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Left: *Pig In The Middle,* 1999 © Robert Workman
Below: *Learning to Love the Grey*, 2000 © Robert Workman

Science Education, Theatre and Y Touring

By Professor Michael Reiss, Institute of Education, University of London

The problem

Across the world students entering secondary school, at around the age of 11 years, look forward to their science lessons. Science is seen as exciting, up-to-date and hands-on. There is the promise of practical work in real laboratories, something that no other school subject can offer in quite the same way.

And yet in many countries, especially, somewhat ironically, those that can afford good school science laboratories, these same students lose much of their interest in school science over the next few years. By the time they reach 16 or so, they all too often describe their school science lessons as boring and irrelevant, and can't wait to give the subject up.

What has gone wrong?

I am passionately in favour of school science laboratories but I want to argue three things in this piece to celebrate 21 years of Y Touring. First, that science teachers and science educators need to be much clearer about the function and limitations of the science laboratory. Secondly, that the contribution of science education outside of the laboratory needs to be recognised. Thirdly, that the particular contribution of theatre to science education is too often undervalued.

The function of the science laboratory

The science laboratory, whether in schools, in industry or in universities, can fundamentally be understood as a place where a simplified version of nature is presented for interrogation. Consider the simple school practical in which students are asked to determine the boiling point of water. The answer they find, of course, is that it is close to 100 °C. But implicit within this is the fact that the water is 'pure'. Take water in which other substances are dissolved – sea water (where most of the world's water is), for example – and the boiling point will be different.

In this case the benefits of a laboratory are fairly minor – we could take rainwater or water from a stream and get a boiling

point as close to 100 °C as makes no discernible difference within the level of accuracy that this practical is undertaken in schools. But consider another school practical in which students are asked to determine the rate at which organisms (whether woodlice or germinating beans) respire (i.e. taken in oxygen and give off carbon dioxide). This is routine given standard school laboratory equipment and materials (test tubes, manometers, potassium hydroxide and so on). But to undertake such work in the field with any degree of accuracy, as professional ecologists sometimes do, is far more difficult.

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So the science laboratory is a wonderful site for helping to discern the laws of nature. Objects glide along linear air tracks with virtually no friction; substances never found on their own in nature, such as sodium, can have their properties investigated; the growth of organisms can be measured with great precision.

But something is lost – namely the richness of the natural world. The laboratory world is one in which clarity is obtained but only with the loss of intricacy and interrelatedness. The same simplifications that enable laboratory practicals to 'work' (in a way that they cannot in the 'real' world) mean that for many students school science becomes irrelevant precisely because they cannot see the relevance of the laboratory situation to the world around them. It is for this reason that teachers of science need to connect what is done in the laboratory with the world outside the laboratory.

The contribution of science education outside of the laboratory

Science education outside the laboratory exists in various forms. A useful distinction can be made, albeit a distinction that runs the risk of oversimplification, between the natural world, the presented world and the imagined world.

The natural world, for science educators, is archetypically studied through 'the field trip'. Field trips are frequent in biology education but rare in chemistry and physics education. This is unfortunate as students generally find it harder to see the relevance of school chemistry and school physics than school biology to their lives. In any event, field trips, whether in biology, chemistry, physics, earth science or astronomy, can greatly help students not only to connect what they have studied in the laboratory with what they see in the natural world but also to appreciate the artificialities of the science laboratory and the complexities of the natural world.

This, in fact, is a lesson many research scientists have themselves to learn. Just because a technique to improve food supply (e.g. the genetic modification of a crop) works in a laboratory setting doesn't necessarily mean that it will work in nature. There can be (indeed, there often are) unexpected consequences.

The presented world is what students experience when they go to a science museum, a science centre, a zoo or a botanic garden. Here there is generally more complexity than in a school science laboratory but a tremendous amount of decision making has gone into what should be there. In a zoo, for example, the animals on display will be there partly because people are willing to pay to see them (people pay more to see tigers than prawns), partly because they can be kept reasonably straightforwardly (so, few zoos have giant pandas or deep sea fish) and partly because they help to fulfil a zoo's mission for education or conservation (so, endangered species that are not too difficult to breed are especially popular, particularly if they are furry).

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The third of the three categories of the natural world, the presented world and the imagined world exists in various forms. Traditionally the thought experiment (*Gedankenexperiment*) allowed scientists, particularly physicists, to imagine what might happen if. Famous examples include the youthful Einstein wondering what it would be like to travel on a beam of light and Schrödinger musing on his endangered cat.

