NO SUBSTITUTE FOR SCHOLARSHIP, AN IN-SERVICE ROLE FOR UNIVERSITY TEACHERS

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ABSTRACT

Initially the discussion is centred on Summer Schools at the University of New South Wales, Australia, and the suggestion is made that, although such part-time activities are useful, it would be much better if they formed part of a continuous programme in chemical education.

UNESCO-sponsored Summer Schools in Thailand and Ceylon are also described and some views expressed on the general need for university–chemist cooperation in assisting chemistry teachers in the development of local rather than imported curricula.

A chemical education programme at Macquarie University, Australia, is then outlined as an illustration of a more comprehensive kind of support for teachers. Included in this outline is some reference to a curriculum reform programme in Indonesia in which the Chemistry department is currently involved and some comments on the method of involvement. Finally there are some general observations on teacher training and the role that university chemists might be expected to play in the maintenance of the status and quality of chemistry teachers.

Summer Schools are a common device for the in-service training of teachers. They come in many guises and are provided by a variety of institutions. My initial experience with these activities was obtained by participation in the Summer Schools for senior chemistry teachers held within the chemistry School of the University of New South Wales, Australia. These Summer Schools, intended to help teachers keep in touch with the latest developments in chemistry and the teaching of it, were for a period of some twelve years organized annually about a range of appropriate themes. The emphasis was always on content rather than method. It was never intended to teach the teacher how to teach. The essential idea was to help to maintain a good level of scholarship in the face of a rapid expansion of both the subject and the demand for the teaching of it.

Programmes were divided between lectures and workshop sessions. Typically a workshop contained twelve to sixteen teachers under the guidance of a member of staff working together with an experienced school teacher. These two people were also responsible for devising and arranging the workshop programme and for preparing a final report. The workshop programmes,

though sometimes only discursive, were usually, and certainly most profitably, centred around some laboratory experiments designed to involve the teachers in a critical and creative way in the practice of chemistry. Workshop reports, along with the texts of lectures were published each year under the title 'Approach to Chemistry'. These publications were distributed widely to teachers within the State and elsewhere and, as a consequence of a touch of local relevance, have proved to be a more than useful byproduct of the Summer Schools. Other byproducts were the stimulating, and often chastening, experiences of the university staff members involved. For example, as a result of discussions during the 1961 and 1962 Summer Schools, a data book, now in a third edition, was compiled containing data arranged in a manner suitable for schools. More than a few of the people concerned were both disturbed and surprised by the dubious origins and lack of reliability of some of the items of data cited in textbooks and other sources. Often they found conflicting estimates and quite arbitrary choices had to be made. Again, frequently, people concerned with testing out experiments both in preparation and during the Summer Schools were often quite disconcerted when commonplace reactions did not go according to the book. It certainly gave them a new appreciation of the problems that might bedevil a teacher in the school laboratory.

Despite the fair measure of success of the Summer Schools, there were always those of us who felt that these part-time activities fell rather short of what could be achieved by a regular chemical education programme involving both teachers and staff within the formal framework of the School. This never did eventuate at New South Wales but, profiting from this experience, there is now such a development at Macquarie University and I would like to return to a discussion of this later.

THE PILOT PROJECT

In 1966, I was appointed Director of the UNESCO Pilot Project for Chemistry Teaching in Asia.The Project was situated in Bangkok at Chulalongkorn University and here in 1967 we, in a manner of speaking 'put the (New South Wales) show on the road' in the form of a Summer School for Thai teachers. It was a most interesting exercise with a really international flavour. Gordon Aylward†, who came up from Macquarie University to assist me with planning, together with myself and our Thai colleagues, worked out a closely interlocked programme of lectures, discussions and laboratory sessions which was to extend over a period of four weeks with places for some forty teachers.

The programme was not based on an established scheme or directly in support of a set syllabus but rather on work done previously at the Project and extensions of this. The advantage of such an arrangement is chiefly flexibility. Not being tied to a particular treatment either in level or content, it was much easier to devise a realistic programme in terms of staff, participants and available facilities. Furthermore, it lent itself to modification during the course of the Summer School and perhaps, most important of all, it provided scope for innovation and creativity.

