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NATIONAL CURRICULUM AND A - LEVEL SCIENCES

The National Curriculum was introduced in 1989, and is changing the way science is taught in schools. Children between 5 and 16 are increasingly studying broad-based science, while at higher levels (eg. A-Level), science continues to be offered as separate subjects. This has generated debate on the compatability of the National Curriculum and science courses at higher levels.

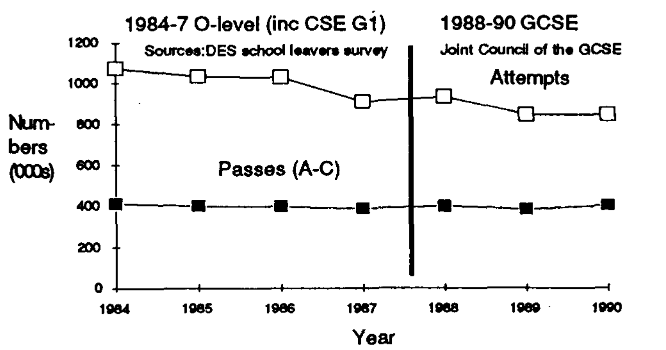
This briefing note examines the effect of the National Curriculum on science teaching and the implications for the future of GCSE and A-Level exams[1], as well as for higher education.

SCIENCE EDUCATION PRIOR TO THE NATIONAL CURRICULUM

In 1951, the General Certificate of Education (GCE) became the basic examination system in schools, providing 'Ordinary Level' exams at 16 and 'Advanced Levels' at 18, the latter comprising the traditional entrance qualification for universities and polytechnics. GCE's were supplemented by the Certificate of Secondary Education (CSE) in the 1960's. In both GCE and CSE courses, pupils could take one or more single science subjects and the final exam grade reflected performance in written papers, with little or no internal assessment component. By sitting three separate science O-levels, it is likely that 30% of the teaching time would be spent on sciences (ie 10% per subject).

In 1984, the Secretary of State for Education announced that the O-Level and CSE exams were to be replaced by a single exam based on 'National Criteria' - the General Certificate of Secondary Education (GCSE), with the first exam in June 1988. The GCSE relied more on internal assessment, where a proportion of the total marks is based on work which the candidate completes during the course. The numbers of science attempts

Figure 1: Total attempts and passes at grades A-C in all sciences



and passes before and after the switch from O-level/ CSE to GCSE are shown in Figure 1. Although the number of attempts has fallen, the numbers of grade A-C passes has changed very little from 1984-90.

NATIONAL CURRICULUM SCIENCE

The Education Reform Act (1988) provides for a National Curriculum comprising four core subjects - maths, english, technology and science, together with seven foundation subjects. All students between the ages of 5 and 16 at state schools[2] will have to study science, whereas previously, candidates not wanting to study sciences for O-Level or GCSE, could drop them entirely. National Curriculum science is broadly based and contains elements of the former three main single science subjects (biology, chemistry or physics), as well as other branches of science (e.g. geology and astronomy).

Timetable allocation. The National Curriculum envisages 20% of total teaching time being allocated to science (model A), with a reduced form (model B) requiring only 12.5%. Elements of models A and B are shown in Figure 2. Model A is designated a **double award** GCSE and model B a **single award**.

Objectives. One of the principal objectives of the National Curriculum is to ensure that all children of school age study a form of broad-based science. In theory, a student who has completed the National Curriculum Science course and obtained a double science award GCSE, should be able to choose virtually any combination of science subjects at sixth form level. Making science compulsory for all school children in this way is intended to ensure a basic grounding in science for all. It is hoped that more may take science further, increasing the number of students pursuing science A-Levels and degree courses. Looking further ahead, it is also thought to be one way of increasing the number of

1. The main focus of this briefing note is on schools where the GCSE and A-levels are the main courses offered. However there are alternative vocational and other qualifications, an example being courses established by the Business and Technician Education Council (BTEC) which combine a mixture of practical skills, knowledge, and relevance to the employment world.

2. These changes apply to all the state sector, but independent schools are under no compulsion to adopt the National Curriculum.

