Chapter 14: A science of equality

Chapter aims

The aims of this chapter are:

- To review the issues of equality in relation to science
- To consider the contribution that science can make to achieving greater equality
- To suggest that the practice of good science is the practice of a science of peace and equality

Introduction

"Modern science has vindicated the natural equality of Man"

Benjamin Disraeli in Sybil, or, the Two Nations

This chapter deals with equality and diversity. These are issues that have become integral to all sectors of education, not just in the modern primary school; and all teachers and educationalists are, or and least should be, committed to their promotion. In fact such promotion has become a major part of modern social educational thinking and as such has been the subject of much review, research and policy advancement in recent years. As teachers, or trainee teachers, you will certainly recognise this. Indeed the Teachers' Standards that applies to all teachers and defines the minimum level of expected professional practice comments on that the values of "individual liberty and mutual respect and tolerance of different faiths and beliefs" (DfE 2012). However, as profound as such ideas and concepts are, how often do we address them when

teaching science? Indeed, how many science-based CPD or INSET events have you attended where they have been discussed, let alone been the subject of suggested science activities? These fundamentally important aspects of modern education are seemingly not readily associated with science teaching. This is quite surprising because in fact science and its practice does have a good deal to offer when it comes to thinking about and promoting issues such as equality and diversity in our teaching. The new curriculum in science may also present us with future possibilities.

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Activity 14.1

Read the quotes below and think carefully about your responses to the questions.

"Science and art belong to the whole world, and before them vanish the barriers of nationality."

Johann Wolfgang von Goethe

"Racism, as we would characterize it today, was explicit in the writings of virtually all the major anthropologists of the first decades of this century, simply because it was the generally accepted world view. The language of the epic tale so often employed….fitted perfectly an imperialistic view of the world, in which Caucasians were the most revered product of a grand evolutionary march to nobility."

Roger Lewin

"The enchanting charms of this sublime science reveal only to those who have the courage to go deeply into it. But when a woman, who because of her sex and our

prejudices encounters infinitely more obstacles than a man in familiarizing herself with complicated problems, succeeds nevertheless in surmounting these obstacles and penetrating the most obscure parts of them, without doubt she must have the noblest courage, quite extraordinary talents and superior genius."

Carl Friedrich Gauss

- What do these three quotes suggest to you in relation to equality and science?
- Do we teach science in a way that suggests that it is a Western tradition?
- Are we ever in danger of inadvertently perpetuating myths and misconceptions about people through the way in which we teach science?
- Do you agree that certain members of the wider community still have to work harder to succeed in science, or is such discrimination a thing of the past now?

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If we are committed to equality of opportunity it really is of great importance that we interrogate our own teaching practices in science to make sure that we are not inadvertently promoting, through implication or otherwise, any tacit forms of discrimination. It is not unusual for schools to dispense with resources that promote racial or gender stereotyping and we should undoubtedly do the same with science resources. However, the problem is with what do we replace them? Try putting the phrase 'famous scientists' into an online bookstore. Now count the number of women, or the non-western faces, that appear on the front covers. It won't take long. In a six volume series of conversations with famous scientists published in the twenty-first century the front cover show the 218 participants (Candid Science Series I-VI). Only 17 are woman and with very few exceptions, the male scientists are exclusively of

European origin. It's probably not the publisher's fault, for how many living woman scientists can you name? How many famous African scientists, historical or contemporary can you think of? Perhaps in science teaching we need to be particularly sensitive to these issues, as unfortunately the practice of science still reflects these inequalities that we oppose and are trying to counter. The National Curriculum Review in Science (2012) suggested autobiographies of scientists; all the examples are white males. Indeed, in the text of the 2014 National Curriculum (DfE, 2013) nine scientists in total are mentioned; all are white males and only two, at the time of writing, are still alive! Of the suggested names on the new science programme of study, Mary Anning (d.1847) is the sole female representative. The very least we can do is select our case examples judiciously.

This is quite curious as actually science has a good deal to offer in terms of promoting both diversity and equality and hopefully the next section will help to identify some of the ways we can realise this through our thinking, planning and practice.

Equality and science: what does it mean?

In the National Curriculum science programme of study one of the key skills that pervades most of the year levels is the student's ability to observe and then to categorise based on those observations. Whether it is the similarities and differences between living plants and animals or between inanimate objects such rocks and other materials, it is through such close observations that children go on to make broad groupings and eventually classifications. This, of course reflects the practice of most branches of science and observation is a key skill.

