Teaching science to the gifted in English state schools: locating a compromised 'gifted & talented' policy within its systemic context

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Abstract

In 1992 the schools inspectorate in England criticised the level of provision for gifted learners in state schools. Subsequently various policies and initiatives were put in place to improve this situation. Yet in 2013 the schools inspection service again reported on this issue, and declared the situation unacceptable. This chapter offers an account of the English school system, and discusses how the implementation of a 'gifted and talented' policy was largely undermined by the wider systemic policy context, including the implementation of a national curriculum for science, a common science examination for all school leavers, an emphasis on objective assessment and teacher accountability, and the conceptualisation of schools as competing for learners in a marketplace. It is suggested that current English government policy of reducing the influence of the Universities on teacher preparation is likely to act as a further impediment to developing widespread good practice in gifted education in science in English schools. The English state school system provides a telling example of how the implementation of a particular policy (here on educational provision for gifted learners in state schools) can be constrained and compromised by the wider systemic policy context.

The organisation of the chapter

This chapter is informed by two reports (published in 1992 and 2013) issued by the bodies responsible for inspecting schools in England, that focused on provision for gifted learners within the state school system. Both of these reports were critical of provision for the most able pupils. The 1992 report (Her Majesty's Inspectorate of Schools, 1992) can be seen as a major impetus to addressing the needs of such pupils and was followed by considerable direction and guidance from national government intended to improve the situation. Despite this, two decades later, the 2013 report (Ofsted, 2013, p. 4) concluded the situation remained "unacceptable".

This chapter explores why (in a national context that has produced many Nobel prize winning scientists) provision in state schools has often failed to meet the needs of the most able pupils. The chapter is organised around the 1992 report as representing a useful touchstone. First some background is provided on the nature of state education in English schools leading up the period when the Inspectorate drew attention to how the system was failing the most able pupils. Then an overview is offered of the key initiatives and policies put in place to ensure that gifted pupils attending state schools in England would be supported in meeting their potential. Over these two decades there was a definite shift in the visibility of the notion of giftedness in schools and in the extent to which those working in schools considered this as an issue that should be addressed. The critical 2013 report can therefore be seen as highly disappointing.

Despite the increased focus on gifted learners in English schools, other features of educational policy have undermined progress in this area. it is argued that teaching practice in relation to the gifted in science is constrained and shaped by the broader policy context in which schools and teachers operate.

The English context

'Public' schools vs. the public school system

The English school system is complex. Figure 1 offers a caricature of the system as it has existed since the second world war. A significant traditional division is between those schools which charge fees for pupils to attend, and those which are maintained by state funding, to offer free education for all. For historical reasons, some of the well-established private schools are commonly referred

to as being 'the Public Schools' - a term that made sense in its original use centuries ago, but is confusing to an international audience today as the English 'public schools' are actually private schools, independent of the publicly funded school system.

