CREATIVE LITTLE SCIENTISTS: Enabling Creativity through Science and Mathematics in Preschool and First Years of Primary Education

D3.2 Report on Mapping and Comparing Recorded Practices

ADDENDUM 13 of 13:

National Report on Approaches in Welsh Policy

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Executive Summary

This National report examines the way in which teaching, learning and assessment is conceptualised in Welsh policy for early years science and mathematics, and the role for creativity. This report is one of 13 European national policy reports that are contributing to the Creative Little Scientist Project deliverable (D3.2 Report on Mapping and Comparing Recorded Practices) mapping and comparing policy approaches across Europe.

In order to map the key messages in Welsh policy, as well as allow comparisons with other nations, this report draws upon a survey instrument used to rate the extent to which certain approaches, and the role of creativity is emphasised across relevant policy documents in this area. In the case of Wales, this was largely based upon the Framework for Children's Learning for 3 to 7 year olds in Wales, Play/Active Learning: overview for 3 to 7 year olds, the National Curriculum documents for Key Stage 2, associated assessment documents and inspection reports. The survey tool was designed drawing on two key sources. Firstly, approaches were distinguished according to nine curriculum themes: Rationale, Aims, Content, Learning Activities, Teacher Role / Location, Materials and Resources, Groupings, Time, and Assessment. Secondly, specific approaches within these dimensions were identified from prior work in this project (the D2.2 Conceptual Framework and D3.1 List of Mapping and Comparison factors). The ratings given from the survey were then discussed in sections within this report that drew upon other sources / commentaries to interpret approaches with the particular context of Welsh education and policy.

The report highlights how many of the approaches identified as being supportive of creativity in early years science and maths are emphasised across policy documents relating to rationale, aims, learning activities and teaching role. They are also present in assessment but are less well represented there which may result in a greater emphasis on knowledge acquisition. This could be why the inspection reports call for more enquiry in both science and mathematics. There are also questions from research and inspection reports about whether teachers are sufficiently knowledgeable and confident to support children's enquiry effectively, which has implications for both ITE and CPD. There are also questions about the role and qualifications of support staff, who form a significant proportion of school staffing.

Because the Foundation Phase extends from 3 to 7 years old there is coherence across the preschool and initial compulsory school years. The key difference does not occur until Year 3 when the children enter KS2. The very obvious difference at this point is the sudden drop of play. Play / Active learning is promoted as the key approach in the Foundation Phase and dominates the teaching approaches. Analysis of the KS2 documents show that play is simply not mentioned. Outdoor learning is also particularly emphasized in Foundation Phase but less prominent in KS2. Inspection reports have indicated that many practitioners recognize the learning potential of the outdoor environment but that some are still reluctant or are using the outdoors in a limited way. One particular concern was that assessment was

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underused in the outdoor area so children's learning in this context was not being recognized, which inhibited teachers' ability to set appropriate challenges to move learning on. The fact that this key area in the documentation is not being applied universally raises questions about whether other aspects of policy are being fully implemented.

This report discusses in greater detail the findings from this national policy, and importantly the implications, not only for the fieldwork planned in the next project phases, but for policy recommendations.

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1. Aims of national report

The main aim of this National Report is to map existing approaches, as recorded in public policy documents and official statements of policy, to the teaching, learning, and assessment of science and mathematics in the early years and to teacher education in early years mathematics and science, in Wales. This report has been prepared as part of Work Package 3.2 of the Creative Little Scientists project (D3.2 Report on Mapping and Comparing Recorded Practices) which aims to map and compare policy within and between European partner countries. The main research question for this phase of the project was: *How is teaching, learning and assessment of science and mathematics conceptualised? What role does creativity play in these?*

In order to analyse Welsh policy documents, this report draws upon previous reports delivered in the Creative Little Scientists Project, the D2.2 *Conceptual Framework* and D3.1 *List of Mapping and Comparison factors*, which identified key dimensions pertinent to the role of creativity in early science and mathematics. As well as providing a structure for this report and facilitating comparison with other European policies, these frameworks help identify inconsistencies and tensions in the key policy messages within Welsh policy.

1.1 Defining terms

Three terms often used in this report that would benefit from defining are: Policy, Curriculum, and Creativity.

1.1.1 Policy

The term policy is used in this report to refer to policy texts, which Ozga (2000, p.33) defines as any *"vehicle or medium for carrying and transmitting a policy message"*. However, in accordance with the aims of this report, policy will be examined according to messages in formal written documentation. This may include either statutory requirements or guidance.

1.1.2 Curriculum

The term curriculum is often used to refer to different aspects of educational policy. In a narrower sense it refers to the content and activities prescribed. In contrast, the term can be used to capture the wider aspects of educational policy. For example, Alexander (2010, p.250) refers to the curriculum as 'what is intended to be taught and learned overall (the planned curriculum); what is taught (the curriculum as enacted); what is learned (the curriculum as experienced)'. In a similar way, Van den Akker (2007) describes three levels of curriculum policy: what is intended (the ideal and formally written), what is implemented (perceived and enacted by practitioners) and what is attained (experiences and outcomes of learners). In this light, policy texts are an element of the intended or planned curriculum: what is formally written.

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1.1.3 Creativity

As reported in the *Conceptual Framework* (D2.2), the Creative Little Scientists project indicates a focus on little c, or personal, or everyday, creativity, i.e. 'purposive imaginative activity generating outcomes that are original and valuable in relation to the learner'. In the Review of Science and Mathematics education in pre-school and early years of primary school (Task 2.2), an appendix to the *Conceptual Framework*, the following definition is used in relation to creativity in Science and Mathematics: 'generate alternative ideas and strategies as an individual or community, and reason critically between these'.

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2. Overview of National early years Education provision and policy

2.1 Phases

In Wales education is divided into a series of phases as indicated in Table1 below.

Table 1: Phases of Education in Wales

Phase of Education	Age range	Provision
Foundation Phase	3-5 years	Pre-school
Foundation Phase	5 – 7 years	Primary
Key Stage 2	7-11 years	Primary
Key Stage 3	11- 14	Secondary
Key Stage 4	14-16	Secondary

2.1.1 Pre-school provision

Children start compulsory schooling in the year in which they are 5, usually in the reception class of a primary school. In Wales, free early years education part-time places are available for all 3- and 4-year-olds for 10 hours a week, which can be used 5 days per week for 2 hours per day. This applies until they reach compulsory school age (the term following their fifth birthday). Free early education places are available at a range of early years settings including nursery schools and classes, children's centres, day nurseries, playgroups and preschool and child-minders. (13)

In January 2011 there were 67,700 children who were 3 and 4 years old, of whom 87.4% of three and four year olds were in pre-school provision, distributed between different providers as follows:

Table 2: Pre-school provision

Type of pre-school provision	Percentage of children
Private and voluntary	Data not provided
Independent	1.0%
Nursery schools and classes	2.3%
Primary schools	83.8%
Special schools	0.3%

School Census 2011 Final Results (13) (14)

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2.1.2 Primary education provision

Mainstream state schools

All children in Wales between the ages of five and 16 are entitled to a free place at a state school. Most children go to state schools. The four main types of *state school* (Community, Foundation, Voluntary aided and Voluntary controlled schools) all receive funding from local authorities. They all follow the National Curriculum and are regularly inspected by Estyn. The Voluntary aided and Voluntary controlled schools are *Faith schools* which are mostly run in the same way as other state schools. However, their faith status may be reflected in their religious education curriculum, admissions criteria and staffing policies. There are also 66 *independent schools* in Wales, although only 38 of these include any children in the 3 to 8 years age range and only 27 admit the full 3 to 8 years age range. These schools set their own curriculum and admissions policies. They are funded by fees from parents and income from investments. Just over half have charitable status. Every independent school must be registered with the Welsh government. (13)

Table 3: Primary provision

Type of School (14)	Number
Community	1197
Voluntary aided	142
Voluntary controlled	92
Foundation	4
Independent	66 [but only 27 admit children from the full CLS age range of 3 to 8 years old]

Primary schools vary in size from fewer than 25 pupils to more than 601 pupils, although the majority of schools are in the middle of this, with an average school size of 181. (School Census January 2011)[1]

Although many schools in Wales operate in English with some Welsh, there are also Welsh medium schools. These include 461 primary schools that operate primarily in Welsh, including Welsh Medium, Dual Stream schools and Transitional schools. (14)

2.2 Regulation

The Schools Standards and Framework Act 1998 limited the size of Reception, Year 1 and Year 2 classes to 30. The Welsh Government then set a target to reduce junior classes in line with infant classes by September 2003. There are allowable exceptions to exceed this

[1] http://new.wales.gov.uk/topics/statistics/headlines/schools2011/110906/?lang=en

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number, such as achieving the place through appeal, need for Welsh medium school and special educational needs. Most schools are now achieving this and many have classes below the limit. (13)

Table 4: Pupil-Teacher ratios

Average Ratios for Wales (14)	Nursery	Primary
Pupil : Qualified Teacher (Jan 2012)	15.2	20.7
Pupil : Qualified Teacher (Jan 2011)	15.7	20.5
Pupil : Support Staff (Jan 2011)	8.7	21.4
Pupil : Adult (Jan 2011)	5.6	10.5

The proliferation of support staff following the introduction of the Foundation Stage has resulted in low pupil : adult ratios. There is more full time equivalent (FTE) support staff in schools than qualified teachers, particularly in nursery schools. The school census does not include any information about the qualifications (if any) of support staff. Nor does it indicate the roles which they carry out so these numbers may well include support staff who do not work in the classroom (e.g. administration, cleaning, kitchen) since these other categories were included in research into support staff (22).

