Invited Research Article

Meeting the Needs of Gifted Science Learners in the Context of England's System of Comprehensive Secondary Education: The ASCEND Project

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Abstract

This paper discusses a project (ASCEND) that was designed to provide science curriculum enrichment for students in publicly maintained secondary schools in an English city. The context of the project was (a) England's National Curriculum, and comprehensive school system, which set out a 'one model fits all' approach to school science; in conjunction with (b) national policies on meeting the needs of 'gifted and talented' students, requiring schools to provide suitable provision for their highest attaining pupils. This context reflects a long-standing tension in English education between, on the one hand, offering equality of opportunity, and considering Education as a means of facilitating social mobility, whilst, at the same time, meeting the needs of different groups of students through offering parents a sense of being able to choose between schools with different strengths and qualities. The ASCEND project responded to this set of circumstances by developing learning activities organised around three key features: a focus on the nature of science (NOS); an emphasis on self-regulation of learning; and a context of small-group work.

The focus on NOS reflected an area of ongoing developments in the English curriculum, and an area of science teaching where it was widely recognised school provision was commonly weak. More importantly, by its nature, this aspect of science learning offers potential contexts that are well suited to challenging the most able students. The focus on developing metacognition reflected both the value to all learners of being able to self-regulate their own learning, and the particular value to gifted learners—who may find limited challenge in many school science activities—of being able to develop as autodidacts. Finally, the choice of adopting group work activities was informed by an awareness that many gifted learners may lack classroom peers able to challenge their thinking at an optimum level, and the opportunity of bringing together selected students from different schools offered the possibility of students meeting and working with like minded peers from other schools. Group work not only offered opportunities for peer scaffolding of learning, and to negotiate and organise team responses to challenges, but also to practice the kind of dialogic argumentation that is central to scientific work.

It was found that students generally enjoyed taking part in the ASCEND programme, and found the degree of control they were given over their work quite novel. The project highlighted a mismatch between students' typical experiences of school science in England and the type of learning activities likely to support the intellectual development of the most able students. The students told us they were used to school science activities that were highly structured and supported by close monitoring by teachers, and they found the more open-ended ASCEND activities—where they were asked to monitor and evaluate their own progress through an extended task—quite different to the demands of school science. It is argued that the ASCEND strategy was broadly successful, and offers an example of how provision for gifted learners can be designed to fit local circumstances. The project also provided resources for adoption and adaption by others offering science enrichment programmes for gifted students.

Key words: Gifted learners, comprehensive system, curriculum enrichment, nature of science, metacognition, ASCEND project

I. Introduction

This paper describes the design of an enrichment programme designed to challenge gifted secondary-age learners by supplementing the standard science curriculum. The project was known as ASCEND: *Able Scientists Collectively Experiencing New Demands*, and it was run as a partnership between the author at the Faculty of Education in Cambridge, and four of the local maintained secondary schools, with financial support from a charitable foundation interested in developing teaching in science and technology. The project provided a series of after-school enrichment sessions on a voluntary basis, staffed by graduate scientists studying in the Faculty of Education.

The project involved developing a programme of twilight (late afternoon/early evening) sessions, organised in the University, which 14–15 year old students from local schools could attend. The programme was later used as the basis of 'activity days', where schools brought students into the University for a full day off-timetable, and the materials were published with an accompanying monograph describing the rationale for the project and its activities (Taber, 2007b). The project responded to particular features of the educational context in which the project was undertaken, and also revealed something of the disparity between typical school science classroom activities and the type of learning experiences likely to challenge the most able learners.

II. The context for the project

The English education system is difficult to describe succinctly, as it has evolved unevenly under pressures from various political forces at both national and local level, and so it cannot be readily reported without considerable simplification. For the purposes of the present account, then, 'considerable simplification' will be employed, whilst referring to particular complications where they are especially relevant to the background to the ASCEND project.