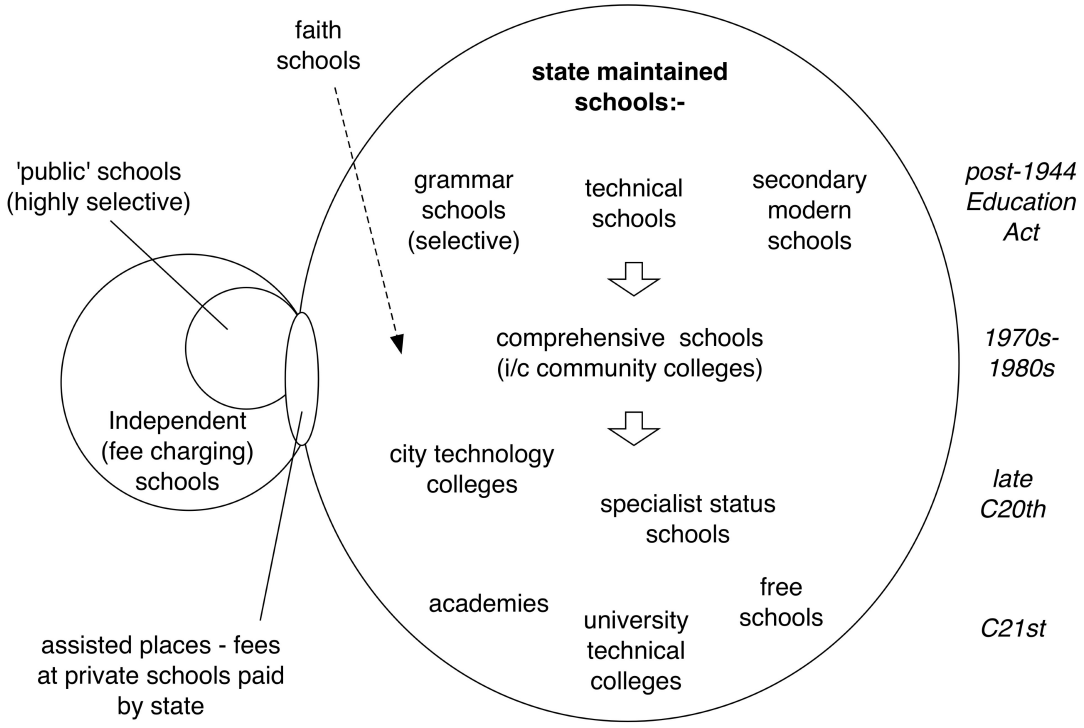

Figure 1: Schematic caricature of the English secondary school system

It is estimated that something like 7% of school children in England attend fee-paying schools. So a great many parents who are entitled to send their children to a local state school without direct cost, choose - despite being expected to contribute to state education through their taxes - to pay fees to send their children to private schools. Pupils attend such schools full-time (rather than attending private classes outside of the normal school day as a complement or supplement to state education as is common in some countries), and indeed many private schools take 'boarders' who live on site during school terms.

Many of the more elite private schools also offer some places on competitive scholarships to pupils who demonstrate very high ability but come from families who could not afford to pay the fees. As well as offering a well resourced education to a few carefully selected less wealthy pupils, this boosts the concentration of gifted learners (and so the profile of school examination results) in a way likely to help market the school.

For almost two decades (from 1981 to 1997) there was also an 'assisted places' scheme by which the state would provide financial support for pupils to attend private schools (rather than state schools) based on these pupils showing exceptional performance on the private school's entrance examinations. Thus state resources were used to increase the proportion of gifted learners in private schools - arguably to the detriment of the state schools that these pupils would have otherwise attended.

This is just one example of the intricacies - or perhaps eccentricities - of the English schools context, which has evolved in response to various historical contingencies, ideological impulses, and practical (often economic) compromises. That successive governments provided public money to send very high achieving pupils to independent schools would seem to suggest that those responsible for the state education system (who often had been privately education themselves) did not feel it was capable of best supporting the learning of gifted pupils.

It is well recognised that private schools, and in particular the elite group of such schools referred to as the public schools, are instruments for reproducing and maintaining social distinctions and a social elite (Cookson & Persell, 1985). These schools, that are well beyond the financial means of most parents, provide a disproportionate number of entrants to the highest-ranked English universities such as Cambridge and Oxford. A very disproportionate share of the UK's prime ministers, government ministers, senior civil servants and others in especially influential positions have attended these schools. Of course, those private schools that charge parents high fees are able to provide pupils with a level of educational resource well beyond what is possible in a school funded by the state. However, these schools often also select on ability/aptitude, and so contain a high proportion of pupils who might be judged gifted, with implications for school norms, expectations, and ethos. The independent sector distorts state education in England by 'creaming' from the general school population many pupils of especially high attainment, as well as those from advantaged backgrounds who have both high levels of social capital and the financial means to readily access resources of educational value.

There are also many smaller private schools that charge more modest fees and are less selective, and sometimes arguably offer a level of educational resource that is clearly inferior to typical state schools. The continued demand for such schools would seem to be an artifact of the well established British social class system that has only begun to break down in recent generations (Taber, 2012). That is, parents seem to pay to ensure that their children are *not* educated in an environment reflecting the full social diversity of the community.

The main focus of this chapter will be the state funded education sector, but the independent sector schools are relevant because they impinge upon the state sector by reducing the pool of pupils of high academic achievement attending state schools. One issue of concern for state schools asked to offer particular provision for their gifted science learners is the size of that group of pupils. This is of principled importance because of the value to the most gifted learners of spending at least some of their time working with similar peers, something they themselves usually appreciate well (Taber & Riga, 2006). It is also of practical importance, because a school that has a small number of pupils considered gifted in science in a year group would not be able to commit much of its limited resources to special provision to meet the particular needs of these learners. We might (by analogy with nuclear fission) use the metaphor of needing a 'critical mass' of gifted science learners to facilitate sufficient like-peer interaction and to justify substantive resource allocation.

The tripartite system as a response to different educational needs

For several decades after the establishment of free and compulsory state secondary education for all (through the 1944 Education Act) there was widespread selection of pupils for different types of English state secondary school at age 11. Although there was provision for the establishment of 'comprehensive' schools that took any pupil (for example in very remote areas that would not demographically support several schools), the widely adopted model was a so-called 'tripartite' system of 'grammar', 'technical' and 'modern' schools. Grammar schools had existed in England for centuries, and had come to be seen as institutions offering education suitable for the middle classes (McCulloch, 2006), and following the implementation of the 1944 Act they could be accessed by any child passing an examination at the end of primary school.

Local education authorities (LEA) were charged with coordinating and supporting the state school provision in their area. These authorities were part of local government, which employed professional officers to administer the school system, but with policy made by a committee of the elected local council. The plans of the LEA were subject to ratification by the national ministry, where civil servants worked under the direction of the education ministers appointed by the nationally elected government. This meant there were two levels of democratic input into developments of the school system (and consequently the political flavour of LEAs did not always align with the National Government).

