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 10 of 13:
National Report on Approaches in English Policy

Authors:

Dr. Esmé Glauert, *Institute of Education, University of London, UK*
Dr. Ashley Compton, *Bishop Grosseteste University College Lincoln*
Dr. Andrew Manches *Institute of Education, University of London, UK*

www.creative-little-scientists.eu

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Project Information
Project no. 289081
Project acronym: CreativeLittleScientists
Start date of project: 01/10/2011
Duration: 30 months
Project title:

Creative Little Scientists: Enabling Creativity through Science and Mathematics in Preschool and First Years of Primary Education

EU Strategic Objective
Funding scheme: FP7/ CP/ Capacities
Call ID: FP7-Science-In-Society-2011-1
Topic: SiS.2011.2.2.3-1 Science and mathematics-related activities carried out in pre-school and in the first years of primary school: their link to the development of creative skills

Information about the deliverable
Dissemination level: **PUBLIC**
Due date of deliverable: August 2012
Actual submission date: 30/09/2012
Deliverable title:

D3.2 Report on Mapping and Comparing Recorded Practices

Contact Information
Coordinator
Ellinogermaniki Agogi, Greece:
Dr. Fani Stylianidou

Lead partners for this deliverable
Institute of Education, University of London, UK
Dr. Esmé Glauert, Dr. Andrew Manches

Website: http://www.creative-little-scientists.eu

This document reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Copyright © 2012 by CreativeLittleScientists Consortium. All rights reserved.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Table of Contents

Executive Summary **4**

1. Introduction **6**

1.1 Aims of national report **6**
1.2 Defining terms 6
1.2.1 Policy *6*
1.2.2 Curriculum *6*
1.2.3 Creativity *7*

2. Overview of National early years Education provision and policy **8**
2.1 Phases of education 8
2.1.1 Preschool education *8*
2.1.2 Primary education *9*
2.2 Class size and teacher deployment 9
2.2 Curriculum documentation 10
2.2 1 Primary Education documentation *10*
2.2.2 Pre-school education documentation *12*
2.3 Monitoring and evaluation of teaching and learning 14

3. Research Questions and Methodology **15**
3.1 Research Question 15
3.2 Method 16
3.2.1 Data selection *16*
3.2.2 Survey tool *16*
3.2.3 Completion of the Survey Tool *17*
3.2.3 Context of policy messages *17*

4. Approaches to Teaching, Learning and Assessment **18**
4.1 Rationale or Vision 18
4.2 Aims and Objectives 20
4.3 Content 23
4.4 Learning Activities 24
4.5 Teacher Role / Location 26
4.6 Materials and Resources 28
4.7 Groupings 30
4.8 Time 31
4.9 Assessment 32

5. Approaches to Teacher Education **36**
5.1 Initial teacher education 36
5.2 Continuing professional development 38

6. Summary **40**
6.1 Limitations 42
6.2 Implications 42
6.2.1 How could in-depth field study work build upon this report? *42*
6.2.2 Policy recommendations *43*

7. References **44**

Appendix A: Survey Ratings: **47**
Analysis of Approaches to Teaching and Learning in Pre-school policy 47
Analysis of Approaches to Teaching and Learning in Primary School Policy 58

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Executive Summary

This National report examines the way in which teaching, learning and assessment is conceptualised in English 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 English 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 are emphasised across relevant policy documents in this area. In the case of England, this was largely based upon current policy documentation: the National Curriculum Handbook for primary teachers (DfEE/QCA 1999), the Statutory Framework for the Early Years Foundation Stage (DfES 2007), Statutory requirements for assessment and testing (DfE 2012), and the Professional Standards for Qualified Teacher Status and Requirements of Initial Teacher Training (TDA 2008). The review also took into account new policy documents that had been proposed or would come into force in the coming year and guidance documents related to learning, teaching and assessment for each phase of education.

