Physics Education: What's Wrong?

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Secondary school physics, already condemned by many universities as inadequate preparation for a degree, has recently been further compromised by changes to the GCSE syllabus.

Originally three separate subjects, declining interest in sciences prompted the introduction in the early 1990s [1,2] of less rigorous 'double' and 'single' science GCSEs. Then in 2006, a new 21st Century Science GCSE was piloted by OCR, completely replacing the old system in 2007 [3–5]. The new suite of examinations comprises a single Science GCSE, Applied Science, worth two GCSEs, and three separate science syllabi [3].

> **"The Applied Science curriculum avoids most quantitative calculations"**

These qualifications were designed to address the declining numbers of post-GCSE scientists, particularly in physics [6,7], where A-level intake has fallen from 46607 in 1985 to only 27466 last year [8]. To this end, the Applied Science curriculum avoids most quantitative calculation, focusing on discussion around more 'exciting' topical issues: in physics, for example, nuclear energy [9]. The courses also aim to meet the needs of students who will not continue with sciences at A-level [10,11], preparing them for informed debate on a variety of scientific issues without burdening them with the analytical detail traditionally taught at this level.

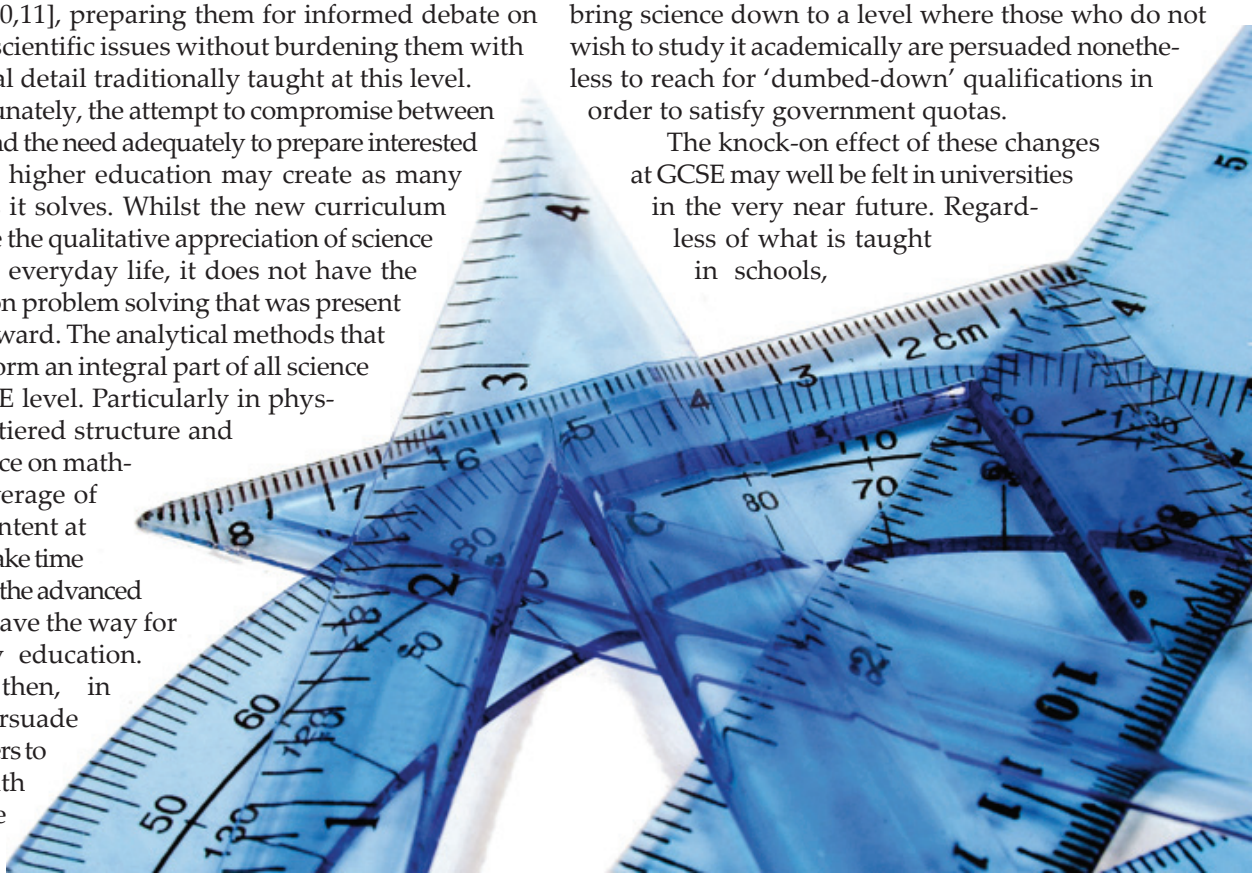
Unfortunately, the attempt to compromise between these aims and the need adequately to prepare interested students for higher education may create as many problems as it solves. Whilst the new curriculum may provide the qualitative appreciation of science required for everyday life, it does not have the same focus on problem solving that was present in Double Award. The analytical methods that are left out form an integral part of all science at post-GCSE level. Particularly in physics, with its tiered structure and heavy reliance on mathematics, coverage of this basic content at A-level will take time directly from the advanced topics that pave the way for a university education. Ironically, then, in trying to persuade more teenagers to continue with science, we are depriving them of the very skills they will require to do so.

