

THE STUDLEY EXPERIMENT

AN EXPERIMENT IN TEACHING HIGH-SCHOOL PHYSICS

A LENGTHY period of study by the Science and Education Committee of the Science Masters' Association (S.M.A.) and the Association of Women Science Teachers (A.W.S.T.), now the Association for Science Education, led to the publication in 1961 of the Policy Statement and the associated syllabuses in biology, chemistry and physics for grammar schools*. As one of the preliminary discussions by which the Association took the opinion of interested bodies, a conference was held at Studley College, Warwickshire, in December 1960, of representatives of the S.M.A. and A.W.S.T. and of the Science Panel of the Secondary Schools' Examination Council (S.S.E.C.), together with representatives of the Ministry of Education. The subject of discussion was the syllabuses in physics and chemistry prepared by the Association. The intermediate physics gave rise to extended discussion and the following proposition was carried: "That a group of schools should be invited to undertake an experiment into ways and means of conducting General Certificate of Education (Ordinary Level) courses based on part 1 of the syllabus and that one or two of the examining boards should be invited to associate themselves with the experiment. The conference was of the opinion that it would be better if meanwhile the examining boards outside the experiment did not include in any revised syllabus material relating to section 7.2-7.6 of part 1 of the physics syllabus". It was also agreed that "the two Associations, working in collaboration with the Science Panel of the S.S.E.C., would take responsibility for designing and launching the experiment" and that "the next step towards the experiment should be taken by the Associations".

Initiation of the project. In the Association's view there were two aspects of the new course. First, the method of teaching which is based on the belief that physics is a necessary part of a liberal education, and secondly, new syllabuses intended to bring the subject into the twentieth century. The first of these was the more important and, to a large extent, the pilot scheme was concerned to discover whether the two aspects were compatible with each other.

An invitation to participate was sent to all grammar-type schools in England and Wales in February 1961. Some 240 schools returned positive replies, but only 30 could be accepted. Three examining boards (University of Cambridge Local Examinations Syndicate, Northern Universities Joint Matriculation Board, Oxford and Cambridge Schools Examination Board) were approached, and all agreed to help. Ten schools taking examinations of each Board were then selected. Meanwhile, an A.S.E.-sponsored team was investigating methods of teaching and supply of apparatus for the modern physics part of the new syllabus. Manufacturers were encouraged to produce needed apparatus at reasonable prices, and short courses in its use were arranged. For the purchase of apparatus a special grant of £400 from Industrial Fund sources was made to all independent and direct grant pilot schools, while local education authorities provided similar amounts for maintained schools.

Visits to schools. During 1963 each pilot school was visited by a team of two, one a H.M. inspector, the other an Association representative. An interim report was published in the *A.S.E. Bulletin* of April 1964. During 1964, 25 of the schools taking part were visited by one of the earlier team.

* *Science and Education* (John Murray, 1961).

Any assessment had to make allowances for the following factors:

(a) The modern physics element, at least in 1963, had to be added to a traditional course.

(b) The schools volunteered and it was reasonable to suppose that the teachers would approach the new work with marked interest and energy.

(c) The action of the 'novelty' effect. The good effects of any reform tend to be exaggerated in the early stages because of initial enthusiasm which may wane.

(d) The proportion of independent schools and direct-grant schools was greater than the national proportion, though fair in the view of the examining boards concerned.

(e) Apparatus was short in 1963, but was more plentiful and of the right kind in 1964.

(f) In both years, some of the teachers appeared not to have been fully briefed on the educational aspects of the course.

(g) In 1963 there was a bias towards choosing the top physics set for the experiment; in 1964 this bias was not so marked.

The best teaching revealed intellectual integrity of high order and was planned to encourage the pupils to adopt a critical attitude of mind. Other teachers seemed solely concerned to ensure that their pupils learned the subject matter—an objective praiseworthy, but insufficient. By 1964 in some schools a sense of added confidence and skill was detected, and in two schools there were encouraging signs of experiments beyond the confines of the interim report of modern physics. The external examination still cast its shadow, and in two schools a decline was noted from teaching which stimulated enquiry to something close to cramming.

Enough was seen in 1963 and 1964 to give evidence that boys and girls of 15-16 within the range of ability represented in the pilot classes were able and willing to understand and to think critically about this part of physics. Boys and girls said that they liked this work, that they thought it modern and relevant and more interesting than some of the traditional parts of the subject. They sometimes lacked the necessary background knowledge such as the nature of wave motion, the point of a control experiment, the relevant mathematics and even the elements of photography. The significance of Millikan's work on electronic charge was not always grasped by teachers and pupils, and the connexion between static electricity and electric current was sometimes assumed without any evidence being given.

The teachers were unanimously in favour of the experiment. Most of them expressed concern about shortage of time which, they claimed, prevented them from approaching the topics as they wished. More than one said he saw the need to revise his physics course, and several expressed a revival of interest in the art of demonstration and in the teaching of electrostatics. Some claimed that the new work had encouraged them to read more widely.

The trials have thrown into sharp relief the extreme difficulty of devising a satisfactory physics course for examination at Ordinary Level in schools which boys enter at the age of thirteen. There appeared no evidence that girls are less perceptive physicists than boys.

Pilot examination at ordinary level. The results of the examination shown in Table 1 enable comparisons to be made between the percentage passing out of the total entry from all schools for normal physics in 1963, the

percentage passing the pilot-scheme physics in 1963, and the percentages from pilot-scheme schools passing normal physics in the previous year, 1962.

