Science has a need for a PR makeover: it is often regarded by adults as a hard, rather dry and boring subject, and certainly not the creative, exciting and relevant subject that it is. Young children do not share this negative view, but many have been ‘turned off sciences’ by the time they reach adulthood. (Gardner, 1985; Bricheno, et al., 2000; Johnston and Ahtee, 2006). Part of the problem is that we do not understand how the concept of creativity can be applied to science; another is that science is not always taught in a creative way. In this article I will try and address these two issues and provide some ideas for creative science teaching and learning in the primary school.

What is creativity in science?
Creativity involves more than making something new or creating something, and can be applied to both the sciences and arts (Prentice, 2000). It also involves thinking and problem solving (de Bono 1992; Beetlestone, 1998), as well as discovery (Johnston, 2004) and innovation. The primary strategy endorses creativity by:

- ‘Making learning vivid and real, by developing understanding through enquiry, creativity, e-learning and group problem-solving;
- Making learning an enjoyable and challenging experience, by stimulating learning through matching teaching to learning styles and preferences;
- Enriching the learning experience, by developing learning skills across the curriculum’.

(DfES, 2003: 29)
A cross-curricular approach to science, which was a characteristic of the early National Curriculum, can make these kinds of creative links across the curriculum (Duffy, 1998) and support individual creativity. Unfortunately, the creative, child-centred discovery approaches advocated by the Plowden Report (DES, 1967) gave way to more subject-focused and mechanistic styles of teaching with the introduction of rigid strategies (DfEE, 1998; DfEE, 1999). Creative science does not focus solely on the acquisition of limited scientific knowledge, but involves the development of relevant scientific understanding, skills and attitudes in a cross-curricular way, so that knowledge and skills can be applied in real situations (see Johnston, 2005).

Creative science also involves taking risks in thinking and acting, and so creative scientists not only develop new ideas, models and applications, but challenge orthodox views and scientific theories. Remember that science is not a body of facts, but a body of theories, with the best and current theory being the one we hold at the present time.

**Historical creativity**

Examples from history show science to involve innovation, discovery, creative thinking and risk taking. Famous scientists, such as Leonardo da Vinci, Copernicus, Darwin and Galileo, were highly creative, producing significant scientific ideas, many of which led to technological advances or deeper understanding of the world. They also took great risks in a world which was reluctant to accept their ideas. Copernicus, Galileo and Darwin invoked the considerable wrath of the Church in expressing their ideas about astronomy and evolution, and were publicly humiliated, tortured and imprisoned for their views. What greater risk can there be? Other scientists, such as Archimedes, Pasteur and Newton, have created new ideas which have advanced our thinking and had practical applications, such as levers to make lifting heavy objects easier, pasteurisation of milk products and lenses to help us see.

**Creative science teachers**

Creative science teachers are interested and knowledgeable about science but, more importantly, they acknowledge that they have a lot more to learn about the world around them and have the thirst for knowledge that we want to develop in children – the awe and wonder of science and scientific phenomena. They are flexible, adapting their teaching to suit the learning objectives, children and context, and do not follow rigidly imposed methodologies which have a negative impact on science teaching and learning (ASE, 1999). Creative science teaching and learning is active and child-centred, involving individual problem solving and exploration (Johnston, 2005a). Creative science teachers make their own decisions about teaching approaches that will help individual children to be independent thinkers and learners (QCA, 2003; DfES, 2003). Fraser and Tobin (1993) identified creative science teachers as:

- managing their classrooms effectively
- using teaching strategies which focus on the children’s understanding
- providing learning environments which suit the children’s learning preferences
- having a strong content knowledge
- encouraging children’s involvement in classroom discussions and activities

Creative science teachers provide stimulating learning environments, in which children can observe, explore and think about scientific phenomena, interacting with other children, and with adults who support their development through challenging discourse. Through skilled interaction, the creative science teacher can challenge ideas and interpretations, facilitating learning which is life-long rather than imparting ephemeral knowledge.