Table 5: Staffing

School Census 2012 (14)	Nursery schools	Primary schools
Number of schools	22	1412
Qualified teachers (FTE)	63.8	12,026.2
Support staff (FTE)	123.4	13,703.7

Research into the use of support staff in Welsh schools found that the best qualified were HLTAs (higher level teaching assistant), with 22% having Level 4 qualifications and 50% with Level 3 but only 17% of the schools in the survey had an HLTA. In general just over half of the primary classroom assistants had qualifications at Level 3 or above. Low pay was identified as a problem in recruiting more qualified staff. (22)

There are no regulations about specialist teachers. It is common for the class teacher to teach science and mathematics in primary, although subject specialists teach these in secondary. The role of support staff in teaching these subjects is not clear.

2.3 Inspection

Estyn (http://www.estyn.gov.uk/) inspects quality and standards of all levels of education in Wales. They also provide advice to the Welsh government on education matters and promote the sharing of good practice.

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The Welsh government removed national testing in primary schools as part of devolution (17) but they are looking to reintroduce national tests in reading and numeracy from 2013. These tests will be taken by all pupils in Years 2 to 9. (13)

The results of these tests will be used as school performance data for the purpose of banding primary schools. Secondary schools are already banded using the externally marked GCSE tests but it was felt that there was too much variability in teacher assessments at primary schools for these to be used in banding.[2]

2.4 Curriculum

The Welsh Curriculum 2000, which was very similar to the English curriculum of the same time but with the addition of Welsh language, was reviewed by the Qualifications Curriculum and Assessment Authority for Wales with a recommendation for a reduced programme of study, greater emphasis on skills and more links between subjects. The Government of Wales Act (2006) gave Wales devolved power over education and training. Following this the Welsh government replaced the Key Stage 2 tests with teacher assessment of communication, number and thinking skills. They introduced the extended Foundation Phase in 2008, along with a revised National Curriculum for Key Stages 2, 3 and 4. (17)

The Welsh government has made improving literacy and numeracy a priority. Alongside this they are determined to reduce the effect of deprivation on educational outcomes. This fits with the social justice stance of the Welsh government (17). There is also evidence that they are interested in increasing the participation of girls in science in that they have approved funding for a project called, "Get on with Science" which promotes the engagement of girls in science education. (13)

A new Literacy and Numeracy strategy is being introduced but the numeracy curriculum has not yet been written. The emphasis of this will be cross-curricular application of literacy and numeracy skills. These are being introduced following a weak performance by Wales in international comparative studies, including the recent PISA results. (13)

2.5 Science and mathematics attainment

Wales has not taken part in many international comparative studies. The 2009 PISA Study (Bradshaw, et al., 2010), showed that Wales ranked 36th out of 65 countries for mathematics and was below the OECD average. There was a low spread of attainment but boys scored significantly higher than girls. In science Wales ranked 21st out of 65 countries and the mean score was in line with the OECD average. In science the spread of attainment was slightly wider than the OECD average but once again boys outperformed girls. Wales was significantly below the other UK countries in both mathematics and science. Resources shortages were noted for Wales. These results were worse than the 2006 PISA study when

[2] http://wales.gov.uk/about/cabinet/cabinetstatements/2012/primaryschoolbanding/?lang=en

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Wales ranked 23rd out of 57 countries for mathematics and 13th out of 57 countries for science (Bradshaw et al, 2007).

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3. Research Questions and Methodology

3.1 Research Question

The main research question for this Work Package, adapted for this National Report is:

How is teaching, learning and assessment of science and mathematics in the early years conceptualised in policy in Wales?

The sub questions identified within this overarching research question were:

- *What is the role of creativity in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in Wales?*
- *What are the main similarities and differences between mathematics and science in the way teaching, learning and assessment of these areas in the early years are conceptualised in policy in Wales?*
- *What are the main similarities and differences between pre-school and school phases in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in Wales?*

In order to examine how teaching, learning and assessment are conceptualised across Welsh policy, this report drew upon the framework of curriculum components *'the vulnerable spider web'* (see van den Akker, 2007) that identifies the following key questions related to student learning:

- Rationale or vision: Why are children learning?
- Aims and objectives: Toward which goals are children learning?
- Content: What are children learning?
- Location: Where are children learning?
- Learning activities: How are children learning?
- Teacher role: How is the teacher facilitating learning?
- Materials and resources: With what are children learning?
- Grouping: With whom are children learning?
- Time: When are children learning?
- Assessment: How to measure how far children's learning has progressed?

As well as factors relating to the curriculum, the *Conceptual framework* (D2.2) identified Teacher factors as a significant in teaching, learning and assessment approaches in the classroom. This is further indicated in the D3.1 *List of Mapping and Comparison factors* derived from the *Conceptual Framework*. Consequently, this project set out to examine Teacher factors addressed in policy, in particular the approaches documented in relation to both:

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- Initial Teacher Education: What are the requirements for initial teacher education?
- Continuing Professional Development: What are the opportunities for Continuing Professional Development?

3.2 Method

This report addressed the research questions through an analysis of relevant policy documents in Wales. One of the first challenges, therefore, was to identify was constituted relevant documents. The second challenge was to adopt an approach to analysis that could not only evaluate approaches across documents but could allow these to be compared to approaches in partner countries. This was addressed by use of a survey tool grounded upon prior work in the creativity Little Scientists project.

3.2.1 Data selection

Policy documents were chosen that captured the different aspects of curriculum according to the nine dimensions identified by Van den Akker (listed in the previous section) in relation to early science and mathematics.

Table 6: Documents

Document name	**Type of document / reference e.g. media report, Journal paper**	**Reference for Evidence**
DCELLS (2008) Framework for Children's Learning for 3 to 7-year-olds in Wales.	Government	(1)
DfES (2011) Foundation Phase statutory assessment and reporting arrangements. Ref: CAD/GM/0182	Government	(2)
DCELLS (2011) Foundation Phase Child Development Assessment Profile.	Government	(3)
DCELLS (2008) Learning and Teaching Pedagogy	Government	(4)
DCELLS (2008) Play/Active Learning: overview for 3 to 7 year olds. Cardiff: DCELLS.	Government	(5)
Department for Education and Skills (2011) Revised professional standards for education practitioners in Wales. Welsh Government Circular No: 020/2011. Cardiff.	www.wales.gov.uk/educationandskills	(6)
DCELLS (2009) Becoming a Qualified Teacher: Handbook of Guidance. Cardiff: Welsh Assembly Government	Government	(7)

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Estyn (2011) Guidance for the inspection of initial teacher training. Cardiff: Estyn.	Inspection framework	(8)
DCELLS (2008) Science in the National Curriculum for Wales. Cardiff: DCELLS.	Government curriculum	(9)
DCELLS (2000) Mathematics in the National Curriculum for Wales. Cardiff: DCELLS.	Government curriculum	(10)
DCELLS (2009) Science Guidance for Key Stages 2 and 3. Cardiff: DCELLS.	Government guidance	(11)
DCELLS (2009) Mathematics Guidance for Key Stages 2 and 3. Cardiff: DCELLS.	Government guidance	(12)
Welsh Government – Education and Skills website http://wales.gov.uk/topics/educationandskills/?lang=en	Government website	(13)
StatsWales - Welsh government statistics http://statswales.wales.gov.uk/index.htm	Government website	(14)
Teacher Training and Education in Wales - http://teachertrainingcymru.org/	Government website	(15)
Murphy, C. and Beggs, J. (2005) *Primary science in the UK: a scoping study. Final report to the Wellcome Trust.*	Policy critique	(16)
Reynolds, D. (2008) New Labour, Education and Wales: The Devolution Decade. *Oxford Review of Education*, v34 n6 p753-765	Policy critique	(17)
Munn, P. (2006) Mathematics in Early Childhood: Early years maths curriculum in the UK and children's numerical development. *International Journal of Early Childhood*, 38 (1) pp.99 - 111	Policy critique	(18)
Estyn (2011) *Outdoor Learning.* Cardiff: Estyn.	Inspection report	(19)
Estyn (2010) *Foundation Phase training and its impact on learning and teaching*. Cardiff: Estyn.	Inspection report	(20)
Estyn (2009) *Best practice in mathematics for pupils aged 3 to 7 years.* Cardiff: Estyn.	Inspection report	(21)
DCELLS (2008) *School support staff in Wales: Research report on the employment and deployment of support staff in schools in Wales. Executive summary*. Cardiff: DCELLS.	Government research	(22)

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Daugherty, R. (2009) Trusting the judgement of teachers: changing assessment policies in Wales. *Education Review*, 22(1) pp.61 - 68.	Policy comment	(23)
Collins, S., Reiss, M. and Stobart, G. (2010) What happens when high-stakes testing stops? Teachers' perceptions of the impact of compulsory national testing in science of 11 year olds in England and its abolition in Wales. *Assessment in Education: Principles, Policy and Practice*. 17 (3) pp.273-286.	Research	(24)

The Welsh government education and skills website (13) contains a plethora of statutory documents, guidance, reports, news items, legislation, case studies and general information. Key documents which could answer the questionnaire items were selected from these, focusing on the main statutory curriculum documents and guidance documents which were flagged alongside these.

(1) sets out the curriculum and statutory requirements for the Foundation Stage. This contains the curriculum statements but also includes some guidance about the teaching approaches and assessment.

(2) and (3) give more detail about the assessment arrangements for the Foundation Stage.

(4) is a guidance paper which gives more detail about pedagogy and focuses on how rather than what teachers should be teaching.

(5) is similar to (4) in that it focuses on pedagogy but this document gives much more detail about what is meant by play / active learning which is a central tenant of the Foundation Stage.

Many other documents relating to the Foundation Phase are available but these are the most central and substantial.

(6) and (7) focus on the organisation of ITE and the standards that teachers must meet.

(8) is the inspection framework for initial teacher training in Wales. Analysis of what is considered good practice provides information about the qualities expected of ITE tutors and mentors and what the ITE curriculum should contain. This information is not explicit in the ITE documents.

