How an inclusive approach can enhance science teaching for all

Jane Essex champions the benefits for everyone of a more inclusive approach to primary science and offers some 'top tips'

'In a science education world where not everybody is viewed as a professional scientist in the making, we can let people learn in diverse ways'

The value of diversity in primary science has become ever more apparent, with the economic costs to organisations of being monocultural increasingly recognised. This data-driven argument for inclusion and diversity adds further weight to arguments for inclusion based on the social costs of a stratified society and moral considerations about social justice. This welcome trend has been accompanied by increasing efforts to encourage a more representative population of learners into post-compulsory science. However, the assumptions inherent in these commendable efforts may, unintentionally, continue to exclude the most marginalised learners of all.

I have listed these assumptions in Table 1 in the order in which they are manifest in current initiatives to achieve a representative science workforce, together with a counter-argument to each of them.

The counter-arguments suggest that some learners are not so much marginalised as overlooked in the drive to meet the interests of a majority. One of the reasons that I am so interested in learners with special educational needs and disabilities/additional support needs (SEND/ASN), specifically those with learning difficulties, is because their experiences tell us so much about what can go wrong with science education. Where SEND/ASN learners fail, others behind them are at risk. One of the saddest things about this group is that their under-representation to the point of total absence from the adult science workforce goes unremarked and un-researched. In my opinion, their absence from what has been termed 'the curriculum high table' is not even seen as a loss worth investigating.

The benefits for all of an inclusive approach

Based on 35 years of teaching science to people with SEND/ASN, I would now like to offer some reasons as to why we should be placing them at the centre of the high table that is science education. If we are prepared to re-think what science education is, and is for, we can all benefit in important ways. These are some of the things I have learnt from my experiences:

- **They stimulate reflection and innovation.** Much teaching is about activity but working with diverse learners encourages, in some cases almost forces, teachers to think deeply about why they are doing things in the classroom and how this, in turn, impacts on the learners. They demand

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Table 1 Assumptions and counter-arguments

Assumption	Counter-argument
The purpose of science education is to create a specialist workforce.	The purpose of science is also to create a scientifically literate population.
The science curriculum is fixed by the needs of the future specialist workforce (see previous point).	The science curriculum could be modified to serve a more diverse population, with the option of progressing on to a pre-specialist curriculum.
To ensure that the science workforce is the best possible, assessments need to be exacting.	The perception of science as hard deters people who are capable of doing it and means that it often missing from the curriculum in non-mainstream settings; both of these are an avoidable loss.
The unchangeable science curriculum is hard, and that makes it too difficult for some learners.	The science curriculum is hard because it is targeted at an elite group of highly academic learners; it does not need to be so.
Once learners know enough basic science, they will see the relevance of it in their lives.	Sound scientific understanding can emerge from experience and interest with suitable guidance.
People need to be supported or encouraged to opt into science at key transition points, e.g. GCSE to A-level, to produce a diverse workforce.	People have decided whether they are 'science-y' or not long before transition decisions have to be made.
If people see role models in science with whom they identify, they will feel more inclined to follow them into science.	Role models are important but cannot overcome the effect of an elitist disciplinary culture.

evaluation of all the assumptions upon which your work rests and require you to make adaptations in response. For example, why do we have to have a hypothesis before we begin an investigation? What happens if pupils just try out some experiments and work out what seems to make the difference?

- **Teaching very diverse learners provides an excellent 'sand pit' for innovations in classroom practice.** Just as these learners often come with much experience of academic failure or other difficulties, they are often the most generous of collaborators, willing to try things out for you and support you when things don't go according to plan. For example, in an evaluation of the experiences of eight university academics, who volunteered to teach on a STEM summer scheme for young people with ASN, several tutors commented on how the experience had given them a chance to try out new approaches to teaching as well as making them think again about their customary practices.
- **The pleasure of teaching people who are willing to openly enjoy science.** Everyone likes to have their efforts acknowledged and learners who are so commonly excluded from science education, for instance by virtue of being in alternative educational provision, or who are treated to an inaccessible and incomprehensible (to them) curriculum, will let you know when you are getting it right for them. At the same STEM summer school, I was very surprised to hear, when I announced that the lunch break was over, one youngster say to another, *'Come on! Hurry up! We're going to do more real science.'*
- **To be reminded of the many ways in which knowledge can be created.** As university graduates, teachers are deeply imbued with the notion that theory shapes experimental design, the results of which lead to further refinements to theory. It is good to be reminded of all the other ways in which scientific knowledge has been created and how some of the approaches, which now seem deeply flawed, have nevertheless resulted in useful knowledge. In a science education

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world where not everybody is viewed as a professional scientist in the making, we can let people learn in diverse ways. Finding things out by observing patterns is not bad science: it is a different way of making sense of the world, as well as the basis of important insights.

Looked at from this perspective, it is clear that not only do SEND/ASN learners deserve their place in the science classroom but we need them in science, and not just for economic or moral reasons. Far more than that, they will help us to become the best teachers of science we can be and to develop a much more complete understanding of our subject. The price of this is movement of the boundary of what we consider to be 'proper' science education and its purposes. In renegotiating this boundary, we are likely to find that many other so-called marginalised groups will also be comfortably situated within the 'footprint' of science education.

Top tips to enhance inclusion

To conclude, I would like to offer my top tips for a more inclusive form of science, to which everyone can contribute and in which everyone can see themselves as a part of a community of science practice. All of these have guided my work with SEND/ASN learners over the years and none of them has held back any pupils who ultimately wished to progress into science as a specialism. Very importantly, anecdotal evidence suggests that they may have encouraged more pupils to study science longer than they had originally intended to.

Based on a published framework (Pomeroy, 1994) and my own experiences, I would suggest that teachers audit their lessons for the following characteristics, which will enhance inclusion for many different marginalised groups:

- Teach science in the context of pupils' lives and show its relevance.
- Show the pursuit of science as being done by different people, in different ways and in diverse contexts.
- Think about and present human difference as a resource to be valued, rather than a problem to be corrected.
- Use a range of teaching and learning strategies.
- Promote understanding by using multiple modalities, e.g. sensory experience, pictures, speech (especially speech in various languages), reading, writing and drawing.
- Focus on the process, rather than the outcome, of knowledge creation, both historical and current.
- Present science as a way of constructing meaning rather than uncovering an absolute truth.
- Actively refer to people whose contributions to science are under-recognised. Among those who had or have a learning disability and who have contributed to science, are Leonardo da Vinci, Alexander Graham Bell, Thomas Edison and Mary Temple Grandin. A less well-known but fascinating example is James Henry Pullen.
- Use scientific vocabulary selectively and strategically, using that which gives status and conveys meaning but being prepared to use everyday terms when these suffice.

This list shows how small adjustments to thinking and to practice can make a large difference to pupils' experience and relationship with science education. Adjustments like these will not dilute the science but will enhance its accessibility and so, ultimately, improve the richness and resilience of the science community.

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References and further reading

Essex, J. (2018) Why 'science for all' is only an aspiration: staff views of science for learners with Special Educational Needs and Disabilities. *Support for Learning*, **33**(1), 52–72.

Essex, J. (2020) Towards truly inclusive science education: a case study of successful curriculum innovation in a special school. *Support for Learning*, **35**(4), 542–558.

Pomeroy, D. (1994) Science education and cultural diversity: mapping the field. *Studies in Science Education*, **24**, 49–73.