CREATIVE TEACHING *in* PRIMARY SCIENCE

Roger Cutting *and* Orla Kelly

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1 Oliver's Yard
55 City Road
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2455 Teller Road
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CHAPTER 1

INTRODUCING CREATIVE SCIENCE

Chapter aims

By the end of this chapter, you should be able to:

- Define some aspects of creativity and what they might look like in the primary classroom
- Recognize a number of ways to promote creativity in the primary classroom

OPPORTUNITY IN A TIME OF CHANGE

2013 saw the publication of the new National Curriculum for England including the individual programmes of study for science in Key Stages 1 to 3. The main characteristic of the new National Curriculum is its return to the original intention of it providing an outline framework:

> The new national curriculum will set out only the essential knowledge that all children should acquire, and give schools and teachers more freedom to decide how to teach this most effectively and to design a wider school curriculum that best meets the needs of their pupils. (Department for Education (2013a))

Schools will now be expected to design their own additional curriculum and are allowed more flexibility in approaches to its delivery. Science remains a core subject at the primary levels of Key Stage 1 and 2 (although the Key Stages are now divided into years) and the content of the science programme of study has not been 'slimmed down' as have the non-core subjects.

The time line for the introduction is very short and the curriculum itself has had its share of criticism, however, its introduction does undoubtedly present schools and teachers with something of an opportunity. Indeed, that is in part its intention. We should not miss this chance. Innovative approaches and creative ideas will be key to developing a challenging, engaging and enjoyable learning experience for children and hopefully this book will provide some ideas and suggest some possibilities to you.

In 2014 an article appeared in the highly prestigious, peer-reviewed international science journal *Nature* on science education that called for social awareness to be recognized as a core scientific skill, for without this, science disengages itself from the world (Cech, 2014). If we are to genuinely engage children in science perhaps we too need to look beyond the traditional approaches to science teaching. To promote the idea that science does not stand alone, nor is it separate from people, but rather that it compliments and therefore enhances our understanding of all sorts of subjects and contemporary issues would be a good starting point.

WHY WE WROTE THIS BOOK

When we first sat down and discussed writing this book we had to think very carefully about who we were writing for. As you are reading this there's a very good chance that you are either training to be a teacher (if so, good luck with it!) or, you may already be a qualified teacher with an interest in teaching science. If so, you've potentially picked up the right book. We say *potentially* for if you are either a trainee or an experienced teacher and you are looking for a book to provide you with well-designed, practical ideas, with A4 monochrome worksheets to photocopy which specifically address precise aspects of the National Curriculum, well, thanks for your interest, but we'd suggest you put this one back on the shelf and look for something else.

However, if you are interested in taking a journey that will go deeper into not only methods and creative ideas for teaching, but also into the nature of science and what it may, surprisingly perhaps, offer to teaching in primary settings, well then, this might be the book for you. Again, we say *might*, as we want this book to help you to think about science in creative and innovative ways. In some chapters we will explore different sorts of pedagogical approaches that perhaps are not readily associated with science teaching. We like to think of these as 'creative approaches' as they rely on aspects of the creative arts. We also want to look at some of the contributions that teaching science topics can make not only to the broader curriculum, but also perhaps, to the wider school community, particularly in relation to its potential for promoting social education. We feel that science topics can have much to offer here to the personal and social development of children and can provide an effective way of reinforcing and enhancing these aspects of the curriculum. We like to call this 'science in creative contexts'.

DEFINING AND ENABLING CREATIVITY

Before embarking on this journey into creative science, it is necessary to explore what creativity is and what conditions allow it to flourish in the primary classroom. There are three main conceptions of creativity:

1. Sectoral – classifies creativity as belonging to a particular sector, for example, the Arts (and not science).
2. Elite – identifies creativity as only evident in very rare people such as the great inventors, painters, architects, etc.
3. Democratic – recognizes the ability for creativity in all sectors and in all people.

