Chapter 5 – Planning and assessing creative approaches in science

Chapter aims

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

- Recognise a number of key strategies for effective planning for creativity in science
- Discuss the issues and concerns surrounding assessment in science
- Develop ideas around effective assessment in science and assessing creativity

Introduction

A creative classroom doesn't just happen with a change in mind-set. A creative classroom requires reconsideration for a range of factors including the physical environment, the teacher's role and identity, the behaviour and learning expectations and the role of assessment. This all requires careful planning and there can be tension for teachers and children with moves towards a more creative classroom.

One of the first things that happen when children start in primary school is that they begin to embed routines. These range from the practical (what to do when you first come into the class in the morning, what to do when you need to use the toilet); to routines for learning (how to use group resources, what to do when you don't understand something or an instruction). These routines provide reassurance for the child and a safe place for learning. However, children, like adults, will get used to these routines and expectations for behaviour and learning in the classroom and some may struggle with a sudden change in the learning environment. This is particularly the case for children with an autism spectrum disorder, where small and big changes in routines need to be carefully planned and managed. Equally for the teacher, who will have worked hard to build and establish routines and procedures in the classroom, there may be reluctance to alter the status quo. However, risk-taking is part

and parcel of creativity so to ensure smooth transitions to a more creative classroom a number of factors need to be considered.

Teacher identity

Planning for a creative learning environment requires focusing on your own identity as a teacher. Odena (2001) suggests that conceptions of creativity held by individual teachers have been found to influence their pedagogic approach and assessment of activities that are meant to develop creativity of their children. Cunliffe (2008 p. 315) highlight the conditions for fostering creativity, including elements of the teacher's ability and desire. He suggests that in order to foster creativity the teacher should:

- Have a cooperative socially integrated style of teaching
- Enable children to learn to cope with frustration and failure, so that they have the courage to try the new and unusual
- Encourage children to learn independently
- Promote self-evaluation
- Encourage flexible thinking
- Offer children opportunities to work with a wide variety of materials under different conditions
- Take children's ideas and questions seriously

Fostering creativity in children also requires teachers to think creatively themselves. Desailly (2012) describes the need for combinatorial, exploratory and transformative creativity, the very elements of creativity that we are encouraging in the children. The ability to combine

ideas in unpredicted or alternative ways, thus providing the children with a broad and rich curriculum (2012 p. 84), requires relevant subject knowledge and the confidence to apply it. Exploratory creativity allows for exploration of ideas, even if they lead to 'failure', coming to the realisation that something doesn't work is in itself a useful outcome. This is something children (and teachers) will have to learn to deal with and come to expect when working creatively. Coupled with this, when considering creativity in science, teachers may have to challenge their existing ideas about the nature of science and how scientists come to develop knowledge and understanding. This has been considered in more detail in chapter 3.

[start box]

Time for reflection 5.1

It is nearing the autumn half-term break and the local amateur drama group have asked your class to sing as part of their matinee Christmas Pantomime show. The children are very excited about the prospect of this. As the class teacher, you have a decision to make. Do you

a) Say thank you but no thanks, it will take too much time away from the curriculum and planned activities?
b) Say thank you, we would love to and use the singing time to prepare?
c) Say thank you, we would love to and use the children's excitement and motivation to plan a whole scheme of work around the theatre, including linking with their earlier work on light and sound in science?

The creative teacher will answer (c) but this is not without potential problems.

[end box]

Teachers will have responsibility for teaching certain curricular areas and this must be taken into consideration. Does this creative opportunity allow for extended learning on concepts already covered? Will it clash with concepts and ideas which are planned for the next year? Does it allow for further skills development? These are all things which need to be deliberated and discussed with the other teachers involved. There is a balance between recognising the potential for enquiry and taking advantage of such opportunities as described above and teacher's responsibility for teaching certain curriculum areas during the school year. (Desailly 2012 p. 83)

Assessment

Assessment is a word that immediately conjures up a lot of ideas and emotions and quite often negative ones. Luckily assessment can take many different forms, particularly in the primary classroom. There are generally two accepted purposes of assessment, formative or assessment for learning which is used as part of everyday practice and summative or assessment of learning which is used to sum up learning on an individual, class, school, local and national level. An important point raised by Harlen (2012) is that what determines whether assessment is formative or summative is not what information is collected or how it is collected but how it is used. (p. 9) Therefore, this chapter will not discuss strategies for formative or summative assessment, instead strategies will be discussed which could be used to inform learning or sum up learning. Wynder (2008) suggests that assessment can impact upon the development of creativity by motivating or impairing the implementation of creative activities. Furthermore, Davies (2000) suggests that use of assessment for summative purposes, combined with a rigid and prescriptive curriculum, is a huge obstacle against creative education. This is further supported by Ponchaud (cited in Murphy 2005 p. 113) who

states that the prescriptive nature of the National Curriculum and the imposed assessment tasks can work against teachers' creativity and their willingness to step outside the box. However, Craft et al. (2014 p. 26) state that it is really important that people don't think that standards and creativity or having fun being outside are somehow mutually exclusive' and this is something which will be addressed in this chapter.