(9) and (10) are the statutory curriculum requirements for science and mathematics at KS2 – KS4. Only the KS2 sections have been considered since the CLS age range only just enters KS2.

(11) and (12) are guidance about teaching approaches and assessment in science and mathematics. These complement the statutory requirements and are promoted on the same web pages. Also on the same web pages are documents about the skills promoted in science

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and mathematics. These have not been included because they merely repeat information that is already in the other documents.

(13) and (14) are Welsh government websites which provide information about the organisation of schools, statistics about Welsh education and information about Welsh education priorities and initiatives. (15) is also a Welsh government website but this focuses on initial teacher training.

(16), (17) and (18) provide some critique of Welsh policy, although they do not focus on the current initiatives.

(19), (20) and (21) are inspection reports from Estyn and are more recent so are evaluating practice related to the current curriculum.

(22) is a research report into the use of support staff. Compiling the report demonstrated that the use of support staff was a factor which needed to be considered further because it received little attention in the curriculum documents.

(23) is policy comment by the leader of assessment reform in Welsh education. (24) is research into the impact of withdrawing high-stakes testing in Wales. Although both of these focus on KS2 / 3 they have implications for earlier years too.

3.2.2 Survey tool

A survey tool was developed in order to quantify judgments about the extent to which particular approaches were emphasised in Scottish policy documents. Whilst quantifying approaches is problematic, this was considered important in order to support comparisons between European partners, as well as provide an informative representation of approaches within Scottish documents.

The survey tool comprised of two main sections: one relating to Teaching, Learning, and Assessment approaches. This was subdivided according to the dimensions of curriculum described previously, namely: *Rationale; Aims; Content; Location; Learning activities; Teacher role; Materials and resources; Grouping; Time.* The other section focused on Teacher Education, subdivided into Initial Teacher Education and Continuing Professional Development.

The sections were comprised of a series of questions about approaches advocated in national policy. In each section researchers in partner countries were asked to provide background information or evaluate the extent to which particular approaches were, or were, not emphasised across policy documents, and also the extent to which the role of creativity is emphasised in these approaches. These approaches listed were carefully drawn from prior work in the Creative Little Scientists project, namely the D2.2 the *Conceptual Framework* and the D3.1 *List of Mapping and Comparison factors*, which drew attention to significant approaches characteristic of creativity in early years science and mathematics. A summary of the emphasis ratings given for Welsh policy is presented in Appendix A;

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information on the background sections of the questionnaire are integrated into the main text of this report.

3.2.3 Completion of the Survey Tool

The author of this report, one of the Creative Little Scientists project team, completed the Survey tool. Inter-rater reliability was not possible due to project limitations and the importance of the local expertise of researchers completing the survey tool for their national documents. Therefore, it was required that each project member completing the survey provided justifications for their responses alongside specific references to the policy documents to support judgements made. These justifications were assessed and discussed with a second project team member.

3.2.4 Context of policy messages

A significant challenge of analysing and quantifying policy messages is that they need to be interpreted in relation to the particular national context: taking into account economic, political, geographic, historical factors for example. Consequently, the results of the survey analysis are interpreted within the broader background to current policy, drawing upon wider sources, as indicated in Table 6.

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4. Approaches to Teaching, Learning and Assessment

This section summarises and reflects upon the findings from the policy questionnaire. The overarching aim is to draw out key messages and highlight any issue, tensions or criticisms that may exist for different aspects. Reflecting the questionnaire, the findings are reported under headings taken from van den Akker's framework of components (van den Akker, 2007) as follows:

- Rationale or Vision
- Aims and Objectives
- Content
- Learning Activities
- Teacher Role / Location
- Materials and Resources
- Groupings
- Time
- Assessment

4.1 Rationale or Vision

What are the key summary points?

There are several aspects to the rationale for teaching science, although creating future scientists is not one that is particularly promoted with these age groups. The Welsh curriculum sets out some general aims to education which focus on giving children a good start for future growth and development. Within science specifically this includes preparing for future learning by stimulating curiosity and creativity and developing a positive attitude towards science. Environmental awareness and developing responsible citizens, globally as well as locally, are particular foci. Understanding about scientific phenomena and developing thinking skills are also factors.

What issues / tensions / policy criticisms exist?

There is a focus on science as a career from the age of 11. (9) Although there are links in the curriculum to everyday life, a greater focus in the early years on science as a career might encourage children to think of themselves as potential scientists and explore this through role play.

In what ways is the role of creativity emphasised?

Creativity is particularly emphasised with respect to developing positive attitudes towards science and, unsurprisingly, in developing innovative thinkers. This is indicated by phrases such as: 'increase their curiosity' (1); 'exploration, enquiry, experimentation, asking question' (1); 'foster curiosity and creativity' (9); 'express their own ideas, opinions and feelings with imagination, creativity and sensitivity' (1).

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What are the main differences between Foundation Phase and KS2?

There is a greater emphasis on environmental issues and global citizenship at KS2. There is a greater emphasis on developing attitudes and dispositions for future learning in the Foundation Stage.

What are the differences, if any, between science and mathematics?

There are explicit statements about developing a positive attitude towards mathematics, while this is more implicit for science. There is still an emphasis on responsible citizenship at KS2 but less on the environmental aspects. (1) (10)

4.2 Aims and Objectives

What are the key summary points?

Similar to the rationale there is less focus on professional scientists and how they operate but there is considerable focus on the children behaving scientifically on their own and in collaboration with their peers. They ask questions, plan and conduct investigations, communicate their findings and explain their reasoning. Some scientific facts, concepts and processes are identified but there priority is given to the skills of enquiry. (1) (9)

What issues / tensions / policy criticisms exist?

As above, a greater focus on how professional scientists operate might encourage pupils to consider science as a profession.

The aims give priority to enquiry in science but there are reports that teachers who have limited subject knowledge and confidence do not honour this priority. (16)

In what ways is the role of creativity emphasised?

Many aspects of creativity are highlighted. Play & exploration and questioning & curiosity feature in conducting investigations. Curiosity as a creative disposition relates to developing positive attitudes towards learning and towards science. Reflecting and reasoning are present but emphasised more at KS2. Dialogue and collaboration are evident in the emphasis on communication. (1) (9)

What are the main differences between Foundation Phase and KS2?

The aims for Foundation and KS2 are very similar but there is greater emphasis in KS2 on communicating reasoning and reflecting on the enquiry process.

What are the differences, if any, between science and mathematics?

There is still an emphasis on communicating in mathematics but less is said about collaboration. Developing positive attitudes is emphasised, as is problem solving. Some mathematical content is identified but the main focus links well to creativity:

"Skills are the essence of mathematics – Solving mathematical problems, Communicating mathematically and Reasoning mathematically." P.8 (12)

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4.3 Content

What are the key summary points?

Science is presented as its own learning area in KS2 but is part of Knowledge and Understanding of the World, which also contains history and geography, in the Foundation Phase. There is an emphasis on investigative skills, as has been evident from the rationale and aims. These include asking questions, planning investigations, collecting and recording data, communicating, explaining, reflecting and evaluating. The Foundation Phase topics emphasise the relationship between the child and the phenomena: Myself and other living things; Myself and non-living things. The first relates to biology: plants, humans and other animals and their interactions with the environment. This is developed at KS2 in 'interdependence of organisms'. Myself and non-living things is more focused on chemistry and leads to 'the sustainable Earth' in KS2. Both of these topics show the importance of environmental issues and responsible citizenship. KS2 has a third topic, 'how things work', which is more related to physics.

What issues / tensions / policy criticisms exist?

Murphy and Beggs (2005) found that the science curriculum was overloaded. This matches with the curriculum review by ACCAC which called for reduced science content and greater emphasis on skills. These seem to have been achieved in the 2008 curriculum.

Although mathematics is presented as a discrete subject, there is also emphasis on its cross-curricular use. (10) (12) *"The ability to be proficient in mathematics and apply skills, knowledge and understanding in other curriculum areas and contexts are vital to educational achievement."* P.2 (21) However, Estyn reported that schools were less good at planning for progression in the application of numeracy versus progression in discrete mathematics lessons. P.10 (21)

In what ways is the role of creativity emphasised?

Creativity is emphasised in the investigative skills.

What are the main differences between Foundation Phase and KS2?

The main difference is the introduction of a third, more physics based, topic.

What are the differences, if any, between science and mathematics?

Mathematics is presented as its own learning area from the Foundation Stage. The emphasis on problem solving is similar to the science investigative skills. As with science there is close alignment between Foundation Phase topics and KS2: number; calculating; measures and money; shape, position and movement; and handling data. There is a difference in wording and a deepening in the enquiry skills, with 'Investigate patterns and relationships' at Foundation Stage and 'Solve mathematical problems; communicate mathematically and reason mathematically' at KS2

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4.4 Learning Activities

What are the key summary points?

Observing and asking questions are key learning activities, particularly for the Foundation Phase. However, all aspects of enquiry are included, from designing the investigation to conducting it, collecting data, analysing the data to form explanations and then communicating these.

What issues / tensions / policy criticisms exist?

As with the aims section there is a tension between calls for more scientific enquiry and teachers' lack of knowledge and confidence which inhibits this. (16) There is a similar tension in mathematics with insufficient using and applying mathematics, in part due to limited subject knowledge and confidence. (21)

In what ways is the role of creativity emphasised?

As with the aims section, exploration, questioning and curiosity, dialogue and collaboration, reflection and reasoning are promoted.

What are the main differences between Foundation Phase and KS2?

There is more emphasis on conducting investigations, observing and asking questions at Foundation Phase but the difference is slight.

What are the differences, if any, between science and mathematics?

