Evolution, insight and truth?

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ABSTRACT Evolution has been positioned at the centre of conflict between scientific and religious explanations of the workings of the world. However, little research has examined other possible reasons for some people rejecting scientific explanations. The author's research indicates that for some people, irrespective of faith, the ideas associated with evolution can be potentially disturbing: ideas about change, uncertainty, absence of purpose, extinction and struggle, as well as identity. The affective dimension of teaching and learning about evolution needs to be taken into account and our classrooms should provide safe places for our students to discuss the personal implications of science.

The theme of this issue of *School Science Review* is 'epistemic insight'. Insight means a deep understanding, apprehending the true nature of something. The *Oxford English Dictionary* gives its etymology as a derivation of 'inner sight', the ability to see into something, to reveal the hidden. I have come to think a great deal about the meaning of truth in science education and particularly in the context of teaching and learning about evolution, a topic that now starts in year 6 (ages 10–11) in primary school (Department for Education, 2013). No other subject in a student's biology education is likely to be more fraught with differing ideas of truth than evolution.

There is much evidence to support the claim that biological evolution in general, and human evolution in particular, is considered controversial by a significant section of the public across the world (Miller, Scott and Okamoto, 2006; GALLUP News, 2017). This attitude is also apparent in some classrooms at the level of both the learners and their teachers (Hermann, 2008), and my experience as an educator also supports this. Religious beliefs in particular have been documented as an obstacle to accepting evolutionary explanations in biology (Rutledge and Mitchell, 2002; Smith and Siegel 2004; Trani, 2004; Friedrichsen, Linke and Barnett, 2016).

A great deal of research has considered how we as educators can teach and how children and young people can learn what is necessary in science, in the face of this potential opposition. It has become clear that understanding does not necessarily lead to acceptance (Nehm and Schonfeld, 2007). This presents a potential problem for teachers working in British schools today, sometimes dealing with their students' resistance to accepting evolution, despite the fact that it represents a foundational idea in biology. A large body of research from the USA has emerged, looking at issues affecting the acceptance of evolution and the implications for teachers and their learners (Rutledge and Mitchell, 2002; Blackwell, Powell and Dukes, 2003; Donnelly, Kazempour and Amirshokoohi, 2009; Nadelson and Sinatra, 2009). However, similar studies in the UK also support the idea that evolution is a potentially problematic topic in science for the reasons outlined (Reiss, 2009; Williams, 2009).

Religious belief is often viewed as antithetical to science. Stephen Jay Gould referred to science and religion as *nonoverlapping magisteria* (Gould, 1997), but what does this mean for the science classroom where students and teachers may have to negotiate between these two forms of knowledge and understanding when tackling evolution? As an educator, I have come to think that whether or not religion has a place in the science classroom is not the most important issue. Whatever our position on this, our learners will bring their own ideas about what they believe is true into the classroom. They are highly invested in these ideas, they are part of their identity and may arise from their most important personal relationships, forged by powerful forces that we have limited, if any, influence over. However, I am not suggesting we give up the endeavour to increase children's understanding about such

a fundamental scientific idea as evolution. We should not allow them to opt out of learning evolution and we as teachers can make a difference. Evolution as a unifying concept and the specific concepts, such as variation, competition, selection and so on, are important ideas for all and can contribute to a greater understanding of and respect for nature. For instance, understanding the rapid change driven by human activity on species can help students understand the potentially permanent impact human activity can have on living ecosystems. An appreciation of the interdependence of life can also develop greater respect and empathy for other species.

If we consider that, by bringing knowledge to our learners, we are revealing truth but from a variety of disciplinary perspectives then we also need to consider our learners' conceptions of truth and what is 'true' for them. I have come to consider the issue of truth in education as a result of my own experiences as a scientist and as a science educator. The reality for me was brought into sharp focus in my experience of teaching Darwin-Inspired Learning (Boulter, Reiss and Sanders, 2015) and my association with the Charles Darwin Trust. The aim of Darwin-Inspired Learning is to inspire children's interest and engagement with the natural world through Darwin's ways of thinking and working. I have been privileged to work with children of all ages, and with their teachers, in diverse school and out-of-school settings. The children, young people and professionals I have come into contact with have all brought their own ideas about science and nature, sometimes in line with scientific explanations, sometimes with intuitively based misconceptions, but behind these ideas, it has become apparent to me, are a complex mixture of beliefs about what is true. Insight when it comes to our personal understanding of the workings of the Earth and the universe is subjective and complexly constructed in and out of school.

Science: one of many truths?

When it comes to what is considered true knowledge, I would argue that our learners could be forgiven for having the perception that scientists and possibly even science teachers consider scientific knowledge to be the only true knowledge, and therefore other forms of knowledge may fall short. Science as taught in school is often portrayed as certain knowledge, as a collection of testable facts (Jarman and McClune, 2007). The reality is messier and more interesting, but are we perhaps inadvertently giving the impression that we as science teachers see science as the only true way of knowing anything? Some scientists in particular may not always have helped in this regard. Sir Harry Kroto in his Nobel laureate speech in 2011 asserted that science is the only way to determine truth. But truth is a problematic concept and I would suggest such claims are not likely to sit well with many people's experiences and beliefs. The question is how do we manage the complexities of belief, truth and the nature of science in our classrooms?

