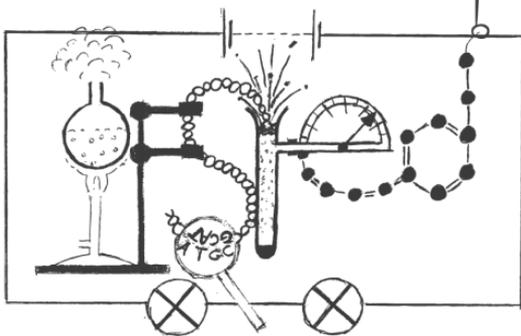


THE PERFECT SCIENCE LESSON



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For the four women in my life: my wife Jackie and our three daughters Kirstie, Lucy and Carrie. Each in their own way has been a role model for all that is best in this book about how to approach learning, and life.

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To all my teaching colleagues in the past, and to all those who still strive to make teaching more enjoyable and rewarding for all – especially my wife, Jackie. Thanks also to Crown House Publishing for all their help and support.

Introduction

There is no ‘perfect’ lesson, not least because there are no perfect teachers or perfect pupils. However, that doesn’t mean that we, and our pupils, shouldn’t strive for perfection.

Ofsted have their version of this Holy Grail set out in the inspection framework and in the descriptors for outstanding in the inspection handbook. This book aims to give some practical advice to help science teachers along the road to perfection – or at least as far as outstanding. It describes the attributes of ‘perfect’ teachers and how, with a growth mindset, you can work towards acquiring all of these. The book shows how you can develop great relationships with your pupils and how you can teach them the habits of effective learners, so that they can get closer to becoming ‘perfect’ pupils, and so become better scientists.

As Ofsted recently said:

‘For pupils to achieve well in science, they must not only acquire the necessary knowledge, but also understand its value, enjoy the experience of working scientifically, and

The Perfect (Ofsted) Science Lesson

sustain their interest in learning it. Pupils in schools need to discover the concepts revealed through observing scientific phenomena and conducting experimental investigations for themselves. Then they are more likely to continue to study science and use that learning for work, for family, and to contribute as informed citizens.'

Ofsted (2013: 4)

Science teachers have the privilege of teaching a subject about which children are naturally curious. It is the subject that answers that great question 'Why?' and opens up pupils' minds to the wonders of both the microcosm and the macrocosm.

Chapter 1

Science Teaching: The State We're In

The intention of this opening chapter is to raise awareness of the issues faced by some primary and secondary schools (and the pupils in them). I describe pitfalls to avoid when teaching now and also when planning the introduction and teaching of the new science curriculum. There is a chance, finally, for good practical work (which pupils love) to become an integral part of learning about science, and for schools to develop a curriculum which truly values the subject and thereby produces model scientists. Let's take this chance and not repeat the mistakes of the past!

Even better if ...

Primary schools saw the end of statutory assessments in science in 2009 and, worryingly, the latest Trends in International Mathematics and Science Study (TIMSS) survey (Martin et al., 2012) showed that the performance of 10-year-olds in science had declined in English schools, relative to their previous survey in 2007. Concerns were also

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being voiced at this time by employers, higher education and professional scientific bodies that too many pupils were leaving secondary school with poor practical, investigative and analytical skills.

Against this background, Ofsted conducted a review of science teaching in both primary and secondary schools and published a report in 2013 entitled, *Maintaining Curiosity*. The report described the best way of raising achievement in science:

‘The schools visited that made science interesting for their pupils, both primary and secondary schools, raised achievement in science. In both phases the most effective approach seen was through practically based investigations. Pupils experienced the scientific phenomena for themselves and then used that experience to raise their own further questions, thereby maintaining curiosity.’

Ofsted (2013: 40)

The report celebrated good teaching practice and underlined how important practical work is to maintaining pupils’ interest and future success in the subject. This is why practical work features so prominently later on in this book. Being an Ofsted report, it also described poor teaching practices. As you read on, consider whether or not you see any of these

practices in your school, and also bear in mind that most (69%) of the science teaching seen was at least good!

There are indications, however, that some pupils are not always getting the best experience of this wonderful subject. I deal with concerns about the primary phase first, but as many of the issues raised are common to both phases, these should also be read by secondary teachers.

Poor primary (practical) practice

In the *Maintaining Curiosity* report, Ofsted noted this concern:

‘Most teachers in the [primary] schools visited no longer provided pupils with time to revise and review their science knowledge, and most prioritised English and mathematics above science, which is still a core subject in the National Curriculum. This is a worsening of science provision since 2011, with about half of the school leaders in the report citing the removal of SATS as the main reason they no longer paid as much attention to science.’

Ofsted (2013: 9)

Worrying enough, but some primary teachers and pupils actually saw science as a sort of respite from English lessons and as a subject where pupils didn’t need to write much.

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‘At its worst, inspectors heard pupils say: “We like science because we do not have to write anything.”’

Ofsted (2013: 10)

They also found that:

‘Almost half of the schools visited were not setting science targets. This emphasises starkly the decline of science, yet targets were set for English and mathematics because leaders and managers knew that this could bring about improvement in outcomes for pupils.’

Ofsted (2013: 21)

Teaching English and maths at the expense of science is short-sighted because science can be an excellent vehicle for teaching these subjects *and* frees up curriculum time. So, use science to teach English and maths!

The main issues raised in the report, and some possible solutions, are set out in the table opposite.

