

# SOME REFLECTIONS ON THE DEVELOPMENT OF SCIENCE EDUCATION

H. F. HALLIWELL

*School of Chemical Sciences, University of East Anglia, Norwich, UK*

## ABSTRACT

Two consequences of the explosion in the demand for education are of importance in any national scheme of curriculum development: the one is that there will be some areas of development that are common with other countries, but large areas which will need to be geared much more closely to local cultural and socio-economic patterns; the other is that any scheme *if it is effective* will alter the conditions that made it necessary and must therefore have inbuilt adjustments to feedback. In the light of these two consequences three questions are asked about the work of development: with what purpose in mind?; with what reasonable safeguards for success?; and by whom should it be done? In attempting answers to these, the speaker hopes to establish a useful background for the session's papers.

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The business this morning is the function of the university in the orientation of teachers in high school and in the development of new teaching methods.

The papers which follow are but indicative of the existence of a great number and a great variety of activities which are taking place to these ends in many parts of the world. There is considerable concern in many countries about the way the local and national programmes of education—and particularly science education—are going: concern which shows itself in change and replanning. As a result there is now no shortage of proposals; proposals which range from that which is acknowledged as only tentative to the but thinly disguised Way of Salvation. Indeed after several decades of comparative changelessness, the present production of new schemes is seen to be embarrassing in its ease—embarrassing and potentially a hazard of bewilderment.

## GUIDING PRINCIPLES

What is needed at a time of easy change is a guiding principle or set of principles which will enable any one community, be it UK, Iran, Brazil, Canada or where-you-will, to pick its way through the increasingly crowded market of competing vendors of educational panaceas.

I suppose I have already implicitly included a fundamental assumption in this last statement. Since it is fundamental I had better make it explicit: it is that I believe that in the present day context of diversified mass-education the answer to the problems we have in mind will be different in different countries. What is wise action for Ghana may or may not be appropriate for Guyana. What is a helpful line for the UK may or may not be what is appropriate for Brazil. Moreover what is appropriate for Australia or Venezuela *now* may or may not be appropriate for those communities in ten years time when present

proposals have had an effect. This statement seems to contradict the obvious truth that chemistry (or whatever science we are interested in) is the same chemistry in Ghana, Brazil or anywhere else in the world and the paradox involved has resulted in quite sharp differences in opinions among initiatory groups. However I did say that I believed the answer to the problems would be different in different countries in the present day context of diversified mass-education: it is not chemistry that is different in the different contexts, but the approach, the selection of content, and the pattern of the demands made on pupils which may well be different in different countries. When education was the privileged acquisition of the few and when its practice focused on the subject, there was, quite properly, a fairly common procedure wherever the activity was taking place. Now that the demand for education has expanded—Philip Coombs<sup>1</sup> in his analysis of the situation says exploded—education itself is a politico-sociological activity of a community, and must, I believe, be regarded in an evolutionary and often specifically local perspective. If we are going to discuss the ways in which high-school teachers can be helped then it is obvious that we shall be concerned not only with the needs of the few pupils who will follow in our footsteps, but also with the needs of the bigger group of pupils whom we think could benefit from a study of material changes but who are not going to be chemists. In this wider aspect two consequences follow:

- (i) that no scheme is likely to have universal application—therefore **each community, while learning from the efforts of others, must base its proposals clearly on its own needs and in its own perspectives:**
- (ii) that any scheme suitable under a given set of conditions, since its purpose is to alter the conditions for which it was designed, **will need to have an inbuilt procedure for readjustment and redevelopment.**

I suggest that in going about our morning's business we shall be well advised to keep in mind these two consequences of the explosion in the demand for education. In this way we shall keep somewhat separate that limited aspect of the development of science education which is of fairly universal applicability and that much wider aspect of it which will be much more influenced by, and geared to, local cultural and socio-economic patterns. The help which we can give to each other will be quite different in these two areas.