First, evidence of approaches in policy was examined according to nine curriculum themes: Rationale, Aims, Content, Learning Activities, Teacher Role / Location, Materials and Resources, Groupings, Time, and Assessment. Second, specific dimensions within these approaches, characteristic of opportunities for inquiry and creativity in science and mathematics, 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 drawing on recent research and inspection evidence related to policy and practice in early years science and mathematics in England.

The report highlights the considerable emphasis in policy for both preschool and primary education on opportunities for exploration and investigation, based on children's interests and questions. Guidance on approaches to learning and teaching advocates physical exploration of materials, use of the environment and making connections to children's everyday lives. Attitudes and dispositions are not highlighted in the aims and content of the curriculum but there are references to attitudes in practice guidance, particularly for preschool education.

English policy since the introduction of a National Curriculum has been characterised by a high focus on standards, particularly in recent years on standards in literacy and numeracy. This is reflected in a high focus on summative assessment and external testing in the primary school. Formative assessment, in particular the involvement of children in assessment, is under-developed in primary schools and very little attention is paid in policy to the

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

importance and assessment of social or affective aspects of learning. These are given greater priority in the Early Years Foundation Stage.

The focus on exploration and investigation, both in pre-school and primary school provides a potential role for creativity for example in relation to skills and dispositions associated with problem finding, problem solving, reasoning, or evaluation. In pre-school there is also a recognition in policy of important roles of attitudes associated with inquiry and with creativity such as motivation, initiative, curiosity and risk taking. However recent research and inspection evidence suggests that a number of factors can limit how far this potential is realised in practice including teacher confidence and knowledge in relation to both subject and pedagogical knowledge in early years science and mathematics and pressures of curriculum and assessment requirements. This highlights an important role for Continuing Professional Development in early years science. In recent years there has been considerable attention in policy to the provision of Continuing Professional Development for teachers in mathematics, however opportunities for CPD in science have been much more limited.

This report discusses in greater detail the findings from this survey of national policy, and importantly outlines implications for the fieldwork planned in the next phases of the project and recommendations for policy.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

1. Introduction

1.1 Aims of national report

This 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 England. 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 English 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 English policy.

1.2 Defining terms

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

1.2.1 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.

1.2.2 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.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

1.2.3 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'.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

2. Overview of National early years Education provision and policy

2.1 Phases of education

In England education is compulsory between the ages of 5 and 16. Provision is divided into a series of phases and key stages as indicated in Table1 below.

Table 1: Phases and Key Stages of Education in England

Key Stage	Age range	Phase of education
Early Years Foundation Stage	0-5 years	Pre-school
Key Stage 1	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 Preschool education

Children start compulsory schooling in the year in which they are 5, usually in the reception class of a primary school. However all three and four year olds are entitled to 15 hours of free early education for 38 weeks of the year. 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. In January 2011 95% of three and four year olds were in pre-school provision, distributed between different providers as follows:

Table 2: 3 and 4 year olds in pre-school education: distribution across different providers

Type of pre-school provision	Percentage of children
Private and voluntary	38%
Independent	3%
Nursery schools and classes	27%
Primary schools	32%
Secondary schools	0%
Special schools	0%

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

2.1.2 Primary education

Most children go to state schools. All children in England between the ages of five and 16 are entitled to a free place at a state school. The four main types of *state school* (*Community schools, Foundation* and *Trust schools, Voluntary aided* and *Voluntary controlled schools*) all receive funding from local authorities. They are all required to follow the National Curriculum and are regularly inspected by the Office for Standards in Education (Ofsted).