I believe that a partial answer is acceptance by scientists and educators that science is not *the* truth, but is part of a larger culture of knowledge and experience encompassing the arts, philosophy and religion. This means looking at science as culture in the classroom and science as a way of knowing, one among other ways of knowing or epistemologies. Jonathan Osborne, in his 2014 article on curriculum reform in the USA, proposed that to understand the epistemic foundation of science, learners need to understand science as it is practised, as it is only through understanding this that they will grasp how scientists authenticate and establish their claims of knowledge (Osborne, 2014). He suggests that the current focus on science inquiry, which has also been a focus in UK science education, creates learning experiences that provide recipe-following investigations designed purely to demonstrate a concept. This approach in truth does not constitute an inquiry at all as is understood by science. He advocates something that is a focus of Darwin-Inspired Learning: to begin with a question. From questions come explanations based on evidence. However, another key aspect is for learners to appreciate why concepts such as reliability and validity are the cornerstone of the epistemology of science. This focus on science as a way of knowing could in turn be compared with other epistemologies that use evidence differently, such as history, or do not rely on evidence of the senses, such as religion. This approach could develop a more holistic learning experience for children and young people that more accurately reflects the ways of knowing as they are in the real world, as opposed to the mutually exclusive subject-based silos of learning they can experience at school.

Hearts and minds

As well as focusing on ways of knowing, engaging students emotionally is important. One approach intended to capture hearts and minds in evolution education is that of the Transformative Experience described by Heddy and Sinatra (2013). They argue that evolution as a scientific explanation can conflict with people's common-sense understanding of the world and that relevance of the ideas to students' own experience can help support understanding and acceptance. These authors advocate an approach that encompasses three transformative qualities: Active Use of a concept, so highlighting its real-world relevance; Expansion of Perception, helping students see things in a new way; and Experiential Value, that is valuing an idea because it positively changes their experience of the world. This could include the ideas I previously introduced; for instance, an appreciation of interdependence may promote a person's appreciation of the natural world and our responsibility for it. Heddy and Sinatra's data suggest that this is a promising approach, although as applied to college students rather than school-age children. It also increased the students' levels of enjoyment of the subject as well as their learning.

Enjoyment means a positive emotional experience, which to me may be the most significant issue and has become the focus of my own research. With the support of the Charles Darwin Trust I have been investigating the role of our emotional responses to the ideas inherent in evolution. The affective dimension, or the impact of emotions on learning, is only now coming to prominence in this debate around acceptance and understanding of evolution. Brem, Ranney and Schindel (2003) studied a group of American college students of varying backgrounds studying a range of subjects, only around 11% of whom were on a life science course. Brem *et al*. were interested in how students perceived the personal and social implications of evolutionary theory: how do scientific ideas impact on how we understand what it means to be human? Their findings were troubling: for a significant number of the students the implications of evolution by natural selection included a perceived justification for racism and selfishness, a decrease in the importance of spirituality, lack of purpose to life and threats to self-determination. So for some, which included both those with a faith and those of no faith, evolution presented moral and existential problems. These findings also highlight a fundamental misconception that the ability to make predictions based on prior observations inevitably leads to determinism. This again lends weight to the idea that understanding science as a way of knowing, and how this knowledge is generated and tested, is crucial to understanding science concepts.

Acceptance of evolution is also potentially difficult because of issues about human identity in the context of the natural world. For some, humans are entities apart from the rest of nature; the idea that humans are animals may be difficult to accept and some people may wish to minimise or deny our relationship to other animals. Science perceives humans as part of nature, as another form of life, and for some this may be troubling (Goldenberg *et al*., 2001; Beatson and Halloran, 2007). A review by Sinatra, Brem and Evans (2008) looked at the attitudes, beliefs, motives and emotions regarding evolution observed in classrooms. They noted Richard Dawkins' observation that he had received comments from worried members of the public, to the effect that his ideas troubled them as they only offered a bleak and depressing view of life without purpose and meaning. For some people, science is not presenting the wonders of the universe, but a challenge to the meaning of existence. From my own experience also, I recall a radio interview on the subject of the limitations of science where the interviewee put this fear very succinctly: '[science tells us] *that we are nothing but just chunks of matter*'. I feel the words '*nothing but*' are very significant. For this person, the scientific explanation did not promote awe at the wonders of nature, of which we are a part, but a lessening, a diminishing of humanity.