FIGURE 2 Attainment Targets (AT) in National Curriculum Science

ATs common to models A and B	*ATs in model A but not B*
Exploration of Science	The variety of life
Processes of life	Human influences on Earth
Genetics and evolution	Making new materials
Types and uses of materials	The scientific aspects of information technology (including microelectronics)
Explaining how materials behave	Using light and electro-magnetic radiation
Earth and atmosphere	The Earth in Space
Forces	The nature of science
Electricity and magnetism	
Energy	
Sound and music	

technologists as well as specialist teachers. At present, both these groups are in short supply.

Advantages. The National Curriculum core science course prevents school students dropping any particular science subject too early. Hitherto, less than 10% of candidates attempted all three subjects (biology, chemistry and physics) at GCSE level (8.5% in 1988). Traditionally, many able girls have done only biology. In future, all students in the age range 5 to 16 will study science, and it is hoped that the balanced nature of the curriculum will open up future career opportunities in science and technology. Supporters of the National Curriculum also see advantages in the attainment targets set for ages 7, 11, 14 and 16 as providing a means of measuring individual progress against national standards. They see regular, defined testing of pupils' performance providing a framework around which teaching can be planned, as well as helping achieve better results in the final GCSE exams at age 16. In addition, the rationalisation of primary school teaching should lead to pupils entering secondary school with a similar background in science, thus facilitating transfer of pupils between schools.

Since it is not just biology, physics and chemistry which are covered, but also such topics as earth sciences and astronomy, the science course should have a much wider perspective. It is also felt that since the science teaching is structured around a detailed programme of study, it will make it easier to estimate how well schools are coping with the new curriculum.

Disadvantages. A number of practical and other difficulties have been pointed out. The broad nature of the science teaching will require more equipment (the Royal Society has estimated that the annual costs of laboratory equipment alone required to teach balanced science is £8.86 per pupil). Initially, teaching schedules may have to be rearranged while schools decide whether to use "teams" of single-subject specialists or general science teaching. Since some classes are over 25 in number, additional staff may be needed to help in assessment. Alternatively, large classes may have to be split up, which would also lead to a need for extra teaching staff. In either case, pressure exists for increased expenditure.

Turning to model B, this option would severely limit a pupil's ability to cope with an A-Level in physics, chemistry or biology, since the model has a very thin content of these subjects. In the view of the Royal Society and other professional bodies, this model will leave pupils with a limited view of science which will not prepare them adequately for life in an increasingly technological society.

Implementation. Two key bodies were set up by the 1988 Education Reform Act. The School Examinations and Assessment Council (SEAC) is responsible for overseeing the examinations as well as approving attainment targets. The National Curriculum Council (NCC) has a duty to research and develop the actual curriculum. Both are Government agencies, working in close association with the Department of Education and Science (DES).

CURRENT ISSUES

How compatible are National Curriculum Science and present A-Levels?

Up to 30% of the timetable used to be devoted to three single science O-levels or GCSE's, whereas double award National Curriculum GCSE will require 20% for a broader range of science subjects. The amount of knowledge of biology, physics or chemistry from double award GCSE will thus be significantly less than hitherto, and questions have been raised whether it will provide an adequate grounding for pupils wishing to go on to study three science A-levels. Separately, other concerns have been expressed at reported difficulties in some schools with the transition from the old single-science GCSE courses to A-level courses in the same subject. The essay-based approach of A-levels following limited essay practice for GCSE, has been cited as one source of difficulty.[3]

Some (including the Headmasters' Conference) have thus argued for a third option at 14, in addition to single and double award sciences (Figure 3). This option would continue single science GCSEs in biology, chemistry and physics, since following them up with an A-Level course is relatively straightforward. Supporters of this option see it as building on the excellent reputations of many schools in the sciences at GCSE level, and some estimate that it could be achieved with 22.5% of the timetable from age 14.

A different view is held by the National Association of Head Teachers, the Secondary Heads Association (SHA), the Association of Science Education and others who consider that the traditional teaching of science encourages specialisation too early, and that a more balanced

3. This year's A-level results included candidates with a GCSE background. Overall, the national pass rate is little changed.