The main evidence for designing simple investigations came from the general introduction for Foundation Phase so applies equally to mathematics and science but is not further emphasised in mathematics. There are elements of this at KS2 with children choosing the appropriate mathematics, materials and resources to solve problems. Like science, communication is emphasised. There are many statements about children developing their own informal methods and communicating in a variety of ways.

The term 'observe' is not used in Foundation Phase but there is an emphasis on exploration which is related to this. This continues in KS2. Exploring, experimenting, solving problems and applying mathematics to practical problems are emphasised at both levels so this is similar to science.

Asking questions does feature in Foundation Phase but is less prominent than in science. At KS2 it is part of the overview. Explaining their thinking and developing reasoning feature strongly. This is emphasised more in mathematics than science.

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4.5 Teacher Role / Location

What are the key summary points?

There is a huge emphasis on open / unstructured play in the Foundation Phase. As the Play / Active Learning document (5) indicates, play is the main way that children are expected to learn in the Foundation Phase. [also (1) (4)]

"Play is an essential ingredient in the curriculum which should be fun and stimulating. Well-planned play helps children to think and make sense of the world around them. It develops and extends their linguistic and communication skills, enables them to be creative, to investigate and explore different materials, and provides them with opportunities to experiment and predict outcomes." P.5 (5)

However, the absence of play in the KS2 curriculum is very noticeable. First hand experiences, both indoors and outdoors are included in both phases, although they are emphasised more in the Foundation Phase. Working in groups, fostering collaboration and communicating feature in both key stages, as do asking questions and conducting investigations. Relating science to everyday life is particularly emphasised and links to building on prior experiences, although this is emphasised more in the Foundation Phase. (1) (4) (9)

Teacher questioning and scaffolding are advocated as teaching approaches in the Foundation Phase. Teachers are encouraged to learn alongside the child. *"Practitioners can support or 'scaffold' learning effectively by working alongside an individual or small group of children, observing, participating and intervening if necessary." P.22 (4)*

What issues / tensions / policy criticisms exist?

The dramatic change from a curriculum based around play to one which does not mention play is a real tension between the Foundation Phase and KS2. (1) (9) This fits with Munn's (2006) finding from a study of early mathematics across the UK countries: "*The early years curricula's translation from process to product results in tension between early years practitioners and primary teachers. Early Years practitioners uphold ideals that are integral to a 'process' based curriculum. Primary teachers, on the other hand, are held professionally accountable by a 'product' version of the same curriculum."* P.109 (18)

Murphy and Beggs (2005) identified the need to make science more relevant to pupils' experience to increase motivation and positive attitudes towards science. (16) Estyn (2009) identified the need to provide more real-life problems practical application of mathematics for more able pupils. They found that practical application were emphasized with the less able but more able pupils were given more work from text books instead. (21) This could be having a negative impact on attitudes towards mathematics in the more able pupils.

Estyn (2009) recommended that teachers should "*provide better and more frequent opportunities for pupils to 'use and apply' mathematics in their daily work, including improving the level of challenge for the more able to develop their thinking and problem-*

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solving skills" p.12 (21) In addition to providing more opportunities for using and applying mathematics, teachers need to be sensitive about how and when to provide help, since the evidence showed that solving problems without teacher support resulted in positive attitudes towards mathematics in most cases. P.21 (21)

In what ways is the role of creativity emphasised?

The emphasis on play / active learning means that play and exploration are key aspects of creativity. However, agency is also an important issue, with children encouraged to *"be **creatively involved in their own learning** which must build on what they already know and can do, their interests and what they understand." P.6 (1)* This agency continues in KS2, *"Teaching should encourage learners to manage their own learning and develop learning and thinking strategies appropriate to their maturity." P.10 (9)*. One way of doing this in science is, *"Pupils turn ideas suggested to them, and their **own ideas, into a form that can be investigated**." P.12 (9)* Once again dialogue and collaboration feature strongly, linked to reflection and reasoning. Motivation and affect also apply here with teachers called to present activities that, *"foster curiosity and creativity and be interesting, enjoyable, relevant and challenging for the learner." p.12 (9).* This also applies to the learning environment: *"Indoor and **outdoor environments** that are fun, exciting, stimulating and safe promote children's development and **natural curiosity to explore** and learn through first-hand experiences. The Foundation Phase environment should **promote discovery** and independence and a greater emphasis on using the **outdoor environment** as a resource for children's learning." P.4 (1)*

Estyn (2011) evaluated the use of the outdoor environment on learning. They reported that, *"Children **persevere** with activities for longer periods outdoors and will **attempt new things** more readily. They learn **to co-operate** and **apply their thinking skills to real problems**, such as making a water-tight den for characters in a story. Generally, levels **of enjoyment** are high and children take pleasure in what they do." P.6 (19)* They found agreement among teachers and local authorities that children's understanding of science improved most when the outdoor environment was fully utilised. However, there is less evidence of impact on mathematics and creativity. They recommended greater use of 'What if…' questions to develop curiosity and possibility thinking.

In terms of inquiry approaches, question, evidence, analyse, connect, communicate and reflect are all well represented at both Foundation Phase (1) and KS2 (9). 'Explain based on evidence' does occur in Foundation p.33 (1) but there is a less explicit link between explanation and evidence, as opposed to prior knowledge at KS2 (9). However, there is attention to evidence at KS2, with pupils required to *"make careful observations and accurate measurements using digital and ICT equipment at times"* and *"check observations and measurements by repeating them in order to collect reliable data" p.13 (9).* The reflection strand is very fully developed at KS2, covering many aspects of inquiry:

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"Reflecting

Pupils think about what they have done in order to consolidate learning and transfer skills, knowledge and understanding to other contexts by:

1. beginning to evaluate outcomes against success criteria

2. deciding whether the approach/method was successful

3. describing any amendments made to the planned approach/method

4. suggesting how the approach/method could have been improved

5. describing how they have learned and identifying the ways that worked the best

6. linking the learning to similar situations, within and outside school." P.13 (9)

This reflection extends to metacognition. *"Learners reflect as they plan and develop a task, ensuring that they think about their thinking and use these thoughts to amend and refine their learning." P.11 (11)*

What are the main differences between Foundation Phase and KS2?

There are many similarities between the phases. At KS2 the curriculum is designed to give teachers *"maximum flexibility in selecting appropriate, relevant content from the considerable range of opportunities to suit the needs, interests and preferred experiences of all learners" p. 9 (11)* This is not stated explicitly in the Foundation Phase but it also contains considerable freedom to respond to learners, their needs and interests.

The key differences are that Play and imagination are very important in Foundation Phase but largely absent from KS2.

What are the differences, if any, between science and mathematics?

Like in science play is heavily emphasised at Foundation Phase but not mentioned at KS2. Physical exploration is emphasised in both subjects but more at Foundation Phase. Using the outdoor environment is emphasised throughout the Foundation Phase. There is some mention at KS2 but much less.

Role play is mentioned in mathematics in Foundation Phase, unlike science, but not at KS2. Teaching mathematics through story, rhymes and songs is more prominent than in science at Foundation Phase but not mentioned at KS2. Mathematics also talks about the use of games and children making things in Foundation Phase. Children make shapes at KS2.

Integrating with other curriculum areas is discussed in the general learning sections. The proposed National Literacy and Numeracy Framework emphasises the cross-curricular use of mathematics. KS2 also mentions cross-curricular mathematics.

Building on prior learning is a general principle for the Foundation Phase; it is not emphasised specifically in mathematics but is in science. However, this is explicit at KS2 in mathematics. Fostering collaboration is another general goal but is emphasised more in KS2

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science. However, discussion and evaluation of alternative ideas is slightly more prominent in mathematics.

Different ways of recording is emphasised in mathematics, with a particular emphasis on general communicating orally and using their own written methods before introducing formal written methods. There are some mentions of using ICT in both subjects, often in relation to communicating. Autonomous learning is emphasised generally but also specifically in both subjects. Relating to everyday life is emphasised in both.

Asking questions does appear in mathematics but has less emphasis than in science, whereas solving practical tasks is a key area in mathematics so is emphasised much more than in science.

The inquiry aspects are well represented in the overview to mathematics at KS2:

*"In mathematics, learners **ask questions**, **explore alternative ideas** and **make links** with **previous learning** in order to develop strategies to **solve problems**. They gather, select, organise and use information, and **identify patterns** and **relationships**. They predict outcomes, make and test hypotheses, **reason mathematically when investigating,** and **analyse** and **interpret** mathematical information. They describe what they have learned, **reflect on their work** by **evaluating** their results in line with the original problem, **and justify their conclusions and generalisations**." P.6 (10)*

4.6 Materials and Resources

What are the key summary points?

Resources are not particularly discussed in the curriculum documents. The main emphasis is on using the environment, both indoors and outdoors. *"Children's creativity should be nurtured in a **rich environment**, indoors and outdoors, that **stimulates imaginative thinking** and offers exciting opportunities **to experiment with new experiences and resources**." P.34 (5)* The local environment is particularly emphasized as learning about Wales and Welsh life is a cross-curricular theme. (9) (10) Rather than use specialized resources, the main emphasis is on *"experiment with different everyday objects" p.33 (1)* and *"investigating the materials around them" p.13 (9).*

ICT is mentioned frequently but generally at both phases rather than naming specific pieces of equipment or software. (1) (9) However, ICT is not meant to replace other approaches because the suggestions for using ICT are *"on some occasions" p.32 (1)* and *"at times" p.7 (9)*.

What issues / tensions / policy criticisms exist?

