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Creationism as a Misconception: Socio-cognitive conflict in the teaching of evolution

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Creationism as a Misconception: Socio-cognitive conflict in the teaching of evolution

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This position paper argues that students' understanding and acceptance of evolution may be supported, rather than hindered, by classroom discussion of creationism. Parallels are drawn between creationism and other scientific misconceptions, both of the scientific community in the past and of students in the present. Science teachers frequently handle their students' misconceptions as they arise by offering appropriate socio-cognitive conflict, which highlights reasons to disbelieve one idea and to believe another. It is argued that this way of working, rather than outlawing discussion, is more scientific and more honest. Scientific truth does not win the day by attempting to deny its opponents a voice but by engaging them with evidence. Teachers can be confident that evolution has nothing to fear from a free and frank discussion in which claims can be rebutted with evidence. Such an approach is accessible to children of all ages and is ultimately more likely to drive out pre-scientific superstitions. It also models the scientific process more authentically and develops students' ability to think critically.

Keywords: *Creationism; Evolution; Socio-cognitive conflict; Misconceptions; Classroom discussion*

> For a biologist, the alternative to thinking in evolutionary terms is not to think at all.
>
> Peter Medawar

Introduction

Recent controversy over the teaching of creationism in UK secondary schools has been bitter (Williams, 2008). The debate has been every bit as heated as that over the truth or falsity of creationism, or so-called 'intelligent design', itself (Pennock,

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2003). Holliman and Allgaier (2006) and, more recently, Allgaier (2011) argue that the media have played a significant role in influencing the course of public debate. The resignation from the Royal Society in 2008 of Michael Reiss, professor of education at the Institute of Education in London and a Church of England clergyman, following a speech which was widely misinterpreted, highlights the sensitivity of the issue (Baker, 2010). Although in his speech Reiss had described creationism as having 'no scientific basis', his suggestion that it might be debated in science classrooms went too far for many of his peers (Sample, 2008). At the time of writing, a group of 30 scientists, including David Attenborough and Richard Dawkins, 'have called on the government to toughen its guidance on the promotion of creationism in classrooms, accusing "religious fundamentalists" of portraying it as scientific theory in publicly funded schools' (Butt, 2011).

While the scientific evidence for the theory of evolution is at least as compelling as that for any other major widely-accepted scientific theory (such as the atomic theory, for instance), it is still the case that many cling to creationist dogma (Berkman & Plutzer, 2011; Bloom, 2009). In the USA, creationism is still tacitly believed by a large proportion of students, including biology majors (Moore & Cotner, 2009), and, despite claims to the contrary, it is far from being a uniquely American phenomenon (Numbers, 2010), even among science teachers (Kim & Nehm, 2011). There are strong social pressures on young people to accept the perspective promoted by parents and religious leaders in the community, and there is much active distortion in various media aimed at supporting a creationist agenda (Dawkins, 2007).

Although Reiss (2009) prefers to see it as a 'worldview', the predominant categorisation of creationism by scientists is as a misconception. For example, Alters and Nelson (2002) describe 'religious and myth-based misconceptions' as:

> concepts in religious and mythical teachings that, when transferred into science education, become factually inaccurate. Two such misconceptions are that organisms do not have common descent and that the Earth is too young for evolution (and most geological processes) to have occurred. (p. 1895)

Nevertheless, calls for creationism not to be discussed in the classroom distinguish it from other scientific misconceptions which students may bring to their science lessons (Gil-Perez & Carrascosa, 1990). It is as though creationism is just too explosive to entertain. Yet in this position paper, I want to suggest that this could be a mistake. Perhaps by attempting to censor creationism (Petress, 2005) we risk inadvertently raising its status in students' eyes and hindering its exposure as a falsity, making it easier for opponents of evolution to portray themselves as an attacked minority and the theory of evolution as some kind of conspiracy (Moore, 2007, p. 26). If creationism cannot be talked about in science lessons, it will be talked about elsewhere instead—the playground, the canteen, the religious studies classroom, the home, the church—where it is unlikely to be challenged as effectively as it might be by a scientist (Driver, Newton, & Osborne, 2000; Moshman, 1985).

