How far has science education come since the Warnock report? What educational research tells us?

Abstract

Looking at the extent to which the notion of inclusive practice, with specific reference to provision for SEND (Special Educational Needs and Disability) but also at social inclusion more widely, has impacted upon science teaching, and explore some of the barriers which continue to prevail in science education.

Background

Data gathered from teachers, trainees and NQTs (newly qualified teachers) suggests that inclusion has presented distinct challenges for teachers of science. I wish to look at how external factors, beyond teacher education, account for much of the mismatch between intention and delivery. I also wish to share ideas, from research and practice, about how we can make science a more genuinely inclusive subject.

The history of science education and that of special education have been very distinct, but Warnock's highly influential report in 1978 provided an unprecedented impetus for convergence. The result could have been the implementation of what came to be known, somewhat rhetorically, as 'science for all'. This description will look at the extent to which science education has become truly inclusive, with a specific focus on the inclusion of those whom the Warnock Report termed as having special educational needs. My account draws on published data, in addition to my own research data, from student teachers and serving school staff, and considers how science might be made more inclusive in future. It also tackles the often unarticulated question as to whether science really is for all learners.

Different historical legacies

Educational provision for children who were considered unsuitable for admission to regular education systems was first documented in the seventeenth century, at around the same time natural philosophy became recognisably the forerunner of modern science. Both educational impulses were shaped by economic imperatives, one aiming to produce economically independent citizens who would not become a burden through requiring 'poor house', 'asylum' or similar provision, the other charged with the improvement of empire building. These similarities mask much deeper differences, intimately associated with the perceived moral and economic value of the learners. The earliest educational initiatives were schools for the blind and schools for the deaf, but support depended on a medical corroboration of the authenticity of the condition, such as a doctor's note confirming the blindness of a pupil. Thus, atypicality, initially on the basis of sensory impairment and only much later on the grounds of learning impairment, afforded entitlement to intervention. Out of this the tradition of medicalising eligibility for educational support arises (and endures), for instance through the recently discontinued 'statement' of special educational needs and the diagnosis of conditions such as dyslexia.

Curriculum content was provided differentially according to the perceived economic capacities of the target learners. (Pritchard, 1963). Special schools tended to focus on functional skills development, which usually precluded science other than incidental science within subjects such as horticulture. Any other justifications for science education for atypical learners has rarely been articulated.

Far more commonly, a dichotomy of teaching cultures, between 'special' education teachers, who teach science, and science curriculum specialists, has persisted Patton, Polloway and Cronin, 1990). Science education has traditionally been elitist, not inclusive. At the inception of science as we know it, only the wealthy were likely to have the money and time to undertake the experiments which are the hall mark of western science. The nineteenth century public schools perpetuated the class divide, being able to teach the 'young gentlemen' in purpose-built laboratories in which they could grasp the principles behind wealth-generating industries such as agriculture and steel making (Jenkins, 1979). This legacy of differential opportunity lived on, for example in the grammar schools, who taught science in a way which enabled pupils to make the expected transition to university study or professional positions. The capacity of science in the hands of highly skilled operators to advance economic, political and military interests after World War 2 found expression in the terms "Sputnik curriculum" and the "*white heat of this (technological) revolution*" (Edgerton, 1996: 57).

Although the comprehensivisation of schools saw increased access to science teaching, adjustments for the all ability pupils comprised modification of the existing curriculum, rather than a systematic review of the basis for teaching science. Initiatives such as the Nuffield Project attempted to overhaul the practice of science teaching to meet the needs of all pupils but did not think about the very different types of science learning which might be required by a diverse population of learners (Millar and Osbourne, 1998). A rare exception to this is Brooke and Solomon's (2001) recognition that, *"suitably adapted science activities might have much to offer children with SLD in terms of increasing their knowledge of the world around them and also their desire to explore it."* (ibid: 943)

Empirical and inductive science was not valued; numeracy and technical vocabulary were foregrounded, abstract thinking was embedded. Yet, none of these are essential to all versions of science (Essex, 2017). A similar lack of criticality beset the imposition of the National Curriculum for Science (NCS) in 1988. Whilst it can be seen as a landmark of entitlement, the unanswered question was, and remains, what sort of science and to what end? A possible model for analysing this is provided by Biesta's (2010) tri-partite framework, which states that good education, that is science education which gives pupils agency as future citizens, should achieve the following:

Socialisation: gaining social and cultural knowledge, skills, insights and dispositions. Science for pub quizzes I would flippantly call this! This strand also includes 'folk science'.