The grammar schools were intended to offer a strongly academic curriculum, and entrance to these depended upon pupils passing an examination taken in primary school at age 11. The assumption was that pupils with academic potential - such as those who would be suitable for university study and the professions - would receive a suitable education in the grammar schools, whilst the majority of pupils - who would not need, be engaged by, nor cope with, such a rigorous academic curriculum - would attend schools that would provide a more practically orientated curriculum.

The system allowed many pupils (i.e. from among those who passed the Eleven-plus examination) who would not have gained admission to independent schools to nonetheless prepare for and proceed to university study and professional careers. However, the system was based on the assumption that it was viable to make decisions at age 11 about the potential for a child to develop into an academically successful pupil by the time they were of university entrance age (e.g. 18). One problem here (leaving aside that the examination was taken in one session during one day at primary school, leaving plenty of scope for an off-day or exam nerves to undermine a child's future) is that children develop at different rates, and many pupils who failed to pass the 'eleven-plus' examination would have shown much greater academic potential a few years later. Nor did the system did not make any allowance for a pupil with uneven development and a specific aptitude or strength in a particular curriculum area, such as science. Transfer between types of schools was not impossible, but once a child was assigned to a school, and taught accordingly, this became very unlikely. Only in a grammar school could the gifted learner in the state sector find themselves part of a critical mass of like-minded peers.

It also became clear that although the process was meant to select on the basis of academic ability, to a large extent the outcomes reflected the socio-economic family background of the children. Where the independent schools largely served the more wealthy in society, the grammar schools admitted disproportionate numbers of children from so called 'middle-class' families (i.e. parents being lower professional and white-collar workers) rather than so-called working class (e.g. children of unskilled labourers). It was found that scholastic achievement at age 11 was strongly linked to social capital deriving from the home background. If schools are expected to be agents of social change, rather than a means to reproduce existing social differences (and that of course is an ideological choice), then determining a person's educational, and so possibly professional, future at age eleven, based on an examination that did not compensate for levels of educational opportunity and advantage in the home environment, was clearly inappropriate.

The move to comprehensive schools and mixed-ability classes

The main response to this perceived inequity was a call for a system of comprehensive schools, that admitted pupils of any ability from the local catchment area (Crook, 2002). Most local education authorities in England with tripartite systems reorganised their schools to a comprehensive system during the 1970s and 1980s - however some areas retained grammar schools alongside 'comprehensive' schools. These grammar schools clearly influenced the ability profile of the pupils attending the (nominally) comprehensive school - making it less likely the number of gifted pupils in a year group in the comprehensive schools would reach a 'critical mass'.

Having different types of schools is only one way of providing particular provision to more academically capable pupils. Alternatives include various ways of dividing pupils within a school so they study different curriculum (whether actually different subjects, or the same subjects studied in different levels of depth and abstractness) - ability streams, bands and sets. However, the 'comprehensivisation' of (most of) England was often accompanied by a strong commitment to mixed ability teaching: the idea that pupils of all levels of potential and achievement should be taught in the same class (White, 1987). Mixed ability teaching was considered to be less socially divisive, and to avoid self-fulfilling labelling of pupils (Taber, 2012).

In principle, a teacher can differentiate effectively for all pupils *within* a mixed-ability class (and of course any class is mixed ability to some extent, as all learners have their own strengths, weaknesses, idiosyncratic alternative conceptions, particular interests, etc.). Ideally this would allow the adoption of an educative notion of giftedness (Taber & Riga, Submitted) where giftedness is not seen as a fixed attribute of a particular learner (even in relation to a particular curriculum subject), but rather an interim judgement made about a learner in the context of a particular topic or activity.

So even within a science class, or say a physics class, judgements of which pupils are to be considered gifted should always be contextual and open to revision. The learner who quickly acquires a comprehensive knowledge of anatomy and physiology is not necessarily the one who can grasp key concepts of genetics or natural selection. The pupil who can apply complex mathematics to solve physics problems is not necessarily the pupil who is most creative in devising experimental tests of hypotheses. In science pupils often hold a range of alternative conceptions, that can vary from pupil to pupil in their specific content, and in terms of how strongly they are committed to and how extensively they are integrated with other conceptions (Taber, 2014b), so

appropriate differentiation may even be complicated by individual pupils' different starting points in particular topics (Brock, 2007).

Although comprehensive schools and mixed ability teaching need not exclude consideration of the needs of gifted learners, the dominant discourses in English state schools during this period avoided labels such as 'gifted' and indeed largely ignored the needs of the most able learners (Taber, 2012). The term 'gifted' is indeed problematic in both its derivation and the tendency for it to be treated as fixed rather than evaluated in particular contexts (Taber, 2016a), but that does not negate the need to ensure pupils are sufficiently challenged.

