Contributions of charles darwin to science

Title: The contribution to science by a scientist of your choice. 3000 words

This paper discusses the contribution to science made by the English scientist Charles Darwin, (1809-1882), author of *The Origin of Species* (1859), the originator of the Theory of Natural Selection or Evolution. It examines the manner in which the work of Darwin could be related into the existing science curriculum, considering his work as an exemplar of the scientific method. It also sets out to relate the scientific discoveries and principles involved to other aspects of the school curriculum, especially in the area of citizenship. The contentious nature of Darwin's ' discovery' in his own time illustrates the fact that there is a common interest in the discipline: we are, in a sense, stakeholders in scientific facts and methods, since they help to determine the shape of our daily lives. As the House of Lords points out, '…. this is not confined to scientists; it extends to those who make policy, whether public or commercial, on the basis of scientific opportunities and advice. Policy-makers will find it hard to win public support…. on any issue with a science component, unless the public's attitudes and values are recognised, respected and weighed in the balance along with the scientific and other factors.' (House of Lords, 2000, para 2. 66). Despite its age, Darwin's theory continues to be debated, and can inform us about the importance of observational skills and scientific integrity. It also provides precedents for the way science and society interact, which may be useful in our society. As the Royal Society observes, ' It is thus not trust in science *per se* which is of concern but the speed of scientific and technological development, the uses to which science is put, and the ability of regulatory and institutional structures to keep pace with this change.' (Royal Society, 2004, p. 13). Darwin's work brought him notoriety, but also controversy and

personal vitriol. (See illustrations). This is where the link between science and citizenship can be made.

How does this contribution map to the science curriculum?

As a 2002 Report by House of Lords acknowledges, ‘ The foundations of an interest in science are laid at primary school, between the ages of 5 and 11.’ (House of Lords, para. 6. 3) The principle benefit which could be obtained through the work of Darwin is a general accessibility, which would itself enable learners to engage with the curriculum. As Meadows points out, ‘ Much of cognition and learning depends on identifying the relevant knowledge that the learner already has in existing memory so that this knowledge can be used as a starting point for learning what is new. Having no starting point...will hamper learning and reasoning...’ (Meadows, 2006: p. 112). A variety of authorities and analysts have noted there that are continuing conceptual problems in the way learners, and the wider community engage with science. These are attributable to a variety of factors. Qualitative (i. e. phenomenological) research commissioned jointly by the DTI and the Wellcome Trust revealed public support for the idea that ‘ Science makes our lives change too fast.’ (Wellcome Trust, 2000, p. 23) Beyond this apparently simple picture there lay a more complex picture, with differentiated levels of understanding and interest claimed for different areas of science. Environmental concerns, health issues and medial discoveries held the greatest interest for 82-91 per cent of respondents, whilst new technology was considered more interesting by 74 per cent. Only 48 per cent of those questioned claimed that energy issues were the most significant for them. (Wellcome Trust 2000: p. 21) The same research also discovered that

it was possible to categorise respondents into different groups, determined by their interest in science, and the degree of trust they felt in science and scientists. Correspondingly, subjects characterised themselves as ‘ confident believers’ at the end of the continuum most engaged with science, to ‘ supporters’ half way along the scale, right down to those who stated that science was ‘ not for them’. (Wellcome 2000: pp. 5-7)

Correspondingly, there are several overlapping benefits which could be obtained through an expanded use of Darwin’s work. Firstly, an enhanced understanding of scientific method, secondly, an improved awareness of the operation of natural laws, and thirdly, the means by which research results are validated, interpreted and shared. The benefits of this could start to be felt even at the Primary phase, as Peacock et. al. argue, ‘ Primary science is perhaps best regarded…as an intellectual, practical, creative and social endeavour which seeks to help children to better understand and make sense of the world in which they live…(and)…should involve children in thinking and working in particular ways in the pursuit of reliable knowledge.’ (Peacock et al., 2007: p. 1). It is in this way that a rigorous interpretation of the general principles established by Darwin might be very beneficial, in overturning and challenging pre-conceived ideas about identity and value, such as those often attributed to the so-called ‘ hidden curriculum.’ As Bishop and Simpson point out, ‘ The pressures of the hidden curriculum are also present with regard to structure. The children themselves can be very forceful in structuring science activities with preconceived social frameworks.’ (Bishop and Simpson, 1995: p. 7).