In England, education is required for all children of the ages 5–16 years. England has a system of schools 'maintained' from the public purse, providing free places for all children of school age. However, something like 7% of children in England attend some form of school independent of government finance and control rather than maintained schools. Understanding why parents choose to send their children to fee-paying schools when they are entitled to (and contribute to funding through their taxes) free state education is a complex issue, but it seems fair to say it reflects more on vestiges of a once prominent class system, than on a general inadequacy in state schools, or a clear superiority of teaching available in the independent sector. Some parents feel that they want to (and that they are wealthy enough to afford to) buy a more *elite* education for their children, which they consider will give them an advantage in their future lives. Others, perhaps, are just more concerned with the 'class' of people their children mix with.

The project discussed here was undertaken with children attending state maintained schools, which were 'comprehensive'. In principle this means that they provide an education for all children in their immediate neighborhood (or catchment area), and may be considered as schools serving all elements of a local community. This was a major change in the organisation of the maintained secondary sector, which, when established in 1944, originally set out a system of grammar schools for the more able minority and secondary modern schools (and some 'technical' schools) for the majority who did not demonstrate high intellectual attainment at age 11.

That system fell into disrepute, as it become clear that what was being measured in the examination at the end of primary school said more about the class-background of pupils than their academic potential. Students from 'middle-class' homes with certain parental attitudes and typically higher levels of resources at home, were better equipped to do well at school (Dika & Singh, 2002) and much more likely to secure grammar school places; whereas most 'working class' children were unlikely to be offered grammar school places, and consequently very unlikely to ever progress to higher education (because the General Certificate of Education (GCE) Ordinary Level courses that were part of the progression system were originally only available in the grammar schools). In time an alternative Certificate of Secondary Education (CSE) system was provided for the secondary modern pupils, which in principle proved an alternative qualification for selection to university entrance level courses (i.e., GCE Advanced Level courses, usually taken by 16–18 years olds). The comprehensive system of schools serving the local community was then a response to perceptions that selection at age 11 was elitist and undermined the possibility of equality of opportunity for children from all social backgrounds.

1. Comprehensive Schools, gifted learners, and elitism

Comprehensive schools were meant to be suitable for virtually all pupils (the exceptions being those with severe special needs, for whom 'Special Schools' were provided), and so admitted a wide ability range. As part of the comprehensive philosophy, there was initially much use of mixed-ability teaching, although this was often reduced in the upper secondary years, and indeed in some subjects such as mathematics, setting by ability was common from the lower forms. (Over time, this has shifted, so that setting in many subjects is now common in most secondary school years.) Initially both GCE and CSE examinations were retained, allowing schools to teach what were seen as more academic GCE courses to their top sets. However, during the 1980s there was another change to homogenize the secondary educational experience when these two examinations were replaced by a new hybrid 'General Certificate of Secondary Education' (GCSE) as a common terminal school examination for all pupils.

The arrival of the comprehensive school also undermined a focus on gifted learners in schools. There had previously been programmes, for example working with pupils identified as gifted in their primary schools (Fisher, 1969), to offer some children more advanced work than their school-mates. These types of initiatives tended to become seen as suspect, as the comprehensive system was meant to avoid elitist approaches. There was a common assumption that the most able pupils already had advantages, and resources should be better be directed to those more needy. What seems to have happened, is that in bringing about change to undermine longstanding social inequalities in England, any attempt to identify high achievers and offer them something different or extra became tainted by association with social elitism.

This was ironic, considering that the main argument against the system of separate types of schools was that selection at age 11 was not based on *the potential* of learners, and so assigned many potential high achievers to a school with lower expectations and norms, where their potential was unlikely to be fully developed. Comprehensive schools are meant to be able to meet the needs of a wide range of learners within a single school community, and that should mean recognising and responding to diversity—including children of exceptional ability.