The argument for particular attention to the needs of gifted learners can be made independently of accepting any such term, for example (Taber, 2015):

- any student's potential to benefit from teaching depends upon their current characteristics as a learner;
- learning depends upon learning opportunities being matched to a student's characteristics;
- learners show a wide range of current capabilities within any particular curriculum area, and vary considerably in terms of their potential for development with suitable support;
- at any age or grade level there will be some students who are considerably further advanced in their science learning than their peers;
- science (and science subjects) present a broad range of learning challenges such that many students will have an uneven profile of current knowledge, understanding and skills;
- science provision needs to offer suitable learning opportunities to allow students to make progress in their learning;
- particular science provision is indicated for those learners in any cohort who are too advanced to find substantive learning opportunities in the standard provision

There was isolated interest in giftedness among educational researchers in England (e.g., Fisher, 1969) but this did not become widely influential. Where considerable resource was focused on provision of special needs (i.e. those with various learning difficulties), and second language learners (in particular those whose families had entered England from Commonwealth countries), there was little official recognition of the particular needs of the most able learners in schools. Indeed a common attitude was that the gifted already had advantages so teacher attention was best focused elsewhere.

At this point the English education system could be caricatured as comprising a private fee-paying sector primarily working to maintain social stratification and state schools that were deliberately seeking to avoid the semblance of there being any substantive intellectual distinctions between learners. Differentiation by support (that is, a common learning activity, with different levels of support for different pupils according to need) can be a perfectly valid and useful teaching strategy for some classroom activities - but is a poor default approach to differentiation when used as a matter of course.

This then is the context in which the chief inspector of schools reported that "very able pupils in maintained primary and secondary schools are often insufficiently challenged by the work they are set" (Her Majesty's Inspectorate of Schools, 1992, p. vii). At this point the vast majority of children in England attended state schools, which in most areas had comprehensive intake, and which were often not meeting the educational needs of the most able pupils through learning activities which were genuinely educative by providing enough challenge to support substantive learning.

The gifted and talented, or G&T, agenda

The concern about underachievement of pupils in state schools resulted in 'Gifted and Talented' (or G&T) policies being developed, initially in inner city areas (Her Majesty's Chief Inspector of Schools, 2001), but then later applied nationally. The policies were based on a notion of giftedness in academic subjects, or talent in artistic and practical curriculum areas, in the local context. The top 5-10% of pupils in *every* state school were to be considered gifted, and to therefore need some special provision.

The government offered guidance on how to identify (e.g., Department for Children Schools and Families, 2008), and offer suitable challenge for G&T learners (e.g., Department for Children Schools and Families, 2007), but schools were largely left to decide how to implement the policy. On visiting schools, inspectors would expect to find a register of those considered gifted in a curriculum area (such as science), and evidence of some kind of particular provision put in place. Most of the guidance available, however, was generic, and it was largely left to schools and teachers to work how how to implement policy within particular subject areas.

Teaching G&T pupils was one strand (Key Stage 3 National Strategy, 2004) of an extensive teacher development initiative (the 'National Strategies', 1998-2011) that was used as a means to set out

for teachers an official notion of good pedagogic practice in school teaching. Another thread of this initiative concerned teaching and learning in science (Key Stage 3 National Strategy, 2002b) - but there was limited cross-over between themes. An extensive guidance framework on teaching science to 11-14 year olds pupils relegated discussion of the needs of gifted learners to three brief paragraphs near the end of the document (Key Stage 3 National Strategy, 2002a, pp. 56-57).

Whereas mixed ability teaching was common after 'comprehensivisation', in more recent years the government has recommended ability-based sets as the norm for most subject teaching - although this does not automatically ensure suitable teaching for the most able. There is some evidence that whereas mixed-ability teaching encourages teachers to differentiate within a class, the very existence of ability-based sets can lead to teachers treating class members as homologous and thinking differentiation is not necessary or appropriate (Boaler, Wiliam, & Brown, 2000). That may be a particular problem in 'top' sets as the 'tails' of any distribution of ability/aptitude/intelligence tend to extend over a wide range. The most gifted learners will often be in 'top' sets with a spread of other high achieving pupils, most of whom have very different learning characteristics.

One particular issue individual non-selective schools face in providing suitable provision for their most able pupils is that by definition the gifted will be a small proportion of the cohort in a school (indeed, by definition, 5-10% according to the official policy!), limiting the amount of resource that could be committed to them. One way to achieve a 'critical mass' is for schools to work together, or for other agencies and organisations to offer provision that pupils from a range of schools can access. As one example, support from an educational charity (Gatsby SEP) allowed Cambridge University to host an after school enrichment programme (Taber, 2007) in science for a group ('federation') of state City comprehensive schools where the pupils from four schools collectively provided a cohort of similar size to a secondary school class (see the chapter *Working to meet the needs of school pupils who are gifted in science through school-university initial teacher education partnerships*, this volume). Many other similar initiatives supported by various organisations have taken place in various parts of England (Smithers & Robinson, 2012), but without overall coordination at a national level.