In thematic terms, Darwin’s work is thoroughly supportive of the *Knowledge, Skills and Understanding* element of the science curriculum, i. e. *, Ideas and evidence in Science, Investigative Skills,* and subsidiary disciplines such as planning and presenting evidence. By the time students reach Key Stage 3, these skills are being further developed under the headings of *Practical and Enquiry Skills, Critical Understanding of Evidence,* and *Communication.* In practical terms, principles developed from Darwin’s theory could be incorporated into the science curriculum as early as unit 1A, *Ourselves,* and then continued on through key Stage 2 in *Life Processes and Living Things.* Within the latter, it would be important to focus on sub-unit 4, *Variation and Classification,* and 5, *Living Things in Their Environment* , noting how living organisms vary and change according to their context. This theme could be carried on developmentally in the context of Key Stage Three, which incorporates two highly relevant modules, *Organisms, Behaviour and Health,* and *The Environment, Earth and Universe.* Moving away from the formal curriculum, Darwin’s theory could help by developing the foundations of causal reasoning and also problem solving, contributing to a general improvement in science standards overall, across all units of study.

How does the work of the scientist demonstrate the scientific method, or is it a counter example?

From an educational and scientific perspective, Darwin’s work is interesting because it is based extensively on observation and deduction, rather than extensive or repeatable physical experimentation. Because of the enormous timescales involved in the evolutionary processes which preoccupied Darwin, it is in effect, impossible to prove, in absolute terms, whether the theory is correct or not. The theory still has its detractors, and direct opponents, who

object to it on ideological or theological grounds. Despite this however, it has become a generally accepted scientific principle. Darwin's work is therefore, in one sense, the purest expression of the scientific method, especially since it was formulated in a vacuum of worthwhile antecedents, and an atmosphere of considerable ideological opposition. The only possible way in which his work might be deemed a ' counter example' is the manner in which it ran directly contrary to much mainstream scientific thinking amongst his contemporaries. However, it definitely was a discovery made *because of* – rather than *in spite of* – scientific method.

Essentially, what Darwin did was to propose an interpretation of events, extrapolated from a vast amount of biological and geological evidence: he then formulated a specific interpretation of causality which, in his analysis, had only one possible scientific outcome. It is this kind of observational model, based on causality, which can tap into the learner's innate cognitive ability, even from the youngest age. As Meadows observes of children's interpretative perception, '…By the beginning of school years, it follows basic causal principles, for example that causes precede effects rather than following effects, that they covary with their effects – the effect regularly and predictably appears after the cause and does not appear without it, and the cause and effect are close, or at least linked, in time and space.'. (Meadows, 2006: p. 109)

How can the work being discussed be used to address citizenship issues in schools?

As Rose and Rose indicate, it has always been possible to take the view that, '…science appears to advance in a more or less ordered manner,

irrespective of the prevailing social environment in which it is performed.’ (Rose and Rose, 1970, p. 241) The power of Darwin’s work lays in its ability to bridge the gap between science and the community, and it is here that his relevance to issues of citizenship may be found. Darwin’s contribution to science as mirrored to a great extent by the way his work reinforced other areas of academic, philosophical and social study: all of this makes it directly relevant to citizenship issues. As Wallace points out, ‘ A reading of the *Origin...* make it difficult to assert that Darwin’s mind was ‘ devoid’ of economic and philosophy. A more sustainable conclusion is that it was permeated by principles of political economy and philosophy in the form of a language which did not differentiate between the political and the biological.’ (Wallace 1995: p. 11) In other words, Darwin’s work was implicitly bound up with the values of his host society: it is this which makes it an ideal link between science and citizenship. The only contrast is that we move from a Victorian context, to a present day one. This, it may be argued, has potential benefits for science, education, and society alike. As the Royal Society concluded with regard to the current science curriculum, ‘…many students lacked enthusiasm for…. the subject, and felt frustrated by a content-heavy curriculum which gave them little room to explore controversial and ethical issues that might interest them.’ (Royal Society, 2004, p. 21) Darwin’s work, it may be argued, is perfectly adapted to facilitate the latter: it is not remote, or obscure, and on certain levels it is highly accessible.

The links between science and citizenship manifest themselves in various ways. Firstly, there is the whole issue of public understanding of, and trust in science. As Meadows points out, ‘…understanding cause builds up into what

has been called a ‘ naïve physics’, a coherent set of notions about how objects behave; if this gives rise to the formation and testing of hypotheses by observation and experiment, it becomes the basis for a physics which is scientific rather than naïve.’ (Meadows, 2006: p. 109). Darwin’s work teaches us that it is not only the observation of a phenomena, but the cultural capacity to assimilate its meaning, which is important. Scientific matters are not the discrete concern of the scientific community itself, but spill over into the political sphere and eventually concern us all. This is especially true when ethical issues become involved, as they increasingly tend to do in the biological and life-sciences, affecting everything from the air we breathe, the food we eat, the health treatment we can expect, and even the degree of control we might have in determining the health, gender, and character of our children. The important point here is that attitudes vary, from a profound mistrust, to an almost myopic faith in science. As the House of Lords observed, neither position is entirely valid, a situation it attributes sqaurely to schools. ‘ In common parlance, “ scientific” is almost synonymous with “ certain”. This perception, which is probably picked up at school, is virtually true of much old and well-established scientific knowledge. In many of the areas of current concern, from climate change to cancer, it is however very wide of the mark.’ (House of Lords, 2000, para. 4. 1) It is not the fallibility of science which is useful from a citizenship point of view, but rather the necessity of maintaining an open mind and capacity for objective debate. It is also important to remember that we all share a collective responsibility for the way that society is conducted, and the manner in which scientific affair are run on our behalf. Again, this is not a remote or academic debate, and at its most intense, can demonstrate the relevance of scientific method in our