Socio-Cognitive Conflict

One of the most well-established pedagogical techniques for dealing with scientific misconceptions is the deliberate creation of socio-cognitive conflict (Perret-Clermont, Carugati, & Oates, 2004). This occurs when a student's way of thinking is confronted by experiences ('anomalous data') that do not fit in with their current understanding (Limón, 2001). The teacher's intention in doing so is that students will react by re-constructing their mental map, reconfiguring it to accommodate the new information. However, challenges to deeply held long-standing beliefs may be experienced as threatening and, when this is too significant, cognitive conflict can lead to entrenchment rather than belief change. Realistically, a single conversation or lesson is unlikely to move a student from outright rejection of evolution to cheerful acceptance, and stages such as uncertainty, peripheral belief change and belief decrease may be regarded as educationally positive steps towards an eventual acceptance of the theory (Kang, Scharmann, & Noh, 2004). von Glasersfeld (1995, p. 187) comments with regard to physics teaching that 'It is … rather naive to expect that one demonstration in class will induce students to give up a "misconception" which they have found useful in their ordinary lives' and compares this resistance to change with that shown by the scientific community when cherished ideas have been challenged by evidence. An initial conversation might merely sow some seeds of doubt leading to later conceptual change (Cobern, 1994; Lawson & Worsnop, 1992; Sinatra, Southerland, McConaughy, & Demastes, 2003).

Cultivating in students a disposition to think critically is a vital part of a science education (Driver et al., 2000). As Siegel (1989, p. 25) comments, 'In order to be a critical thinker, a person must have … certain attitudes, dispositions, habits of mind, and character traits, which together may be labelled the "critical attitude" or "critical spirit"'. However, although Pennock (2002, p. 28) concedes that 'there is some merit in the idea of considering the creation/evolution controversy as a case study to develop critical thinking', suggesting that at university level this could be practicable, he argues that at high school too much knowledge is required: 'It takes a semester-long college course just to give undergraduates an introduction to evolutionary theory, and one needs at least that much background to be able to begin to judge the evidence for oneself' (p. 28). If this is correct, it is problematic, since we are therefore expecting students to accept evolutionary theory without possessing sufficient knowledge to see the inadequacies of creationism—thus taking on trust from their science teachers that evolution is correct. I once heard a strident atheist student say that it was ludicrous to believe that the earth was only 6,000 years old when science had shown conclusively that it was in fact 6 million years old. He was closer by a factor of 1,000 but still almost 1,000 times out, suggesting that he had perhaps merely exchanged one mantra for another, with limited real scientific understanding. We cannot regard young people as scientifically literate merely because they know some important scientific facts—they need to be able to make evidence-based scientific judgments for themselves (DeBoer, 2000; Oulton, Dillon, & Grace, 2004).

The common advice in creative writing to 'show not tell' is equally applicable to science demonstrations; thinking adults are more readily persuaded of a conclusion when they see it themselves rather than when it is foisted on them (O'Brien, 1991). Students should dismiss creationism because they *see* that it is absurd, not because they are *told* that it is, and it is not necessary to study biology at a highly advanced level in order to do this. Dawkins (2010) most ably presents evidence that can be understood by anyone of any age who takes the trouble to examine it. If there is not time in school science lessons for scientific evidence of the kind he presents, then something is very wrong pedagogically. It does not take a PhD in biology to see the problems with creationism and that there is overwhelming evidence that the earth is nearly a million times older than creationists claim. This can be understood by young children. In a similar manner, several authors have found highly effective ways of debunking pseudoscience for a lay audience, and there may be much that science teachers can learn from the techniques of popular science writing and broadcasting (Goldacre, 2008; Singh, 2008). If science students merely accumulate correct facts without participating in the process of *concluding* that they are correct, they are likely to acquire a warped perspective on what science is all about (Sandoval, 2005). As Spencer (1910) comments:

> To *tell* a child this and to *show* it the other, is not to teach it how to observe, but to make it a mere recipient of another's observations: a proceeding which weakens rather than strengthens its powers of self-instruction—which deprives it of the pleasures resulting from successful activity. (p. 102)

Teaching about the errors of creationism can help students to understand the character of scientific inquiry better, both in and beyond the context of evolution (Pond & Pond, 2010). It might be thought that students are too young to make complex judgments for themselves, but this overlooks the fact that they are inevitably doing so constantly, both in and out of school (King & Kitchener, 2004). It is the science teacher's role to encourage development of this vital skill (Oulton et al., 2004). To expect students to suspend their critical faculties in school and become passive recipients of generally accepted wisdom would be the very antithesis of science.