The changes to the curriculum have had a mixed reception. Proponents maintain that it caters much better for the needs of students ending their science education at GCSE, who had previously been considered 'expendable' [12]. Whilst many teachers are enthusiastic about the syllabus, saying it has revived interest and enthusiasm among less able students [3], there has been widespread criticism of the course. Sir Richard Sykes of Imperial College, London, has condemned the new syllabus as "dumbed-down" and warned that students with aspirations to study science at university would be unable to do so without more rigorous qualifications [12]. Baroness Mary Warnock, a philosopher and educationalist, warned that such innovations could lead to a situation where "science will be relegated to the position of Latin and Greek and will only be taught in the independent schools" [12].

> **"An extra year at university would represent significant additional debt"**

It is clear that in an effort to satisfy irreconcilable aims, it is those who wish to continue their studies who are being let down. It seems that we are unhealthily busy trying to bring science down to a level where those who do not wish to study it academically are persuaded nonetheless to reach for 'dumbed-down' qualifications in order to satisfy government quotas.

The knock-on effect of these changes at GCSE may well be felt in universities in the very near future. Regardless of what is taught in schools,



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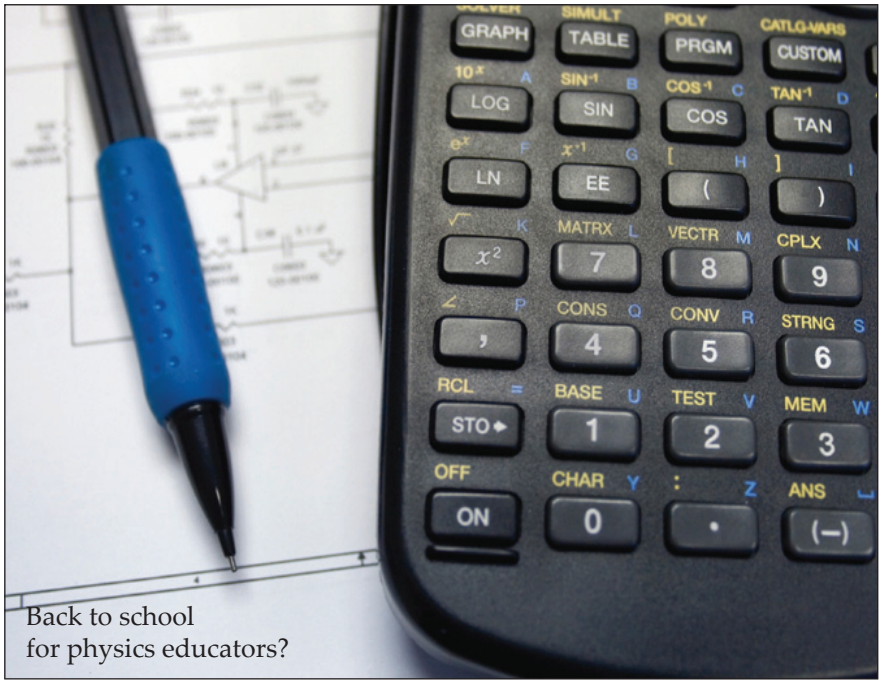
there is a minimum level that further education students must reach before they are equipped for scientific research. Increasingly this training will have to be done at undergraduate level, putting more pressure on institutions whose primary function is arguably not teaching, but research. The most obvious solution here, from a teaching viewpoint, becomes an increase in the length of an undergraduate degree: a practise that is already in place in Scotland, as Scottish Highers do not cover as much detail as the present A-levels. The difficulty with this, from a student's viewpoint, is financial. Present tuition fees in Scotland are half of those in England [13,14]; for English students an extra year at university would represent significant additional debt, and would likely discourage science-related applications.

> **"The attempt to compromise ...may create as many problems as it solves"**

The best way to fix the A-level curriculum may be to fix its prerequisites. A C-grade in Double Award science, the previous requirement, could not be replaced by the equivalent in Applied Science given the reduced quantitative content, so separate sciences can be considered as a candidate prerequisite. The disadvantage of this requirement is that students would have to decide at the age of 14 whether or not they wish to study any science above the compulsory level. Science teaching in primary schools is at best sporadic, giving children a mere three years' learning on which to base this important decision. Although previously a problem for Single Award science, this choice until now has been the exception rather than the norm, with ten times as many students taking Double Award as Single in 2007 [15].

To avoid closing doors to further study at such an early age, the best option might be to stop offering this GCSE suite altogether. This, however, is made virtually impossible by market forces: if one exam board is cleared to offer a simplified GCSE, others will follow to compete for the market in schools. In the same way as a product on the retail market will not be withdrawn if it sells well, it will be difficult to convince exam boards to remove an obviously popular qualification; and education authorities are unlikely to be disposed to persuade them, since easier GCSEs mean better government statistics and the illusion of a better schooling system.

In conclusion, then, there appear to be only two practical options available. We can allow the quality of secondary physics to deteriorate, transferring the burden of basic education to universities. Or we can stream students at an early age, where they have arguably insufficient information on which to base a like or dislike of science. Streaming would allow potential physics undergraduates to develop the necessary mathematical and analytical skills, whilst giving less interested students the opportunity to obtain a qualitative understanding and appreciation of science in today's world. The loss of some candidates at pre-GCSE level would be a small price to pay for a generation of school leavers who are properly equipped to make a difference. ■



Back to school for physics educators?

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