Subjectification: gaining expertise in a subject, learning to 'think/ see like a scientist', so pre-specialism education.

Qualification: the acquisition of knowledge, skills and dispositions to advance further in an area. For science this overlaps considerably with subjectification.

(Phillipson, 2017)

A common future post-Warnock?

There were multiple drivers for the plasticisation of boundaries between special and regular schools, but reflected the move towards non-selective education which had grown up during the 1960s and changes in employment patterns in post-industrial Britain. The removal of the label 'ineducable', meaning not able to be educated, in 1970, meant that <u>all</u> children were now to be offered some form of education. This led to additional pressure on special school places. Baroness Warnock's (1978) report, responding to these social pressures, advocated that pupils be re-assessed for their suitability for attendance at a mainstream school, with the proviso that necessary adjustments were in place. The Salamanca agreement (UNESCO, 1994), corroborated Warnock's ideas on inclusion on a global basis and set out expectation that schools would change their practices and culture to accommodate and advance the learning of all pupils. This resounding moral endorsement failed, however, to advance inclusion further in the UK, where separate educational provision had strong historical legitimacy. The responses schools needed to make to ensure authentic inclusion has remained the conundrum which 40 years have not fully resolved and which ultimately led Warnock, the 'architect of inclusion', to retract her earlier advocacy (ibid, 2005).

One subject fits all?

The focus of this article is the extent to which science has experienced inclusion as a damaging or a democratising impulse. Ainscow, Booth and Dyson (2004:15) say that one typology of inclusion is as '*a response to disciplinary exclusion*' and, indeed, this seems to be at the heart of the question for inclusion in science. But this appears to have been very hard to achieve in science. One reason, already shared, is that science education has multiple purposes, which are not equally applicable to each learner, and that the form science education developed needs to take account of this. Another contributory reason is the need to have a flexible and multi-faceted knowledge (so-called 'deep understanding') of the subject taught and this takes time and support to acquire (Coe, Aloisi, and Higgins, 2014). This deep understanding is especially difficult to achieve when retention figures for teachers have plummeted in recent years.

The instigation of the National Curriculum for Science heralded a major step forward in universal entitlement to science education. However, there was a hidden price for this, in that the version of science that was represented was very narrow. In promoting the hypothetico-deductive ('ideas and evidence') model of science, which has come to be seen as the scientific method. However, there are other approaches which learners commonly adopt, in particular induction from observations, which the National Curriculum for Science excluded. The placing of scientific theory in the foreground of the NCS, including abstract and formal thinking which is especially challenging, and the associated high demands for numeracy and technical literacy, have also alienated learners, in a way that more 'grounded' science had not. A

further anti-inclusion feature associated with the NCS was the expectation of a specified rate of progression through the levels, difficult for any learner to meet and even more so for many SEND pupils. More recent anti-inclusion trends include the erosion of practical work, which is popular with many pupils but may have an especially important role to play for those with atypical intellectual development (Özgüç and Cavkaytar, 2015). Enquiry-based learning and certain, exploratory, forms of group work which benefit learners with intellectual disabilities (Mastropiri, Scruggs and Butcher,1997) have been compromised for a 'content-rich' curriculum have similarly removed approaches which are especially helpful for SEND pupils (Villanueva et al, 2012). If we are to establish that science is an entitlement for all learners, that is to see the 'socialisation' element which does not serve the Sputnik agenda as being equally valid, it may be helpful to re-evaluate the process view of science, which unifies disparate content and, importantly, cultural context.