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Time for reflection 14.1

In the now replaced National Curriculum (1999) Key Stage 1, Sc2 Life processes and living things under Variation and classification stated that, “pupils should be taught to recognise similarities and differences between themselves and others and to treat others with sensitivity’

This has been removed from the 2014 Programme of study.

Does ‘working scientifically’ not involve such sensitivities?

What strategies might you adopt to promote sensitivity to people’s observed physical differences?

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When it comes to the observation of themselves and of others physical differences are generally easy to identify as they are tend to be most obvious be it height, gender, hair colour or skin colouration. Identifying differences is an important part of science observation and is clearly intriguing for children. Even beyond the classroom physical differences between people can be captivating and interesting for them. Visitors to schools from different countries or different ethnicities coming in to talk to children about their culture will sometimes appear both wonderfully exotic and exciting to children. We all have these stories.

Children are intrigued by differences and we, as scientists, characterise by it. Race, ethnic origin, nationality, gender are all terms that we are familiar with, and indeed at

times we have a legal obligation to record it, but perhaps we need to remind ourselves that none of these are science terms. Indeed, in science not only is there uncertainty over their meaning but some terms such as ‘race’ are simply not recognised as having any scientific foundation.

This is a really important point, for the concept of ‘race’ is a sociological term, and has little basis in science.

Of course in the past the scientific community has been less considered. The impact of the false and defective science has been appallingly profound. The consequences of providing a bogus scientific credibility for genetic discrimination and selection were ultimately realised in the death camps of Nazi Germany. This devastating legacy still haunts science and in particular modern genetics and genetic research today. It is a period of science history that we often tend to overlook or forget, but it is important for us as science teachers to remind ourselves of the risks and dangers associated with stressing the differences between people and the sensitivity with which we have to approach the science of people.

A Science of Equality

Despite the great diversity of people on the planet, it is modern genetics that is providing evidence of our similarities rather than our differences, as one of the most revelatory findings of genetic research has been the almost species-defining characteristic of human genetic uniformity. For example, the Human Genome Project (Chow-White, 2009) found 99.9% of the human genome to be identical between individuals. This is quite astounding. Indeed, one of the defining features of the

human genome is its startling lack of variation between individuals. We are incredibly similar. Very few genes control our physical variability; in fact skin colour is controlled by just twelve of our twenty thousand genes (Quillen, & Shriver, 2011).

Given these startling similarities at a genetic level, have such findings been used to repudiate and directly challenge dogma? Do we use them at all in science education?

Of course we need to recognise that the negative social forms of discrimination between people is something very distinct from identifying simple visual differences and has highly complex, multi-layered origins that do not simply start nor stop with a branch of biology. However, as scientists perhaps we could do much more to combat percipient discrimination based on the basis of colour, ethnicity or gender, especially in challenging the sort of exclusivity that so often appears to be based on pseudo-science and myth. After all, we always argue that science is based on rationality and evidence and the evidence suggests that it is our similarity, not our differences that defines us in a scientific sense. Given that nearly 88,000 cases of racist bullying (including name-calling and physical abuse) were reported in UK schools between 2007 and 2010 (Talwar, 2012) and that each year during this period there was an increase in the number of reported incidents that in some large metropolitan boroughs witnessed a 40% increase, everyone involved in education has a role to play in confronting this issue including science educators. Perhaps one of the most effective and direct challenges to racism will be our genome; after all we are seemingly all equal under a microscope.

Not surprisingly, children are of course aware of physical and visually identifiable differences between people from an early age (Njoroge et al 2009) and those

differences need to be explored and discussed to avoid the development of misconceptions and misunderstanding that may form the basis of future negative discrimination. It would be naïve to suggest that teachers teaching science in primary schools can counter discrimination solely by using science topics, but we must be aware that we do need to tread carefully. Classification is based on both difference and similarity. Looking at differences between the physical characteristics of people is an important activity; it is vital to note those differences, not only in a science sense but also in a way that allows us to explore, understand and appreciate different ethnicities and different cultures. What we need to avoid is any opportunity to discriminate on physical difference. In other words, all animals show differences; zebra have different stripes, leopards have different patterns of spots, but we hardly notice the differences, simply recognising the particular animal. The similarities between people are, in fact, far more striking than any superficial difference. That's the science-based message.