Within the state schools system there are a number of schools with particular characteristics. As with other state schools, admissions are coordinated by the local authority. However, some may have different admission criteria or funding arrangements. These include *Faith schools*, *Academies* and most recently *Free Schools*. *Faith schools* 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. *Academies* are independently managed, all-ability schools set up by sponsors from business, faith or voluntary groups in partnership with the Department for Education (DfE) and the local authority. Together they fund the land and buildings, with the government covering the running costs. *Free Schools* are non-profit making, independent, state-funded schools set up in response to demand within a local area for a greater variety of schools. *Free Schools* are funded on a comparable basis to other state-funded schools. They are expected to be open to pupils of all abilities from the area and cannot be academically selective. *Academies* and *Free schools* are not required to follow the National Curriculum, however they are subject to Ofsted inspection and statutory requirements in relation to assessment as all state schools. *Free Schools* have some additional freedoms. For example, teachers in *Free Schools* will not necessarily need to have Qualified Teacher Status. [1]

There are also around 2,300 *independent schools* in England. 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 Department for Education (DfE). To ensure the school maintains the standards set out in its registration document, standards are regularly monitored by either Ofsted, or another inspectorate.

2.2 Class size and teacher deployment

The 1998 School Standards and Framework Act [2]introduced a commitment to a maximum class size of 30 pupils per teacher for children aged 4-7 in Reception and Key Stage 1 classes except in certain permitted circumstances where not to admit the child would be prejudicial to his or her circumstances (for example children with special educational needs, children in care, where there is no other available school). For pre-school settings for children aged 3-5 governed by the new Early Years Foundation Stage there must be at least one member of staff for every 13 children. Outside the hours of 8am to 4pm or where staff with QTS, or

[1] http://www.direct.gov.uk/en/Parents/Schoolslearninganddevelopment/ChoosingASchool/DG_4016312

[2] http://www.legislation.gov.uk/ukpga/1998/31/contents

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Early Years Professional Status (or the equivalent) are not present there must be at least one member of staff for every 8 children.

In the vast majority of pre-school and primary school settings in the early years the class teacher teaches science and mathematics.

2.2 Curriculum documentation

2.2.1 Primary Education documentation

At the time of writing education policy in England is in transition. The National curriculum is under review and most of the guidance produced by the previous government is no longer official policy. This makes selection of existing documents for review challenging and is an important limitation of this review of policy. The list below includes current statutory regulations and key guidance documents that are still influential, although they no longer represent official government policy. The numbers indicated are used for reference throughout this report. The role and importance of each document is indicated in the sections that follow.

Document name	**Reference for Evidence**
The National Curriculum Handbook for primary teachers in England (DfEE/QCA1999)	(1)
Statutory requirements for assessment and testing (DFE 2012)	(2)
Aims, values and purposes (QCDA 2005) http://media.education.gov.uk/assets/files/pdf/c/curriculum%20aims.pdf	(3)
QCA Scheme of work for science (QCA/DfEE 2000)	(4)
The Assessment for Learning Strategy (DCSF 2008)	(5)
Draft proposals for the National Curriculum (DfE 2012)	(6)
Initial Teacher Training Criteria (Teaching Agency 2012)	(7)
Professional Standards for Qualified Teacher Status and Requirements of Initial Teacher Training (Revised 2008) (Training and Development Agency 2008)	(8)
Teachers Standards (Department for Education 2012) available to download from www.education.gov.uk	(9)

(1) *The National Curriculum* was introduced in 1989 and has since undergone several revisions. The current version dates from 1999. The four main purposes of the curriculum were to:

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

- Establish an entitlement
- Establish standards
- Promote continuity and coherence
- Promote public understanding (p12)

The National Curriculum is compulsory for all children from 5 years old, except for children in Academies or Free schools or outside the state system. The National Curriculum currently consists of statutory requirements for three core subjects English, mathematics and science and the following foundation subjects: design and technology, Information and communication technology, history, geography, modern foreign languages (at Key Stage 2), art and design, music and physical education. The National Curriculum provides statutory programmes of study that outline specific areas of knowledge and skill to be addressed. It also sets out assessment criteria in attainment targets for each subject consisting of a series of level descriptions. These provide the bases for making judgements about pupils' performance at the end of each key stage. Religious education is also statutory but there is no statutory programme of study. There are non-statutory programmes of study for citizenship and personal, social and health education.

(2) *The Statutory requirements for assessment and testing* set out the legal requirements, arrangements and duties of head-teachers each year.