everyday lives. As the Royal Society points out, contemporary crises such as that created by BSE illustrates this. '… BSE highlighted profound concerns about the science advice process and the role of scientists and government officials, the effectiveness policy making and action within departments such as the Ministry of Agriculture, Fisheries and Food, the ability of Ministers to both gauge and communicate risk effectively, and fundamentally the relationship between science and politics.' (Royal Society, 2004, p. 17)

If we take the Key Stage Three Citizenship curriculum as an example, the continued relevance of Darwin's ideas becomes apparent. In the sphere of political, legal and human rights, we must take account of the DFES guidance that every child is '…A unique child…. every child is a competent learner from birth who can be resilient, capable, confident and self assured.' (DFES, 2007: p. 5). The essence of Darwin's thought is that all people are descended from the same ultimate source, and therefore equality before the law, and of political rights, is a prerequisite of an equitable society and civil polity. This in turn leads into the principles of democracy and the idea everyone should have a voice in determining the legislative conduct of government. The importance of maintaining freedom of speech and allowing a diversity of views are also essential to the principles of citizenship as enshrined in the curriculum.

It is important to remember that, without these facilities, Darwin's scientific ideas might never have received public attention. In Section 2, *Key Processes,* the KS3 Citizenship curriculum requires that learners '…engage with and reflect on different ideas, opinions, beliefs and values when exploring topical and controversial issues and problems.' (QCA 2007: p. 30).

Darwin knew that publishing his ideas about evolution in Victorian society would draw fierce opposition from many quarters, because of its dissonance with biblical teachings about the Creation. This opposition was likely to be immovable and resistant to logic: As Hull points out, those '…who rejected evolutionary theory primarily for theological reasons…would not have been able to accept it even if all the evidence had been overwhelmingly in its favour – which it was not.' (Hull 1974: p. 450). Similarly, his right to debate his theories with opponents and critics formed an important part of the way in which he fundamentally changed attitudes, way beyond the purely scientific sphere. As Darwin himself wrote of one of his counter-theorists, ' He will be dead against me, as you prophesied…but he is generously civil to me personally. On his standard of proof, *natural* science would never progress, for without the making of theories I am convinced there would be no observation.' (Hull 1974: p. 229). As can be seen from this, it should be possible, in a tolerant and progressive society, to express and discuss opposed views in a reasonable way: the freedom to do this, and determination to protect such freedoms, are important tenets of contemporary citizenship. As the Key Stage Three citizenship curriculum puts it, responsible citizens should be able to '…communicate an argument, taking account of different viewpoints and drawing on what they have learnt through research, action and debate…justify their argument, giving reasons to try to persuade others to think again, change or support them.' (QCA 2007: p. 30).

In contemporary UK society, responsible citizenship also requires us to understand diversity of cultures and identities, and that movement of

people, either temporarily or permanently, is an intrinsic feature of our society and economy. This is fully reflected in the citizenship curriculum, which states that learners should recognise ...the hanging nature of UK society, including the diversity of ideas, beliefs, cultures, identities, traditions, perspectives and values that are shared.' (QCA 2007: p. 33) Darwin's theory of natural selection is supportive of such perspectives in a variety of ways. By teaching us that we all have common origins, his thinking undermines any ideas of intrinsic racial difference, or any barriers erected around such ideas. Since we all developed from the same biological source, there can be no justification for valuing any individual differently: in other words, concepts of ' biological determinism' are invalidated. Moreover, any attempt to do so can, by Darwin's teaching, at once be revealed as arbitrary, subjective and unscientific. There are obvious cross-curricular links to be made here, both historically and in terms of contemporary societies, where such conditions still endure. Children are natural observers of the phenomenon around them, and Darwin's ideas are profoundly supportive of this. Meadows points out that children '...appear to draw inferences about the causes of events they see, to discriminate between self-caused and other-caused movement, to categorize living things that are agents as different from inanimate objects.' (Meadows, 2006: p. 109). Being citizens also accrues us the responsibility to change things for the better: correspondingly, although we have rights in society, we have a duty to ensure that such rights are exercised responsibly, without impinging on the rights of others. Darwin's theory also taught us that we are, as social actors, entirely interdependent upon each other.

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