The move to a common examination system occurred a few years before a legally enforceable National Curriculum was introduced at the start of the 1990s (Statutory Instrument, 1989). That set out (for the first time in England) what all students should learn in four 'key stages' (KS1, 5–7 year olds; KS2, 7–11; KS3: 11–14; KS4: 14–16). This had the effect of further reducing the diversity of courses studied in schools. This was especially so in secondary science, where a 'broad and balanced' science course was prescribed that was intended to be suitable for all. Lower attaining students who had previously often studied more 'applied' science courses (such as rural science or automotive science) were now expected to study the same common science course as the highest achievers—who might have previously undertaken separate science courses in biology, chemistry and physics, and indeed supplemented these with geology or astronomy in some cases. (Again, this account is necessarily simplistic: e.g. the introduction of the national curriculum had the positive effect of increasing the numbers of students studying topics from across the sciences at ages 14–16. However, its positive achievements were accompanied by less desirable, unintended, consequences).

Since the 1990s, the comprehensive nature of maintained schools has been repeatedly undermined by initiatives to allow parents some choice of schools for their children, by encouraging them to apply for places at schools other than just the school serving the particular catchment area where they lived. This was associated with shift to a 'marketplace' mentality in maintained sector schooling, setting up schools as being in competition for pupils (and so for *per capita* funding). In part this was achieved by the establishments of league tables, based on pupil examination results, and in part by various initiatives to allow schools to have special character—as 'City Technology Colleges', or as having a nominal subject specialist status, or most recently to be considered 'Academies'.

The school league tables were based upon a fairly simple measure of the number of students obtaining at least five passes with grades in the A-C range (when grades were on a scale of A–G). By comparison, the highest obtaining students might be expected to pass twice as many subjects, with mostly A grades. The key criterion was then based not on excellence but a modest level of attainment. A school became publically recognised as performing well when *as many as possible* of its students attained at least moderate examination results, without regard to any broader profile of attainment. Schools often responded by focusing extra resources not on the students who were struggling or were unchallenged by school work: but on those who were on course for D grades but might with extra support achieve enough C grades to count as successful in the league tables.

2. Supporting the 'gifted and talented'

In effect, secondary education in England had shifted from a situation where high attaining pupils attended their own schools, to an increasingly homologised system, where a common curriculum, and common examination system, were intended to meet the needs all pupils, and where success was largely judged in terms of the proportion of pupils in a school that could achieve at mediocre levels in examinations. Schools were encouraged to develop their own distinctive character, and to compete with neighbouring schools, but within the constraints of a common curriculum and examinations regime (i.e. to be seen to be doing much the same thing as other schools, but 'better'). Within this context, it increasingly became clear that the most able students were often not being challenged enough (Her Majesty's Chief Inspector of Schools, 2001), and many high attaining pupils found their science courses lacking intellectual demand.

The government introduced policies on what it termed 'Gifted and Talented' ('G&T') pupils. In its use of the term, a gifted pupil was simply one who was considered in the top 5–10% of pupils in the year group in academic subjects (DfES, 2003). This local norm referencing meant that a pupil judged gifted in one school might well not be considered so in another school with a different profile of attainment among pupils. Once this priority had been identified, advice on what made students gifted, how to identify them, and what to do for them once identified, was plentiful (DfES, 2002, 2003; The National Strategies, 2008), but often quite vague and seemingly based on recycling general guidance. This was perhaps inevitable, as limited research had been undertaken on provision for the gifted in the UK for the several decades as a focus on gifted learners was considered politically suspect and elitist. Such a situation, apart from anything else, was entirely counter-productive in tackling social inequalities. If parents considered their children were not being sufficient challenged in comprehensive schools, then they could in principle consider moving them to the independent sector where elitism was more likely considered a badge of honour than a stigma. Yet, this option was only open to those with the financial means to pay for a place, or those with the cultural capital to support their child in applying for a highly competitive scholarship that would fund a place.