Murphy and Beggs (2005) found that a lack of classroom assistance caused problems in science. (16) The use of support staff is not discussed in the documents but the statistics presented earlier show that there is more support staff FTE than qualified teachers, especially in the nursery phase. (14) The statistics do not say how the support staff is being

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used and it may be that they are not fully deployed in the context of science. However, it should also be noted that the level of support staff has increased significantly since the Murphy and Beggs (2005) report was published so this may no longer be an issue, although the Collins et al (2010) research reported that 41% of the Welsh teachers surveyed said that the lack of support staff in science lessons was a challenge (24). How support staff is used is at least as important as whether they are there. Estyn (2011) found that outdoor learning was more effective when teachers were involved, compared with settings which left the outdoor area completely under the supervision of support staff. The presence of the teacher was deemed to show this was an important learning area. (19) Estyn (2009) also found that involving support staff in planning for mathematics resulted in, *"increased commitment from classroom support assistants, greater clarity of learning objectives, improved assessment procedures and some evidence of rising standards." P.5 (21)* However, research into support staff in Wales showed that there was "*a feeling of slight injustice that they carry out many of the tasks attributed to teachers but for a fraction of the salary." p.10 (22)*

Murphy and Beggs (16) and Collins et al (24) also identified a lack of resources as an issue in science. As discussed above few specific resources were identified, with most being everyday objects or materials. This could indicate that there is limited money available for providing scientific resources. Headteachers have also reported that provision of resources, including books and ICT, is poor. (17) One of the recommendations was for more funding for resources. (16) There may be a contrast with mathematics here. Estyn (2009) found that *"almost all schools resource mathematics well." p.25 (21)* They also found that teachers were making good use of ICT in supporting mathematics. (21) Although textbooks are not mentioned in the curriculum documents, Estyn reported that published schemes are being used in mathematics and warns against an over-reliance on these. (21)

In what ways is the role of creativity emphasised?

Creativity is emphasised in the exploration of the resources and the environment, especially outdoors.

What are the main differences between Foundation Phase and KS2?

There is greater emphasis on exploring resources and using the outdoor environment in the Foundation Phase. This matches with the reduced emphasis on play at KS2 discussed earlier.

What are the differences, if any, between science and mathematics?

They are similar in that both emphasise hands-on exploration both indoors and outdoors. There is greater emphasis on stories and games in mathematics at Foundation Phase, although not at KS2. Both subjects mention ICT but in a general way. However, some specific resources are identified: number lines, measuring equipment, analogue and digital clocks, money and calculators. Estyn (2009) identified a range of ICT resources that were being used:

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- Home-made and published software;
- Calculators
- Beebots (small programmable robots)
- Electronic cash-registers
- Digital cameras
- Computers
- Interactive white boards. P.23 (21)

4.7 Groupings

What are the key summary points?

This is not an aspect that is particularly discussed in the documents. Paired and group work is mentioned many times, alongside developing collaboration. The Foundation Phase does also mention pupils working on their own (1), which is implied but not stated in KS2 (9). There is no mention of whole class activities at either phase but this does not necessarily mean that they do not occur.

What issues / tensions / policy criticisms exist?

Estyn (2009) reported that schools were using baseline assessments to help group pupils by ability. "Teachers commonly group pupils according to ability and plan activities for groups and/or individuals to ensure progression in learning. Only a few use friendship groups or other arrangements." P.17 (21)

However, they do not evaluate this approach so it is uncertain whether they were promoting or questioning this approach or merely presenting it as information.

Collins et al (2010) reported that upper KS2 teachers were having to use more group work rather than whole class activities to fit with the formative assessment agenda. (24)

In what ways is the role of creativity emphasised?

Creativity is present in the emphasis on dialogue and collaboration, leading to increased risk taking. *"Classroom tasks and activities include many examples of paired and group work, so that learners are **given time to ask questions, think and justify their thought**s to their peers before **reaching conclusions**. Collaborative learning produces higher quality outcomes and enables learners to **take risks** without fear of self-failure." P.16 (11)*

What are the main differences between Foundation Phase and KS2?

They are similar in terms of documentation. The observation phase of CLS will demonstrate how similar they are in terms of practice.

What are the differences, if any, between science and mathematics?

This is not discussed much in mathematics either but is broadly similar.

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4.8 Time

What are the key summary points?

This is not discussed for either subject or either phase.

What issues / tensions / policy criticisms exist?

Murphy and Beggs (2005) identified lack of time as a key issue in science (16). This particularly inhibited carrying out science investigations in the classroom. This was also identified by Collins et al (2010) (24).

4.9 Assessment

What are the key summary points? and What are the main differences between Foundation Phase and KS2?

There are marked differences in the documentation between the purposes of assessment at Foundation Phase and KS2, although there is overlap. The KS2 documents have a strong emphasis on formative assessment that has been designed into the curriculum. *"So that the revised science order is **learner-centred**, it has embedded within it **assessment for learning vocabulary**." P.9 (11)* This emphasis on the learner is evident in the following statement: *"Ongoing formative assessment – assessment for learning – lies at the heart of good teaching. Through the assessments that you make in the course of your teaching you will build up an extensive knowledge of your learners' strengths, as well as the areas that need further development, and you will use this knowledge to help you plan for the next steps in their learning." P.2 (11)* There is also considerable emphasis on giving feedback to children to support their self- and peer-assessment. *"Learners will also gain understanding of specific learning goals and the associated success criteria so that, supported by you, they can develop their capacity for **self-assessment and peer assessment**. In this way, they can establish their current position, **set and move towards targets**, and discover if and when the targets have been reached." P.2 (11)* These examples are all from KS2 but formative purposes for assessment have been identified in the Foundation Phase as well. Observation-based assessment is recommended for *"…evaluating provision for learning." P.22 (4)* and because it *"…helps inform [teachers'] planning for progression" P.22 (4).*

The Foundation Phase puts a greater emphasis on monitoring children's progress against the seven steps of the profile and reporting these to parents (2) (3). Assessments are undertaken within the first month of children starting school to establish a baseline. This allows future assessments to be used *"by the settings / schools and local authorities to provide **value-added indicators**" p.8 (2)*. The Foundation Phase emphasizes observation and discussion in a range of contexts as the main forms of assessment. *"Through **observing** children while they are involved in activities, practitioners will find out how the children's skills are developing, what they are able to do and what support is needed to take the learning forward. Practitioners will also be able to gather information on what the children*

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know and understand, as well as their personal preferences." P.2 (2) Some of these observations are focused on profile statements while others are more open.

Little guidance is given on how teachers should assess children at KS2 but they are encouraged to ask *"some pertinent questions" p.16 (11)* and consider evidence from a range of contexts, as well as providing opportunities for pupil self and peer assessment.

There is more similarity in what is assessed. Both phases assess a combination of scientific knowledge, the ability to carry out scientific inquiry and the ability to communicate findings and conclusions. (1) (9)

What issues / tensions / policy criticisms exist?

The recent PISA results have resulted in an increased focus on literacy and numeracy, with impending strategies designed to raise standards in these areas. This international comparative study has also raised the profile of comparing schools based on attainment, as well as on social characteristics such as free school meal provision. This has resulted in banding schools. Currently this is only feasible for secondary schools because the externally assessed GCSE results can be used as a comparative measure. Children in nursery and primary schools are assessed internally by teacher assessment and there are concerns about the comparability of these. To address this national tests on literacy and numeracy are to be introduced for each year group from Year 2 to Year 9. These tests will then be used to band primary schools. The information about banding seems to indicate a reluctance to rank schools with frequent emphasis on how the banding will be used to provide targeted support. (13) This reluctance may be related to a rejection of the English league tables system and an emphasis on working with teachers, supporting schools rather than pressuring them. (17) (23) Daugherty (2009) emphasised that Welsh assessment was about supporting pupils rather than accountability. *"This is assessment for learning (AfL) as integral to classroom practice and not the target-driven, test-based distortion of AfL favoured by some policy-makers in England who are more interested in narrowly-defined outcomes than in the quality of children's learning." p.63 (23)*

Collins et al (2010) researched the impact on science of removing high-stakes testing from the Welsh curriculum. They found that removing the KS2 science test resulted in pupils having more opportunities to investigate, with this becoming a more central activity in lessons. "*There has been a huge move in science education away from content onto skills. The children's attention is being drawn to Sc1 all the time, more, 'What skills are you using here?' than 'Can you tell me what's a conductor, what's an insulator?' (Y6 teacher: Wales)" p.281 (24)* This has impacted on teaching and assessment strategies and lesson organization, with fewer whole class activities and more group work with the teacher assessing through observation, focused questioning and discussion. P.281 (24) However, some headteachers were concerned about an increased emphasis on investigations *"as they believed this presented challenges for some Y6 teachers who were unfamiliar with teaching strategies required to support investigatory science activities." P.282 (24)* They did acknowledge that CPD could address this.

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The increased use of the outdoor environment could have a negative impact on assessment. Estyn (2011) identified that, *"Teachers tend to assess children's learning less often and less well outdoors than indoors. They do not track the progress children make in developing their skills outdoors well enough. With children spending more time outdoors, this means that important milestones in their development may be missed." P.1 (19)* However, this issue might be addressed once practitioners have more experience with teaching and learning in the outdoor environment.

Although the curriculum guidance focuses on assessment through observation, Estyn (2009) reported that nearly all schools mark pupils' mathematics frequently but found that the level of feedback in the books was weak. P.22 (21)

In what ways is the role of creativity emphasised?

The main creative aspects of the science assessments are thinking skills, especially reflecting on and evaluating their work (1), while at KS2 *"They say what they have found out from their work and make their own decisions by weighing up pros and cons." P.16 (9)* Other creative aspects are curiosity and asking questions and making connections between the science topic and everyday life. (1) (9)

What are the differences, if any, between science and mathematics?