Research case study 1 *Teacher education for inclusive practice – responding to policy*, Dr Nafsika Alexiadou and Dr Jane Essex
The study considered institutional mediation of government policy by 7 lecturers, 45 pre-service teachers, staff and pupils at partnership schools at one English university. Policy documents, course materials, essays submitted for assessment, lecture and workshop observations, questionnaires and interview data was analysed to describe how inclusion, diversity and special educational needs were understood. Findings were:
Regulatory frameworks, coupled with inspection, powerfully shape practice through marketisation and performativity agendas.
Inclusion is interpreted by ITE staff in a context of local need and is thus culturally sensitive.
Inclusion takes account of notions of 'ability', often accompanied by segregation, and diversity, specifically multi-culturalism.
It is viewed as synonymous with good teaching that is graduated and incorporating targeted adjustments into material which is thoroughly understood by the teacher.
In practice, this is not always well integrated into ITE courses.
Better preparation for inclusion would require a policy framework that doesn't rest on deficit assumptions.
ITE students need to be supported in challenging current practice and assumptions if inclusion is to be more meaningful.

Literacy, an illustration of possible responses to the inclusion agenda

Technical vocabulary is a key element of formal science, used to convey rich meaning 'economically', and something required by formal assessments. Various strategies can be used to help pupils develop fluency in the target vocabulary.

Careful selection of the most important words/ phrases

Repetition of target terms

Strategies to help pupils make conceptual associations with technical terms e.g. writing a glossary, pictograms, word bingo, charades

> Technical approaches to accuracy e.g. morphographs, aurally coded English dictionary

But these approaches all take teaching time and may feel like a distraction from content delivery. What we <u>don't</u> do is discuss why we use technical language and what alternative words might be more accessible for some learners and, at the same time, acceptable for assessment purposes.

Research case study 2: *Creating a modern asylum* (Currently under review) Questionnaires, with both open and closed questions, were completed on a voluntary basis by 21 staff bringing pupils to chemistry festivals, some of which were explicitly designated as suitable for participants with SEND. Thematic analysis showed that staff saw science as serving distinctive learning purposes when undertaken by learners with SEND although there was a surprisingly high level of consensus around science revolving around 'ideas and evidence'. This differential in purpose is reflected in the reported variable resourcing of science education, including staff development and the availability of outreach events. For learners with SEND, science was widely perceived as a vehicle for the development of transferable skills and affective outcomes, rather than as a means to career development. Barriers created by low expectations persist, as do barriers to accessing experimental science. An exclusionary effect was created by the difficulties inherent in the curriculum subject, and also in staff perceptions of people who go on to use science in their working lives. Staff who accompanied SEND pupils expressed more positive views towards the running of separate outreach events for SEND pupils than other respondents. The desire for different provision for SEND learners appeared to arise from pastoral concerns about their pupils and a reluctance to let their pupils 'fail'. The data suggests that, despite policy and legislative reform in the UK, curriculum science is still viewed primarily as a means to career progression for an able minority, rather than as an educational and cultural entitlement for all. The findings also highlight the fact that, despite the expectations of the Equality (2010) Act, staff do not see science outreach events as truly open to all. The broadening of the aspects of science presented in the curriculum, for instance practical as well as theoretical approaches to knowledge creation, could afford meaningful access to authentic science for all learners. In the short term, science educators need to monitor the hidden messages that they convey about the accessibility of the subject and to signal much more unequivocally that they are teaching 'science for all'.