3. Meeting the needs of the most able in science

Under the new 'G&T' policies, English secondary school science departments were now being expected to identify from among their pupils some who would be considered 'gifted' in science, and there was an increasing expectation that schools would be able to demonstrate they were doing something to meet the particular needs of this group. This was the context in which Prof. John Gilbert (then at Reading University, later King's College London), Prof. Mike Watts (then at University of Roehampton, later Brunel University) and myself initiated a seminar series on *Meeting the Needs of the Most Able in Science*, supported by funding from the University of Cambridge Faculty of Education. The work of the seminar series was later used as the starting point for compiling an edited book (Taber, 2007d). Various themes were explored, such as the nature of giftedness in science (Gilbert & Newberry, 2007; Taber, 2007c; Winstanley, 2007), and how gifted students might best be served by a focus on modelling (Grevatt, Gilbert,

& Newberry, 2007), the use of student questions (Watts & Pedrosa de Jesus, 2007), dialogic teaching (Scott, 2007), context-based courses (Kind, 2007), exploration of controversial issues in science (Levinson, 2007), and so forth. Local teachers were involved in the work of the seminars (Taber & Corrie, 2007), and some ideas were tested in local schools (Taber, 2007a). Graduate scientists on placement in schools whilst preparing for qualification as teachers used ideas from the seminars to plan teaching about the nature of science within their classes, with a particular focus on challenging the most able pupils (Taber et al., 2006) as part of project on 'Teaching about ideas and evidence in Key Stage 3 science' (Braund, Erduran, Simon, Taber, & Tweats, 2004).

4. Able Scientists Collectively Experiencing New Demands

The ASCEND (Able Scientists Collectively Experiencing New Demands) project developed from this work, and was set up following an invitation to the seven comprehensive schools in the City of Cambridge to participate. Four of them chose to join the project. It was decided that Y10 pupils (14–15 year olds) should be involved, as this is the penultimate year of compulsory schooling, before decisions are made in the final year about applying to college courses or for posts in employment.

Schools were asked to identify suitable delegates. It was made clear that the intention was to provide more challenge than the standard science curriculum, and schools were asked to invite pupils who showed interest in science and who would benefit from being challenged in this way. Delegates had to be prepared to give up some of their own time, parents had to notify the school they gave permission for attendance, and schools were asked to nominate roughly even numbers of boys and girls. Seven after-school sessions were organised during 2006, each with a somewhat different activity, but with some common themes.

III. Features of the ASCEND programme

The programme was planned around three particular features (Taber, 2007b). Firstly the area of the nature of science (NOS) was chosen as a suitable theme for the programme. Secondly, attention was given to ideas about metacognition and the notion of a self-regulated learner. Finally, it was decided that the sessions would be arranged around small group activities.

1. The nature of science

The theme of the NOS was selected for three main reasons. Firstly, although learning about the NOS had always been intended as an integral part of the English national curriculum programme in science (DfEE/QCA, 1999; Statutory Instrument, 1989), it was recognised to be an area that was often not well understood by teachers, and so one that often did not get effectively treated in class (QCA, 2005). Revisions of the National Curriculum being undertaken by the government's curriculum authority (QCA, 2007), informed by a lively debate about the type of science education most suited to young people (Gilland, 2006; Millar & Osborne, 1998), were meant to be rebalancing the emphasis away from prescribed content of topics to an understanding of NOS (or what was termed 'how science works')—that including the processes of science as well as the products. This theme therefore offered something that schools might recognise as an area for development within their science provision. The earlier project on 'teaching about ideas and evidence' had included an analysis of how ideas in the NOS might be presented at a suitable level in the school curriculum (Taber, 2008).

Secondly, as the programme was meant to provide enrichment, it was important not to simply repeat, or pre-empt, content that students would be meeting in their school curriculum. One common criticism of the English science curriculum at the time was that what was intended to be a spiral curriculum with principled revisiting of key ideas built in, was actually often *experienced by students* as repeating much the same work in different school years. By using the NOS theme, it was possible to call upon examples of science not usually met in school science as contexts for teaching about NOS. Finally, NOS offered the possibility of introducing ideas, for examples from the philosophy of science, that were considered likely to be challenging even for students of high attainment and potential in science.