With the introduction on the National Curriculum testing in the core subjects was introduced at the end of Key stage 1 (age 7) and Key stage 2 (age11) alongside statutory teacher assessment. KS1 Standard Assessment Tasks (SATs) were first administered 1991 with the first cohort experiencing the National Curriculum. In both science and mathematics they were more like classroom tasks and very teacher intensive so were reduced a couple of years later to paper and pencil tests. The SATs in science were removed from Key Stage 1 in 1994 and more recently from Key Stage 2 so end of Key Stage reporting is now based entirely on teacher assessment. (SATs are still in place for mathematics.) The intention at the time was to replace the science SATs with a national survey. Since the change of government the situation for the future is unclear. Opinion is divided on the removal of the SATs. Some argue this has resulted in a lower status for science in the curriculum (although evidence from a longitudinal study conducted by Boyle and Bragg (2005) suggested this had already happened following the introduction of the National Strategies in literacy and numeracy). The science community was generally of the view that the SATs were having a very detrimental effect on science learning and teaching, in particular opportunities for science investigations and supported of the removal of the tests (see for example Collins et al 2008, SCORE, 2007). There is some evidence from recent Ofsted survey of science (Ofsted 2011) that in some schools this has resulted in greater focus on inquiry rather than recall of facts.

(3) *Aims values and purposes* - This statement of aims for education was developed by the Qualifications and Curriculum Authority in 2005 to cover all maintained schools. These aims were introduced for secondary schools and it was intended that they would become statutory for primary schools. However this did not happen as the then Labour government

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

initiated a review of the National Curriculum. These aims appear on the current Department for Education website but their status is unclear. (The aims developed in association with the 1999 curriculum are no longer shown). Currently a new set of aims is being developed in conjunction with proposals for a new National Curriculum.

(4) *Qualifications and Curriculum Authority scheme of work for science* (QCA/DfEE 2000)- This document published in 2000 provided non-statutory guidance to support primary teachers' planning of science. This is now archived and is not part of current government policy, however it is included within this report as it continues to form the basis of much planning and teaching in schools.

(5) *The Assessment for Learning Strategy* (QCDA 2008) - This document was produced in 2008 as a significant element in the then Labour government's commitment to personalised learning and to improving rates of progression in attainment. It reflected increasing attention given to the role of formative assessment in enhancing learning and teaching informed by the influential review of research on formative assessment conducted by Black and Wiliam (1998) 'Inside the Black Box: raising standards through classroom assessment'. Again this is not now part of current government policy but is included as the ideas it represents continue to have a significant influence on assessment guidance given in schools and local authorities and on inspection frameworks both for schools and teacher education.

(6) *National Curriculum for Science Key Stages 1 and 2* (draft) (DfE 2012) - Draft proposals for a new National Curriculum to be introduced in 2014 have just been published (June 2012). These are out for consultation and may change considerably. They have been selected for inclusion as they provide an indication of current government thinking and it is likely that they provide some indication of the direction of travel in terms of future policy.

(7*) Initial teacher training criteria* (Teaching Agency 2012) - This document lists requirements for accreditation to deliver initial teacher training from September 2012.

(8) Professional Standards for Qualified Teacher Status and Requirements of Initial Teacher Training (Training and Development Agency 2008) - This sets out current QTS Standards and requirements for Initial Teacher Training in operation until September 2012.

(9) Teachers' Standards (Department for Education 2012) - This document sets out the new QTS Standards to be introduced in September 2012.

