To combat evolution denial, teach kids genetics first

Evolution is one of the trickiest subjects to teach – and not just because some people find it controversial. The ideas are subtle and the language and concepts can be confusing; how many of us have thought that survival of the fittest was an encouragement to go to the gym. Many studies have sought to discover the reasons why evolution is so difficult for students to understand and accept, but few have attempted to find ways to improve the understanding of evolution in the classroom.

As there is such a direct connection between genetics and evolution, we thought that perhaps if you teach genetics before you teach evolution, this might help students understand evolution better. Our large randomised control trial of UK secondary school students, published in PLOS Biology, showed this to be true to a surprising degree.

It seemed intuitive to us that a good understanding of genetics should help understanding of evolution: DNA is the heritable material through which variation needed for evolution occurs. If you understand DNA, you can understand what mutations are. And if you understand what mutations are, you can understand that they can change frequency in populations – and bingo, evolution can happen. In its simplest, evolution is no more than mutations changing frequency. The differences between species started out as new mutations that went from being rare within one species but then became very common.

While this connection might seem self-evident, genetics and evolution are typically taught to 14 to 16-year-old secondary school students as separate topics with few links and in no particular order. Sometimes there's a large time span between the two. Our idea was simple: teach genetics first and look at how that of evolution.

Using questionnaires, we conducted a study of almost 2,000 students over three years. Importantly, all that was changed in our study was the order of the teaching material – exactly what was to be taught was left to the teachers. This meant our study was a realistic mimic of what would happen should any switch be made. We tested students before and after the two subjects were taught and so could examine the extent to which students improved in their understanding.

We found that students who were taught genetics before evolution performed 7% better on knowledge-based questions about evolution than those who learned about evolution first. This is a strikingly large effect – potentially a grade difference in UK school-level exams. Importantly, this order of topics also had a positive impact on genetics knowledge with students who learned genetics first, performing 3.5% better

on genetics-based questions than those students who learned evolution first. This means that teaching genetics first doesn't come at a cost to a student's understanding of genetics.

Schools typically split students by their ability, into higher level and foundation level classes. Importantly, we found that both ability groups did best when taught genetics first.

Understanding vs acceptance

An understanding of evolution and acceptance of the idea of evolution are two different things. Acceptance is the belief that the scientific view of evolution is the correct version: you can understand evolution but not accept it and you can accept it but not understand it.

We found that students typically accepted evolution to a greater degree after taking the genetics class. Both before and after testing, the students with a better understanding were those with higher levels of acceptance. However, these effects were not strong.

We also set up a series of focus groups to find out why the understanding and acceptance of evolution are not more strongly coupled. Evidence from these suggests that what is more important for evolution acceptance is not what is taught, but who provides the endorsement. For some students, being told that key authority figures such as parents or teachers approve of scientific evidence for evolution made a big difference to their ability to accept it.

Television documentaries were commonly given as a source of reassurance about evolution, and some students felt that these, and their presenters, were important in helping them accept evolution. Perhaps more predictable, religious leaders, and their views on evolution, were also of key importance. For students from a Catholic background, being told that the Pope approves of evolution was important in helping them to approach evolution as any other science.

evolution

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Our study was not designed to investigate why teaching order has an effect. Ordering effects like the one we looked at have been seen before – indeed, in the field of artificial intelligence there are cases where ordering matters for computers to learn too. But why does the order matter? Our original idea was what psychologists called "priming" – preloading with some facts to make it easier to take in other information.

But could it also be that teaching genetics first minimises the disruption to understanding that can happen when people think that their beliefs are being questioned or challenged? Many students told us that the perceived conflict between their religious views and the science made it hard for them to study evolution.

Perhaps helping them understand that mutations can change frequency under the banner of genetics

enabled students to learn with less of a clash of ideas? We suggest a simple test: don't teach students material labelled as evolution, teach it as "population genetics" instead – and then tell them after the fact that they have just learned about evolution.

Whatever the underlying cause, the data suggest a really simple, minimally disruptive and cost-free modification to teaching practice: teach genetics first. This will at least increase evolution understanding, if not acceptance. As with many emotive subjects, it takes more than teaching the facts to shift hearts as well as minds.

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