The government funded the establishment in 2002 of a *National Academy for Gifted and Talented Youth*, which was located at Warwick University. This initiative had several strands including offering events such as summer schools specifically for gifted pupils (something already common in some other countries), and acting as a membership organisation for gifted learners who were able to demonstrate they met the criteria (Department for Education and Skills, 2005). However, the

National Academy closed in 2007 when Warwick University decided that the follow-up contract offered by the government was not acceptable. Responsibility for this area of work (The National Programme for Gifted and Talented Education, 2009) was then transferred to an "education consultancy and service organisation", CfBT Education Trust.

Despite these various initiatives, practice has not always followed policy. For example, commenting on inspection evidence collected during 2002-3, a full decade after the problem had been highlighted by the Inspectorate, the Government's chief inspector of schools noted that "consistently high-quality provision for gifted and talented pupils, for example in secondary schools, remains the exception rather than the rule" (Bell, 2004, p. 4).

In 2013 the issue was subject to its own designated report. The agency charged with inspecting schools in England reported that many "able students" in non-selective state schools "fail to reach their full potential", describing this situation as "unacceptable" (Ofsted, 2013, p. 4). Among other findings, this report concluded that:

- "the most able students in non-selective secondary schools are not achieving as well as they should";
- "leaders in our secondary schools have not done enough to create a culture of scholastic excellence, where the highest achievement in academic work is recognised as vitally important"
- "teaching is insufficiently focused on the most able".

It seems that two decades of initiatives meant to improve the provision for gifted learners in state secondary schools had largely proved ineffective. In seeking to understand this failure, it is useful to consider curriculum and assessment policy operating in English state schools during this period.

The English science curriculum

The Chief Inspector's 1992 report coincided with the implementation of a prescribed National Curriculum (NC) in England for pupils in state schools from age 5-16 (Statutory Instrument, 1989). Prior to the introduction of a NC in science, schools were given considerable freedom in determining the curriculum for their pupils. Examination boards offered a wide range of science subjects such as rural science, sometimes with syllabuses developed with groups of teachers to meet local needs, that allowed teachers to frame schemes of work for particular groups of pupils.

So it might be possible for a school to offer their most academic pupils courses in biology, chemistry and physics and perhaps additionally astronomy or geology; to offer a more practically based general science course to other pupils; and to also offer especially focused courses which would appeal to the particular interests of some pupils: for example a suite of engineering science courses such as applied science and automotive science. This flexibility led to gender imbalances in some subject areas in many co-educational schools, however there was scope both for pupil choice and differentiation in the style and content of courses offered for different groups of pupils (Jenkins, 2000).

Homogenised 'double science'

The NC was compulsory in all state maintained schools (although a few special schools working with pupils with high levels of special needs were not expected to teach the full curriculum), and required all pupils to study 'broad and balanced' science across ages 5-16 (DfEE/QCA, 1999). All boys and all girls then had to take examination orientated courses combining topics from biology, chemistry and physics up to the school leaving age of 16 years. Moreover, there was a specified core that virtually all pupils should study, an extended 'outer core' that the vast majority should study, and some provision for certification in additional topics.

The basic course taken by most pupils, 'Science - double award', counted as two subjects in the school leaving examinations and was generally known as 'double science'. By studying for and taking additional examinations in extra topics pupils could instead be certified (and graded) separately in biology, chemistry and physics. This 'triple science' or 'separate sciences' option was sometimes seen as suitable for the most able learners - although some schools offered all pupils the chance to opt for the triple science route and others decided not to offer it at all (see below). However all state schools were expected to teach the 'double science' core which was prescribed as part of the NC.

The norm then was a common core curriculum in broad and balanced science for all pupils from ages five to 16. The curriculum designers offered a vision of *differentiation by outcome*, by setting up a series of 'levels', with descriptor level statements as guides for teachers, suggesting that pupils could achieve very differently in response to the curriculum. However, the assumption was that all pupils were taught the same basic set of topics, and in doing so covered the same nominal content, even if the degree of learning achieved would vary considerably. Teachers generally found that there

was limited time to explore the many prescribed topics in any depth, giving little opportunity to supplement them with anything else to respond to local circumstances or particular pupil groups.

One approach to meeting the needs of gifted learners is curriculum compaction where the material to be taught to most learners is condensed: omitting material it is felt gifted learners have already mastered, and assuming pupils need less time for what is retained. This can free up time for more challenging topics, or for more in-depth exploration of the topics other pupils are meeting fro the first time. Yet the content-heavy curriculum; a requirement to teach particular topics in particular 'key stages' (e.g. 11-14 year olds; 14-16 year olds); and the introduction of a regime of national testing at age 14, restricted the ability to coordinate compaction across the secondary phase.

The availability of 'separate sciences'

Where a form of compaction was used, it was usually to ask top sets to tackle the full set of separate science topics ('triple science') in the time allocated for 'double science' during the final years of secondary education (i.e. for 14-16 year olds). This meant learning new topics more quickly rather than the in-depth exploration of the nuances of scientific ideas which might challenge the most able. Moreover, as suggested above, in some state schools, the separate sciences were simply not offered for 14-16 year olds - sometimes because it was felt there was not the critical mass of suitable pupils to justify assigning teachers (and sometimes because of a lack of subject specialist teachers able to teach the additional range of topics).

