Primary Science and Creativity: Strange Bedfellows?

Orla Kelly[1] and Roger Cutting[2]
[1]Church of Ireland College of Education; Plymouth Institute of Education, University of Plymouth[2]

Subjects like visual arts, drama and technology are by their very nature perceived as creative whereas science is not. This is observed in a simple comparison for words starting with 'creat-' in the visual arts and science curricula in the Irish Primary Curriculum. There are more than 100 instances in visual arts but just 16 in science. In this practice-focussed paper, a case will be made for the importance of creating space and time for creativity in the primary science classroom. The benefits of considering creativity in science will be shared, including supporting the development of science skills. Fortunately, the primary science curriculum naturally lends itself to creativity through its focus on investigations and problem-solving. Furthermore, inquiry-based science education is rich with opportunity for creativity. Other creative opportunities include using integrated approaches which can be employed to help children better understand science as well as develop scientific attitudes and skills. As well as sharing examples of such inquiry and integrated approaches, various aspects of pedagogy will also be considered through a creative lens.

INTRODUCTION

What is creativity in school (science)?

Creativity can be conceptualized in three ways; one is that it belongs to a particular sector for example the Arts; another is that is only evident in very rare people such as Albert Einstein; the third and the one that defines creativity in schools, is the ability for creativity in all sectors and by all people. This is democratic creativity. (NACCEE 1999) In an interview with Sir Ken Robinson, he stated that one misconception people have about creativity is that '*is that it's about special people—that only a few people are really creative'*. He adds that *'Everybody has tremendous creative capacities. A policy for creativity in education needs to be about everybody, not just a few*' (Azzam 2009).

Creativity is defined by four main factors: using imagination, pursuing with purpose, being original and judging value. On first glance, there may seem to be little space for being original in the primary classroom but this can be seen as a child thinking about things in different or unexpected ways, making connections between new ideas or experiences and old ones or finding novel solutions to problems which are new to them. Creativity requires a balance between generative thinking, the process of generating and exploring new ideas and analytical thinking, examining ideas and identifying strengths and weaknesses.

'*Being Creative*' is one of the six key skills of the new Junior Cycle Curriculum in Ireland (NCCA 2013). This development is welcome one. This key skills framework largely mirrors the focus on thinking skills and personal capabilities in the revised Northern Ireland curriculum (CCEA 2007a), where 'Being Creative' is also identified as one of the key skills and capabilities. By being creative '*Children should be able to use creative approaches to be imaginative and inventive, to explore possibilities and take risks in their learning'*. Furthermore the development of these skills and

capabilities are at the heart of the Northern Ireland curriculum from foundation stage right through to key stage 4, the full range of formal education.

More interesting in the Northern Ireland Curriculum is that in the primary curriculum area 'The world around us – science and technology', there is explicit guidance around being creative through curiosity, exploration, flexibility and resilience (CCEA 2007b). Here children are expected to be creative in science. This suggests a positive shift in the relationship between science and creativity. However, doing a simple comparison of words starting with 'creat-' in both the Science (DES/NCCA 1999a) and Visual Arts (DES/NCCA 1999b) primary curricula in Ireland reveals that while there are over 100 instance in visual arts, there are only 16 in science. These are shown in Table 1.

Table 1: The instances of 'creat-' words in the Science and Visual Arts Curricula

	Creativity	Creative(ly)	Create(s)(d)	Creation	Creating	Creature(s)
Science	0	4*	7	3	2	0
Visual Arts	4	11	60	1	24	5

BACKGROUND

Benefits of considering creativity in primary science

The importance of creativity in current education discourse is largely to do with children and young adults having the necessary skills and capabilities to face the uncertain and challenging future which lies before them. Natural resources are under threat and diminishing in a time of population growth. Access to clean water, food, education and health care will become ever increasing difficulties across the globe. This is coupled with the global concerns around climate change and energy resources. Sir Ken Robinson states that '*we're going to need every ounce of ingenuity, imagination, and creativity to confront these problems'* (Azzam 2007). Moreover, technology is developing at an unconceivable rate and the future possibilities and directions are vast. Additionally, employers are calling for innovative and critical thinkers to compete in a global market. Therefore, teaching for creativity is essential in education. This needs to start from the early years and continue right through to further and higher level education.

Of course, the role of STEM subjects in tackling these problems is crucial and creativity therefore needs to be central to these subjects. The primary science curriculum states that '*Investigations and problem-solving tasks nurture the inventive and creative capacities of children*' (DES/NCCA 1999a p. 6) Furthermore, one of the core aims is to '*foster the child's natural curiosity, so encouraging independent enquiry and creative action'* (p. 11). This suggests a strong link between creativity and investigations and enquiry. Investigations and enquiry demand that children develop and use scientific skills. The science curriculum (DES/NCCA 1999a) states that science skills will be developed as work is completed on the strands and strand units of the curriculum. This is important and we would strongly advocate for working scientifically taking the central stage in primary science. As well as fostering creativity, through working scientifically children also develop important scientific attitudes such as curiosity and respect for evidence. There are seven key skill areas

which are developed through the primary curriculum. Each of these encourages creativity and allows for children to be creative. As part of the new Junior Cycle Curriculum (NCCA 2013), learning outcomes for 'Being Creative' have been devised. Table 2 shows the working scientifically skills developed across all stages of the primary science curriculum and how these link to being creative using these 'Being Creative' learning outcomes as a framework.