It might be felt that answering students' questions is one thing but *planning* to discuss creationism is deliberately introducing a misconception into the classroom and wasting valuable time on falsity. On the contrary, I would argue that the process of distinguishing truth from error is the whole business of science, and to spend classroom time on doing so is exactly what science education should be about. Such a journey involves examining numerous pieces of evidence, all of which are factual, and considering how they can be best explained. This is not to elevate creationism to the status of an alternative competing theory—there is no competition; categorising it as a misconception is more appropriate—but the facts that support the theory of evolution simultaneously expose the errors of creationism. It is not unusual for a science teacher to choose to deliberately introduce false ideas in other scientific topics. Some examples of 'discarded science' would be the idea of phlogiston in combustion, of the luminiferous ether in the transmission of electromagnetic waves and of the flat earth in earth sciences (Grant, 2006). A science teacher might even choose to adopt a devil's advocate stance, placing students in the role of combating the teacher's points:

> When you burn a candle, it weighs less afterwards, not more, doesn't it?
> How can a wave travel through 'nothing'? What would be doing the 'waving'?
> If the earth were a ball, the people on the bottom would fall off, wouldn't they?

Most science teachers will have been confronted by students who have encountered conspiracy theories on the internet, such as the idea that the moon landings were fake, and may be skilled at turning such conversations to educational advantage (Bowdley, 2003). Science teachers frequently see part of their role as debunking pseudoscience, and might, for instance, discuss the dilution difficulties of homeopathy in connection with Avogadro's number (Martin, 1994) or the absurdities of astrology in connection with astronomy. In all of these cases, real scientific learning is produced through interaction with false ideas.

It might be objected that science teachers do not have the expertise to address religious views in the classroom, yet in the history of science it has always been necessary for scientists to challenge superstition and false 'common sense' arguments. When teaching Newton's laws of motion, for example, it could be seen as a missed opportunity not to contrast these with popular 'impetus' and Aristotelian notions of 'force', and it is not necessary to be a scholar of Greek philosophy to do so (Gilbert & Zylbersztajn, 1985; Nersessian, 1989). (Important links might also be made to theories that were yet to be established, such as special relativity and quantum mechanics.) Scientific observations and theories inevitably stand in opposition to alternatives, and it is reasonable to expect science teachers to locate them in such contexts. Confronting clashing ideas is not unique to science teaching, and science teachers may benefit from some of the 'softer' approaches used by teachers in other disciplines. Ross (2007), writing with a completely different curriculum area in mind, comments:

> The teacher needs to engage in discussion: to be provocative, to be a chair who permits dissent, who puts forward views . . . listening to others, putting forward evidence and arguments, allowing people to differ, picking up and elaborating points of similarity and difference. This includes putting cases that challenge the children's views—if necessary making it clear that they are not your views—in a way that allows the class to respond, to rebut, and to challenge them. (p. 125)

Modern-day scientific controversies, such as those over the nature of dark matter or the role of string theory or the nature of consciousness, can also be naturally engaging for students if handled skilfully (Oulton et al., 2004). Although there is no controversy among knowledgeable scientists over the truth of the theory of evolution today, there was a time when an honest scientist could be unsure. Likewise, even up to the late nineteenth century, a scientist could argue against the atomic theory (Brock & Knight, 1965). Such historical scientific disputes can be a natural way of coming to see how the scientific community has embraced something which initially may have seemed unlikely or counterintuitive, and the historical process of accumulating and connecting evidence may even mirror students' individual experiences of developing their scientific understanding (Wandersee, 1986).