In this book we propose a democratic conception of creativity. Democratic creativity was coined in the NACCCE Report (1999) to mean the creativity of the ordinary person, recognizing that all pupils can be creative. In this, creativity is defined by four main factors; using imagination, pursuing with purpose, being original and judging value. To be creative there needs to be a focus on both outcomes and process. Outcomes need to be original and appropriate. The latter is where judging value is important as are pursuing activities or tasks with a purpose. Originality interpreted as development of globally transformative products, processes, understanding or knowledge is not likely in the primary classroom. However, originality recognized as a child establishing new connections to old ideas or finding novel solutions to problems that are new to them is much more likely in primary classrooms. This fits with the model of 'little c' creativity reported by Schmidt (2010), which is concerned with construction of novel solutions to problems of limited relevance. 'Big C' creativity on the other hand is about the development of transformative performances or products and sits more in the 'elite' conception of creativity.

Creative Scotland (2013) defines creativity as the capacity to generate ideas that have value to the individual, to look at familiar things with a fresh eye, to examine problems with an open mind, make connections, learn from mistakes and use the imagination to explore new possibilities. Ultimately creativity is the ability to make the world anew, to shape the future and enrich the here and now. Education Scotland (2013) recognize that definitions of creativity have similar characteristics, these include; analysis and identification of problems and issues, the exploration of ideas and the processes by which these ideas are realized, implemented, evaluated and refined.

Creative processes and products therefore need both generative and analytical (or evaluative) thinking. Creative thinking is seen as the ability to move between the two. To be fixed in either generative thinking or evaluative thinking only will stifle creativity. Generative thinking, the process of generating and exploring new ideas, is certainly a key element of the creative process but without a reflective lens, the new ideas may not be appropriate or of value. Conversely, analytical thinking, the process of examining an idea and identifying strengths and weaknesses, will suppress any imaginative thought as each will be met with a critical judgment before they have a chance to develop. Therefore to harness and promote creativity, an environment that promotes generative and analytical thinking is essential and children should be encouraged to move between the two as they progress with their ideas.

The process of creativity requires particular learning conditions. Davies et al. (2013) carried out a systematic review of literature on creative environments for learning in schools. Their review identified several key characteristics of the environments and conditions that are most effective in promoting creative skills in children and young people. These included the physical environment, availability of resources/materials, use of the outdoor environment, pedagogical environment, use of environments beyond the school, play-based learning, effective and flexible use of time and relationships between teachers and learners including allowing children to work at their own pace without pressure (pp. 84–8). Howard-Jones (2008) stresses the importance of a relaxed and uncritical environment and working within an area of personal interest as crucial for generative thinking. Generative thinking is influenced also by intrinsic motivation. Fascination and curiosity are intrinsic motivators, therefore an environment that promotes questioning and interest will also support generative thinking. Curiosity is a key scientific attitude as is a willingness to change ideas in light of evidence. Therefore, science is, by its very nature, twinned with creative thinking. Furthermore, Murphy (2005) suggests that learning science enhances the development of creative thinking skills, such as fluency, flexibility, originality of ideas and imagination.

It is interesting that Torrance (1965), an eminent creativity researcher, put forward nearly 50 years ago the following definition of creativity,

> As the process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results. (pp. 663–4)

This definition, a scientific definition of creativity, met resistance, with objections that he had no right to use the term ‘creative’ outside such fields as art, music, and writing. He argued that his definition seemed to fit the creativity of both artists and writers as well as it did that of the creative scientist (Torrance, 1965, p. 665). Fortunately, things have moved on from then and the notion that science and creativity may not be mutually exclusive is certainly plausible but this shall be discussed in more detail Chapter 2.

In his highly regarded Technology, Education and Design (TED) talk (Robinson, 2006), Sir Ken Robinson made a robust case for creativity in formal education stating that it should have equal status with literacy. He argued that all children have tremendous talent and have an extraordinary capacity for innovation. However, he declared unequivocally that children are 'being educated out of creativity'. To be creative, he asserted, you have to be prepared to be wrong, and that the current model of formal education leaves children frightened of being wrong. Unfortunately, this is particularly pertinent in science where there is often a perceived 'right' answer and this notion drives down creativity and divergent thinking. Scotland have rooted creativity firmly in their Curriculum for Excellence and it is seen as fundamental to the definition of what it means to be a 'successful learner' in the Scottish education system (Education Scotland, 2013). Unfortunately, the National Curriculum for England (Department for Education, 2013b) does not seem to be embracing creativity as much.