2.2.2 Pre-school education documentation

There have been rapid developments in the field of early years education policy and provision since the late 1990s. The Desirable Outcomes (DfEE 1996) were published in 1996 setting out guidance for the education of children from 3-5 and from 1997 with the new Labour government considerable investments in early years education. The Curriculum Guidance for the Foundation Stage was published in 2000 (DfES 2000) setting out Early Learning Goals and guidance on learning and teaching and Birth to Three Matters in 2002 (DfES 2002). The Every Child Matters initiative was launched in 2004 (DfES 2004) to promote

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

integrated care and education with closer links to health. The move from a separate Birth to Three Matters to the integration of this stage with the 3 to 5s in 2007 was a significant mind shift, aligning the EYFS more strongly with younger children and a developmental approach and a little less with preparation for more formal schooling. The Early Years Foundation Stage Framework became statutory in 2008. This framework has since been revised and a new framework is in place for September 2012. This report makes reference to both current documents and those about to be introduced as follows.

Document name	**Reference for Evidence**
Department for Education (2012) Statutory Framework for the Early Years Foundation Stage. Runcorn: DfE. (From September 2012)	(11)
Early Education (2012) Development Matters in the Early Years Foundation Stage. London: Early Education. (From September 2012)	(12)
Department for Education and Skills (2007) Statutory Framework for the Early Years Foundation Stage. Nottingham: DfES. Sept 2008 -2012	(13)
Department for Education and Skills (2007) Practice Guidance for the Early Years Foundation Stage. Nottingham: DfES.from Sept 2008 – Aug 2012	(14)
Nutbrown, C. (2012) Review of Early Education and Childcare Qualifications. Interim report.	(15)

(11) *Statutory Framework for the Early Years Foundation Stage (DfE 2012)* - This is the new statutory framework for the Early Years Foundation Stage. The Early Years Foundation Stage (EYFS) sets the standards that all early years providers must meet to ensure that children learn and develop well and are kept healthy and safe. It promotes teaching and learning to ensure children's 'school readiness' and gives children the broad range of knowledge and skills that provide the right foundation for good future progress through school and life. This framework is mandatory for all early years providers (from 1 September 2012): maintained schools, non-maintained schools, independent schools, and all providers on the Early Years Register.

(12) *Development Matters in the Early Years Foundation Stage (Early Education 2012*) - This document produced by the British Association of Early Childhood Education provides non-statutory guidance to support the implementation of the Early Years Foundation Stage Framework for 2012.

(13) *Statutory Framework for the Early Years Foundation Stage (DfES 2007)* - The statutory framework introduced in 2008 and in operation until September 2012.

(14) *Practice Guidance for the Early Years Foundation Stage (DfES 2007)* - Non-statutory guidance to support the current framework for the Early Years Foundation Stage.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

(15) *Nutbrown review of Early Education and Childcare Qualifications (Nutbrown 2012)* - Professor Cathy Nutbrown was commissioned by Government to lead an independent review to consider how best to strengthen qualifications and career pathways in the foundation years. The review looked at qualifications and training – both for young people who are new to the early education and childcare sector, and for those already employed there. It also considered how to promote progression through an early years career and into leadership roles. This provides an authoritative review of issues related to qualifications and training of pre-school practitioners.

As indicated in the sections above, the government is undertaking a widespread review of policy affecting all phases of education. It is intended that a new National Curriculum will be in place by 2014.

2.3 Monitoring and evaluation of teaching and learning

Both pre-school and primary settings are subject to regular inspection by the Office for Standards in Education (Ofsted). While the future of national testing is uncertain both preschool and primary settings are required to report on children's outcomes at the end of each phase of education to their Local Education Authority (LEA). The Local Education Authority has a duty to monitor and moderate assessment judgements to ensure consistency.

In England an explicit focus on raising standards has been a key feature of policy since the introduction of the National Curriculum, reflected in the high focus on summative assessment in schools, including external testing (Hall and Øzerk 2010). Studies of trends in attainment (for example Tymms 2004, Tymms et al 2008) indicate that the number of children at KS1 and KS2 reaching expected levels rose sharply between 1995 and 2000 but only modest gains thereafter. The Whetton et al (2010) review of standards in English Primary Education, conducted as part of the influential Cambridge Review concluded that primary science was something of a success story. (However how far this represented real gains in standards has been questioned (Tymms 2004, Alexander 2010). Issues highlighted include whether the tests were comparable from year to year, and how far the results were a consequence of teaching to the test and focusing on borderline pupils. No statistically significant differences in attainment have been found between boy and girls in primary schools. However concern continues, not only in relation to overall standards (especially in international comparisons), but in relation to equity as the spread of attainment is wide in comparison to other countries (Alexander 2012). In addition there is increasing evidence of declining attitudes to science across the primary school (for example Murphy and Beggs 2005).