Current state of primary science assessment

The 2014 National Curriculum for England has brought about changes to the assessment regime in science with the reintroduction of key stage 2 tests in science, based on the new national curriculum, which will be sat by pupils for the first time in the summer of 2016. (Department for Education 2013 p.2) This reverses the earlier decision to abolish science testing at the end of key Stage 2 in 2010 in England. The science tests were abolished in recognition that they failed to provide relevant and useful information about pupils' performance and had a constraining impact on teaching. (Harlen 2012 p. 7) Perhaps not surprisingly, one outcome from the abolishment of end of key stage 2 testing in science is a general decline in attention to science. Ofsted in their most recent report on science in school (2013), report that half of the school leaders surveyed in the study cite the removal of end of key stage 2 testing as the main reason for less attention to science. Furthermore, the Bew report (2011 p. 64) stated that many respondents felt that the removal of statutory tests had significantly downgraded the place of science within the curriculum. However, others felt that this allowed more freedom 'Teachers are free to teach science as it was intended to be taught now, and do not have to teach to the test'. Either way, beyond the tests at key stage 2 (and GCSEs at key stage 4), it will be for schools to decide how they assess pupils' progress in science and across the curriculum. (Department for Education 2013 p.2) Additionally,

levels have been removed from the 2014 National Curriculum for England. Therefore, until additional guidance or a new assessment framework is put forward by the Department of Education, it is in the reliable hands of classroom teachers.

However, Harlen (2012) reports that some teachers continue to use past or published tests in science as there is no alternative framework for assessment designed to support learning and provide dependable information for reporting achievement at pupil, school and national levels. This is the crux of the issue. While the classroom provides a rich source of data for assessment, issues to do with validity and reliability and lack of attention to quality mean some teachers' stick with the tried and tested method of standardised testing in science.

This is a particular problem in the creative science classroom, whereby working scientifically can only be validly assessed when children are in situations where scientific work such as planning and carrying out investigations is taking place. Worringly, Murphy (2005 p. 11) reported that fewer than 1% of the teachers surveyed, from a sample size of 300, indicated that they assessed children's investigative skills. The application of knowledge is best assessed through discussion of events and phenomena that are new to the pupils (Harlen 2012 p. 13), which does not necessarily align with standardised tests. These creative situations offer more authentic assessment opportunities and with the right planning and support can be both valid and reliable.

Validity and reliability

Assessment should be both reliable and valid and this can be difficult to achieve in teacher assessment. When we assess we want to know that on another day or if it was done by another teacher, the same outcome would be achieved, this gives a sense of reliability.

However, we also want to know that we are assessing what we set out to measure, this is validity. This justifies the implications of assessment.

Harlen (2012 p 17-18) suggests using exemplars, group moderation, and using some form of test or special task as a check of teachers' judgements but not to be reported as a part of the result as ways to increase quality and reliability and teacher's confidence in assessment. One way of moderation found in practice includes professional collaboration, where teachers meet to review examples of pupils' work and in doing so clarify their understanding of the assessment criteria.

Teachers' have long been effectively assessing their children and Harlen (2009 p. 253) highlights the benefits of teacher assessment:

- there is the potential for the full range of goals to be included as teachers collect evidence as part of their normal work with children; teachers' assessment can provide information about learning processes as well as outcomes;
- it relieves the pressure of tests and releases time and other resources for alternative use;
- when teachers gather evidence from pupils' on-going work, they can use information about students to help learning as well as for summative purposes;
- pupils can share in the process through self-assessment and focus on their 'learning goals' as distinct from 'performance goals'.

Elicitation

Pre-assessment or elicitation of children's ideas is crucial to children's learning. Starting from children's ideas is critical in constructivist science teaching, allowing children to begin with what they know and to develop or adapt their own ideas in light of evidence and their

experiences. The importance of this is highlighted and discussed in Chapter 2 and is of particular importance in creative teaching, where children have a lot more responsibility for their learning and independence.