Activity 1.1

Education Scotland (2013) recognizes three key factors in enabling children and young people to develop creative skills.

1 To help children to take greater responsibility for planning and managing their own learning.
2 The need to establish open-ended approaches to learning, where learners and teachers work together to explore a theme.
3 The potential to use external partnerships to broaden and enhance the learning experience.

As you read through this book, keep these three pillars for successful creativity at the forefront of your thinking.

WHY CREATIVITY IS IMPORTANT

Science is exciting and engaging in many of the ways in which it is already explained and taught. Some teachers, or trainee graduates, particularly with science backgrounds will already hold a clear and functional view of what science is and what is important in terms of teaching it. You may have very clear ideas of what constitutes a scientific approach and quite strongly held views on what is really important for children to understand about 'science methods'. However, such interpretations can framework and even confine your approach to teaching. The issue here of course is not everyone, even within the scientific community may share your view. We may be very different in terms of the subject we studied (such as physics, chemistry, biology) and the different skills and approaches that this imparts. Indeed, it is not uncommon for those with science degrees, training to be science specialists on initial teacher education courses, to express concerns about teaching areas of science that they 'know nothing about'!

If you don't have a science background; don't worry; you are actually in quite; a good position. You are coming to this with no preconceptions and therefore no confines as to what constitutes a scientific approach. If you have a creative arts background, or come from the humanities you may actually have an advantage in thinking innovatively and creatively about science and science teaching. It's the scientists that need to worry! Hopefully this book will be helpful to all.

In this book we suggest that science teaching can be approached in different ways. We can utilize all sorts of creative and imaginative methods and apply these to topics not normally associated with primary science curricula. Of course the obvious question is why should we bother to change? Well, the answer to this is twofold. First, we want to reassure those who are new to science that they have a whole range of valuable skills that can really promote and encourage children to see science as a creative and relevant subject and second, to address a wider issue; that something is going wrong in science education for across many of the 'high-income countries' (including the UK) a distinctive downward trend in the numbers studying science has been recognized (Fensham, 2004). Yet, for those of us who work around children, it is plainly obvious that they are natural scientists in that they have an almost universal curiosity about the world around them. Young children are always asking the question 'why?' Yet, somewhere along the line they appear to lose this curiosity and fascination.

Of course paradoxically in the last 20 years the advances in science and technology have bordered on the revolutionary, particularly in areas such as biomedicine and electronic communications. The technological tools that we have developed now allow us to explore not only adjacent planets but to view horizons that span from the edge of the known universe to sub-atomic space. Never before in our history have we understood so much about ourselves, or the physical world around us and never before have we had the means of communicating this understanding (as well as intriguing questions concerning that which we still do not understand) to such a wide and literate audience. The advances that we have made and the pace of such developments have been little less than spectacular.

It is also undoubtedly true that the planet is facing a seemingly worsening environmental decline and that there needs to be a profound change in the way we live that is based on sustainability. Science also has a profound role in providing the knowledge and skills that young people will need to face the problems that the future will certainly pose.

Given this, how can it be that young people, it would appear, are being put off science as early as 7–8 years old? The only possible answer is somewhat worrying. Children do not tend to 'do' science at home and only rarely in 'out of school' settings. They come across it predominantly at school and therefore something is quite clearly going wrong at this point. Put plainly, children appear to be put off science at school.