2. Encouraging metacognition

A supplementary theme used in planning the programme was that of metacognition. One of the areas in which it was considered gifted learners might be more advanced than most of their peers was in having a metacognitive approach to their learning (Shore & Dover, 2004). Moreover, one of the problems facing teachers working with groups of pupils of widely varying levels of attainment in the English context was being able to effectively differentiate the needs of different students (Stepanek, 1999). Genuinely gifted learners—in the sense of the term as it is generally used internationally (Cropley & Dehn, 1996; Sternberg, 1993), rather than in the English context (as the top few percent in attainment in the local context)—were likely to be considerably under-stretched even when in 'top sets'. Developing these students as self-regulating learners could help them be more aware of when they were not benefitting effectively from lessons, and allow them to develop their own strategies to ensure they were being sufficiently intellectually challenged (Taber, 2009).

One aspect of the NOS which has traditionally been underplayed in school science in England, is the creative process (Taber, 2011b). A number of the ASCEND activities were deliberately made as open-ended as possible, with potential for a range of possible outcomes, both to reflect the creative nature of science, and to counter a common criticism of school science in England: that in order to maximise examination results, it is often taught as a succession of specific formulations which match what examiners report they are looking for in their mark schemes. Arguably, the evolution of English school science over the period of the 1980s and 1990s had led to the greatest challenge for pupils being one of memory, rather than one of imagination or logical argument. Open-ended activities, without tightly defined criteria for successful outcomes, offered opportunities for learners to develop skills of planning and evaluation so important to self-regulation in their learning.

3. Group work

A third design decision was to organise activities around small group work, and furthermore to require students to work in cross-school groups so that they were having to work with some peers who they did not know, and so had not already established working relationships with. In part this decision derived from work presented by John Gilbert at the earlier seminar series suggesting that gifted students should be able to take on roles within working groups. It also built upon ideas about the importance of dialogue in learning (Mortimer & Scott, 2003; Staarman & Mercer, 2010): that is, in developing not only the ability to present and critique argument, but also to be able to entertain, compare, and look to draw upon, a range of voices—something considered important in intellectual development (Perry, 1970).

A group of four high ability students should provide a social resource for tackling tasks that were deliberately designed to be under-specified (and so required a degree of planning and problem-solving for successful completion). This meant that the ASCEND activities encouraged metacognitive reflection upon progress, and also provided opportunities for students to act as peer tutors when sharing personal knowledge with other group members. This also reflected the nature of much scientific activity, which often involves teamwork, sharing of specialisms (a particular focus of one of the activities), and engaging in dialogue to critique ideas. This was encouraged by strict instructions to the teaching assistants to only offer help and support when explicitly requested by the groups.

IV. An overview of the programme

The outcome of this 'design brief' was a series of 10 activities, intended to occupy seven 90 minutes sessions. These are reported in more detail in the report '*Enriching School Science for the Gifted Learner*' (Taber, 2007b), and here the activities are simply listed for information:

- How do we decide if some activity is, or is not, scientific?: Exploring the criteria we used to define what is, and what is not, a science
- How do we learn?: The science behind learning, and how it can inform study habits
- What makes a good scientific explanation?: The criteria for a good explanation in science
- Can we identify patterns in data?: A practical activity looking to identify a scientific law

- Can we learn from computers?: Using independent learning materials designed to support learning about college level Physics
- How do we produce new scientific knowledge?: Exploring the work of famous scientists in terms of simplified 'philosophies' of science
- How do science specialists work together?: Developing a model of plant nutrition by synthesising ideas from biology, chemistry and physics
- Why do scientists believe in evolution?: Exploring objections to evolution by considering the argument for natural selection
- What is it like?: A card game encouraging players to find analogies between scientific concepts and everyday ideas and phenomena
- How do we evaluate scientific models?: Comparing two particle models, and two models of ionic bonding, in terms of how well they can explain phenomena/properties.