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Activity 14.2

There have of course been previous debates about multi-ethnic science and there has been much discussion as to what actually means. What kind of activities could you design to promote similarities between people?

We can count similar characteristics and perhaps compare the results, but

can we design something that goes beyond physical characteristics? That might consider the similarity of emotions such as sadness, happiness, love? Perhaps through facial expressions?

Activities that stress the positives aspects of humanity and that are universal can be seen as something that 'classifies' us.

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Science and cultural identities

Using similarities in simple physical appearance is one thing, but children may also identify differences in relation to ethnicity and culture. Such distinctions are properly celebrated in schools, and usually beyond the scope of science activities, but they do not have to be.

Schools will, for example, invite members of different ethnic communities to talk about their lives and beliefs. On occasion they may bring in food for the children to taste, or talk about their families. This is good practice and plays an important part in showing how different people live in different ways. The different foods may seem wonderfully exotic and different but of course there are the considerable similarities of dietary requirements. The same food groups are used over and over again and it is generally only the preparation that varies.

In 'Science in Primary Schools: the Multicultural Dimension' (1991) Alan Peacock discusses a range of scientific activities that can be carried out in relation to everyday aspects of different cultures and ethnic groups. He suggests topics such as food, particularly different types of bread that can be examined under hand lenses, to find similarities and differences. Fruits can be examined and compared likewise. He suggests making 'ethnic' musical instruments. Utilising religious festivals particularly those involving water and light are also suggested as interesting ways of using science in different contexts.

Science and similarities in emotion and behaviour

Another area of similarity between people that can be explored with children which is perhaps not drifting too far away from science *per se*, is the concept of the similarities of emotional experiences and responses. There are many examples of powerful universal emotions, not least of which, for example, could be a parent's love of their child or children. Such collective emotions clearly transcend culture and ethnicity. Not only do we all look the same, but also we also feel the same and respond emotionally in similar ways.

When we think about behaviour and emotional responses we perhaps categorise them as psychology rather than science. We certainly may not instantly consider the contribution that modern ecology can make. Yet the subject of ecology is the study of the relationships between living organisms and one of the characteristics of our species, and perhaps contrary to what we may believe, is that we are very social creatures. Far from being violent, aggressive and destructive, we live in close proximity, share limited, and finite resources. Despite the wars and armed conflicts being regularly shown on television news footage, such events are actually remarkably rare. The London Underground or the trains in Mumbai during the Friday rush hour is a great example of how 'social' we actually are; that number of individuals in such close proximity and nothing (much) untoward happens.

Furthermore, as a species, we clearly exhibit biological altruism. Sam Harris (2012) has recently argued that such altruism, the simple fact that we help each other and exhibit highly levels of compassion, is because we are empathetic creatures and we demonstrate this all the time in our day-to-day behaviour. We look after our elderly

and our infirm and increasingly this behaviour is seen as being one of our great evolutionary advantages. The idea of ‘fitness for survival’ is so frequently (and to be fair, understandably) misunderstood, in that it has something solely to do with strength, or physical and mental prowess. Of course in reality, our co-operation, compassion and indeed our biological altruism are contributing evolutionary behaviours that have underwritten our evolutionary superstardom. Having opposable thumbs is one thing, but our ability to care and to empathise are arguably as important; but how many times do we make this scientific point? The teaching of basic science in the classroom does have the potential to contribute something to anti-discrimination strategies and we, especially as science teachers, perhaps need to recognise and develop these ideas further in terms of stressing the science of similarity and the science of altruistic human ecology.

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Time for reflection 14.2

“We have so far to go to realize our human potential for compassion, altruism, and love.” Jane Goodall, Harvest for Hope: A Guide to Mindful Eating

We want excitement and adventure; we want routine and security. We want to have a large number of sexually attractive partners, and we also want those we love to love us in return, and be utterly faithful to us. We want cute, smart children who will treat us with the respect we deserve. We want to be surrounded by music, and by ravishing scents and attractive visual objects. We don't want to be too hot or too cold. We want

to dance. We want to speak with the animals. We want to be envied. We want to be immortal. We want to be gods.