The contribution of theatre to science education

Theatre in science education draws on the four forms of science education considered above: the laboratory; the natural world; the presented world; the imagined world. The stage is clearly analogous to the laboratory both in its situatedness (the commonalities of touring theatres and initiatives such as 'Lab in a Lorry' just prove the point) and its stripped down version of reality. The performed play incorporates

elements of the natural world in that there are real actors behinds their personae. The play as perfomed is manifestly a presentation. And the play as authored is the product of the playwright's imagination – and as performed and received it incorporates the imaginings of the actors, the director, other involved in the production and, finally, the members of the audience themselves (even without Pirandello).

Consider, for example, two examples of plays, by major playwrights, in which science features strongly: Bertolt Brecht's *Life of Galileo* and Michael Frayn's *Copenhagen*.

In Brecht's *Life of Galileo* perhaps the greatest benefit for a student audience would be to help them get away from a simplified understanding of the relationship between science and religion in which the two are always in conflict. The standard, some have argued 'mythical', version of the Galileo-Church interaction is that as an old man Galileo was imprisoned and tortured by the Church for refusing to abandon his scientific conclusion that the Earth goes round the Sun rather than vice versa. We shouldn't, of course, see Brecht as presenting a neutral view of the issue but even if one ignores the circumstances in which the play was written (shortly before the outbreak of the Second World War while Brecht was in exile in Denmark), even a cursory attendance to the play serves to undermine the conflict model and helps an audience appreciate the historical contingencies.

In Frayn's *Copenhagen* a student audience would be likely not only to deepen their understanding of the physics of uncertainty and the structure of the atom but to gain some appreciation of the way in which such pure physics as discerned by Bohr and Heisenberg was played out against a backdrop of some of the most awful events of the twentieth century. History in physics textbooks is usually either omitted altogether or presented as a sort of muzak for mild entertainment or distraction. Perhaps too students would learn something of uncertainty not only in physics but in history and life in general.

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The particular contribution of Y Touring

I have been going to Y Touring productions or using them in my teaching for at least 15 years. For me one of the things that I have always liked about them is the way they engage with the social and moral aspects of science. While I mainly work in science education, I did spend a number of years writing academic bioethics. I have always been impressed by the way in which Y Touring managed to engage with the complicated implications of 'advances' in medical and scientific technologies in a way that much of the academic literature fails to. Take, for example*, Pig in the Middle*, first produced in 1997. In common with many who have seen it either on stage or on a video / DVD, I found parts of it very moving. It is one thing to write dispassionately, as I and many others have, about whether or not xenotransplantation – the subject of the play – should or should not be permitted and the risks if it were to be, it is another thing to be brought face to face with someone – even a fictional someone – for whom this is not an abstract but a deeply

From Left to Right:

Learning to Love the Grey, 2000
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personal issue. School science rarely considers emotions and yet emotions are part of how we gauge the significance of what we do or what we might do.

As a science educator I have particularly valued the ethical perspectives that Y Touring productions invariably discuss. I have written at some length about whether school science lessons should or should not deal with the ethical issues raised by science. My own view is that they should, so long as the teacher feels comfortable with that. However, we know that many science teachers do not feel comfortable at handling ethical debate in the classroom. Even if they feel such debate would be of value, they often believe they lack the expertise either in handling principles of ethical reasoning or in managing whole class discussions and debates.

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This is where another feature of Y Touring productions – the so-called 'Theatre of Debate' - can help. For a start, the play is followed by a discussion between the members of the audience and members of the cast (as they remain in role). And then there are a number of more conventional on-line resources to support learning. All this is helped by the quality of the plays which benefit from expert Advisory Panels. In the case of *Pig in the Middle* this included a cardiac surgeon, two transplant coordinators, a professor of medicine, a transplant recipient and the director of Animal Aid! Such a list makes clear that the aim of such debate is rarely agreement but critical thought, engagement and an enhanced awareness of the significance of science for all of us.

The future

At a 21st Birthday Party one naturally hopes that a new phase of life is beginning, traditionally one marked by fresh opportunities or by 'settling down' to a more responsible adulthood. It is difficult, though, to see Y Touring settling down – and not just because of the apparently endless succession of financial crises affecting theatre and the arts in general and school-based theatre in particular. I think it likely that theatre will always remain a marginal activity for school science. In one sense, given the capacity, as I have argued above, for drama to enhance learning, this is a shame. And yet there are advantages to living on the margins. On the rare occasions that one is spotted one may hope to make a greater impact. The occasional shooting star can be more impressive than another full moon.

From left to right:

Pig In The Middle, 2005
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