There are a range of strategies that can be used to assess children's existing ideas. Common strategies include questioning, brainstorming and KWL grids, which allow children to recognise what they already know about a particular subject, K; what they want to know about it, W; and then what they have learned after, L. In science, concept maps are a particularly effective strategy. These can be done as a class, as a group or individually. Depending on the age range of the children, concept maps may need scaffolding to maximise their use. Providing pictures for younger children where they have to describe the connections between them is more appropriate, whereas for slightly older children providing them with a word bank from which to make their own concept map is best. At upper key stage 2, children should be encouraged to come up with their own words and connections and to use scientific language and notation where possible. However, the focus here is for children to share their existing ideas and some children may struggle with having to organise their ideas using the structure of a concept map.

Another option in science is annotated drawings. Some children may find it easier to do a drawing to share their ideas about a concept or phenomenon, with either their own annotations or the teacher can annotate for them as they describe their drawing. This was a particularly effective method used for finding out children's ideas in the SPACE project (Nuffield Foundation No date) carried out between 1989 and 1998. Using physical objects can also be valuable. Allowing children time to explore objects and share their ideas about it or describing how it works or how it is similar or different to another.

As the aim is to give children the opportunity to share their existing ideas, it is important to use a variety of strategies that allow the range of learners in the class to consider and share their existing ideas. Moreover, Ofsted (2013) reported that effective practice in science allowed for extended opportunities for children to explain, either orally or in writing, their understanding. This may be particularly relevant in classrooms with children with English as an additional language. For example, drawings may be best for them to share their ideas in science, where the scientific language provides an additional barrier to their verbal communication

Assessing creative science

Creative science has a strong focus on enquiry and investigation. Problem-based and enquiry approaches were put forward in chapter 3 as appropriate teaching and learning methodologies for more creative science. Assessment that can happen while children are engaged in such enquiry and investigation, from the initial questioning and planning to the communication and evaluation, is what is needed. This will require you to observe and step back from the process, to listen to children's idea and discussion, to watch them work with materials and objects, to hear them review and consider ideas, to see them communicate ideas in a variety of ways, to notice how they respond to other children's ideas and evidence. The importance of children's explanations cannot be understated, both as a tool for the children to make sense of their experiences and for the teacher as an assessment opportunity as well as reinforcing the central position of explanations to the development of scientific ideas. Newton (2010) suggests it is these very scientific explanations that evidence creative thought.

Abrahams et al. (2013) highlight another issue that of assessing practical skills in science. They report that while practical skills in school science are clearly valued as being of importance, there is a lack of clarity as to what these skills actually are and how they might, most effectively, be validly assessed. In their international study, the found that there was too great a reliance on indirect assessment of practical skills, whereby a student's level of competency is inferred from the data they generate or reports of the practical work that they undertook. They suggest that this reduces the likelihood that practical work will be taught and learnt as well as it might be. This emphasises the key role teacher observation should play in assessment when children are involved in practical enquiry and investigation.

Teacher observations can be recorded in a number of ways. For example, a simple rubric could be used, such as that shown in Table 5.1. A rubric is a type of matrix that provides scaled levels of achievement or understanding for a set of criteria. This could be used to monitor individuals in a particular group that you are working closely with and used over a number of scientific investigations. A similar rubric could be developed to assess their written work or how they communicated and evaluated their work. Other ways of recording observations are on post-its, noting particular phrases or skills which children demonstrate, or using video or audio clips which can be analysed later. Even better, these video and audio clips could be ones children have produced themselves as part of their science work. Reviewing the full range of children's work offers excellent opportunities for assessment of children's abilities, understanding and skills across science.

[insert table 5.1]

The approach described above is akin to the strategy put forward by an earlier government - Assessing Pupils' Progress (APP). APP was developed by QCA to help teachers in their

assessments of student progress in the National Curriculum, summatively at the end of the key stage, and to inform teaching formatively throughout the key-stage (Department for Education 2011). In this teachers were encouraged to periodically consider the full range of children's work; including written and oral contributions. There is little research evidence on the effectiveness of this strategy in primary science. However, an Ofsted report into the impact of APP (2011) across English, mathematics and science, described a secondary science department that used it to help define the precise learning outcomes for all practical activities. Subsequently, the teachers could talk precisely about the purpose of practical work and saw how the intended learning linked with, and consolidated, other aspects of subject knowledge. While there were some issues with implementation and how it works in practice day to day in the classroom, the assessment grids do offer a useful framework to consider children's enquiry and practical work in science. As describe earlier, this is where we are likely to encounter children's creativity in science. It is not possible to show all the levels and descriptors but a selection have been chosen and are shown in Table 5.2

However, other elements need to be considered with assessment. To what extent will the children be involved? The benefits of involving children in assessment through self- and peer-assessment have long been identified (Black and William 1990), so teachers need to consider ways to allow for self and peer- assessment. How the assessment will be recorded and who it is for are also big considerations. The recognition of the importance of feedback in the assessment process is evident in all education spheres and allowing children time to respond to feedback.