Supposedly the 'double science' award prepared pupils sufficiently to allow those scoring high grades to progress to post-compulsory university entrance courses in science subjects. However pupils who followed 'double science' courses at school before selecting science courses in colleges often found they were in classes with students who had covered additional topics in 'triple science'. This was especially likely when classmates had attended fee-paying schools to age 16 before switching to state maintained colleges.

This situation continued until 2008, when the government decreed that schools had to provide all pupils who performed at high levels on the national science tests taken at age 14 the option of taking triple science (Taber, 2006). Where schools lacked the 'critical mass' of pupils to put on classes they were expected to organise joint provision with other schools.

Curriculum review

The NC has undergone a range of changes. Some of these were modest revisions of the original NC, but there were much more drastic changes set out in 2007 (Qualifications and Curriculum Authority, 2007a, 2007b) and then in 2015 (Department for Education, 2014). The first of these changes replaced the highly prescribed curriculum with a much more minimal specification, that in principle gave much more scope for teachers to develop schemes of work to meet the needs of local pupils. In particular, the science curriculum replaced long lists of prescribed content with brief outlines of key topic areas, and shifted emphasis away from being primarily about the products of past science to giving equal attention to the processes of science - as widely recommended by science education experts (Clough & Olson, 2008; Matthews, 1994; McComas, 1998). A strong focus on the nature of science offered a particular potential for extending and challenging the most able learners in science (Taber, 2016b).

Unfortunately, the major change in curriculum was not reflected in the requirements for the major school leaving examinations taken by 16 year olds so that many teachers did not feel empowered to shift from their existing practices. Moreover, aspects of the curriculum which could have led to creative, challenging work were attacked in the media by those who saw the reduction in prescribed material and the exploration of contemporary socio-scientific issues as a reduction in rigour. This stance was also adopted by the senior national minister (Secretary of State) for Education, who wanted a curriculum "focused on fundamental scientific knowledge and essential principles that are not subject to controversy and change every month or year" (Gove, 2011). He ordered a new curriculum to be developed which would supposedly ensure rigour and academic standards. When the new science curriculum was published (Department for Education, 2014) it was certainly not academically rigorous (Taber, 2014a), but did mean a return to prescribing a good deal of content to be learnt. It seems likely that the needs of gifted learners will continue to be effectively ignored in English state schools if once again the science curriculum will encourage learning lots of content, but with limited depth of understanding and avoidance of anything that might be considered scientifically controversial - as would be found in any area of active scientific research.

Assessment in the English NC

The introduction of the NC was accompanied by increasing government control of assessment though agencies set up to monitor assessment and examination. Examination boards setting school examinations in England had been independent (for example, set up by universities), but the government set out to reduce the number (requiring mergers), and to limit the choice of syllabi ('specifications') schools could choose from. All examination specifications for 16 years olds now had to reflect the NC, those for post-16 Advanced level had to encompass a prescribed common core, and all these specifications to be approved by the designated Authority. School leaving examinations (for pupils aged 16) with a different flavour for different groups of pupils - originally designed for grammar school pupils, and secondary modern school pupils - were replaced by an examination meant to be suitable for all levels of achievement.

The resulting science examinations for 16 year olds required learning a great deal of prescribed material in detail to score high grades, but offered little scope for the most able pupils to apply their knowledge in creative ways in response to especially challenging tasks. The formal education and examination system in England has been plagued by an obsession with objectivity and accountability in examining pupils - something which puts a premium on precise marking (often by minimally qualified markers) of what can be objectively assessed, rather than what it might be most important to assess. In consequence, teaching practice often gravitated towards asking pupils to learn phrases and definitions by rote, because marking schemes were considered so inflexible. The impression given was that in science precise recall is more important than offering a genuine formulation of a personal understanding - not an image likely to excite most gifted learners.

Even in the laboratory aspects of school science there was limited scope for gifted learners to demonstrate their creativity and aptitude within the NC. Again formal assessment requirements constrained teaching practice. Teachers tended to plan practical work which would lead to pupils performing well on a highly structured form of practical assessment introduced with the NC (Taber, 2008). This was intended to be a flexible system that allowed teachers scope for how best to set up practical work and assess their pupils. Yet because the system relied on teacher assessment a system of moderation was introduced to ensure accountability.

As often happens, well-meaning decisions have unintended outcomes. In principle, teacher designed, supervised and marked practical work gives scope for varied, creative practical work. Yet the moderation system soon led to an almost uniform approach by teachers to selecting a limited

number of readily achievable practical investigations, and then designing laboratory schemes of work to support preparing pupils to achieve high marks on those standard 'investigations' (which rarely had outcomes pupils should not have anticipated). The moderation scheme offered assurance that all teachers were teaching to the same rigid mark scheme - but did nothing to allow for the different levels of preparation and support offered in different classrooms (to the extent of professional malpractice in a few documented cases); and allowed teachers to repeat activities until pupils demonstrated achievement (as the decision about which marked practical activities to include in the portfolio could be made at the end of the process). Teaching and assessment often focused on one stage of laboratory enquiry (such as data analysis) at a time to give pupils the best chance to demonstrate high performance: but this was performance on an isolated task detached from any authentic enquiry activity. An approach intended to ensure accountability simply gave an assurance of uniform appearances and did little to encourage good practical work or actually measure pupil aptitude for it. Some teachers offered pupils experience of science as a creative activity through extra-curricular schemes (Taber & Cole, 2010) but sadly the prescribed curriculum and tis assessment made science seem a process of learning and applying specific skills within formulaic practical exercises. This was the antithesis of authentic research with its scope for imaginative leaps and unexpected outcomes.