Table 2: Working scientifically skills developed across all stages of the primary curriculum mapped to being creative

Working scientifically	**Being creative learning outcomes (NCCA 2013)**
Questioning	Imagine different scenarios
Observing	Seek out different viewpoints and perspectives
Predicting	Predict different outcomes
Investigating and experimenting	Think through a problem step-by-step, test out ideas, try out different approaches when working on a task, take risks and learn from mistakes and failures
Estimating and measuring	Repeat the whole exercise in necessary
Analysing	Evaluate different ideas, evaluate what works best
Recording and communicating	Express my ideas through movement, writing, music, art, story-telling and drama

While the 'Being Creative' framework offers some scope for thinking about creativity in science, it neglects other areas such as working with others, communication and using information. These are all important aspects of creativity. Fortunately, these are also recognized as other key skills within the new Junior Cycle Curriculum (NCCA 2013). Sir Ken Robinson recognized the central importance of collaboration in creativity stating '*The great scientific breakthroughs have almost always come through some form of fierce collaboration among people with common interests but with very different ways of thinking'*. (Azzam 2009) Furthermore, he offers that collaboration, diversity, the exchange of ideas, and building on other people's achievements are at the heart of the creative process. Therefore, children need to have opportunities to share ideas, work collaboratively together, build on existing ideas and to follow their own ideas in science to allow for creativity to flourish. Luckily these are easily achieved in the primary science classroom, particularly one which advocates and values experiential and inquiry based approaches to science education.

CREATIVE APPROACHES IN SCIENCE EDUCATION

Inquiry based science education (IBSE)

IBSE is being advocated in both Europe and beyond (Rocard et al. 2007, Osborne and Dillon 2008, National Research Council 2012) According to Rocard et al. (2007) inquiry based approaches proved their efficacy in science learning at primary level with increasing both children's interest and teachers' willingness to teach sciences. In

this report, it was stated IBSE emphasizes curiosity and observations followed by problem-solving and experimentation. Also, inquiry-based methods provide children with opportunities to develop a large range of complementary skills such as working in groups, written and verbal expression, experience of open-ended problems solving and other cross-disciplinary abilities. An inquiry based approach has the potential for promoting creativity, however such experiences need to be carefully planned to ensure that these are child led rather than teacher led and allow for real collaboration and exploration. They also need to be purposeful so that children can judge and evaluate the outcome, solution or product.

Cross-disciplinary approaches

There is also real potential for creativity when science teaching and learning is integrated with other subjects. As already highlighted the Arts can be seen as the home for creativity and this is with good reason. However, visual arts, drama and music can be integrated effectively with science to encourage creativity and develop knowledge understanding and skills. For example, stories provide a natural hook for children and from here they can explore a myriad of science concepts using drama techniques such as freeze-frame and conscience alley. Kelly (2012) described the use of the popular Disney story 'Finding Nemo' and drama to develop science ideas around food chains and habitats. From here the discussion can move to controversial issues such as over-fishing and whaling.

Integrating science with visual arts has particular scope when considering living things. Painters the world over have been inspired by the natural world. By doing pencil drawings, children are encouraged to develop their observation skills, noticing details such as lines, textures and colour. This is particularly effective when considering one object e.g. a leaf, a snail or a cut orange. Children will begin notice less obvious features. Such observations have the potential to lead to questions which may then open the path to a child-led investigation. This provides a snap-shot of the potential for creative approaches in science. Teaching science outside the classroom, considering the science of health and well-being and the science of sustainability and other controversial issues all offer scope for creativity teaching and teaching for creativity in primary science. These are discussed in the forthcoming publication by Cutting and Kelly (2014).

Pedagogy for creativity

While such approaches may seem inviting, teachers' concerns around the demands of planning and assessment may be a natural barrier. However, luckily in Ireland teachers are free to choose how and when they assess their children. Equally approaches that allow for children to self-and peer- assess are encouraged. The classroom assessment methods promoted by the NCCA (2007) include:

- Self-assessment
- Conferencing
- Portfolio assessment
- Concept mapping
- Questioning
- Teacher observation

The inquiry-based approaches advocated in this paper along with collaborative learning offer scope for teacher observation and conferencing. Equally when children are engaged in inquiry and other creative endeavors teachers can question children for

both formative and summative purposes. Through concept-mapping children can make sense of their own ideas. This is where the balance between generative and analytical thinking, central to creativity, is important. Children can use concept maps to generate ideas, making connections between ideas and experiences, however, analytical thinking is needed to ensure these ideas make sense and are purposeful to the task at hand.

Every lesson and scheme of work should be carefully planned and this is no different when considering creativity. Creativity won't just happen in the classroom without the teacher planning experiences and activities which have the correct balance of teacher input and independence and choice for the children. Equally the resources available and the timing need to be considered. Again, these issues and others are further discussed in Cutting and Kelly (2014).

CONCLUSION

In this period of welcome curriculum reform and consultation, it is essential that creativity is seen as a skill which is encouraged and developed across all areas of the curriculum and at all levels. The NCCA will shortly be inviting contributions for their consultation *Primary Curriculum: New Pathways for Teachers and Children* (NCCA 2014) and it is hoped that this paper has provided some food for thought and made a case for creativity in primary science. It is however acknowledged that initial teacher education needs to respond to such changes. Equally continuing professional development courses are needed to develop teachers' confidence in such approaches and methods. This has been an issue when implementing inquiry-based approaches in Ireland and more widely. (Dunne 2013)

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