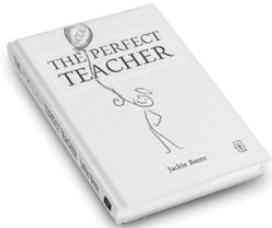
Primary		
What's wrong	How to put it right	Where to find this
Not enough time is given to revise and review pupils' science knowledge.	Spiral the curriculum to revisit and review previous work.	See Johnston (2012)
Almost half of the schools visited were not setting science targets.	Targets are known to improve outcomes for maths and English, so why not set targets for science?	See Chapter 2
Science has a lower priority than maths and English.	Use science as a vehicle for teaching literacy and numeracy (e.g. use science content as material for reading and writing non-fiction, use experimental data for graphical and other numeracy skills, make explicit connections between science and literacy). This practice shows clear evidence of better science and literacy outcomes for pupils (Ofsted, 2013: 10). When the same teacher teaches these subjects to the same pupils, and knows their strengths	<i>cont ...</i>

Primary		
What's wrong	How to put it right	Where to find this
	<p><i>cont ...</i></p> <p>and weaknesses, why wouldn't they use science as a vehicle to do so if it improves outcomes and frees up time?</p>	
<p>The national curriculum content is not always fully covered and science is not being taught with enough emphasis on 'working scientifically'.</p>	<p>Plan for teachers to meet the overarching aims of the national curriculum for science. These aims spell out clearly the central role of scientific enquiry in developing pupils' ideas, skills, knowledge and understanding in a way that sustains their natural curiosity. Teach more of the content through a 'working scientifically' approach.</p>	
<p>Teachers do most of the planning of investigations for pupils, often with detailed step-by-step instructions on worksheets.</p>	<p>First, ascertain pupils' prior knowledge (of skills as well as content) before any practical work is carried out. Encourage more independent thinking especially among the most able. Allow pupils to propose their own</p>	

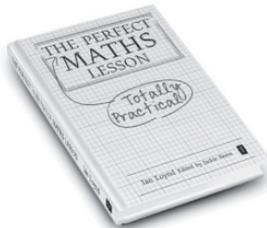
<p>Pupils' skills of scientific enquiry are weak relative to learning content.</p>	<p>questions and then to plan, carry out and evaluate their own investigations in order to answer them.</p> <p>Teach these skills consistently year on year and allow the pupils sufficient time to develop them.</p> <p>Think first about control of variables or fair testing, then specifically develop pupils' skills of observation, drawing, measuring, recording, analysing and calculating. Teach them that designing and doing investigations is central, but that it is just as important to learn how to do this accurately, reliably and consistently. Use skills grids to do this.¹</p>	<p>Show models and exemplars. See Chapter 2</p>
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¹ See the grid produced by Nicky Waller of the National STEM Centre, which has been adapted for 'I can ...' language in science at: <http://www.tes.co.uk/ResourceDetail.aspx?storyCode=6407005>.

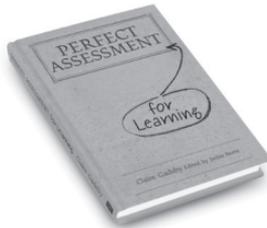
Primary		
What's wrong	How to put it right	Where to find this
<p>Sometimes pupils are simply passive observers of practical work, with little opportunity to work independently.</p>	<p>Don't imagine that doing demonstration work is the same as doing practical work.</p>	
<p>It is essential that pupils develop a healthy scepticism about apparently 'scientific' facts.</p>	<p>Pupils need to recognise that established scientific knowledge is built on repeatable experimental observations and results, not one-off claims. Use stories from the media about the MMR vaccine, food scares, etc.</p>	<p>See note 2 below</p>
<p>Lesson planning is often not adequately differentiated.</p>	<p>Where this is done 'by outcome', make sure that there is sufficiently challenging material for the most able. Design effective, stepped proof activities.</p>	<p>See Chapter 2</p>
<p>Grouping by ability in science is rare.</p>	<p>Ability grouping is common for maths and English. Consider extending this into science.</p>	



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THE PERFECT SCIENCE LESSON

draws together tips and activities, research into the science of learning and Ofsted guidelines for the new curriculum; in fact

all the ingredients science teachers, both primary and secondary, need to create outstanding lessons year after year.

“Excellent ideas and practical tips on how to make this core subject manageable alongside an already over-crowded curriculum. The ideas about running science alongside the maths and English curriculum are well thought out and meet Ofsted’s demands for a truly integrated curriculum that combines knowledge and skills equally.”

Lucy Westley, Primary AST in maths and assessment

“An essential read for all training science teachers. A toolkit with ideas to try out – really useful for trainees hungry for suggestions. I like how it relates to metacognition and the use of learning conversations in relation to peer assessment. This book makes good reference to the relevant literature, whilst making it accessible. It also highlights the important of science in society and positive role models to make it relevant.”

Dr Jo Anna Reed Johnson, Senior Teaching Fellow,
University of Warwick

“The useful and informative guidance in this book should form part of the armoury of all teachers who want to ensure that they deliver effective, informative and enjoyable science lessons. It clearly demonstrates not only the knowledge delivery but also the strategies that practitioners can employ to make learning enjoyable and relevant to their students, regardless of age.”

Ian Fergus, Ofsted Inspector and former Head Teacher

John Beasley has had a highly successful 25 year teaching career as a head of science and later as a deputy head teacher in a school in challenging circumstances, helping to turn it around quickly. More recently, he has worked as a university PGCE tutor, teacher trainer and science consultant.

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