V. Reflections on the programme

The programme was judged effective by the participants, and the science teachers working with them (Taber & Riga, 2006). However, it is important to point out that ASCEND was a research and development project, primarily seeking to develop materials for a programme, and there was no *independent* evaluation. Although pupils generally rated sessions highly, it should be noted (a) they were all both school- and self-nominated, and so clearly approached the programme with positive expectations; (b) the programme involved visiting a prestigious university, and presented novelty as well as, potentially, status; (c) the sessions were designed to treat the 'delegates' as adults: these 14–15 years olds arrived for a conference type registration with refreshments provided, and then mixed with new like-minded peers (of both sexes), and were then introduced to learning activities in an adult environment where the teaching staff only offered help when asked, and avoided criticising students for their ideas, approaches, or even off-task behaviour such as 'wasting' time chatting and ignoring the set task. That kind of off-task behaviour was certainly seen, although only extensively in a very small number of the learners. It was considered that these young people had to be given responsibility to regulate their own use of their time: especially in a voluntary programme, when surrounded by good role models of peers working away at the set tasks.

Given these various conditions, marking out involvement in the programme as something special, it would be inappropriate to assume the success of the programme can be seen as validating the design of the activities. Rather, the programme provided provisional indications that these design features are promising for testing out in the contexts of other programmes offering enrichment in similar curriculum contexts. Perhaps just as interesting, despite the apparent success of the programme, ASCEND did raise some issues for further reflection.

1. Selection of participants

No recommendations were offered to schools in terms of examination scores, intelligence test measures or similar benchmarks for who should be nominated for the ASCEND programme. It made sense to invite schools to set their own specific selection criteria, as schools were already being asked to identify gifted learners, and the teachers were in the best position to make judgements about which pupils in their care were able to respond positively to extra challenge.

However, this meant that the make-up of the delegates reflected the government's notion of which pupils are 'gifted', in that a secondary school would be expected to have something like ten-twenty gifted learners in a year group. So those identified would include not only the exceptionally able, but also other intelligent, competent and hard-working students. The students we worked with in ASCEND included some who seemed obviously exceptional in terms of their knowledge base, modes of arguing, sophistication of thinking etc, but as part of a more heterogeneous group. Probably only a handful of the students we worked with would have been considered suitable for gifted programmes in some national contexts.

These most likely benefitted considerably from the opportunity to take part in ASCEND, and in particular to undertake open-ended and self-(/group-) directed activities, as it probably offered a rare glimpse of the challenge that education can offer to such learners. Some other delegates at ASCEND were perhaps less ready to benefit fully from this type of science education provision.

2. Different expectations of what science learning is about

However, whether this reflected the learners' potential to respond more than their expectations and familiar norms was less clear. This is difficult to judge, as it was clear from the feedback provided by the delegates that most of these students were quite unused to the types of demands our programme made. This was certainly intentional, but the extent to which these 14–15 year olds found aspects of ASCEND novel was quite notable. Generally, from what they told us, these adolescent students were not used to being asked to undertake anything open-ended in science lessons: rather classroom science always had definitive goals, and clear and expected structured means to reach them. In an English idiom, these students expected to be 'spoon-fed' in science classes—to be told what to do, and how to do—and then what to do next, and how to do it.

Moreover, in keeping with this expectation, these students were also used to a classroom environment where there was constant evaluation and feedback on progress: the idea of being given a task and allowed to construct, develop and execute a strategy over a period of around an hour or so without a teacher interjecting regularly to advise on whether a suitable path was being followed, seemed unheard of.

This is not a criticism of school science, and of science teachers doing what they see is their job. Leaving most secondary students with minimal guidance, on most tasks, does not represent good teaching (Taber, 2011a). However, if gifted learners are not sometimes given this experience, then they are not going to be supported in developing their potential. Moreover, this raises a more general issue about how we scaffold student learning for all learners (Wood, 1988). In specific terms, we need to fade support as students learn skills and develop conceptual frameworks and cognitive strategies. Arguably the English science national curriculum programme of study in operation to 2007 (DfEE/QCA, 1999) was so cluttered with content that teachers always felt the need to move on from any particular topic area long before most students had developed sufficient understanding to work with minimal guidance. In more general terms, if we expect all learners to develop metacognitive skills and habits of self-regulated learning, then we have to provide opportunities to scaffold these meta-level skills by gradually providing possibilities for less closely directed working. ASCEND showed that only the most gifted students in the English context were ready to cope with work that was genuinely open-ended in science, but other able learners should be expected to adopt such modes of working at this age.

