it was decided to launch a pilot study of teacher assessment of practical work for a two year period, 1973-75.

Details of a scheme of teacher assessment were circulated to all schools with sixthforms and volunteers invited for the pilot project. Over half of the

A-level schools in Hong Kong volunteered, but only 15 could be chosen, approximately 25% of the total. They were invited to undertake teacher assessment of either one or two groups of students, either for the academic year 1973-74, or for the full two year period of the sixthform from 1973-75 with a different group. The majority of schools carried through both stages of the project. It was made quite clear to teachers and students that the study was not operational as regards its influencing the A-level grades of their students in any way - they would still be expected to sit for the standard practical examination. The scheme used was substantially based on that of the Joint Matriculation Board in Britain, which in turn has close relationships with the other two schemes of teacher assessment currently operating at this level in Britain, those of the University of London Board and the Nuffield Advanced Chemistry also run by the London Board. Teachers were asked to make assessments of five abilities using a five point scale for each ability. The abilities to be assessed were:

A. Skill in observation and accurate recording of observations
B. Ability to interpret practical experience
C. Ability to devise critical experiments
D. The possession of appropriate manipulative skills
E. Attitudes to practical work.

Teachers were given some guidance as to the kinds of experimental work which might be suited to assessment and some indication of the different ways in which they might choose to assess students' work. All teachers in the scheme were given one full day of training and induction, during which time they assessed practical work in progress in one school. They were asked to make at least two assessments for each ability except the last (E - Attitudes) which was to be assessed once at the end of the course.

Information as to the nature of the experimental work assessed was received from the report forms submitted by each school. The range of experimental work assessed was very wide, going far beyond the confines of volumetric and qualitative analysis, even though teachers had been warned against radical changes in programme as their students were still to be committed to a practical examination. The popularity of experimental work recently introduced in in-service courses reflects a continuing need for teachers to be given access to new experimental ideas.

Teachers reported no great problems in following through the schedule of assessments, except in respect of Ability C (Ability to devise critical experiments), which was assessed less frequently than any of the other abilities, and in which students were given significantly lower gradings than in the other abilities. An operational scheme of teacher assessment would have to include a re-statement of this ability. Teachers also gave consistently higher ratings for Ability E (Attitudes to practical work) than to any other ability. They were clearly reluctant to mark down students in this respect, although it later emerged from a questionnaire that they were quite willing to assess this ability. It is clear from analysis of teacher assessments that in general teachers are able to put their students in rank order within a teaching set, and that the rank order produced correlates well with the performance of their students in the overall A-level examination (correlations between 0.5 and 0.6). However, teachers in different schools assess to very different means which bear very little relationship to the total A-level population There is, therefore, a very clear case for retaining the rank orders produced by teachers' assessments with the application of an appropriate moderating

instrument to place them in the appropriate segment of the A-level population.

The search for an appropriate moderating instrument has puzzled all workers in this particular aspect of teacher assessment. In Hong Kong, a compulsory question was introduced on to the written papers, which purported to test practical experience. While discriminating well between candidates, it correlates very poorly with teacher assessments of practical skills and with virtually all other measures. It seems that the question tests something quite different, probably related to interpretation of data in one form or another. The teacher assessments correlate poorly with candidates' scores in the practical examination (0.20 to 0.26), figures which are confirmed by Wood and Ferguson in their work on the London Board's trial (4). This seems to suggest that the restricted scope of a practical examination makes it an inadequate instrument for properly assessing performance in practical work. The best correlations with teacher assessments were obtained with candidates' scores on the total written portion of the examination (two three-hour papers) these varying from 0.43 to 0.59. It seems that the best available moderating instrument is likely to be found therein.

At the end of the two year trial period, a further questionnaire was put to all teachers and students who participated in the scheme. It was very encouraging to receive a one hundred per cent response. Both teachers and students felt that, given acceptable moderation procedures, this method of assessment of practical work gave a much fairer basis than a single three-hour examination. Neither students nor teachers felt that the student-teacher relationship in the laboratory had been affected adversely by the scheme, although this must be interpreted with caution as all knew that it was in non-operational trial form. Teachers were then finally asked to reconsider their overall position with respect to the assessment of practical work by stating their preference as below:

In the light of your experience would you prefer:

(a) Teacher-based assessment plus a compulsory question based on practical work in the written paper	36%
(b) Teacher-based assessment over two years	21%
(c) End-of-course practical examination such as the present A-level practical one	15%
(d) Teacher-based assessment plus a practical examination	21%
(e) No assessment of practical work	7%

It should be recognised that this list of possibilities is not exhaustive. When compared with a similar question earlier mentioned, it is clear that there has been a strong shift of emphasis in the teachers from the trials schools. Most teachers in the trial (78%) had clearly gained sufficient confidence to feel that an element of teacher assessment was a useful component of an overall assessment in chemistry. The percentage wanting both teacher assessment and a practical examination fell from 52% to 21% of our sample.

Finally, the attitude of those teachers involved in the trials towards the A-level process as a whole is perhaps the most important feature to emerge. The involvement in what has been both a process of continuous assessment, continuous formative and summative evaluation and continuous curriculum development has undoubtedly contributed to the professional growth and competence of those teachers involved.

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