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Despite these advantages, because of the presence of a number of lecturers and other staff from overseas, there was still the problem of language. The lectures were given in English and this added a further dimension to the usual difficulty of communication between lecturers and their audiences. We attempted to overcome this difficulty by means of the 'teachers' friend', a group leader attached to each of four groups of eight to ten teachers. Each lecture was preceded by a briefing session for the group leaders who were responsible after each lecture for leading group discussions. In this way, and by dropping in on group discussions, lecturers were able to establish sensible starting points, clarify difficulties and often obtain guidance in pace and depth of presentation.

An interesting departure from the usual laboratory work was a workshop designed to produce an 8 mm loop-film. Each week one of the four groups was responsible for the main steps in the production of this teaching film. The story board of this film plus an abridged film guide was published with the proceedings. This was an indication of our attitude in favour of getting people involved in doing and creating rather than just observing the work of others. For, even if 'one picture is worth a thousand words', as someone else said 'one idea is worth a thousand pictures'.

In the same spirit, the laboratory sessions, guided by local leaders, were more in the nature of chemical investigations than routine demonstrations and after each laboratory session, each group came together for discussions, each member providing a separate part of the total group experience. There was no examination and it was evident that such a spur was not necessary. The teachers surprised their leaders by their willingness to work through the worst of the Bangkok heat which even the Thais themselves find trying. They were obviously delighted to practise and discuss chemistry and some later returned to the Project in their spare time to extend assignments commenced during the Institute.

The theme was 'Compound Formation' and under this heading were grouped the topics energy, rate, structure and acid–base theory. The choice of such a broad theme was made deliberately with the object of showing the relationships between the various divisions of the study of chemistry. It is also recognized that teachers are rarely permitted the luxury of specialization as they spread their efforts across a general syllabus, and not infrequently, across the whole gamut of science.

Following this example, the Thai Study Group† ran a successful 'Winter' school for Teachers' College staff, using Project facilities but, except for some consultative help from the Project staff, it was virtually independent of outside assistance. The content and organization was similar to that of the Summer Institute with some additional material on programmed instruction and nuclear chemistry.

SUMMER SCHOOL ACTIVITIES

It cannot be over-emphasized that programmes such as I have just described depend enormously on careful planning and organization: for unless this is

† Study Groups associated with the Bangkok Project were set up in most Asian countries composed of people representing the various areas of concern with chemical education. They were the main avenues of communication with the countries the Project was set up to assist.

recognized, Summer School activity though showing up well in the form of finished reports may be of little benefit to the actual participants and a depressing experience for the staff involved[1]. Time was needed, among other things, for the adaptation of experiments designed for a more temperate ambient than that prevailing in Bangkok. We found that experiments working well at 20° can prove quite intractable at 35° or more. We also needed time for the preparation and distribution of background materials to teachers well in advance of the opening day. These materials all had to be translated into Thai—a not inconsiderable task for our Thai co-workers. Translation was not always straightforward by any means and the outcome, as in the case of the title of the proceedings sometimes droll. The proceedings were published under the title 'Compound Formation—A Teachers' Digest'. The phrase 'Teachers' Digest' was meant to emphasize that the contents were a digest of a large chunk of chemistry reduced for reasonably quick and easy assimilation by teachers. However, when it came to the Thai translation of the word 'Digest', the nearest equivalent was the word for 'stomach'. I still do not know how the problem was resolved. I do not really think the books went out entitled 'A Teachers' Stomach'. However, it is just possible that, even if the Summer School achieved nothing else, it added to the Thai language.

The staff of the Project included Mr J. Ratnaike†, who was then Head of the Ceylon Science-Mathematics Project, a project responsible, among other things, for the development and introduction of school science courses. He was sufficiently impressed to want to organize a similar activity in Ceylon, and at the end of 1968, sponsored by UNESCO, I went there to assist him.

VACATION SCHOOL IN CEYLON

The vacation school was held in 1969 at the Colombo branch of the University of Ceylon and was applied to content areas possibly to be included in a foreshadowed new A level syllabus. This part of the high school curriculum, since it is the basis for university entry, effectively belongs to the universities. Under these circumstances creating the situation where university people and senior teachers, as a preliminary to syllabus reform could sound each other out on chemistry seemed sensible, and a nice switch from the syllabus first, pay-later approach that I had seen cause problems elsewhere.