3. The role of laboratory work

Because of the foci selected for the project, only one activity contained substantive laboratory work. The students would have liked more 'practical' (i.e. laboratory) activities. There have been significant criticisms of the way practical work has evolved in English schools particularly since the national curriculum was imposed (Abrahams, 2011; Taber, 2008), and in particular the limited extent to which much school science laboratory work facilitates conceptual learning. Associated with this, there has often been a perception of school science in England being taught through a combination of 'theory' (often based on largely didactic presentations) and 'practical' (laboratory) work, such that students often expect practical work to be a break from considering theoretical ideas, and teachers consider that their classes include sufficient active learning as they include plenty of 'practicals'.

Government guidance on teaching science (Key Stage 3 National Strategy, 2002a, 2002b) is informed by constructivist thinking (Bodner, 1986; Tobin, 1993), but over-simplified to such an extent (Taber, 2010) that in practice English science classrooms often include limited 'active' learning opportunities besides practical work (Taber & Bektas, 2009). ASCEND was designed so that the activities would be 'active', despite being generally classroom (rather than laboratory) based. Ideally a programme such as ASCEND would be complemented by provision of enquiry-based laboratory project work (West, 2007). Suitable schemes are already available in the English context, that are suitable for adoption within sequences of lessons (where teachers can find 'space' for them), or as extra-curricular activities (Taber & Cole, 2010).

4. Final thoughts

The ASCEND programme was intended as a programme that the schools involved could adopt, and then organise between them, taking over the teaching. Schools working together would ensure a sufficient cohort size for a viable programme. Despite the schools being very positive about the initiative, they failed to adopt the programme as intended. In part this was probably due to other teacher commitments, but in part it related to the demise of the formal 'confederation' arrangements by which schools had for a short time been encouraged by the government to cooperate—something at odds with the general market-place mentality (developed by successive governments) which made these schools competitors for local students.

However, the programme was adapted for use in an activity day format, where students from local secondary schools came into the University for a day to work with science graduates completing teacher training. The publication of the materials by the educational charity the Gatsby Science Enhancement Programme (Taber, 2007b) has now made them more widely available. Although the programme was developed in the specific curriculum context outlined here, the open-ended tasks drawing upon NOS are suitable for use in many other educational contexts.

The ASCEND programme provided secondary age students a taste of a more challenging and open-ended type of science education, and so a glimpse of what could be done to challenge the most able learners in school science. It also suggested that many of those considered 'gifted' in English secondary schools are not ready to learn effectively from such challenges at the present time, and would need transitional support before being able to take full advantage of such learning opportunities. In part this is due to the rather pragmatic, but under-theorised way that 'giftedness' is currently understood in the English education system, so that the category 'gifted' actually includes students of a wide range of attainment and potential, many of whom would be considered able or intelligent, but not gifted, in most countries.

More significantly, the standard fare of English school science consists of moving quickly through many science topics, high demand in terms of how much to learn (and often the specificity of the form of words expected in examinations), but limited opportunity for developing genuine research skills, for creativity, for opportunities to self-regulate, or indeed to do virtually any work that is not guided by high levels of external feedback and evaluation. In such a context there is not only limited scope to challenge those who might currently be considered to show exceptional ability in science (those we saw who clearly thrived in the context of ASCEND), but also limited opportunities to develop those others of less exceptional ability but who are also marked as gifted in the English context. Some of these students found the discontinuity from school science to the challenge of ASCEND activities quite extreme, and did rely on input and support from the teaching assistants more than had been anticipated. These students would probably have benefitted from having previously met work of intermediate levels of challenge to prepare them for getting the most out of ASCEND, but their experience of school science did not seem to offer that.