These results suggested that significantly more schools had been penalized by taking the experimental papers than had been favoured. In consequence, a meeting between members of the S.S.E.C. Science Panel, representatives of the Pilot Committee and of the three exam-

	Normal physics % passing out of total entry 1963	Pilot scheme physics % passing 1963	Normal physics pilot scheme schools % passing 1962
Cambridge	57.9	68.9	68.3
Joint Matriculation Board	54.1	58.1	62.5
Oxford and Cambridge Board	56	52	Not applicable

ining boards examined the position and from the discussion the following points emerged:

(a) The boards had clearly attempted to set and mark papers in the spirit of the A.S.E. Policy Statement.

(b) Candidates' performance was much the same on the modern physics as on questions covering other parts of the syllabus. It appeared that sufficient allowance may not have been made for the unfamiliar nature of some of the questions.

(c) The boards suggested that a longer period might be required in 1964 for standardization. More extensive comparisons between the scripts of pilot candidates and normal candidates would be necessary.

In 1964 the same three Examining Boards set papers and the results are shown in Table 2.

	Normal physics % passing 1964	Pilot scheme physics % passing 1964	Normal physics pilot scheme schools % passing 1963	Pilot scheme physics % passing 1963
Cambridge	60.0	58.1	57.9	68.9
Joint Matriculation Board	51.7	68.6	54.1	58.1
Oxford and Cambridge Board	57.9	64.3	56.0	52.0

Other information suggested that some schools entered rather weaker candidates for the Cambridge examination than in the previous year; also it can be assumed that, after the intensive enquiry into 1963 results, all three boards exerted even greater efforts to ensure that there was no unfairness in the treatment of pilot scheme candidates. From the report of the examining boards it seems that papers can be set and marked on the new syllabus as well as on syllabuses accepted for many years. It remains true that the questions which proved most difficult to set and to answer were those in which an attempt was made to test the appreciation and understanding of concepts. Pupils need to be made familiar with this type of question in class work and home work. It was gratifying to note that one examiner stated that many candidates showed a philosophical study of the subject, showing understanding rather than mere 'know-how'.

The boards have agreed to make similar papers available in 1965.

Conclusions. (1) It seems likely that greater interest and understanding and consequently a more careful study of physics may be achieved, if the enthusiasm evident in the pilot schools can be passed on to other schools.

(2) Questions in sympathy with the A.S.E. proposals are more difficult to prepare than traditional questions; they require a greater measure of invention. It is important that examiners should guard against slipping back into setting the more traditional type of questions. For all this, examiners have shown that suitable papers can be set. Criticisms were invited from the schools, and it is not surprising that the new questions elicited more than normal criticism. It would appear advisable for the boards to allow more time for the design, analysis and

revision of question papers if the quality is to be maintained.

(3) One step taken in the A.S.E. syllabus was the inclusion of new work, the parts associated with atomic physics. The immediate purpose of the experiment was to see whether this could be understood by boys and girls at the fifth-form stage. Fears were expressed that the change might lead to a falling-off in the quality of the teaching, which might decay into mere telling, especially as there seemed at the time small hope of an adequate practical course to substantiate the theoretical ideas to be introduced. The considerable success of the A.S.E. Modern Physics Committee and the apparatus makers in providing suitable apparatus has improved the situation during the period of the experiment. In the pilot schools commendable efforts have been made to introduce this practical work. Such efforts would be common if the new work were to be introduced into all schools provided that the examinations include questions which assume acquaintance with the apparatus. The question papers in the pilot examinations of 1963 and 1964 set some questions of this kind, but scarcely enough to make the point. It may even be desirable, for a strictly limited period, for the examining boards to draw up and issue a list of apparatus with which the candidates can be supposed to be familiar and on which the examiners can base a variety of questions.

(4) Many examination questions, particularly in relation to the new work in the syllabus, invite the candidates to explain a physical fact in terms of a theory accepted at present, as though the theory were more substantial than the fact. It would be better in keeping with A.S.E. policy if questions were phrased to emphasize the provisional nature of all theories.

(5) There are certain parts of the syllabus which only admit of instruction in the prevalent theory, with little opportunity for critical assessment by the pupils at this stage. The notable example is the section on nuclear energy. The film aids so far produced help to make the theory intelligible; but the element of remoteness remains. Such work, for all its intrinsic interest, should be included in the teaching syllabus only if the teacher makes it plain to his class that as he cannot substantiate his statements they must be accepted with reservations. The particular section should not appear in an examination syllabus. It is considered that questions so far set on nuclear transformations, in which candidates must complete mass numbers, atomic numbers and so on, encourage drill in simple rules and are of comparatively small value.

(6) There are a number of able teachers who do not wish to teach the work at this level, although they may be ready enough to include it in advanced courses, because they feel that what can be done before the age of sixteen, at least with some of their pupils, is too shallow to be comparable with the work done in other parts of physics. It is believed that at least for a number of years there should either be alternative papers at Ordinary Level, or else sufficient variety in the questions which may be selected by the candidate for a student to be able to omit the new work without handicapping himself.

(7) To make room for the new work in the syllabus a number of long-established topics were omitted or reduced in content. No complaints have been received from the pilot schools about the disappearance of these parts. Many of the teachers are still oppressed by the bulk of work to be covered.

(8) The need remains urgent for teachers, and examiners, to meet in discussions of the principles underlying the A.S.E. statements and the consequences in teaching methods.

(9) On a balance of considerations the committee recommends that the Science Panel of the Schools' Council approves the inclusion, with the one exception given, of the new material in the Ordinary Level physics examination syllabuses.