Conclusion

It is just as important in science to teach the negatives as it is to teach the positives: students need to know what is *not* true as well as what is. (On a mundane level, preparing students for good-quality distractors in multiple-choice science assessments highlights the necessity of this [Haladyna, Downing, & Rodriguez, 2002].) It is naïve to suppose that what is not mentioned in science lessons will be assumed to be false. To be in favour of discussing creationism in science lessons is not to be in favour of *promoting* it; on the contrary, creationism's demise will inevitably follow from its careful examination. Should the Holocaust 'be taught' in history lessons? Should eugenics 'be taught' in biology? To teach about these topics does not imply that they are *good* or *correct* (Brown & Davies, 1998). Many of the debates concerning whether creationism should 'be taught' implicitly invoke a transmission model of teaching, in which the teacher is passing on facts to the students, who are accepting them on trust. Thus, to 'teach' something is to imply that it is true or valid. By contrast, a constructivist paradigm (Cobb, 1994) might be envisaged as placing the responsibility on students to make sense of the evidence and judge for themselves what makes scientific sense. From this perspective, creationism as a case study can be seen as an opportunity for learning real science.

For a student to believe in evolution because they have been told by their teacher that it is true is not much better than believing in creationism because they have been told by their pastor that it is true. Although evolution happens to be right, the belief of such students is simply an acquiescence to authority, little different in character from a religious belief. Although they know a true fact, they know it for the wrong reason. As Russell (2006, p. 74) writes of the Greek philosophers, 'By good luck, the atomists hit on a hypothesis for which, more than two thousand years later, some evidence was found, but their belief, in their day, was none the less destitute of any solid foundation'. Duschl and Osborne (2002) argue that students should be given:

> the opportunity to consider *plural* theoretical accounts and the opportunity to construct and evaluate arguments relating ideas and their evidence ... Not to do so will leave the student reliant on the authority of the teacher as the epistemic basis of belief leaving the dependence on evidence and argument—a central feature of science—veiled from inspection. (pp. 52–53)

Believing in the right thing for the wrong reasons is not a minor problem: students who do take evolution 'on trust' might be presumed to be more vulnerable to being talked out of it at some future point than those who feel the weight of evidence for themselves. Science students should be discouraged from believing *anything* which they have not been honestly persuaded of, by evidence and argument (hence The Royal Society motto '*On the word of no one*'). Otherwise, we may appear to win the evolution issue in our classroom today but leave students vulnerable to more charismatic individuals that they may meet in the future, who may undermine all our good work. With regard to misconceptions generally, von Glasersfeld (1995, p. 187) points out that 'Telling [students] that they have to change their ideas because they are not "true", may create obedient lip service but does not generate understanding'. A disinclination to believe *anybody's* theory, even ours, unless it is supported by convincing evidence, is a much better legacy to leave students with, and will ultimately direct them towards the truth in *all* areas, not just evolution.

Research

A number of research questions remain, which can be settled only by empirical evidence from the classroom:

(1) Does frank and free evidence-based discussion of creationism in the classroom incline students towards evolution or simply entrench creationist ideas? What skills does the teacher need to use in order to help students to benefit scientifically from such discussions?
(2) How much background knowledge of biology is necessary for students to engage meaningfully in such debates? Can this approach be effective in high school or not until university level?
(3) Does discussion of creationism in the classroom assist in undermining creationist 'conspiracy theory' viewpoints, as compared with classrooms where it is a 'no-go' area, or does it merely lend it an unwarranted status in students' eyes?
(4) How might the teaching styles used in the classroom affect the robustness of students' resulting beliefs? For instance, are students who, through discussion, have come to their own conclusions in favour of evolution less easily talked out of it by friends, family or religious leaders than those who have simply taken evolution on trust from their teachers? It would be interesting to see how easy or difficult it is to talk good science students out of their belief in a less controversial area (e.g. atomic theory) and to probe how this might relate to the teaching methods used.
(5) In what ways can teachers support students who are convinced by the scientific evidence for evolution but afraid to admit so? How might students be helped pastorally to deal, for instance, with being ostracised for taking a scientific position on this issue? Would students be more inclined to go with the evidence if they could see that the social consequences of their changing sides could be ameliorated?
(6) How might the answers to all of these questions depend on students' prior beliefs and the social-cultural context of the school? Unlike many other scientific misconceptions, creationism is being vigorously promoted from many directions, so the degree and kind of background exposure is likely to be highly significant.

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