It would seem then that the English school science curriculum understood largely in terms of broad coverage, and regurgitation of pre-packaged knowledge, did not provide the type of experiences either of these groups of learners needed to meet their full potential. Such school science is neither fit for gifted learners, nor indeed for preparing scientists of the future. This suggests that enrichment programmes, such as ASCEND, are needed both to stretch the most able, and to extend other able students.

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Note

The text of *Enriching School Science for the Gifted Learner* may be downloaded at https://camtools.cam.ac.uk/wiki/site/~kst24/gifted.html.

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イギリス総合中等教育における科学才能児のニーズへの方策
―ASCENDプロジェクト―

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要 旨

本論文では，イギリス都市部の公立中等学校の生徒を対象とした拡充型科学カリキュラムの開発プロジェクト，ASCEND（Able Scientists Collectively Experiencing New Demands）プロジェクトについて概説する．ASCENDプロジェクトの背景として，(1) ナショナル・カリキュラムと総合中等学校制度により，学校科学教育において‘単一の教育モデルを一律に適用する’アプローチが試みられていたと同時に，(2)‘才能豊かな’生徒のニーズに応じるという国策から，達成が非常に高い生徒に適切な方策を講じることが学校に求められていた．そこには，イギリスの教育に長年にわたって続く緊張関係が反映されている．教育の機会均等を設け，教育を社会的流動性の促進手段と考える一方で，同時に，保護者に対して特長や質の異なる学校を選択可能であるという意識を持たせることで多様な生徒集団のニーズに応じてきたのである．ASCENDプロジェクトはこの対をなす状況に応えるものであり，「科学の本質（NOS: Nature of Science）の設定」「自己調整学習（self-regulation of learning）の強調」「少人数グループによる活動の場づくり」という3つを鍵となる特徴を据えて，系統的な学習活動を開発した．

「科学の本質」は，イギリスのカリキュラムにおいて開発が進行中の領域であること，そして科学学習指導において学校での取り扱いが一様に不十分であることが広く認識されている領域であることを考慮して設定した．より重要なこととして，本来，この側面からの科学学習指導は，非常に能力の高い生徒に対して挑戦的となるような学びの文脈を提供できる．「メタ認知の育成」には，すべての学習者が自分の学びを自己調整できるようになるという有用性，そして特に，通常の学校科学活動では挑戦的な部分が限られてしまう才能児に対して，彼ら／彼女らが自分で学べるようになるという有用性があった．3つ目の「グループ活動」は，多くの才能児が同じクラスに自分の思考を最大限にして挑戦できる仲間を欠いているであろうことを意識して設定した．異なる学校から選抜された生徒が集まる機会を通して，自分と似通った興味や能力を持った他校の仲間と出会い，共に学ぶことができるようにした．グループ活動は，単に生徒同士の学び合いへの足がかりを提供したり，挑戦的な課題に対するチームとしての回答を協議したり整理したりするばかりでなく，一種の対話による議論を実践する機会となった．その対話による議論こそが科学活動の中核なのである．

生徒たちはASCENDプログラムへ喜んで参加した．そして，参加生徒にとって，プログラムの活動における自由度が大変新鮮であったことがわかった．ASCENDプログラムを通して，イギリスの学校科学における生徒の典型的な学習経験と，非常に能力の高い生徒の知的成長を支援するようなタイプの学習活動との不一致が浮き彫りになった．参加生徒は，自分たちが高度に構造化された学校科学の活動で教師から間近に監視され，支援されることに慣れていたが，ASCENDの活動はよりオープン・エンドであり，発展的な課題を通して自分自身の向上をモニターし，評価するよう求められ，それらは学校科学で求められるものとは全く異なっていたと答えた．本論文では，ASCENDプロジェクトが広範囲にわたって成功であったことを論じる．そして，地方の実態に即した才能児への教育方策の可能性について例を示す．ASCENDプロジェクトは，導入教材も提供しており，才能児を対象とした拡充型科学教育プログラムを設けている他のところでも導入された．

キーワード：才能児，総合学校システム，カリキュラムの拡充，科学の本質，メタ認知，ASCENDプロジェクト

（訳：隅田 学）