Let us start from a base about which we can be quite certain: if a country's younger generation is to be given an education which is pertinent, if teachers are to be helped to cope with the new demands made on them and if new materials are to be developed for them, then someone is going to be involved in a great deal of work. I propose to try to establish a useful background to the papers which follow by asking and attempting to answer three questions about this work: a great deal of work to what purpose?; with what safeguards for success?; and by whom? This order of treatment is chosen merely because an answer to the first is required before the second can be dealt with and an answer to both is obviously needed before we can say who should be involved.

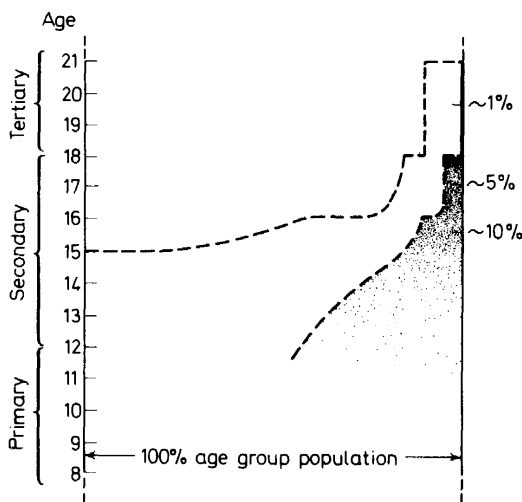
### **A GREAT DEAL OF WORK: TO WHAT PURPOSE?**

Here each one of us had better be honest about our interests: are we concerned with the teaching of chemistry to the small percentage of the more

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capable who will be following in our footsteps as chemists, or are we concerned with the part that chemistry can play in the science education of the great bulk of the community—including that important majority of the more capable who are not going to be chemists? I raised some of the implications of the latter part of this question in a preliminary form at the previous IUPAC meeting in Rome<sup>2</sup> but the whole question is part of a general need to be clear, at the outset, about the politico-sociological purpose of that organized interference with the young (of course for their good) which we call education. The over-riding need for clarification of purpose has been stressed on many occasions. Its repetition must detract from its novelty, may detract dangerously from its impact but it does not diminish its fundamental importance. Yet once again therefore I urge that we focus our attention on what, in any country, the educational system is trying to do *to*, and *with*, and *for* its young people.

When we look at the chemical education of the young in the majority of urbanized societies, the pattern is a fairly common one and is shown in *Figure 1*.



*Figure 1.* Approximate extent of chemistry in a community's education system. See text.

Although the percentage of an age-cohort in higher education in the USA is about three or four times that shown as the common value, the percentages indicated in the diagram are approximately true for many technologically developed countries<sup>3</sup>. The significance of these figures lies in their evidence of groups with different interests and ambitions.

I submit that we cannot decide what chemistry (if any) should be taught, or how it should be taught, to these diverse groups until we have at least a provisional hypothesis about the good it might do them.

We are therefore clearly constrained to act within the guidance of the interaction of the four As of curriculum reform<sup>4</sup> to which I have often referred.

We as a group *could* lovingly work out a beautiful way of teaching introductory kinetics, or the unravelling of chemical formulae in the naïvely arrogant