The organization of the programme was somewhat the same as for Bangkok except that there were fewer and possibly more highly selected participants and, apart from myself, there was no foreign participation. The lectures, which were the chief university input, were given by various members of staff from the four parts of the University of Ceylon and from the Ceylon Institute for Scientific and Industrial Research. A bracket of three lectures was given by each lecturer and within this he developed a particular topic from an elementary presentation through to the contemporary view and its implication for teaching, finishing with a discussion on some aspect of the topic upon which he had done some original research. This last part was considered especially useful as it placed the

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lecturer in the position of an expert in the application of the principles about which he was speaking. Even if teachers are not able to practise chemistry at such a level at least it provides them with some contact with the main stream of the subject and gives reassurance that it is still alive and in the hands of live people. However, this attempt to lessen the vicarious lot of the teacher did have the serious drawback that some of the material went rather over the heads of the teachers†. The problem was rather exaggerated by the fact that the lecturers were seldom able to afford time beyond that required for the lectures and the discussions immediately following. Due principally to the dispersed nature of the university, this rather inhibited the kind of feedback arrangement that had been so helpful in Bangkok.

There was, however, a real bonus in the shape of the lectures given by a tea researcher from the Research Institute. He linked his talk on tea research with a workshop session in which the techniques of paper and thin-layer chromatography were applied not only to tea but also to some other commonly available materials. The teachers were extremely interested and a number of projects were designed for them to follow up. It was most instructive to note how the enthusiasm of this researcher rubbed off on the teacher where there was local relevance and a chance of involvement. What better way to enthuse the teacher and what better way to inspire effective teaching? For that matter, what better than the simple and elegant techniques of chromatography as a starting point for field work in countries like Ceylon where natural product research and development is bound to be of central economic importance for years to come?

THE MACQUARIE APPROACH

About this time I joined two old colleagues of mine‡ at Macquarie University where, under the motto 'and gladly teche'§, a good many novel (at least for Australia) methods and ideas were being applied. This was no less true within the School of Chemistry where, among other innovations, a M.Sc. programme in Chemical Education had been introduced. In brief, it now combines formal study of the more recent developments in chemistry with project work within a content area of interest to the teacher. Some units are also taken within the School of Education. The overall programme includes informal discussions, seminars and library work. However, by far the greatest emphasis is on project work to which about three-quarters of the total time is devoted. The projects are expected to fulfil three main aims as follows:

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† This drawback is not confined to this type of lecture and one really comes to question the worth of this kind of communication unless it is coupled with ample opportunity for discussion and feedback to the lecturer.

‡ G. Aylward (*loc. cit.*) and G. A. Barclay (Head of the Department), both formerly of the University of New South Wales.

§ Of studie took he moost care and moost heede.
Noght o word spak he moore than was neede,
And that was seyd in form and reverence
And short and quyk and ful of hy sentence;
Sownynge in moral vertu was his speche,
And gladly wolde he learne and gladly teche.
. . . CHAUCER

(a) Further the experience of the chemistry teacher in the practice of chemistry;

(b) make a contribution to the teaching of chemistry; and

(c) make an original contribution of a research kind.

Whilst the third aim may not always be fulfilled, at least the possibility of its fulfilment should be fairly evident if a candidate is to proceed beyond the pass M.Sc. standard to the award of honours. Individual projects meet these specifications to a variable degree, very much dependent in the long run upon the candidate's interests and capacities. The chemical systems or areas studied frequently relate to the class room situation and to this extent, the research may be regarded as applied. Supervisors therefore must be prepared to work in a chemical 'no-man's land' of a kind unfamiliar to the academic but everyday to the teacher.

POTENTIAL LEADERS

The overall aim is to develop potential for leadership in curriculum design and implementation; a potential based on a blend of practical competence and scholarship. The extent to which the aim is achieved is measured in a practical way by asking the candidates at an advanced stage of their work to design and lead a Summer School for other chemistry teachers. There have been two of these so far; at first on a voluntary basis, they have now been incorporated as a formal part of the M.Sc. programme. The new style Summer Schools are staffed entirely by the teacher M.Sc. candidates who, after discussions with their academic supervisors on theme and overall design are thereafter responsible for the total programme including the publication of the proceedings under the title of 'Chemical Action'. Following the standard practice within the Chemistry School no lectures are given. The whole of the *action* takes place in the laboratory. The ideal arrangement is that each leader shares responsibility with one other for a workshop in the area of his research interest and to which he may therefore bring new insight and enthusiasm.