This book looks to suggest some ways in which we might not only halt this decline, but also propose methods to engage the natural enthusiasm and interest that children innately possess in the world around them. We suggest that one way in which this may be achieved is by removing the artificial barriers that lead to the compartmentalization of science in primary teaching. We suggest a more holistic approach to science teaching; one that both blurs the distinction between approaches in arts and science and also sees science as an integral part of social, emotional and personal development. In a way we would like children not to be able to necessarily distinguish science from any other area of the curriculum. Going even further, sometimes barriers are not just theoretical, but made from bricks and mortar and in the same way we would wish to see artificial divides removed, we'd extend that wish to the classroom walls. Teaching in the environment, for the environment may be a well-worn phrase now, but it is still a valuable sentiment.

This book's primary objective then is to break science teaching out of any artificial confines. First, it will look at various aspects of pedagogy for creative teaching and learning in primary science, looking among others at the role of misconceptions, working scientifically and, assessment and ways we can use an enquiry approach to teaching. Second, it will look at some creative contexts in the sense of the role of science in areas not traditionally associated with Science, Technology, Engineering and Mathematics (STEM) subjects. It will consider the contribution science can make to social development such as making friends and feeling safe and it will consider how it can be of use in other areas such as the promotion of well-being and sustainability. Other areas include the use of contexts usually confined to the creative arts, including art and drama.

We would like to move science away from being a distinct subject to having a more integral role across the wider curriculum. A potential problem with this lies in the way that science is sometimes perceived. How would you describe science? Logical? Precise? Analytical? Or creative, imaginative and inspiring? Most people would probably draw up a list close to the sentiments at least to the first set of words. We would like to think that the primary outcome of this book would be, having read it, for you to more strongly associate science with the second set. However, before we move on to consider some of these different ideas and approaches, it may be worth reflecting on our own views and experiences.

WHAT DO YOU THINK?

We'd like you to think about your own experiences of teachers and of teaching and reflect upon specific aspects of your own learning. We don't spend long at school (more or less depending where you are in the world) but the majority of us have still attended some form of formal learning and therefore have experiences to reflect on.

When you think back to your time at school there are certain things that will come to mind. If school was a generally positive experience, you will easily remember the ridiculous (and ridiculously funny) things that may have happened. Generally, lessons or/and even subjects that you were taught (perhaps seemingly endlessly at the time) are less well recalled. We have found with our students that it is not uncommon for them to remember almost verbatim certain things teachers said outside the classroom, but hardly anything that was said in it!

Before reading on, look at Time for reflection 1.1.

Time for reflection 1.1

Spend a little time and try to think of the most profound learning experience that you have had? Try to identify one or two events from which you learnt the most.

Having thought of it, was it when you were at school or outside school? How old were you?

If the learning experience that you identified above was not at school, what learning experience do you remember most from your school days?

Again, was it in a classroom, or outside? Was it a special event?

How does reflecting on your own learning experiences influence your teaching?

Every year we ask students to write down their most profound learning experience and every year, it involves something that happened when they were travelling, or working somewhere, or on a placement. Rarely, if ever, do they mention school. When asked to identify key learning events at school, equally rarely does the most profound learning experience ever involve some sort of science. No one identifies 'sinking and floating' as deep, or making circuits (even with buzzers) as transformational. However, if you do have a science background, something must have hooked you, something made you want to carry on with it. If we are to promote and develop science and teach it in a way that inspires children to continue studying it as they progress, then it is important that we reflect on what it was that moved us. After all, what enthused us is likely to excite others; we perhaps need to harvest that enthusiasm and remind ourselves how it feels to really see something for the first time. It is, of course, not only seeing 'things', it is also the excitement of 'doing' science that can inspire. From role playing a marine habitat, to thinking about why it makes scientific sense to be nice to people, science can be without doubt genuinely exciting, inspiring and actually pretty useful.

CHALLENGES

Calls for new approaches to teaching science are undoubtedly not new (see Time for reflection 1.2), the famous Nuffield Science Teaching Project was developed in the 1960s and the Schools Council Integrated Science Project in the early 1970s.

Time for reflection 1.2

'In the early 1960s most primary teachers had little scientific knowledge. Little was known about how children develop conceptual understanding of science. Few teachers had received any training in the use of scientific processes, they did not know what was meant by a variable, and could not design experiments, evaluate evidence or draw valid conclusions. They did not know how to ask or recognize appropriate questions for the children.