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

3. Research Questions and Methodology

3.1 Research Question

The main research question for Work Package 3.2, adapted for this National Report is:

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

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 England?*
- *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 England?*
- *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 England?*

In order to examine how teaching, learning and assessment are conceptualised across English 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:

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

- 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 England. 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 above in section 3.2) in relation to early science and mathematics. The documents selected, their significance and role within policy are outlined in section 2.3. They cover curriculum and assessment requirements, guidance in relation to teaching approaches and regulations that relate to teacher education. As indicated in previous sections, policy in England is in the process of change therefore for both preschool and primary school phases both current and future policy documents were reviewed.

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 English 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 English 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

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

significant approaches characteristic of creativity in early years science and mathematics. A summary of the emphasis ratings given for English policy is presented in Appendix A; 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 first two authors of this report, from the Creative Little Scientists project team, completed two policy surveys, one related to the preschool phase of education and another for the early years of primary school. Establishing inter-rater reliability across the partnership 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 project members completing the survey provide justifications for their responses alongside specific references to the policy documents used to the support judgements made. In each case these justifications were assessed and discussed with a second project team member.

3.2.3 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.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

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 issues, 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?

For the primary age phase the current vision for science in the National Curriculum is expressed in the introductory pages to the published paper copy of the National Curriculum (1). (These pages are no longer displayed in the online version on the Department for Education website). The draft proposals for the new National Curriculum contain an introductory section on the purposes of science education (6). In both documents the main purposes listed reflect knowledge, skills and attitudes associated with scientific literacy for example '*building up key foundational knowledge and concepts*' (6, p1), awareness of interconnections between science, technology and society and engagement with science-based issues '*question and discuss science-based issues that affect their own lives, the direction of society and the future of the world*' (1, p76) and fostering positive attitudes and dispositions in relation to science including *curiosity*, *imagination* and *critical evaluation* (1, p76).

In the Early Years Foundation Stage (EYFS) science is included in the area of learning entitled Knowledge and Understanding of the World. Here the focus is more on children's development in their own terms through opportunities to develop their own understandings and skills and the promotion of curiosity and interest in the world around them through first hand experiences. There is limited detail about subject specific knowledge and skills to be developed. Reference is made for example to 'guiding *children to make sense of their physical world and community through opportunities to explore, observe and find out about people, places, technology and the environment*' (11, p5). The importance of childhood in its own right is underlined but importance is also given to the need to develop '*essential skills*

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

and knowledge to participate in society' (12, p2) and for future learning (11, p2). The notion of school readiness is prominent in the new framework for the EYFS that comes into operation in September 2012 (11).

What issues / tensions / policy criticisms exist?

In relation to the primary curriculum an enduring concern has been the limited attention to the rationale for policy and the lack of coherence between rationale, aims, curriculum content and assessment criteria (see for example White 2010). This is reflected in the current curriculum in the low profile given to the rationale for science education in official documentation and lack of explicit connection to curriculum content or assessment criteria as discussed in later sections of this report.

In what ways is the role of creativity emphasised?

The term creativity is used to a limited extent but in the introduction to the National Curriculum for Primary Science (1, p76) there are references to the ways in which science education can foster creative dispositions identified in D3.1 such as *curiosity* and *imagination*. The general aims for the curriculum, developed by the Qualifications and Curriculum Authority (3) and recently introduced on the DfE website (but not yet statutory at Key Stages 1 and 2) refer to '*characteristics of successful learners*' that also highlight creative dispositions for example '*creative, resourceful and able to identify and solve problems'* '*willingness to try new things'*. In the Early Years Foundation Stage connections to creativity can also be seen in the emphasis on *problem solving*, *exploration* (12) and encouraging children to '*make decisions about what to investigate and how to do it*' (14, p5).