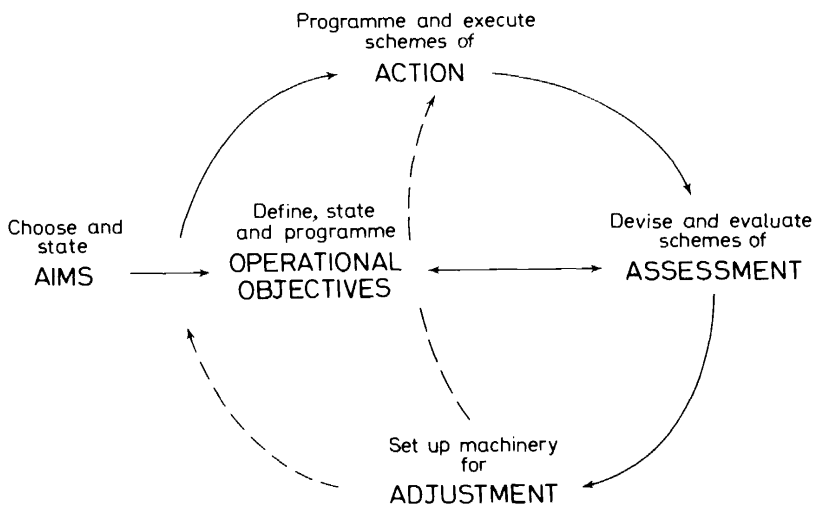


Figure 2

opinion that because we like it therefore anyone who is not exposed to it is not educated. Yet of course we are confronted in more and more countries with an alarming increase in the number of young people who with some justification feel they have been 'educated' out of life. I ask you, as you go about the city here during the next few days (or your own city when you get back), that you look at the young people you meet in the street, in the shops, in the park or on the beaches, and ask the question 'should they be taught chemistry?' I am not saying the answer is 'no' nor 'yes', nor 'maybe'. I am at this stage saying that the question must be asked and an answer honestly worked out before someone starts spending time and money on this 'great deal of work'. If the answer is 'No—chemistry is only of value to the very few', then the administrative boundaries of all problems are much more limited. If this is so I would even ask whether chemistry should be included at high school level. If the answer is 'Yes—Chemistry has something to offer the non-chemists', then maybe we should try to sort out what that something is—and see that they get it and not get something else.

To go back to the four As for a moment the point the scheme makes is that if you know where you want to go you have a better chance of getting there and at least you should know whether you have arrived. You might also find others would like to join you! It might even be that they would pay your fare!

Such common sense approaches should be the basis of our deliberations.

### **A GREAT DEAL OF WORK: WITH WHAT REASONABLE SAFEGUARD FOR SUCCESS?**

The major factor which influences the outcome of any effort is the great variety of factors. Supposing we have been competent, wise, and exceedingly hardworking—have in fact produced in detail a first-rate scheme of proposals—what are the various factors which can help or hinder its implementation? I have indicated below a few of which I and my friends are personally aware.

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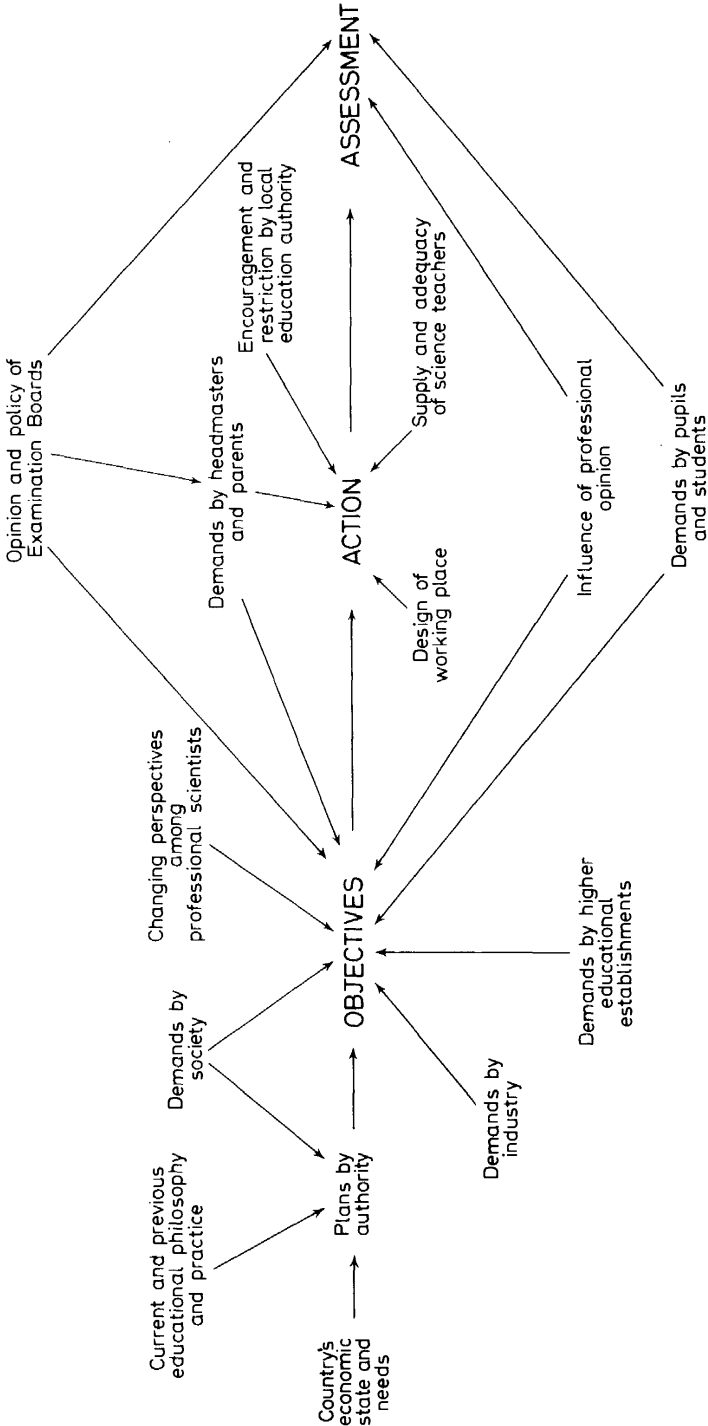