Impact of wider policy drives

The account above has focused on the area of curriculum and assessment where government policies have had direct impact on the kind of science teaching that pupils, including those gifted or potentially gifted in science, have experienced in state schools over recent decades. Of course this account is necessarily simplified and generalised, but it seems that policy in these areas failed to offer a suitable response to the recognised deficiency in the English system in regard to meeting the needs of the most able pupils.

Policy areas should not be considered in isolation when they interact. The chapter now briefly considers wider areas of educational policy concerned with school organisation and governance, and with teacher preparation, which inevitably impact on gifted provision in science.

Parental choice and competition between schools

A key issue that has influenced school policy in England is the issue of parental (i.e. parent or other legal guardian) choice of school. Ideally in a system with comprehensive schools, and all children allowed to attend their local school, it might seem that school enrolment should be straight-forward. That is, each school has a catchment area, and children living in that area would be expected to attend that school. However, even when most parts of England shifted to a system of comprehensive schools, the admissions procedures of schools were allowed to consider more than simply the child's address. In effect a state funded school was expected to admit local pupils who's parents wanted them to attend, but was also allowed to have additional criteria to allow them to admit other pupils from outside the catchment. (This of course makes it very difficult for LEAs to plan for school provision in relation to changes in local demographics when it is uncertain that pupils will attend their local school.) In part, this can be seen as a necessary complication due to the inclusion in the state sector of schools established originally by the Churches.

Church schools, generally Roman Catholic or Anglican, which had been established by the Churches long before compulsory secondary education for all was introduced, became incorporated into the state system following the 1944 Education Act - after a period of negotiation over what would be acceptable to both the secular government and the churches themselves. These schools adopted 'voluntarily aided' or 'voluntary controlled' status. The difference related to the extent to which key decision-making in managing the school was switched from the Church diocese to the LEA and how the financial cost of the school was shared between the two bodies.

The outcome was that an LEA would often maintain church schools in its area along with secular schools. The church schools were allowed to admit pupils on the basis of faith background where parents were keen for their child to attend a school with a particular religious ethos. The schools could establish criteria - such as family church attendance, recommendations from a priest or vicar, etc. - that allowed them to take pupils for whom the church school was not their nearest school.

In more recent decades, national government has tended to see parental choice as a tool in the accountability culture. In this 'marketplace' model competition between schools for pupils (and so financial resources tied to enrolments) is seen a strong motivator to enhance school performance. In practice this tends to mean schools put great emphasis on examination results and school inspection reports even when these are necessarily rather limited indicators of the complexity of educational provision being offered in a school. In a system where the most able pupils might be

taking a dozen examination subjects, the default measure of school success became the proportion of its pupils achieving five C grades (sic, not the top grades) in the school leaving examinations. This led to schools often focusing resources on those pupils who were considered potentially able to achieve, but not assured of getting, five C grades. This was a response to league tables that offered no additional credit for exceptional results of high performing pupils, but simply recorded the proportion of pupils showing the more mediocre attainment.

In city areas where examination results tend to reflect the different socio-economic profiles of the different school catchment areas, there is a tendency for some parents to seek to have their children admitted to a school other than their local community school. Arguably, it is those parents with greater cultural capital that have the attitudes and resources to 'work the system' with the result that existing demographic differences between schools become exacerbated - e.g. middle class parents in catchments with high levels of social deprivation arrange for their children to attend a different school, so the actual social profile in the local school becomes even more skewed towards pupils from more deprived backgrounds.

The manifestations of this policy drive are complex, but included (i) a proliferation of different kinds of schools; (ii) a reduction in the proportion of schools under LEA control, and a reduction in influence of the LEA more generally; and (ii) a blurring between state and private school status. One initiative was the establishment of some schools as City Technology Colleges, and another was allowing schools to adopt subject specialist status (e.g. being a science specialist school) that could admit a proportion of pupils on the basis of particular aptitudes. A more recent initiative is the establishment of University Technical Colleges to which pupils can switch at age 14 from their 11-16 or 11-18 schools. Such schools could distort enrolment in other local schools, disrupting their chances of having a critical mass of gifted science learners.