It is wonderful that creative science teachers are acknowledged as Advanced Skills Teachers, through Science Teacher Awards and as Chartered Science Teachers (see ASE 2007), although the potential for creativity is in all primary teachers. The problem for some teachers is that teacher training in the last ten years has struggled to balance the need to use and understand curricular requirements and strategies with creativity. It can be done, and we will look now at how we can make creative primary science a reality.

**Cross-curricular science**

In the Foundation Stage and Key Stage 1, cross-curricular play and exploration has been well established. This ranges from exploratory play, stemming from the children’s interests, to play areas. Reading the story of *Mr Bumbleman’s Bakery* (Green, 1978) can lead to exploration of how different materials (flour, salt, oil, water) mix together and change to make dough, and how drying and cooking it makes it change again. Children can:

- read the story (language and literacy)
- make their own dough, measuring the ingredients (mathematics) and exploring the different materials and how the mixtures change (science)
- sell the finished products (mathematics)
- make price labels for the bakery shop (language and literacy)
- make their own pizza dough bases and toppings (technology)
Other ideas for cross-curricular science in the Foundation Stage and Key Stage 1 can be found in the Primary Partnership publications (see de Bóo, 1999) and other publications (e.g. Johnston and Herridge, 2004; Johnston, 2005).

Some Key Stage 1 and 2 schools have developed creative schemes of work that use the six key areas of the Foundation Stage (Personal, Social and Emotional Development; Language, Literacy and Communication; Mathematical Development; Knowledge and Understanding of the World; Creative Development; Physical Development) throughout primary education. This is a highly creative approach to covering the curriculum and involves teaching science in a holistic context. For example, one class, as part of their study of World War 2, built an air-raid shelter in the classroom. They explored what school and home would be like in historical times, reading extracts from books such as *Tom’s Midnight Garden* (Pearce, 1958). The science involved investigating structures and forces whilst building their shelter.

I have used *Stig of the Dump* (King, 1983) as a starting point for investigating different sorts of rubbish. During the term we:

- collected rubbish from around the school
- decided the best place to put new waste bins in and around school
- sorted and classified clean rubbish according to its physical properties
- investigated the decomposition of waste in different conditions (burying in wet and in dry ground, placing in a compost bin with and without worms to aid decomposition, or leaving in a metal box)
- explored recycling rubbish, selling cans to raise money for the school and using waste paper to make our own paper pulp and different types of paper (see Richards, 1991)

We invited a local waste disposal company to visit school and, as a result, the children decided to initiate a school recycling programme, identifying what recycling points could be placed in the school, such as bottle banks, aluminium can banks, newspaper and bottle-top recycling points.

These types of cross-curricular activities are not just motivating – developing understandings, skills and attitudes in a fun way – they also cover a great many curricular requirements. The children can also see the relevance of science to everyday life. In this way, some of the arguments against creative science teaching regarding time, coverage, control, safety and the achievement of learning objectives can be resolved. The time is well used, and many objectives can be achieved in one activity. Control is not an issue as the children are well motivated and manage their own behaviour as well as their learning. In fact, you can have more control over the children’s learning by being less controlling of them. The focus on the application of real-life science – very important to
creative teaching – helps children to develop conceptual understanding. Children acquire skills through practical work, rather than in response to didactic teaching.

Problem solving
Setting small challenges and allowing children to solve problems for themselves is also a creative way to achieve learning objectives. These can range from simple challenges, whilst children are playing or exploring, to more sophisticated problem-solving activities. Children playing in a water trough can be asked how they can make something that floats, sink, or something that sinks, float. Children can also be challenged to problem-solve by asking, ‘What do you think will happen if….? questions. Bigger problem-solving activities include building a strong bridge using a piece of A4 paper or ten art straws and some adhesive, or making a tall tower or a strong paper bag. Children can also make musical instruments that are ‘played’ in different ways to produce sound, such as by plucking, hitting, blowing and shaking. A further challenge is to make instruments that produce a range of different notes or even a scale.