Preparation of staff for inclusion
Given the structural pressures that the NCS introduced, and the increasing focus on attainment in science, it is unsurprising that science staff felt challenged by the simultaneous pressure for of inclusion.(not sure which fits best – probably "for") One of the most damaging consequences has been in terms of expectation, or "identity contingence" (Steele, 2010). This can be further exacerbated if support staff do the work for pupils, rather than helping them to do it. A common response, now

universally expected, is differentiation and the underpinning notions of intrinsic 'ability' and the associated, damaging values of ableism. "Ability" is a very dominant but highly problematic concept. The persistence of the medical model of disability, where disability is seen as a deficiency to be corrected or mitigated, is still prevalent. More recent thinking, the social model of disability which has been advanced by disability rights activists, would advocate that schools adjust and remove barriers which they have unintentionally constructed or maintained. In order to do this effectively, teachers need to research the ways in which such attitudinal and practical adjustments can best be made. Allied to the centrality of attitude, either as a barrier to, or facilitator of, inclusion is the necessity of allowing time for a discussion of attitudes towards inclusion, including the source of negative attitudes, during initial teacher education.

Research case study 3: Teacher training and experience of Special Educational Needs. Dr Despoina O'Flynn and Dr Jane Essex (unpublished)
Student supervision generated questionnaire data showing that 35% of student teachers felt they were very well-prepared and 76% were Very Well Prepared/ well-prepared to teach pupils with SEN. Nevertheless, 72% said they would like more training in this area, which appears paradoxical unless one considers the teaching of SEND pupils to be technicist knowledge (illustrated by quote in Case Study 4.).
I don't see how the 35% and 76% fit. Is it 75% WP including 41% VWP?):

This is very different to sector wide data from NQT survey showing a rising number (from 10 to 30%) of NQTs felt very well-prepared to teach pupils with SEN in the years 2006 and 2015 (50 to 70% stating they were very well-prepared & well-prepared). The institution where the data was derived had end-of-course evaluations which were broadly average when compared to other training providers. An NASUWT (2012) survey of serving teachers indicated that only 2.3% 'strongly agreed' (13% strongly agreed and agreed) that they had been well-prepared to teach pupils with SEN.   Do we need date of your unpublished survey to compare with these dated ones?

This discrepancy is in line with other work which found that teachers needed extensive experience of skill transfer to new classroom situations, and support to connect classroom and contextual factors in understanding learning, seeing the learner's perspective, and being reflexive about their own practice. In other words, inclusive teachers have a similar disposition to that of an educational researcher.

Research case study 4: *What effect does policy have on pre-service teachers' understanding and enactment of inclusion?* (In preparation)

The research describes the views of 25 pre-service teachers at the end of their Initial Teacher Education course and how these have been shaped by government policy, as well as other factors which have shaped their conceptualisation of inclusion. Inclusion was viewed as a piecemeal endeavour, with distinct interventions needed for a vast range of learner deficiencies, exemplified by comments such as:

"There are so many groups we have to be familiar with, knowing terms beforehand helps, to know what you can do with an individual."

Focus group responses showed that the pre-service teachers identified a tension between the need to incorporate a human dimension into the science curriculum – and the pressure towards inclusion. Differentiation was the dominant concept used by newly qualified teachers when discussing inclusion. A utilitarian position seems to have been adopted, with the primary drivers of viewpoints being those policy elements which were of immediate relevance to the attainment of Qualified Teacher Status and for obtaining maximum attainment outcomes for pupils. Thus differentiation was the predominant manifestation of 'inclusion' whilst the pre-service teachers' thinking around the Prevent Strategy (2011) and its impact upon inclusion, was minimal and inconsistent, despite the statutory nature of UK anti-terrorism legislation.

Conclusion

A narrow and elitist interpretation of the science tradition presented by the curriculum, delivered in a climate of performativity, undermines science teachers' well-intentioned initiatives towards inclusion. Current efforts, directed at mitigating the demands of the formal curriculum for those identified as being deficient, are partially successful according to narrowly defined outcomes. Various findings indicate that newly qualified teachers and those with whom they work during placement, find it difficult to know how to achieve inclusion for the variety of potential underachievers (sic) they encounter in the science classroom. What is entirely missing from the current discourse is the possibility of a radical re-envisioning of the curriculum to provide experience of authentic science for <u>all</u> learners, irrespective of their identity.

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