Additionally, Black highlighted the importance of increased clarity of what was expected of children and, importantly, how it would be recognised when they had achieved 'it'. (Nuffield 2012 p. 3) In this way, Black recognises the importance of sharing the learning intentions, with examples, with the children and sharing how intended learning would be demonstrated.

This was referred to as the ‘front loading’ of assessment. Taking such an approach will ensure that the teacher is clear on the key learning foci for the lesson and will recognise the learning when it happens.

[insert table 5.2]

[start box]

Activity 5.1

Considering the key characteristics of creativity below, explore the connections between these and the APP assessment grid descriptors given in Table 5.2.

Key characteristics of creativity -

- Using imagination
- Identification of problems and issues
- Analysis of problems and issues
- Exploration of ideas
- Pursuing activities/tasks with a purpose
- Establishing new connections to old ideas
- Finding novel solutions to problems
- Being original
- Judging value
- Exploration of processes by which these ideas are realised, implemented, evaluated and refined.

Which elements of creativity could be assessed when observing and supporting children working scientifically?

Which elements of working scientifically could be assessed when observing and supporting children working creatively?

In both cases, think about what children might be saying, doing, writing, or drawing.

[end box]

[start box]

Time for reflection 5.2

Can you think about a time when you were involved in an activity in school, college or university and you displayed some of the creative characteristics described? What did it look like? What did it feel like? What do you think would have been the most effective way of assessing the creative elements and the subject based knowledge and skills?

[end box]

Conclusion

When considering assessment, teachers need to think carefully about their role in the process and how their own conceptions of assessment, creativity and science will impact on their planning and classroom practice. By considering the learning environment when planning, teachers can promote creativity as well as through modelling of creative thinking. Finding out children's ideas are crucial first steps in the teaching, learning and assessment process in science. For assessment, teachers should consider the rich opportunity investigative work provides for assessment of science knowledge, skills and attitudes as well as creativity. It is

recognised that teacher-led assessment may have issues around validity and reliability. However, using a moderation process can go a long way towards minimising such issues.

Good practice in teaching and learning will allow for more creative planning in the classroom. Planning for collaborative learning and for children to discuss and share ideas in a co-operative environment will encourage imagination and for children to be freer with their ideas. Making connections between subjects and doing integrated work will foster a wider view of science and encourage more 'out-of-the-box' thinking. Encouraging the exploration of science ideas through alternative media such as drama will again encourage creativity. Additionally, enabling children to work in more authentic contexts which are relevant to them will make learning more meaningful. The practical nature of science is a key motivator and done in the right way, can promote creative thinking and exploratory investigations. These are some of the teaching and learning issues that will be explored in other chapters in this book.

Further reading

Harlen, W. (2012) Developing policy, principles and practice in primary school science assessment. London: Nuffield Foundation [Online] Available at: http://www.nuffieldfoundation.org/sites/default/files/files/Developing_policy_principles_and_practice_in_primary_school_science_assessment_Nuffield_Foundation_v_FINAL.pdf

This is an excellent overview of best practice in primary science assessment. While it was written before the 2014 curriculum was finalised, including the assessment requirements, the guidance is pertinent as it focuses on teacher-led assessment.

Newton, D.P. (2010) Assessing the creativity of scientific explanations in elementary science: an insider-outsider view of intuitive assessment in the hypothesis space. *Research in Science and Technological Education*, 28 (3), p. 187-201

In this research paper, initial teacher education students assessed children's explanations of simple science events. The study revealed that that the assessment was more reliable when assessment switched to particular assessment criteria related to creativity e.g. novelty. Overall, this is an interesting study and provides an excellent review of literature on creativity and assessment.

Wellcome Trust (2010) The Effects of National Testing in Science at KS2 in England and Wales Executive Summary [Online] Available at:

http://www.wellcome.ac.uk/About-us/Publications/Reports/Education/WTX062723.htm

In this report the effects of national testing in science at KS2 in England and Wales are discussed. It highlights in particular, the continued reliance on standardised tests due to a range of factors including teacher confidence.

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