The purposes and methods of assessment are currently the same, although the impending numeracy tests will change both of these as discussed above. In terms of content, the pupils are assessed on their problem solving, reasoning and communicating, as well as their understanding of place value, negative numbers, the four operations, standard units of measure, classification of shapes and interpretation of data. The main creative aspects are problem solving, dialogue and trying different approaches. (10)

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5. Approaches to Teacher Education

5.1 Initial teacher education

There are three main routes into teaching for prospective teachers in Wales. They may follow a 3 or 4 year undergraduate degree that leads directly to recommendation for Qualified Teacher Status (QTS), a 1 year postgraduate course or a 1 year graduate teacher programme (GTP). The PGCE may be taken part time over a longer period, while the GTP may be completed in less than a year (minimum 3 months full time in school) if the trainee has suitable previous experience and qualifications (7). The undergraduate and PGCE routes are university based in partnership with schools in a concurrent model. The GTP is an employment based route where the trainee teacher is working in school and does not result in an academic qualification. The undergraduate programmes result in a Bachelor degree while the PGCE may offer up to 60 Level 7 (Masters) credits.

There are four official providers in Wales. Three of these run the full time routes (undergraduate, post graduate and graduate teacher) and are made up of several universities who work in partnership with schools. The fourth is the Open University who organizes the part-time post graduate route, again in partnership with schools. (15) There are no explicit requirements for tutors in ITE. (7) However, the Estyn framework (8) indicates that tutors should have up-to-date subject knowledge, participate in professional networks and engage in relevant research.

In most cases tutors will have qualified teacher status (QTS) and have experience teaching in the relevant age phase. Higher degrees (masters or doctorates) are preferred but this is not a legal requirement. Spoken and written Welsh are an advantage

Regardless of the route the candidates must have GCSE (or equivalent) Grade C or above in English, mathematics and science. (7) There is a proposal to raise the GCSE Grade to B or above for English, maths and science, as well as having an assessment of functional personal skills in literacy and numeracy applicable in a professional teaching context. (13) In addition to the academic requirements all applicants must take part in an **interview**, have a **criminal records check** (enhanced disclosure) and pass a physical and mental '**fitness to teach' test.** (7) (15) For the undergraduate route they must have **2 passes at A Level** (normally minimum 200 UCAS points), or equivalent, or the Welsh Baccalaureate. For the PGCE an undergraduate degree from a UK institution (or equivalent) is needed. For those wishing to train under the GTP the degree must be in a subject that is taught in schools.

The standards which the student teachers must meet (7) are:

Professional values and practice – endeavour to personalise learning to meet diverse needs; Inspiring learners; demonstrate professionalism; ability to communicate with others; promote the school in the community; Working with others; reflect on own practice and take responsibility for development; Working within the law

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Knowledge and understanding – subjects and curriculum; National curriculum aims and guidelines; make good use of national guidance; Progression; How development affects learning; special needs; behaviour strategies

Teaching – Planning, teaching, monitoring, assessing, using resources; Behaviour management; Working in teams; Out of school learning; promote sustainable development and global citizenship; Meeting learners' needs; English or Welsh as an additional language; Recording progress; Reporting to parents; Teaching and class management; Delivering effective lessons; Differentiating teaching; Diversity; Time management; Using resources; Using ICT; Homework; equal opportunities

"The QTS Standards and ITT Course Requirements give ITT providers flexibility in the way they design their programmes, and encourage increased use of professional judgement." P.6 (7) However, some specific curriculum content is identified in the guidance (7) and this relates closely to the standards. Other curriculum content is derived from what the Estyn framework considers good practice in ITE (8). Courses must cover:

- Subject and pedagogical knowledge, especially in the core subjects of mathematics, science and English.
- Planning, teaching, assessing, behaviour management
- Diversity – including special educational needs (SEN), English as an additional language (EAL), developmental differences
- Child protection (7)
- Welsh language and Welsh culture (8)
- Professional literacy and numeracy (8)

Murphy and Beggs (2005) recommended that primary student teachers should develop expertise in planning, designing and conducting science investigations. They suggested this could be done through approaches, such as co-teaching with a school mentor, which would develop both confidence and skills. Effective use of ICT in science was another area they felt should be developed. (16)

There are minimum requirements (7) set for time learning and practising in schools:

- 32 weeks for 4 year undergraduate;
- 24 weeks for 3 year undergraduate;
- 18 weeks for post-graduate.

This time in schools should take place in Wales. "*All individuals who have commenced a course of initial teacher training since 1 September 2008 are required to have undertaken their practical teaching experience, wholly or mainly in a school, independent school or other institution (expect a pupil referral unit) in Wales." P.142 (7)*

While in school students are supported by a school mentor. Like tutors there are no specific requirements for school mentors, although the guidance recognises that *"Most of the QTS*

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Standards can only be fully demonstrated when trainees are working with learners in the classroom or other settings where learners are taught; and training is most effective where practising teachers are directly involved." P.162 (7) In addition, the Estyn framework (8) wants the practising teachers to be up to date with professional knowledge and to have had opportunities to study and accredit their skills of mentoring.

There are no prescriptions for how the academic work is assessed by the university. The QTS standards are to be assessed in partnership with the schools, the HEI and the students themselves. The standards are assessed from a range of evidence. *"Deciding whether a trainee meets the Standards is a matter of professional judgement, taking into account the trainee's performance as a whole and all the other relevant evidence" p.145 (7)* Some suggested methods of assessment (7) are:

- observation of teaching;
- discussion with student-teachers;
- looking at planning and setting of targets for individual learners;
- their analysis of learners' progress;
- their assessment of the learning of those they teach;
- subject-based assignments or tasks;
- written work;
- portfolios recording prior achievement;
- presentations;
- contributions to tutorials

5.2 Continuing professional development

Practising teachers have a set of 55 standards that they have to meet. These are divided into Professional values and attributes, Professional knowledge and understanding and Professional skills. (6)

The main national initiative for CPD is the Early Professional Development (EPD) programme. This is a 2 year programme following the induction year. During the first year of this programme the teachers will be given the option to focus on one of the national priority areas. Currently this includes numeracy but not science. (13) The Science Learning Centres which provide science CPD in England do not operate in Wales. There may be local initiatives or independent consultancy on science but Murphy and Beggs (2005) determined that Wales was *"poorly served in terms of primary science professional development" p.13 (16).* They also found that lack of teacher's subject knowledge and confidence were major issues in science teaching. They found that those teachers who had undertaken CPD in science were significantly more confident to teach science. They recommended there should be UK wide science CPD for teachers to develop their science teaching skills and confidence. Confidence is important because they found that a lack of confidence constrained the use of

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investigations in the classroom. (16) Collins et al (2010) had reports from headteachers that some teachers' knowledge of how to support investigative activities in science was inadequate and that CPD was needed. P.282 (24)

There may be a need for parallel CPD in mathematics since Estyn (2009) identified that, "*Some teachers lack confidence and mathematical understanding. This often leads to a rigid adherence to published schemes in mathematics, an over-reliance on worksheets and weaknesses in diagnosing what pupils need to learn next. Many teachers do not make enough use of classroom strategies that will challenge more able pupils to work at level 3." P.6 (21)* There are also worries that insufficient subject knowledge in some teachers prevents them from being able to break learning into small steps that challenge the pupils appropriately. This lack of knowledge is reported to result in an over-reliance on published schemes. (21)

There are recommendations for an entitlement for initial training and CPD for classroom support staff. (22)

Recently there has been a national CPD initiative related to training practitioners, including those in non-school settings such as playgroups, on the teaching approaches in the Foundation Phase. Each local authority has organised their own training so there have been variations in delivery despite it being a national initiative. There have been positive comments about training and the Foundation Phase approaches but there has been insufficient evaluation of the impact of this training on pupil outcomes. (20)

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6. Summary

There is evidence of the promotion of enquiry approaches throughout the documentation at both stages. It is there in the rationale, the aims, the learning activities and the teaching role. All of the inquiry approaches identified in section 2.5 C are well represented in both phases. It is present in assessment but less well developed there than the other areas which may result in skewing the children's experience towards a knowledge acquisition. This could be why the inspection reports call for more enquiry in both science and mathematics. There are also questions from research and inspection reports about whether teachers are sufficiently knowledgeable and confident to support children's enquiry effectively, which has implications for both ITE and CPD.

There is considerable emphasis on developing responsible citizens, locally and globally, with environmental awareness. The environmental aspects are particularly evident in science but the idea of social responsibility is clear in both subjects, particularly in KS2. This is much more of an emphasis than future careers for the 3 to 8 year old age range. It fits with the social justice stance of Welsh education (17).

Related to the emphasis on environmental awareness is the increased use of the outdoor environment for learning. This is emphasized particularly in the Foundation Phase documents but is also present at KS2. The inspection report on outdoor learning (19) has shown that many practitioners are recognizing the learning potential of the outdoor environment but that some are still reluctant or are using the outdoors in a limited way. In some settings the outdoor area was left in sole charge of support staff and this created the impression that learning in this area was not valued. One particular concern was that assessment was underused in the outdoor area so children's learning in this context was not being recognized, which inhibited teachers' ability to set appropriate challenges to move learning on. Once again there are CPD issues in promoting the full use, including assessment, of the outdoor environment. However, the issue may be more about changing attitudes rather than needing more knowledge.

Previous curriculum reviews had called for a slimmed down curriculum that was skills based and had less emphasis on knowledge. The analysis of the Foundation Phase and KS2 curriculum for science and mathematics indicates that this may have been achieved. However, further inspection and evaluation of the teaching and learning related to the new curriculum will need to be undertaken before it can be seen how fully this change has been embedded. The inspection report for mathematics indicates that further emphasis on investigations is needed so there may be need for CPD to change the teaching emphasis to match the changed curriculum.

There is a significant number of support staff in nursery and primary schools but there is no mention of their role in the curriculum documentation. Some of the research findings (16) (24) have indicated that there is a lack of support staff in science. It was not clear whether

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there was sufficient support in mathematics. Therefore, there are questions about the deployment of support staff. There are also questions about their skills with just over half having qualifications at Level 3 or above. Since it has been recognized that some of the teachers, with qualifications at Levels 6 and 7, lack sufficient knowledge and confidence to support enquiry, it is likely that the same is true for support staff.