FIGURE 3 Options in National Curriculum Science

	Option	Time	GCSE	Single Science Equivalents
	A	20%	Double Award	2
	B	12.5%	Single Award	1
	C	20% -25%?	3 single sciences	3
Age	14		16	

science course will increase pupil awareness and encourage more young people to study science at higher levels. However not all these bodies go so far as recommending that single sciences be abolished. A recent Government decision will allow schools to continue to offer single sciences (see also next section).

Turning to model B, most professional bodies consider that it is extremely limiting, and could not provide the basis for the study of any A-Level science subject. They have therefore argued that this option should continue be restricted to the 'small minority of pupils' originally envisaged in the regulations.

The status of GCSE Sciences

The GCSE is the main method of examining progress at the final (age 16) attainment test of the National Curriculum. The double award science GCSE exam is already in existence, and numbers taking both double and single award sciences should rise dramatically. A typical broad-science GCSE currently consists of four papers, the first three corresponding to a paper in each of biology, physics, and chemistry, the fourth being an "integrating" paper. Such papers do not however fulfil all requirements of the National Curriculum since the earth sciences, astronomy etc. do not feature. Virtually all GCSE syllabuses will thus need some amendment.

It is likely that fewer candidates will have access to single science GCSEs in physics, biology and chemistry, due to the intention that double science award GCSE should be the end of course exam. This is born out by the trends between 1989 and 1990 in Table 4. On the other hand, there is no planned withdrawal of single science GCSEs, since the examination boards envisage a considerable continued entry for biology, physics, and chemistry exams, from three main areas :

(a) Independent schools

TABLE 4 Numbers Sitting GCSE Science Exams in 1989 and 1990 (Grade A-C pass rate (%) in brackets)

	1989	1990
Double Award Science	171,883 (49%)	262,704 (40.5%)
Biology	249,749 (45.9%)	219,085 (47.9%)
Chemistry	201,799 (51.2%)	173,025 (53.7%)
Physics	224,052 (49.3%)	190,040 (52.4%)

(b) Further education and sixth form colleges
(c) State schools choosing to offer them in addition to the double science award.

In the latter case, SEAC investigated the possibility of assessing double award A science through separate criteria in biology, chemistry and physics, but concluded that this would not be consistent with statutory attainment targets. In the light of the recent decision to allow schools the option of offering single sciences however, SEAC has been asked to reexamine their earlier conclusion and develop revised criteria for the single sciences by 1992, such that they simultaneously cover the requirements for double award science. Should a school take this option, candidates would have to sit all three sciences, thus maintaining the 'balanced science'approach of the National Curriculum.

Timetable allocations for 'option C' (Fig. 3) science are now being investigated. There is concern however, that any increase in the amount of the timetable devoted to sciences, should not lead to the displacement of another subject such as history, geography, music, religious knowledge or physical education.

The Future of Science A-Levels

Irrespective of any specific changes in the course requirements for science A-levels, the appropriateness of all A-Level exams in their present format has been questioned. The Higginson report of 1988 called for major changes, favouring a five subject curriculum, but this was rejected by the Government which argued that the "tried and tested" A-levels should remain the major route to study at higher levels.

Nevertheless, pressure for change continues, arising both from the low staying-on rate for A-levels and the differences between the National Curriculum and A-levels in content, approach and exam style. Bodies such as the Committee of Vice-Chancellors and Principals, the Secondary Heads' Association, the Headmasters' Conference, and the Girls' Schools Association, consider A-Levels too narrow a training. Figures from the Associated Examining Board indicate that entries for syllabuses with a practical bias have risen sharply, reflecting the preference in some schools for A-Levels which mesh better with the GCSE approach.

SEAC have recently proposed a number of substantial reforms which would bring A-Level courses more in line with GCSEs. These include a broadening of the curiculum, allowing up to 40% of coursework to be teacher-assessed and pursuing the possibility of transferring credits between A-level and vocational courses in some subjects. It is also envisaged that common requirements for 'core skills' will be developed across all syllabuses. The NCC has suggested that these 'core skills' should comprise communications, numeracy, information technology, problem-solving, modern language competency and personal, or study, abilities.