These 'Chemical Action' schools are not only a testing ground for our chemical education programme, they are also a shop window displaying our wares to other teachers. In 1970, members of the group were invited as part of the chemical education effort of the Royal Australian Chemical Institute to present part of the 1969 'Chemical Action' in another State and at another university. Somewhat nervous at the prospect of putting the show on in a strange environment they, nevertheless, achieved a notable success. It was a great source of satisfaction for all concerned.

Thus, we now feel that we are in the process of proving the point that the best way to help the teaching of chemistry in the schools is to give interested teachers the support and opportunity to do this for themselves. Perhaps it has been necessary in the past for syllabus and examining committees to be dominated by senior university people and for package teaching schemes to be handed down but surely the future must hold out a better prospect than this for a teacher with an interest in his subject and the desire to make a real contribution to the teaching of it. It seems reasonable that, if education authorities are

prepared to invest in the teacher and provided that universities will cooperate, it should always be possible to maintain a cadre of teachers well able to provide within the schools the leadership necessary for the production and maintenance of modern curricula. If this is not done, there will be little chance of changing a situation that places so much emphasis on the act of teaching and so little on creativity and innovation on the part of the teacher. This imbalance is so palpably wrong, yet so little is done by way of redress. In-service courses that are subject-specific are almost non-existent† in many countries. Many activities appear as such, but upon closer inspection, they turn out to be familiarization exercises with a popular curriculum frequently imported and designed for another milieu. Imported schemes, because of their almost biblical‡ authority, may simply exchange the old straightjacket for the new unless, at the same time, teachers are encouraged to seek change and, indeed, to contribute to it. Really, it is quite sad to see that these excellent compilations, having contributed so much to curriculum improvement, are now tending to stifle the development of teachers. Contrary to the popular view, I believe that the teaching of brand name chemistry is a philosophy of despair, an admission that mass education in science leaves little scope for the teacher who is master of his subject.

ATTENTION TO LOCAL REQUIREMENTS

It is especially important for developing countries that university and senior teachers should collaborate in the production of local curricula that will more nearly reflect capabilities and need. For there is evidence that local people given access to what is going on around the world will produce the most useful curricula. Nevertheless, it is only fair to say that home-grown curricula carry no guarantee of success without a commensurate concern for the ability of the teacher to handle the material.

It so happens that, at the present time, as part of the UNESCO Chemical Education programme, we are assisting the Institute of Technology in Bandung, Indonesia, to assume responsibility for the up-grading of teaching in Indonesian high schools. As part of this programme two vacation courses have been run at the ITB using much of the material from 'Chemical Action' modified and expanded where necessary after consultation with our Indonesian counterparts. In addition, the plan allows for a number of Indonesian teachers to spend a period at Macquarie working alongside our teachers on projects pertinent to their own local situation with, as an immediate objective, the development of teacher leaders in urgently needed curriculum reform.

In this way and by seeking areas of research that might, in common with the ITB staff, be profitably pursued, we are hoping to assist them to maintain a dual interest in teaching as well as research similar to our own.

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† For example, inspection of a Teachers' Course List for 1971–72 put out by the Department of Education and Science of Great Britain reveals that out of a list of 250 courses only one appeared to be concerned with the content of science.

‡ However, there are those in influential positions in education who see authoritarianism as the only solution to their problems. I recall one very senior man in government asking why the *best* scientists could not write *the* book and be done with argument. On another occasion an administrator of a large foundation asked why not have just one syllabus, one curriculum for the whole of Asia!

Each course has involved myself and one other member of the Macquarie staff spending two months in Bandung†. On each occasion the first month has been spent in preparation and the second has been taken up by the actual programme of lectures and practical sessions with a composite staff variously representing the ITB, the Bandung Teachers' Training College, the University of Djakarta and the Science Teaching Centre. At no time, are we involved in any other way than as advisers. The whole course proceedings are in the Indonesian language and our contribution is achieved solely through the agency of local people with whom we work in very close association.

Both Aylward (*loc. cit.*), who was with me the first time, and I are now convinced that working in support of, and through, effective local counterparts is far better than substituting for them. We would say that, if such people are not available or cannot be persuaded to take an interest, then this kind of activity is just not on. This may seem to be a fairly obvious point of view but we have found sufficient opposition to it to warrant its reiteration here. No work of this kind is likely to be very successful unless local people are fully and effectively involved.