Resources for science received little attention in the curriculum documents. Most resources mentioned were everyday objects and materials and the local environment. This has the advantage of keeping science relevant to the children's lives. However, it may be an indication of insufficient funding for resources, since lack of resources in science has been identified as a problem (16) (17) (24). This may limit the scope for pupils' investigations.

A report on education in the STEM subjects has identified many concerns. Although this report primarily focuses on secondary teaching, there are implications for younger children as well. The concerns focus on a lack of specialist teachers, pupils' poor practical science skills, negative perceptions of the subjects by both pupils and staff, gender stereotypes of STEM as male subjects and low take up of STEM at A level. They have recognized the need to address these issues from an early age to redress these.[3]

The Welsh 2009 PISA results were even lower than the 2006 PISA results. This leaves Wales significantly behind the other UK countries in English, mathematics and science. This has resulted in literacy; numeracy; reducing the impact of poverty on attainment and tackling underperforming schools becoming education priorities. Interestingly science was not included in this priority list although the results were low for this subject too. One result of this priority is the impending introduction of literacy and numeracy strategies and their associated testing regimes.

Because the Foundation Phase extends from 3 to 7 years old there is coherence across the preschool and initial compulsory school years. The key difference does not occur until Year 3 when the children enter KS2. The very obvious difference at this point is the sudden drop of play. Play / Active learning is promoted as the key approach in the Foundation Phase and dominates the teaching approaches. Analysis of the KS2 documents show that play is simply not mentioned. Reading comments from Welsh teachers on the TES Cymru forum showed that this is causing problems when children who are used to exploring, choosing and directing their own learning in many ways reach KS2 where they are expected to learn in more structured, teacher directed ways. Both sides recognized the need for transition but there were opposing views about whether the end of Foundation Phase should prepare

[3] [*Action call on science teaching in Wales* (28 Jan 2011) Online Available at: http://www.walesonline.co.uk/news/education-news/2011/01/28/action-call-on-science-teaching-in-wales-91466-28069521/ Accessed 22/07/12.]

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children for KS2 approaches or whether the beginning of KS2 should include some Foundation Phase approaches.

The purposes of assessment differ in emphasis between Foundation Phase and KS2. KS2 documents put a strong emphasis on Assessment for Learning. This does exist at Foundation but there are documents which focus on summative assessments for the purpose of reporting to parents, establishing a base line for future value added indicators and monitoring progress against the seven steps of the profile. However, the introduction of the literacy and numeracy tests for Year 2 to Year 9 pupils may result in a change of emphasis to a more summative focus at KS2. At KS2 there is emphasis on involving the child through self and peer-assessment and setting and monitoring targets, as well as giving feedback to the child. In the Foundation Phase there is much less discussion of the child's role in assessment, with a greater focus on the teacher observing and talking to the child. This does not fit well with the emphasis on pupil ownership and autonomy in other aspects of the learning process.

There are several differences between science and mathematics. Mathematics is presented as a discrete subject at Foundation Phase while science is part of an integrated area, Knowledge and Understanding of the World. However, numeracy is cross-curricular theme so it does not exist solely as a discrete subject. There is less emphasis on asking questions in mathematics but more emphasis on explaining reasoning. There is greater emphasis on resources in mathematics. These include using story, songs, rhymes, games and props for role play in Foundation Stage. Specific mathematical equipment such as number lines, measuring equipment, clocks and shapes are named and there is a greater emphasis on ICT. According to the mathematics inspection report (19) resources are well used in mathematics. The new numeracy framework and the numeracy tests for Years 2 to 9 will probably result in increased differences between mathematics and science but since the framework has not yet been published it is not possible to determine in what way or to what extend.

In the conceptual framework a series of synergies between inquiry-based science education and creative approaches were identified. These synergies are all present in the Welsh curriculum.

- play and exploration – especially in Foundation Phase but there are still elements of exploration at KS2.
- motivation and affect – promoting an interest in and positive attitude towards science and mathematics is part of the rationale for these subjects; making the subjects relevant by linking to everyday life features; more effort is put into making Foundation mathematics appealing by using story, songs, rhymes, role play and games
- dialogue and collaboration – paired and group work are specifically identified; communication is given a high priority in both subjects and at both phases

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- questioning and curiosity – fostering and encouraging curiosity is a key goal; pupils' questions are prominent in science but there is more focus on teachers' questions in mathematics
- problem solving and agency – problem solving features strongly in the mathematics documents, although there are still calls for this to be developed further in practice; in science the focus is more on asking questions which lead to investigation; agency, with the child as an active learner and decision maker is a strong feature of the Foundation Phase but is also part of KS2
- reflection and reasoning – This is particularly developed in KS2 but the younger children are also required to reflect on their learning
- teacher scaffolding and involvement – This is highlighted in Foundation Phase but not at KS2.
- assessment for learning – very prominent as the main purpose of assessment at KS2 with considerable pupil agency in the process

6.1 Limitations

Policy messages need to be interpreted in relation to context: a complex background of historical, economical, geographic, political and likely other factors. Certain expressions, or terms such as 'creativity', hold particular currency within this context. Consequently, evaluating messages is challenging, particularly using the rather blunt survey tool adopted in this analysis. Whilst the survey provided a useful structure with which to examine messages, this methodological approach was selected predominately in order for comparisons to be made between national policies: where the data from this analysis will contribute along with 13 other nations. Articulating policy in terms of how pre-determined approaches are emphasised is a limitation of this report. There is also a question of whether the precepts set out in the documents represent actual practice.

The survey was completed by only one researcher, due to project limitations and the need for a broad understanding of the national background. Unfortunately the project did not have any experts in the Welsh education system so the author drew on understanding of the English education system when interpreting documents. Since the Welsh curriculum was previously the same as the English curriculum these shared antecedents should aid understanding, although there it is possible that the researcher misunderstood aspects. Although all ratings were qualified and these qualifications checked by a co-researcher, this dependence on an individual researcher presents a potential source of bias. A further source is the decision over what documents to draw upon. As an outsider to the system it is possible that the researcher has missed important documents. The fact that most of the documents were taken from government sources is a potential source of bias since they may come from a particular political viewpoint. Since the current Foundation Phase and KS2 curriculum have only been introduced a few years ago so there has not been sufficient time for full impact studies so there were limited critiques of practice.

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One of the main limitations of the Welsh report in terms of the comparative study is the fact that the Foundation Phase spans both preschool and compulsory schooling, making it difficult to discuss the CLS age range of 3 to 8 years and the differences between preschool and compulsory schooling.

6.2 Implications

The findings from this report are intended to inform two further pieces of work in the project: firstly, in-depth field study examining the role of creativity in early years science and mathematics in classrooms; secondly, recommendations for policy.

6.2.1 In-depth field study

Policy was identified in the *Conceptual Framework (D2.2)* as one of various factors shaping practice in the classroom. Therefore, alongside the Teacher survey (D3.1), observations in school would indicate whether the aims and approaches described in the documents happen in practice. Observation of and discussion with children would help indicate the impact of these policies on them.

6.2.2 Policy recommendations

There are several areas where this study could contribute to policy recommendations:

- The role of the teacher
- The role of support staff
- Assessment in the outdoor environment
- Peer and self assessment in Foundation Phase
- The use of resources in science, including ICT

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Appendix A:
Survey Ratings: Analysis of Approaches to Teaching and Learning

The Foundation Phase covers 3 to 7 year olds. This includes 3 and 4 year olds who are 'pre-school', in that school is not compulsory at that age, and 5 to 7 year olds for whom education is compulsory. After 7 years old the children move to Key Stage 2 (KS2). Since CLS is looking at 3 to 8 year olds we need to look at both the Foundation Phase and the beginning of KS2. However, it would not be feasible to separate the pre-school and compulsory schooling aspects on this questionnaire because they are essentially the same from 3 to 7 and only change at 8 years old.

Key
F: Foundation Phase (nursery, reception, Years 1 and 2)
KS2: Key stage 2 (Years 3, 4, 5, 6)

Rationale or Vision

Ai. What are the purposes of science Education?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. To provide a foundational education for future scientists and engineers	F/KS2			
b. To develop socially and environmentally aware and responsible citizens		F	KS2	
c. To enrich the understanding and interaction with phenomena in nature and technology		F/KS2		
d. To develop more innovative thinkers		F/KS2		
e. To develop positive attitudes to science		KS2	F	
f. To develop important attitudes and dispositions as a foundation for future learning		F/KS2		

Aii. What is the emphasis, if any, on the role of creativity in the purposes of science Education? (Adapted from T survey Q23)

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
a. To provide a foundational education for future scientists and engineers				
b. To develop socially and environmentally aware and responsible citizens		F/KS2		
c. To enrich the understanding and interaction with phenomena in nature and technology		F	KS2	
d. To develop more innovative thinkers				F/KS2
e. To develop positive attitudes to science				F/KS2
f. To develop important attitudes and dispositions as a foundation for future learning		KS2		F

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Aims and Objectives

Ai. What views are indicated about the importance of the following science learning outcomes?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
To know and understand the important scientific ideas (facts, concepts, laws and theories).				F/KS2
To understand that scientists describe the investigations in ways that enable others to repeat the investigations.	F/KS2			
To be able to ask a question about objects, organisms, and events in the environment.			F/KS2	
To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.			F/KS2	
To know and understand the important scientific processes.	F		KS2	
To be able to communicate investigations and explanations.			F	KS2
To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.	F/KS2			
To have positive attitudes to science learning.		F/KS2		
To be interested in science.		F/KS2		
To be able to plan and conduct a simple investigation.				F/KS2
To have positive attitudes to learning.		F/KS2		
To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).	F/KS2			
To be able to collaborate with other children			F/KS2	
Other – reflecting		F	KS2	

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Aii. What is the emphasis, if any, on the role of creativity in the following science learning outcomes?