The Government has also introduced the Advanced Supplementary (AS) exam, equivalent to half the content (at the same standard) of A-Level. A total of 172 AS syllabuses have been approved (including 50 science courses), and they were examined for the first time in June 1989. But AS courses currently have a low uptake rate - in the first year, only 15% of schools offered them, with only 6% of the total number of A-level candidates taking one or more AS exams. The slow rate of adoption of AS programmes may be due to fears that changing from the traditional A-levels to AS exams may be a disadvantage in the competitive world of higher education. Indeed, one A and two AS qualifications are not universally accepted for mandatory grant purposes, and 4 AS (equivalent to the statutory 2 A-Levels), are not accepted as satisfying minimum requirements for university entrance. (Liverpool University was the first to say that it would accept 5 AS qualifications for entry.)

SEAC's 18-plus Committee have approved a proposal that AS courses should become the main route to university entrance. It is proposed that most sixth formers would take four AS and one A, or 5 AS courses. Supporters of these changes (including the DES) see them as allowing the new broader basis of education at secondary level - as embraced by the National Curriculum - to be extended to study at the next level, avoiding the need to specialise into all science or all arts subjects. Such a broadening would bring Britain in line with many European educational trends where specialisation in the sixth form does not occur.

From a broader perspective, SEAC and others also see AS and A exams taking their place alongside vocational and other qualifications, as part of a strengthened and more flexible system of post-compulsory education. They see it as important to broaden the range of options if the UK's rate of participation in post-16 full-time education is to be raised.

Implications for Higher Education

Any major change in the secondary school science curriculum or exams structure is bound to affect study of sciences at university level. Moves towards a 'slimmed down' A-level syllabus or AS-Levels would reduce the factual content of science courses and will mean that students enter university with less knowledge in a given subject area. The implications of such trends are under consideration not only by universities and polytechnics but also by those dependent on postgraduate education for research (Research Councils, research charities, employers etc.).

Some have suggested that the existing depth of science degrees could be maintained by adding an extra year's study to a three year course, although this could be very expensive. The alternative would be to reduce the BSc course content to suit the intake (e.g. the Institute of Physics has recommended a reduction in the factual content of physics degree programmes). This would also have implications for higher degrees, whose emphasis is currently on research, with only a limited amount of instruction (particularly with PhDs). Given the demands on scientists to have increased knowledge of their specialist fields, the implication is that standards at MSc and PhD level will have to be maintained by increasing the course content at the expense of time for research. Since a significant amount of basic research funded through the Science Vote by the Research Councils is carried out by higher degree students, such changes could have important implications for the productivity of this research, and some organisations have expressed concern at the eventual outcome.

Other Options

Other options available contrast with the traditional secondary school exams structure. The BTEC courses have already been mentioned and have the advantage that the whole of a student's course (to degree level if required) can be related to that student's future employment aspirations. Students may well continue their studies if they see their courses as relevant to their future career, and improving their overall employment prospects. Indeed, the latter are impressive ; some 95% of Higher National BTEC Candidates (equivalent to at least two A-level passes) are employed within three months of qualifying.

Another alternative to A-levels is provided by the International Baccalaureate (see box below). This exam is widely available in Europe and throughout the world, and is accepted as an entrance qualification for University. It is available in some British schools which have experimented with it as a replacement for A-Levels, and has recently been accepted as an approved qualification for university entry in the UK.

The International Baccalaureate course consists of six elements: a first language, a second language, Man in society, the experimental sciences, maths, and one other subject (three are studied at higher level). In addition, a course in 'Theory of Knowledge' must have been followed. Candidates must also take part in some creativity, action and service. Each subject is examined and graded, and the International Baccalaureate only awarded if the total score is above a prescribed minimum, and each subject is above a certain grade.

FURTHER READING

Additional details and background information are available from POST, 2 Little Smith St., London SW1P 3DL, tel: (071)-222-2688

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