Figure 3. Factors influencing educational decisions.

What a collection of vested interests, of prejudices and of ingrained habits! Recently I have been fairly intimately concerned with science teaching reform in several countries. In one country no change is likely for quite a few years because students and parents are against any scheme of assessment (and advancement) other than that based on rote-learning and on arbitrary demands for repetition from, and only from, publicized notes. In another country, some highly regarded and very competent authors found that their fondly regarded scheme was unsuccessful (in spite of considerable financial resources) because no effort had been made to get the Education Authority's backing for teacher reorientation. In a third, real trouble and disturbance is likely to arise because the technically highly successful scheme is producing an unemployable frustrated disillusioned group of articulate and intelligent people.

If chemistry is to be a high school subject—and presumably it is according

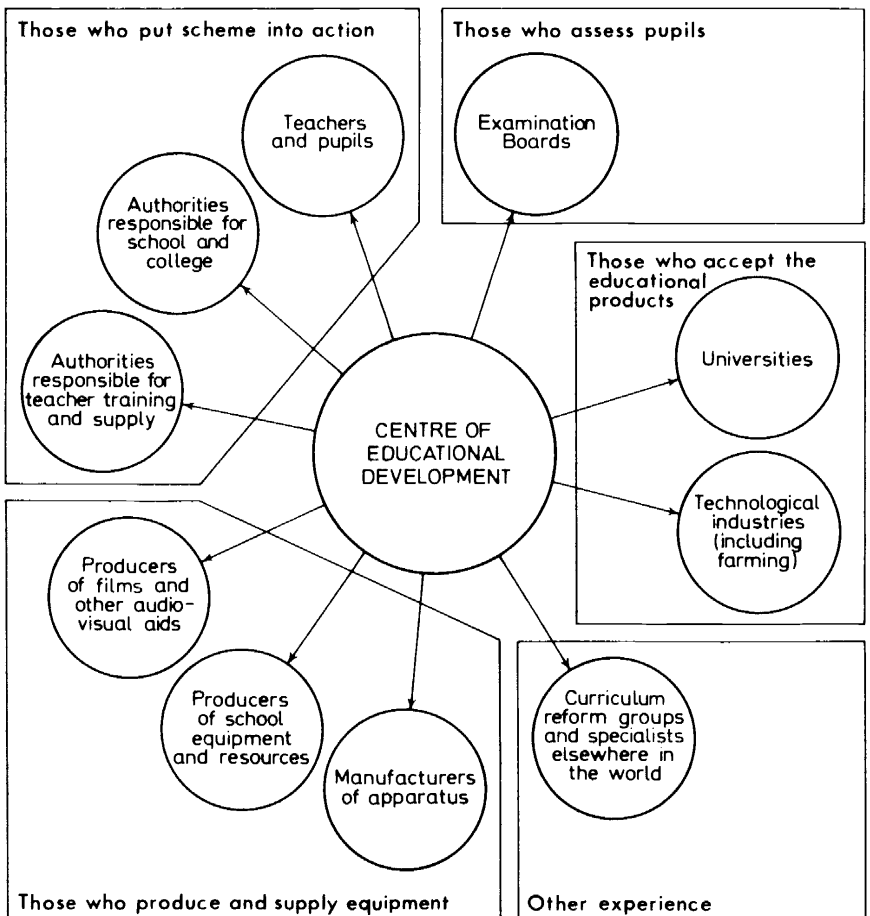


Figure 4. The variety of contacts the Centre of Educational Development would need to make.