Currently the government favours all state schools becoming 'Academies' and 'free schools' that are independent of LEA oversight. Schools can be managed by external companies as long as they do not do so for profit. The company that has the contract to run the national G&T programme, CfBT Education Trust, has a much wider educational portfolio - that includes managing some state schools and owning some private schools. In the educational marketplace now operating in England there are secondary schools 'taking over' and managing other secondary schools, or their local primary schools. Not only are the new flavours of school outside local government control, but they are increasing released from the safeguards previously operating in the system such as

following the NC, following nationally agreed conditions of teacher employment, and even requiring teachers to be qualified.

These various initiatives to increase parental choice (and so put market pressures on competing schools) undermine initiatives to encourage neighbouring schools to work together in partnership, one of the mechanisms by which schools lacking a critical mass of gifted learners could ensure suitable provision to meet the needs of these pupils.

Teacher education and development

Another key area of policy that impinges upon teaching practice in England concerns initial teacher education. In recent decades science graduates have generally qualified for teaching by following courses organised by a university, usually in partnership with a range of schools (see chapter *Working to meet the needs of school pupils who are gifted in science through school-university initial teacher education partnerships*, this volume. Universities are able to attract a large enough cohort to include viable teaching groups in each curriculum subject, so pupils could spent time both in mixed subject and subject specific groupings. The ability to network with other new teachers with the same subject specialism is something strongly appreciated as a key part of successful teacher preparation.

Successive national governments have introduced a whole range of initiatives designed to reduce Academia's input into determining the agenda and curriculum for teacher preparation. One key issue in science education is that with the introduction of the NC the school teaching subject became 'science', and biology, chemistry and physics did not officially exist as school curriculum subjects. The government focus was therefore on 'training' teachers of science - and some university providers accordingly diluted the subject specialist aspects of science programmes. Severe shortages of chemistry and, particularly, physics specialists were not officially recognised because plenty of science teachers (mainly biologists) were being prepared. This led to many secondary schools having no specialists in, for example, physics; or a newly qualified teachers finding they were the only specialist in their school and so had limited subject-specific mentoring available. This impacts all pupils, but is a particular loss to gifted pupils looking to engage in areas of science in more depth. After strong pressure from the learned societies, the government began to acknowledge the importance of specialist training within the sciences - but the lack of subject specialists in some schools had inevitably damaged the scientific education of many pupils - and

was one reason why some schools had not offered the separate science examination option before this became required (see above).

The present national government intends to shift as much initial teacher education as possible away from university-school partnerships to give schools themselves primary responsibility to train new teachers (with the option of buying in specialist input from other agencies on a perceived needs basis). It is quite likely that many university education departments that have traditionally led and co-ordinated programmes of specialist teacher preparation will decide they do not wish to shift to becoming service providers hawking their wares to schools.

Whilst there are excellent biology, chemistry and physics subject mentors working in many schools who contribute to the preparation of new teachers, it remains to be seen if quality teacher preparation can be widely maintained if it does shift to being the responsibility of the schools themselves, without the input of the expert teacher educators and academic scholars based in universities. The potential for damaging teacher quality and the education of future generations of pupils is vast. Given the way curriculum and assessment policy has tended to work against the particular needs of the most able learners in science, teacher preparation that occurs almost exclusively within the culture of the school, and that has limited input from research-informed critical perspectives (Taber, 2010), may be especially damaging to those learners who are gifted in the science disciplines.

Conclusion

The state of gifted education policy in England and how this impinges on provision for the most able in science is a complex story. One lesson to be drawn is the need for coherence across policies designed to bring about educational change. Simply recognising there was a problem and setting up a policy decreeing teachers identify and provide for gifted learners was not enough. In practice, schools are subject to all kinds of initiatives and pressures, and have to balance priorities carefully. There is little point in asking teachers to address the needs of the gifted, if curriculum and assessment policy has not been designed with the needs of this group of pupils in mind; when getting as many pupils as possible to attain moderate levels of examination success is the primary measure by which schools are ranked; when objective assessment is considered more important that valid assessment of higher order thinking; and when teacher accountability is more important than teacher creativity.

Schools are supposedly encouraged to work together, yet are actually incentivised as competitors in an educational marketplace. Reducing academic (and so critical) involvement in teacher education reflects a vision of teaching as a practical craft learnt on the job, and is likely to limit the sharing of good practice in teacher preparation to within schools or school consortia. In areas where current practice in English state schools is below par, such as the "unacceptable" (Ofsted, 2013, p. 4) state of provision for the most able learners, a policy of asking schools to be responsible for preparing new teachers seems unlikely to support systematic improvement.

At best, then, provision for gifted learners in school science in England is patchy. This is widely recognised, including by government. Yet attempts to address this issue through initiatives and policies focused on teaching the gifted have largely been undermined by the failure of such concerns to impact on other areas of educational policy. Ideologically driven policies on marketisation, parental choice, teacher accountability, objective assessment and de-theorising (and so de-professionalising) teaching, along with misguided notions of rigour in science education that focus on coverage rather than authentically representing the nature of science (with its deep engagement, creativity, and inherent uncertainty) seem likely to continue to work against meeting the educational needs of the most able in English state schools.

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