The first principle was that children should have the widest possible range of practical experiences rather than just learning facts at second hand. It was thought vital that children should handle materials as well as hear, smell and taste them where practicable. The overall aim was to produce children who are keenly observant, questioning, able to devise means of getting answers to their questions, rigorous in their work and able to communicate their findings and ideas.' Nuffield Junior Science (1966).

How far have things moved on? If you are starting teaching, to what extent does the first paragraph apply to you? How far do you agree with nearly 50-year-old comments on principles and aims?

We have over 50 years of pedagogic and curriculum development as a backdrop to the decline in numbers studying science. Given the amount of time, money and enthusiasm put into these projects to re-contextualize science and to change the approach to science teaching, one wonders about the real impact of any suggested change on teaching approaches. Perhaps the difference here is that we only want to utilize the skills and develop the confidence of teachers in primary settings, not to see science as something daunting and separate from everything else that goes on. In fact to see ways of teaching science that don't necessarily depend on designing and carrying out experiments, that maybe are creative and artistic in the way that data are presented, that can lead to discussions about 'bigger' ideas and concepts, not being afraid to engage in potentially controversial areas. In reality of course, all the characteristics of good science!

What we are **not** suggesting here is a 'new science' but rather different ways of teaching and seeing the old one. Whenever there is an attempt to change the way we approach teaching science, we have to be very wary of slipping into what could be called pseudo-science. Pseudo-science is perhaps best described as something that purports to be scientific, looks scientific, even sounds scientific (in terms of the language it uses) but on close inspection it is not. It is a bit like a science 'tribute band' – it looks a bit similar from a distance, but doesn't stand any degree of closer inspection. It normally lacks supporting evidence, employs non-scientific methods and cannot be reliably tested or verified. In this sense it is different from something that has come to be called 'Bad Science'. Bad Science is just that, poorly designed, erroneous results; it is generally just poor practice. Any endeavour, however noble and well intentioned can be carried out badly, it sometimes happens and can be understood. Pseudo-science cannot. In this book we have tried to be careful in avoiding any accusations of pseudo-science and so should you.

We've all come across ideas such as science in the kitchen or activities that involve onomatopoeic words like 'boom, bang, crash!' These are fine, but we consistently look at the subject and outcome, rather than the processes. This is curious, as science is a process, yet we rarely try to sell it as such. One very obvious activity that gives all sorts of wrong messages, is the 'kitchen volcano', when putting vinegar on a pile of baking soda is meant to give you a model volcanic eruption. Actually, the reaction tends to be short-lived, neither tells us much about volcano's nor the chemical reaction taking place. Yet still this activity is promoted. Simply putting the baking soda on a digital scale and looking at what happens to its mass as you add a known mass of vinegar might lead to some intriguing questions about reactions. Also, as the loss will be quite small the experiment would be need to be replicated a number of times, so again, a better introduction to real science.

This of course, is the objective of this book and it's not easy. How do we make science really engaging for children, but at the same time avoid the pitfalls of reducing the robustness of the subject?

Furthermore, while science remains a statutory subject in the national curriculum it is increasingly under pressure from other subjects. One way forward is to better integrate science across the curriculum. Of course this is easier said than done and often such integrative approaches do neither the primary subject area, nor the integrative science area much good.

Children should be involved in an exploration, both in the sense of hands-on and mind-on. In other words, being engaged in problem solving, designing experiments, drawing conclusions. Wherever possible you should go with them on the adventure. Don't feel that you need to know the answers; be a fellow explorer. It really doesn't matter, if you all come up with something that's not quite right; that's half the fun and that's the nature of science.

FURTHER READING

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This paper, an in-depth study of two primary schools recognized nationally for their creative approaches, offers pertinent insights into their creative teaching and learning practices. Three characteristics emerged co-construction, high value placed on children's ownership of their learning and high expectations in skilful creative engagement.

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