But in addition, we want wisdom and justice. We want hope. We want to be good." Margaret Atwood, In Other Worlds: SF and the Human Imagination

- Jane Goodall seems to suggest that we are innately compassionate and loving. Do you agree with that?
- Is Margaret Atwood suggesting the same?

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A 'world science', rather than 'science and the world'

The nature and story of science is often depicted as one of 'progress' and as such we can promote a sense that it moves forward. We do tend to 'look backwards' at the history of ideas, of how they came about, the people that carried out the experiments, worked on the problems and eventually discovered the answers or developed the theory. The problem, of course, and this is widely recognised, is that we run the risk of often portraying this undoubtedly important history of science as (if not uniquely) one that is predicated on the work of long-dead, white, male, Europeans (with an occasional North American). This of course is a completely inaccurate picture of scientific development. We may recognise this but how many times is the contribution of Islamic science discussed in class? Its influence to physics, mathematics, medicine and astronomy (and a whole range of other areas) is well documented, yet how often do we turn to it in our teaching? The great African civilizations built cities, irrigated land, and studied the stars and yet are rarely referred to in science histories. Indeed, as Briffault as early as 1919 recognised:

"The debt of our science to that of the Arabs does not consist in startling discoveries or revolutionary theories, science owes a great deal more to Arab culture, it owes its existence... What we call science arose in Europe as a result of new spirit of enquiry, of new methods of experiment, observation, measurement, of the development of mathematics, in a form unknown to the Greeks. That spirit and those methods were introduced into the European world by the Arabs." Briffault (1919)

The point here is that it would not change our understanding of biology, chemistry or physics; however, it would help to provide evidence that science is not uniquely European but is quite clearly multi-ethnic in origin, development and practice and it remains so. To imply anything else, even unintentionally, is simply bad history, let alone bad science teaching. Good practice involves different examples of science developments in different countries at different times.

Making science relevant to all

Dillon and Manning (2010) suggest that science should be delivered in a way that encourages children to think and act scientifically by addressing topics that are relevant to them. Of course few would disagree (why would they, given the alternative stance?) but the more difficult question that we have to consider is what topic areas are relevant to children and young people in schools? This idea of relevance is one that is regularly put forward in literature concerning science education, but the key the question here is, do we know what these areas are? There is a distinct paucity of research that actually explores this, particularly pre-adolescent children's perspectives (Sargeant, 2010). Some suggest science may be best taught through topical issues, a socio-political science for example (Eastwood, 2012) where

present environmental issues are examined. However, perhaps we could look at other areas that are actually more directly relevant, for when we consider what is relevant to children, studies of their personal worries are probably the most sensitive indicator and successive studies in this area show children's major concerns to be related to personal relationships, such as friendship and separation, health and death and coming to personal harm. (Silverman, et al, 1995: Bernstein, 2002). Wider issues concern war and environmental disasters. For older children (9 – 14 years old) their future relating to careers and money are increasingly cited (Ofsted, 2008).

Children's concerns about being 'different' in a variety of ways, both physically and culturally, within the school environment are important. Making science relevant is often interpreted as relating it to children's everyday lives in terms of their external environment, but this has often focused on explaining the science behind everyday items, or activities. This of course is valid and important and can form the basis of innovative, interesting and engaging learning activities. However, how often do we as teachers see a role for science as part of anti-bullying strategies, or assuaging children's fears about school and the wider world? If we really want children to engage with science we need to at least consider using science to help reduce their fears and concerns; after all, ecology is the science of relationships.

Science and gender equality

When it comes to gender differences in academic performance at primary level research has usually concentrated on the lower achievement levels attained by boys and the efficacy of strategies that may be adopted to improve them (Harlen and Qualter, 2009). Of course in science we have far greater concerns, namely the

internationally recognised under representation of women in the majority of science subjects. Harlen (2008) states: “It is universally accepted that learning science is important for the future lives of all citizens and because of this it is a required part of primary and secondary education in practically all countries. Science is a major area of human mental and practical activity and the knowledge it generates plays a vital part in our lives and in the lives of future generations.” (Harlen, 2008:P3). So important and so vital is the perception of students that when it is no longer compulsory students particularly girls, drop it with alarming readiness. Despite females outperforming males in UK schools (Sheppard, 2011) there is still a significant under-representation of females studying science beyond the age of 16 and the disparity in some areas of science has become progressively worse (OECD, 2008).