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
To know and understand the important scientific ideas (facts, concepts, laws and theories).		F/KS2		
To understand that scientists describe the investigations in ways that enable others to repeat the investigations.				
To be able to ask a question about objects, organisms, and events in the environment.			F	KS2
To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.		F/KS2		
To know and understand the important scientific processes.		KS2		
To be able to communicate investigations and explanations.			F	KS2
To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.				
To have positive attitudes to science learning.		KS2	F	
To be interested in science.				F/KS2
To be able to plan and conduct a simple investigation.				F/KS2
To have positive attitudes to learning.			KS2	F
To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).				
To be able to collaborate with other children			F/KS2	
.n. Other - reflecting			F	KS2

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Content

A. How are science and mathematics presented as learning domains?

	As its own learning area	Encompassed within other social sciences (e.g. geography)	Encompassed within more general understanding
science	KS2	F [*Knowledge and Understanding of the World* also contains geography (places and people) and history (time and people)]	
mathematics	F/KS2		

B. What are the key science and mathematics topics/strands/themes?

	Science F	Science KS2	Mathematics F	Mathematics KS2
1	Skills in investigating – asking questions, observing, planning investigations, collecting and recording data, communicating, explaining, evaluating	Skills – communication; enquiry; planning; developing; reflecting	Number – recognizing numbers, counting, comparing, ordering Calculating – mental calculation strategies (addition, subtraction, multiplication and division); use own methods to record calculations	Number – number / notation; calculate; investigate patterns and relationships
2	Myself and other living things – human body; plants; animals; interactions with the environment	Interdependence of organisms	Investigate patterns and relationships	Solve mathematical problems Communicate mathematically Reason mathematically
3	Myself and non-living things – features and properties of familiar objects and materials; natural versus manufactured materials; changing materials through forces and temperature; light; sound	The sustainable Earth	Measures and money – compare and order using non-standard units then metric; choose and use appropriate measuring equipment; length, mass, capacity, time	Measures and money – length, mass, volume, capacity, temperature, area and time, angles
4		How things work	Shape, position and movement – recognize 2-D and 3-D shapes; understand and use properties; make models and patterns; sort	Shape, position and movement – properties 2-D and 3-D shapes; reflective and rotational symmetries; angles of turn
5			Handling Data – collect, represent and interpret data	Handling Data – collect, represent and interpret data; probability

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Learning Activities

Ai. What activities are encouraged?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Observe natural phenomena such as the weather or a plant growing and describe what they see.			KS2	F
Ask questions about objects, organisms, and events in the environment.			KS2	F
Design or plan simple investigations or projects.			F/KS2	
Conduct simple investigations or projects			KS2	F
Employ simple equipment and tools to gather data and extend to the senses.		F	KS2	
Use data to construct reasonable explanations.			F/KS2	
Communicate the results of their investigations and explanations.				F/KS2

Aii. What is the emphasis, if any, on the role of creativity in the following activities?

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
Observe natural phenomena such as the weather or a plant growing and describe what they see.			KS2	F
Ask questions about objects, organisms, and events in the environment.				F/KS2
Design or plan simple investigations or projects.				F/KS2
Conduct simple investigations or projects			KS2	F
Employ simple equipment and tools to gather data and extend to the senses.		F/KS2		
Use data to construct reasonable explanations.			F/KS2	
Communicate the results of their investigations and explanations.				F/KS2

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Teacher Role / Location

Ai. What learning/teaching contexts and approaches are mentioned?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Open/unstructured play	KS2			F !!!!
Role/Pretend play	F/KS2			
Drama	F/KS2			
Teaching science from stories	KS2	F		
Using history to teach science (e.g. transport, the work of scientists)	KS2	F		
Working in small groups			KS2	F
Physical exploration of materials			KS2	F
Using outdoor learning activities			KS2	F
Taking children on field trips and/or visits to science museums and industry	F/KS2			
Integrating science with other curricular areas			F/KS2	
Building on children's prior experiences			KS2	F
Fostering collaboration				F/KS2
Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical				F/KS2
Encouraging problem finding – e.g. children asking questions			KS2	F
Encouraging problem solving – e.g. children solving practical tasks		F/KS2		
Encouraging children to try out their own ideas in investigations				F/KS2
Fostering classroom discussion and evaluation of alternative ideas		F/KS2		
Fostering imagination	KS2			F
Relating science to everyday life				F/KS2
Using questioning as a tool in science teaching	KS2		F	
Using digital technologies with children for science teaching and learning			F/KS2	
Fostering autonomous learning			KS2	F
Other – scaffolding			F	

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Aii. What is the emphasis, if any, on the role of creativity in the following learning/teaching contexts and approaches?

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
Open/unstructured play				F
Role/Pretend play				
Drama				
Teaching science from stories			F	
Using history to teach science (e.g. transport, the work of scientists)		F		
Working in small groups			KS2	F
Physical exploration of materials				F/KS2
Using outdoor learning activities			KS2	F
Taking children on field trips and/or visits to science museums and industry				
Integrating science with other curricular areas			F/KS2	
Building on children's prior experiences			F/KS2	
Fostering collaboration		F		KS2
Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical				F/KS2
Encouraging problem finding – e.g. children asking questions				F/KS2
Encouraging problem solving – e.g. children solving practical tasks				F/KS2
Encouraging children to try out their own ideas in investigations				F/KS2
Fostering classroom discussion and evaluation of alternative ideas			F/KS2	
Fostering imagination				F
Relating science to everyday life			F/KS2	
Using questioning as a tool in science teaching				F
Using digital technologies with children for science teaching and learning			F/KS2	
Fostering autonomous learning			F/KS2	
Other – scaffolding			F	

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C. What, if any, Inquiry Approaches are discussed?

	A (Open)	B (Guided)	C (Structured)	N/A
QUESTION: Children investigate scientifically oriented question	F/KS2	F	KS2	
EVIDENCE: Children give priority to evidence	F/KS2	F		
ANALYSE: Children analyse evidence	F/KS2	F		
EXPLAIN: Children formulate explanations based on evidence	F	F		
CONNECT: Children connect explanations to scientific knowledge	F/KS2	F		
COMMUNICATE: Children communicate and justify explanation	F/KS2	F		
REFLECT: Children reflect on the inquiry process and their learning	F/KS2	F		

Materials and Resources

A. What materials are suggested?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Instructional materials (e.g. textbooks)	F/KS2			
Audio-visual resources		F/KS2		
Relevant library materials (e.g. story books)	KS2	F		
Equipment and materials for hands-on exploration in the classroom (e.g. magnets, building blocks)			KS2	F
Equipment and materials for hands-on exploration outside the classroom			KS2	F
Computers			(F/KS2)	
ICT resources (e.g. computer applications)			F/KS2	
Other digital technologies (e.g. interactive whiteboard, camera)	F		KS2	
Budget for supplies (e.g. paper, drawing materials)	F/KS2			
Teaching support personnel (e.g. classroom assistant)	F/KS2			
Other support personnel (e.g. technical support)	F/KS2			

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Groupings

A. What groupings, if any, are suggested for teaching mathematics and science

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Individual work			KS2 (implied)	F
Pair work				F/KS2
Small group work				F/KS2
Whole class activities	F/KS2			

Time

A. How much time should be planned for teaching science and mathematics per week? (Adapted from T survey Q21)

	science	mathematics
Less than an hour		
1-2 h		
3-4 h		
More than 4 h		
N/A (Please explain)	Not discussed for either phase.	Not discussed for either phase.

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Assessment

A: What purposes of assessment are included?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
To identify areas for improvement in your science teaching		F	KS2	
To identify aspects of the science curriculum that could be improved	F/KS2			
To identify ways to improve child science learning		F		KS2
To monitor regularly individual children's or cohorts of children's progress towards a set of desirable science learning outcomes			F/KS2	
To inform parents of their child's progress in science			KS2	F
To help group children for science instruction purposes	F/KS2			
To monitor year-to-year child progress in science	KS2		F	
To provide feedback to children about their progress in science		F		KS2
To set targets with children for their own development in science	F		KS2	
Other – to establish a baseline	KS2		F	
Other – monitoring school success	KS2		F	

B. What importance is given to of the following priorities for children's assessment in science?

To assess the development of children's:

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Knowledge and understanding of scientific ideas (facts, concepts, laws and theories)				F/KS2
Knowledge and understanding of scientific processes	F/KS2			
Competencies necessary to carry out scientific inquiry				F/KS2
Understandings about scientific inquiry (e.g. how science and scientists work)	F		KS2	
Positive attitudes and increase of interest in science	F/KS2			
Positive attitudes and increase of interest in learning science	F/KS2			
Other – communicating				F/KS2

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C. What ways of assessing are advocated?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Using checklists to record observations of children	KS2		F	
During classroom interaction	KS2			F
Evaluating children's pictures, graphs etc which show their scientific reasoning	F/KS2			
Evaluating children's relevant gestures or physical activity	F/KS2			
Marking their homework	F/KS2			
Using authentic problem-based tasks	F/KS2			
Asking each child to reflect on their own learning and progress	F		KS2	
Using closed question tests	F/KS2			
Using open question tests	F/KS2			
Using questions in context	F		KS2	
Using portfolios (collection of evidence of children's work and progress)	F/KS2			
Children correcting each other's work and giving each other feedback			KS2	

D. What Creative attributes are addressed in assessment?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Sense of initiative	F/KS2			
Motivation	F/KS2			
Ability to come up with something new	KS2	F		
Ability to connect what they have learnt during your lessons with topics in other subjects		F	KS2	
Imagination	F/KS2			
Curiosity	KS2		F	
Ability to work together	F/KS2			
Thinking skills			F/KS2	

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