An immediate objective of the work in Bandung was the development of a minimal set of experiments that could be introduced into the schools. To this end there was a good deal of concentration on locally available materials and processes. For example, sessions in polymers used rubber latex as a starting point and the laboratories were a joy to behold, full of flowers and vegetables being used as sources of acid–base indicators and extracts for thin-layer and paper chromatography exercises. I doubt if a physical chemistry laboratory has ever looked more gay. As in Ceylon, this kind of approach seemed to have considerable appeal to teachers without any sacrifice of chemistry.

The Indonesian programme builds upon the excellent start made by a UNESCO sponsored Study Group (*loc. cit.*) led by Dr S. Achmad‡ and formed by him upon his return in 1967 from a six months period at the Chemistry Pilot Project. In this and other respects this programme could be regarded as almost a model outcome of the UNESCO support for science education and, consequently, for me a particularly satisfying one. Another pleasing feature for us at Macquarie is that this extramural activity is much more an extension of our own day-to-day affairs than a separate enterprise.

IN SUPPORT OF TEACHERS

Having discussed somewhat in detail some experiences in in-service work both in Australia and elsewhere, I would like to turn to some general observations on the training of chemistry teachers and the role of university chemists in their support.

Most people concerned with science education will agree that the teacher is the most important factor in the educational process. As recently as a year ago both of the plenary lecturers at the International Conference on Education in

† On the first occasion we were pleased to have some useful discussions with Dr J. Campbell (CHEMS) and Dr H. Herm, both of whom came down from the Bangkok Pilot Project for a week or so during the course of the School.

‡ Acting Dean of Science, Institute of Technology, Bandung, Indonesia.

Chemistry held in Colorado came out very strongly in support of this position. Hornig† said in concluding his address: 'Finally, I would like to observe that discussions on science education tend to focus on choice and sequence of subject matter, structure of professional curricula and organization of course. I suspect that, important as all these things are, they are not the heart of the matter. Even perfection in all of these aspects will be no substitute for dedicated and inspiring teaching. The most important matter of all may be how to increase the numbers of knowledgeable and inspirational teachers at all levels from elementary school up. It could even be that the declining market for university research people will make the job easier, but of one thing I am sure, it is the quality of people that work at it that will determine the course of the next 50 years in chemical education', and Nyholm‡ said: 'But, above all, we must emphasize that the centrally important person in the educational process is the teacher. This is true whether one is concerned with the five-year-old infant or the Ph.D student, although the role of the teacher may vary', and again, 'given ideal classrooms, first-class apparatus and plenty of teaching aids, the main factor in teaching will always be the teacher'. And yet again: 'But the public in general and the politicians in particular need to recognize that only the *best* people should be attracted into teaching at all levels'. And UNESCO reminded us at the beginning of the International Education Year of its own policy which has been to 'concentrate much of its effort on the improvement and status of teachers'[2].

It seems curious perhaps in view of the earlier statements that the status of teachers should be in question at all. Yet it is, and no doubt the principal causes are not too hard to find. In the last decade or so the demand for education has far outstripped either the capacity or the will to pay for it. Some developing countries spend up to 25 per cent or even more of their total budgets on education whereas some advanced countries do not match the cost of their cigarettes.

Inevitably this has led to an averaging down in the level of science teacher pre-service preparation; a problem compounded by a similar effect on in-service rehabilitation. Concurrently and perhaps consequently there are increasing inroads on the science teacher's independence especially within the more centralized education systems. Here the teacher is increasingly beset, at this time of education ferment, by experts who usurp his authority not only in his subject but in most other aspects of education as well. Examinations are set by authorities to which he has little recourse and new curricula are passed down for which he is inadequately prepared. All this, despite repeated assertions that *he* is the most important person in the teaching process. Teachers must really feel at times that someone must be joking.

It is eminently desirable that the teacher should be trained and encouraged to counter and criticize new curricula and new methods when they are placed before him. He should not be required to go quietly away in a thankful attitude. It is the boast of some modern educators that things are so much better now that the old dictatorial methods of teachers have given way to the much broader and

† Professor D. F. Hornig, President, Brown University, Providence, Rhode Island, USA.

‡ Professor Sir Ronald Nyholm, late Head of Department of Chemistry, University College, London, U.K.

flexible methods of the new science schemes. Yet one of the originators of such a scheme is prepared to say of it 'if you cut it, it bleeds'. Who are the dictators now?