Another problem-solving activity is to make a rubber-band powered vehicle (see Picture 2). This can be made with anything cylindrical, such as cans, tubes and reels. The construction involves putting a rubber band through the cylinder and fastening it to the cylinder at one end and a stick at the other. When the stick is wound up and the vehicle placed on the floor it will move along – sometimes in a straight line and sometimes in a circle. The children need to make a successful vehicle that will either go the furthest, quickest or in a complete circle. Then they explore the reasons behind the most effective performance.

Another problem is to find out which pen wrote a secret message. A message is written using a black felt-tip pen on some blotting paper. The children can find out which pen, from a selection, wrote the message by using a forensic science technique called chromatography. To do this, they need a collection of different black felt-tip pens and markers, some blotting paper cut into strips (15 cm by 4 cm approx), a plastic tray filled with water, some string and some washing pegs. The string should be hung over the tray of water like a washing line and the message can be pegged so that its end is just in the water. The paper will soak up the water and the ink will run, revealing colours and patterns of colours unique to that type of pen. This is because of the unique combination of pigments making up the colour black (unique to that type of pen). The pen that was used to write the message can be found by putting a mark or some writing on the strips of blotting paper using the different pens, and hanging them in the water. Once the colours and patterns are revealed, they can be compared with the pattern on the message.

Motivating experiences
Children can be motivated through the provision of creative science experiences which enable them to discover new ideas and experience new phenomena. Discovery learning was advocated by Plowden (DES, 1967), and popular in the 1960s and 1970s. It is an approach that I have attempted to reinvent and use in primary education (Johnston, 2004). Discovery learning is motivating, as children and their needs are central and children choose what to explore and how to do it, constructing their own understandings in the process and being supported by the teachers and their peers.

Children of all ages can explore their environment using all their senses, looking for patterns in their observations as well as similarities and differences in the environment. This will also help them to make sense of the world around them, developing both their knowledge about plants and animals and their observational, classification and interpretation skills. I encourage children to close their eyes and smell, and to feel and listen to things in the environment. They can hug a tree and feel the pattern of the bark and then make a rubbing of the pattern with a wax crayon. They can use a paint colour chart with different shades of colours to see the range of colours in the environment. Don’t just use greens and browns – yellows, reds and blues can also be found in stones in gravel paths, bricks and flowers. Children can use magnifiers to enlarge small things and take small things back to the class to enlarge further using a microscope (the digital one attached to computers and multi-media projectors are particularly good).
Thinking Skills

Creative science experiences also involve the children in developing their thinking skills. This can happen through challenge such as problem-solving activities as described above. Another challenge can be by exposing the children to different ideas through discussion and debate. Deep discussions that enable children to share, explore and analyse ideas can be stimulated by a range of activities such as:

- Concept cartoons (Naylor and Keogh, 2000; Naylor and Keogh, 2000a), which identify different ideas about a specific concept.
- Concept probes (annotated diagrams which encourage children to analyse a concept and identify their own ideas)
- Unexplained phenomena, which sometimes children consider to be the results of magic lead to similar

These approaches allow for the truths that not everybody has the same ideas and that there is often not one correct answer. Teachers can play devil’s advocate by providing alternative explanations for what children observe and experience. Thus, they challenge children’s ideas and provide a model that children can emulate when they challenge each other.

In Summary

Creativity is an attribute that we can all develop and is not exclusively to be found in the arts. Creativity in primary science involves children in solving problems and thinking laterally. We need to support children in being creative in science and for this to occur we need creative teachers, who think flexibly and provide motivating experiences for the children in their care, because as W. B Yeats said ‘education is not the filling of a pail but the lighting of a fire’.

References

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Using puppets


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