Research into the reasons for this disparity has shown that there is little variation in the academic performance of females (Hide and Lynn, 2006) and that at degree level, female graduates in science gain slightly better degree classifications than their male counterparts (OECD, 2008). We can therefore reject any difference in cognitive performance.

Given a lack of identifiable differences in cognition and academic performance, relative interest has formed the next focus for research. Research studies have indeed identified, in the UK at least, that interest in science topics varies with gender. Jenkins (2006) as part of the Relevance of Science Education project found that in UK schools the interests were markedly different. The most popular areas of interest listed by girls were nearly exclusively health and well-being related for boys it was topics concerned with atomic weapons, space and dangerous animals (Jenkin, 2006)

The image of science, its history and apparently the content of the modern science curriculum seem to be male dominated. Is it any wonder that women are put off? Of course a valid question to ask here is ‘does it matter’? If the advances in medical science or physical sciences are made, does the gender of those making such discoveries and contributing to such advancement particularly matter?

Well, to those with an interest in science and who care about it, it does. In fact such gender disparities are of real concern. Ben Barres (2006) has reviewed the gender imbalance in science and finds no evidence of any difference in innate academic or intellectual ability. In fact, so lacking is evidence for differences in performance, interest and ability that he concludes that the gender disparity in science must be the result of discrimination. Barres goes on to point out that this is hard to accept for many and that much of this discrimination is subtle rather than overt, however, it conspires to put girls off continuing with science, by undermining their self-confidence. No matter how unintentional, no matter how ‘low-level’, this is discrimination and we as scientists and more importantly as teachers cannot tolerate this. In fact we need to take an active role in combating it. One of the simplest ways, as Virginia Valian suggested as long ago as 1998, is simply to raise our expectations of girls in science. We can also check our resources, think about our examples and change our histories.

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Activity 14.3

It is good practice generally to remember about role models and challenging stereotyped images, however, it is even more important in science. Ways in which

this could be achieved could be the study of the work of women scientists, past and present. The latter point may be emphasized by inviting local women scientists to visit the school.

Think of the apparent differences in interest, perhaps individual or group project work may be useful. Can these projects be based around a unifying theme, such as health?

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Conclusion

Hopefully this chapter has given you a few things to think about. You may not agree with some of the points discussed here, or you may think that strategies to promote diversity and inclusion are best done in other ways. However, the point here is that we can be imaginative in our science teaching. We can integrate it into all areas of the curriculum, but we can also use science in creative ways to promote many of the wider commitments of tolerance and understanding that we share as professional teachers. As Barress (2006) points out;

We can teach young scientists how to survive in a prejudiced world. Self-confidence is crucial in advancing and enjoying a research career. From an early age, girls receive messages that they are not good enough to do science subjects or will be less liked if they are good at them. The messages come from many sources, including parents, friends, fellow students and, alas, teachers. When teachers have lower expectations of them, students do less well. But we are all at fault for sending these messages and for remaining silent when we encounter them. Barress (2006)

If you also see yourself as a teacher of science, well, science is a subject limited only

by imagination. We therefore need people with imaginative, creative and perceptive minds and to exclude anyone with those criteria is to undermine the future of our subject. Therefore a science based on equality isn't just a laudable aim, it should be the very basis of our philosophy and of our practice.

Further reading

Peirce. E. (2008) *Activity Assemblies to Promote Peace: 40+ Ideas for Multi-Faith Assemblies for 5-11 Years: 50 Ideas for Multi-faith Assemblies for 5-11 Years.* David Fulton Publishers

A useful resource book of ideas dealing with issues of peace from a multi-faith perspective.

Hill, D. & Helavaara-Robertson (2011) (Eds) *Equality in the Primary School: Promoting good practice across the curriculum.* Continuum

Excellent 'in-depth' discussions on a variety of topics relating to equality issues.

Online resources may be found at

http://peace-education.org.uk/

For general peace education resources and ideas.

Some 'debunking' of ideas relating to boys and girls may be found at

http://www.theguardian.com/science/blog/2013/feb/08/pseudoscience-stereotyping-gender-inequality-science

For ideas specifically relating equality and science the ASE has the following

resource.

http://www.ase.org.uk/resources/scitutors/professional-issues/ethnicity-and-gender-issues-in-science/#3.2Primary

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