It is a further misfortune that there is a tendency to train teachers even at the highest level in such a way as to hold them within the profession. I have had personal experience of courses that, instead of increasing the professional ability of the teacher within the science disciplines were certainly designed to downgrade it, and in its place, add further education subjects; not only putting at risk his ability to be 'inspirational' in the subject for which he would have some responsibility but also his chance of moving out of teaching if he felt unsuited to it.

There is no doubt good reason for training a prospective teacher differently from somebody who may have aspirations to be a professional scientist either in industry or in research, but this should not really be at the expense of his knowledge and confidence in the content itself. It seems at the interface separating content and method there needs to be a good deal of discussion to resolve sharp differences of opinion on this issue.

A view might be held that because a teacher tends not to receive continuing contact with his subject that he should receive a deeper and more complete training if this were possible, rather than one that is more superficial. However, it is perhaps more reasonable to recognize that a variety of backgrounds and variety of training are not only inevitable but probably desirable among science teachers because of the enormous variety of the teaching that is likely to be required in high schools or, for that matter, even in primary schools. It is not necessarily a bad thing that there should be some kind of heirarchy established within the schools where graduate teachers, well-trained and maintained† in their subject, are responsible for the content of science taught within a school. For whatever form this takes, if it is to be styled 'science', then it is very important that people reasonably well wetted by the main stream of the subject matter should be available to ensure that it is recognizable as such. It is at this point, as I have already suggested, that university chemistry departments might be expected to make a major contribution. A contribution, not just in terms of Summer Schools, but of post-graduate courses and other modes of continuing communication‡ with responsive teachers.

In developed countries there is a strengthening opinion that too much time has been spent on research and not enough attention paid to teaching and, as a consequence, universities may well seek to assume commitments of this kind. University chemistry departments of the developing countries will continue to find rewarding and challenging experiences in working alongside teachers and aiding them in the development and maintenance of high school curricula. This is especially true now when the lack of unanimity on science teaching objectives coupled with ideas that perhaps science in the event is really unteachable[3] tend to obscure the way forward. For, although there appears to be general spoken

† The IUPAC Committee on the Teaching on Chemistry suggest a minimum of three months retraining every five years.

‡ See *Chemistry in Britain*, **5** (No. 7), 29 (July 1969), where under 'Not So Refreshing' D.E.S. Refresher Courses are discussed and a teacher is reported to have said that the real way to refreshment was for universities to offer 'Open House' one afternoon a week so that teachers could establish regular dialogue. No more than that!

agreement on the importance of the teacher, there is a considerable diversity of opinion on what he should be doing in science. In some developed countries there is a fairly widespread view that science should be taught more for its own sake as part of a liberal education. Not surprisingly, it turns out that this is rather at odds with many of the views of the less developed countries where their investment in comparatively expensive science education is seen as a stepping stone along the path of technological progress.

The existence of these extremes of thought helps to underline the view expressed earlier that solutions adjudged satisfactory in developed countries are hardly likely to be acceptable in the developing countries and the seeking of proper alternatives is something in which universities are bound to be involved. In many such countries avenues for research at universities are only slowly opening. Creative work in chemical education, by providing an immediate alternative for the application of specialized knowledge could in the long run help to develop a more appropriate balance between teaching and research than now obtains in the more advanced countries.

This is the kind of balance we would like to achieve at Macquarie and if we can do it as a consequence of assisting teachers to maintain their own integrity and autonomy as both chemists and teachers of chemistry then we will be very happy indeed. We do not pretend that what we are doing is original in concept or performance. Professor Halliwell at the University of East Anglia in England has a group working along similar lines and there are others. However, there is still plenty of room for other university chemistry departments to try their hands at it. I feel I can assure them of profit in respect of their teaching and, far from diluting their research effort, this will be strengthened and better justified.

Chemistry is part of the 'glorious entertainment'[3] of science. It is great fun for the initiated but it is not easy and where it appears to be then it is almost certainly not chemistry. There is no real substitute for scholarship in science and this, above all, is something that teachers should be encouraged and assisted to maintain. Surely this is the best way to improve the status and quality of teachers and this, I suspect, is the prime purpose of this gathering.

REFERENCES

[1] Everett Hafner in *Physics Today* (June 1967).
[2] *UNESCO Courier*, p 10 (January 1970).
[3] J. Barzun, *Science: The Glorious Entertainment*, p 143. Secker and Warburg: London (1964).