to our briefing for this morning—then more than chemists must be involved in its development. Indeed, if we change from consideration of some of the factors as indicated by *Figure 3* to a consideration of some of the areas of activity as indicated in *Figure 4* (adapted from author's diagram for UNESCO<sup>5</sup>), we begin to get a feeling for the range of problems which will have to be tackled. This done we can turn to the last question which in fact will need to be almost the first to be answered.

### A GREAT DEAL OF WORK: BY WHOM? AND WHERE?

The implication of our briefing is that it is 'the university', but the university is an institution and it is not institutions who work—it is people belonging to them. Who then is implied by our briefing? Senate? Such an august body is unlikely to be the agents. Surely because of the nature of the work it should be the education faculty? What chemists would say to that suggestion I will not elaborate upon. Then it must be the chemistry faculty. But can they by themselves cope with the great range of non-chemical problems which as we have seen will arise?

It was with these queries in mind that some while ago I proposed through UNESCO that the first step in any educational undertaking of this sort should be formation of a 'national steering committee'<sup>5</sup>.

In that suggestion I was in error for such a label suggests something far too formal, monolithic and (human nature being what it is) far too entrenched and permanent.

However, I am quite sure of two points: the first is that whoever starts the work must see that among themselves they have the necessary variety of interests and knowhow, and secondly that there must be national recognition of their importance so that they have adequate weight in argument and adequate resources in production.

The variety of interests and knowhow I see as being supplied by at least four groups of people, *Figure 5*.

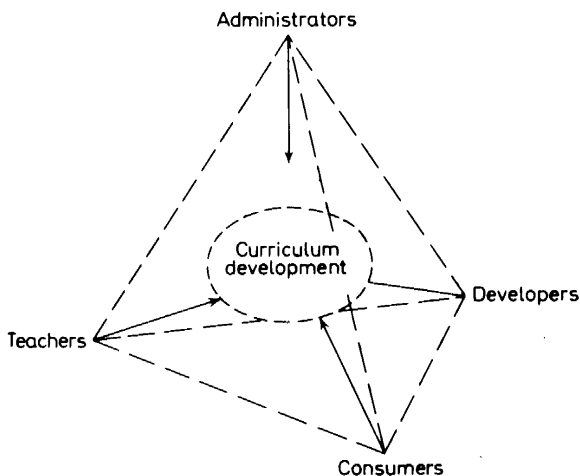


Figure 5  
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I don't believe any one of these groups can be successful alone. I am, however, sure that it is possible to find, from among a country's progressive university faculty, its experienced science teachers and its imaginative administrators, a group of people into whose keeping this coordinated and pertinent development can profitably be delegated **PROVIDED THE GROUP IS GIVEN THE NECESSARY FREEDOM AND ENCOURAGEMENT**. Here then is a major function of the university: to encourage the formation and work of such a group, to help supply resources to it in the form of men, as well as materials, and to **do this as a partner and not as a dominating influence**.

Let us turn then to our business of the morning: The function of the university in the orientation of teachers in high school and in the development of new teaching methods.

Orientation from what to what?

Developments for what purpose?

### REFERENCES

- <sup>1</sup> P. H. Coombs, *The World Educational Crisis*, Oxford University Press: London (1968).
- <sup>2</sup> 'The problem of conflict between specialism and generalism in chemical education', *Pure Appl. Chem.* **22**, 17 (1970).
- <sup>3</sup> 'The university and the needs of contemporary society'. *Papers of the International Association of Universities* No. 10, Paris (1970).
- <sup>4</sup> 'Chemical education: problems of innovation', *R.I.C.Rev.* **1**, 205 (1968).
- <sup>5</sup> 'Strategy and Tactics in Educational Reform in Science', UNESCO, *SC/WS/11*, Paris (1967).