So why do some people see science as a source of awe, wonder and understanding and others as suggesting there is no purpose or meaning to life? Rutjens *et al.* (2017) suggest that acceptance and non-acceptance of science may both be shaped by a need for order, control and meaning and that science itself can act as a belief system. However, unlike some other scientific explanations, evolution does not necessarily imply order, as natural selection is not concerned with action towards a particular end but is under the

control of chance events. Perhaps this explains why those without a faith also exhibit some unease in the face of evolutionary explanations of life on Earth (Brem *et al.*, 2003).

An unusual experimental study in 2015 looked for physical evidence of an emotional response towards evolutionary themes (Bland and Morrison, 2015). These responses were inferred by the detection of physiological changes. The findings indicate that questions asking for people's opinions on the validity of biological evolution did produce an emotional response in some. Although their study was small and their measure indirect, they point out that their results are backed up by a large body of anecdotal evidence.

Evolution and the unconscious

In looking at the role of the affective domain in teaching and learning, I have become interested in psychosocial research approaches and in particular the potential for psychoanalytical theory to throw some light on people's attitudes and emotions. Psychoanalysis deals with unconscious thoughts and feelings, including those that threaten the personality (Frosh, 2012). If evolution presents ideas threatening to a person's sense of self, do these potentially need to be repressed and denied? This is a difficult question to answer but I have attempted, through Free Association Narrative Interviewing (Holloway and Jefferson, 2000), to throw some light onto the role of conscious and unconscious emotions regarding the ideas presented by evolution.

I interviewed 19 undergraduate and postgraduate students of education, including PGCE science students as well as others with no science background. The interviewees were volunteers and came from a diverse set of backgrounds, including a range of religious affiliations or no affiliation. I chose three interview prompts, which in some way exemplified a potentially disturbing idea associated with evolution, to show and discuss with the volunteers. These were a picture depicting an evolution timeline, a piece of video artwork showing a fish transforming via intermediate stages to a man, and finally a set of photographic portraits of great apes. These prompts or probes were chosen as they in some way could represent change, extinction, the vastness of geological time and humans as animals.

Narrative interviewing asks for people's personal accounts, but the stories they tell are not just representations of absolute truth, they are subjective retellings (Josselson, 2011). I was interested in unconscious meaning and not in people's rational explanations. They may consider evolution as a dry scientific topic, so why would they have any particular feelings about it, particularly perhaps if asked by a biologist, someone seen to have a vested interest? I also did not want to lead their responses in any way. My idea is that evolution by definition is difficult for us humans to appreciate and even the most rational of us may not like to consider the possibility of extinction or possible challenges to our distinct human identity. Free Association seemed a way to explore our unconscious feelings about it. I therefore allowed the interviewees to interpret the images and video in any way they wanted with minimal questioning. Any questions were more about how they felt about their own responses and whether they were reminded of anything else.

My research is ongoing, but already I have revealed some interesting responses. A question that has recurred is '*What will we humans evolve into?*', which has been posed by a number of my interviewees. This question seemed to trouble some of them, even though it has no implications for their own lives, as they are talking about a process that will take place over many millions of years. There were also common references to science fiction and fantasy dystopias and an association of human evolution with disturbing and sometimes monstrous outcomes. The morphing creature in the video threw up ideas about monsters, but also ideas about the arrogance of seeing a human as the culmination of evolutionary change. The very human images of apes also seemed to disturb some people, but in a complex way, some feeling they were being manipulated, others anthropomorphically reading human emotions in the animal faces, others expressing guilt regarding humanity's part in the fate of the animals, but also worry at seeing them as human.

What may this ultimately mean for the teacher in the classroom dealing with evolution? I began this article with a discussion about truth, scientific truths and subjective personal truths, our own and our learners'. In my own personal experience through my transition from scientist,

novice educator to a teacher with a significant experience of teaching evolution, I have become aware that I have at times been worried about addressing 'the controversy', particularly in my earlier days. I have had no personal concerns as to the validity of the science; it was the unifying concept of my own discipline and a source of fascination for me, but I was concerned about upsetting and offending others and, if I am truthful, I was concerned about coming up against other people's emotional responses. I have come to wonder whether other teachers have had similar feelings. Could this lead some of us to avoid allowing our students to discuss their feelings about evolution and how they make sense of it in the context of their own beliefs? I believe that we need to accept that our learners may, for reasons of personal truth and identity or because of conscious and unconscious anxieties and uncertainties, resist a scientific explanation.

The debate as to what this means is not over and it is important that it continues, but if the aims of education are '*to enable each learner to lead a life that is personally flourishing and to help others to do so*' (Reiss, 2015: 3) then we must acknowledge that learning is sometimes difficult, not just in a cognitive sense but also possibly in an emotional sense too. From this position we can explore how our learners are feeling in our classrooms and establish the trust and enjoyment so essential for learning to occur. By also holistically presenting science as one way of knowing among others, we may help children and young people to appreciate science and its potential to help us understand the natural world alongside the potential understanding provided by art, music, literature and religion. By helping them appreciate the relevance to their own lives, we may stimulate their interest and promote their enjoyment of learning.

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