What are the main differences between preschool and school?

In both phases the importance of promoting interest and curiosity is recognised. In the primary age phase there is greater reference to science specific skills, to understanding of scientific concepts and procedures and to links between science and society. In the Early Years Foundation Stage the rationale is expressed in more general terms in relation to children's development or preparation for school. The rationale provided in both phases suggests opportunities for creativity in the emphasis on creative dispositions, exploration and inquiry

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

The rationale for mathematics is similar to that of science and includes providing a foundation for science and technology, amongst other areas. There are quite grand aims relating to citizenship, 'equip pupils with a uniquely powerful set of tools to understand and change the world', '*Mathematics is important in everyday life, many forms of employment, science and technology, medicine, the economy, the environment and development and in public decision-making'* (1 p60). The draft curriculum (6) is similar, looking towards the future, but with a greater focus on employment. Both documents highlight mathematics as a creative discipline that relates to problem solving and reasoning, encouraging also curiosity, excitement and wonder.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Ofsted (2012) believe that the top pupils in mathematics are not sufficiently challenged and that this may reduce the likelihood of them going on to careers in Science, Technology, Engineering and Mathematics (STEM).

4.2 Aims and Objectives

What are the key summary points?

The current National Curriculum for primary science (1) emphasises both the development of children's knowledge and understanding of scientific ideas and the skills, processes and understandings associated with scientific enquiry. This is reflected in the titles of the programmes of study for science

- Sc1 Scientific Enquiry
- Sc2 Life processes and living things
- Sc3 Materials and their properties
- Sc4 Physical processes (pp 79-81)

The range of skills and processes addressed within the programme of study for Sc1: Scientific Enquiry encompasses those associated with the different phases in an investigation identified by Duschl et al (2007) namely

- Generating evidence – '*planning investigations*'
- Observing and recording – ' *use simple equipment* ' and '*communicate what happened in a variety of ways* '
- Evaluating evidence – '*review and explain work to others*' and ' *provide explanations for observations*'. (1 p78)

The programme of study also makes reference to the development of children's ideas about the nature of science – the notion that '*it is important to collect evidence when trying to answer a question*' (1, p78). The guidance associated with the QCA scheme of work (4) also places considerable emphasis on developing skills and understandings related to scientific enquiry. Content addressed in the programmes of study associated with promoting understanding of important scientific ideas (Sc2, Sc3, Sc4) are listed in the following section.

In the proposed new National Curriculum (6) there is a stronger emphasis on key ideas and the teaching of specific scientific vocabulary. Aims and objectives linked to inquiry are more limited, focusing mainly on '*observing closely using simple equipment, performing simple tests, identifying and classifying and recording findings*' (6, p6, p12). In particular questioning and evaluating evidence are not emphasised and there is no explicit reference to understandings related to the nature of science.

Positive attitudes and dispositions such as curiosity and collaboration are given very limited attention in the programmes of study (either current or proposed) but attitudes and values are mentioned in the QCA guidance related to the current curriculum such as *curiosity*, *enjoyment* and *respect for the environment* (4).

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

In the current Framework for EYFS the Early Learning Goals related to science are found in the area of learning Knowledge and Understanding of the World. They make reference to skills and processes associated with scientific inquiry for example encouraging children's questioning '*ask questions about why things happen and how things work*', '*investigate objects and materials'* (13 p14). The practice guidance (14, p76) highlights the importance of the use of equipment and communication. There is no mention of specific content in both current and new documentation, although the general importance of providing a range of experience and introducing correct terminology and vocabulary is highlighted (12, p40, 14, p76). Although not included in the Early Learning Goals, the EYFS practice guidance makes reference to the role of attitudes '*creating a stimulating environment that offers a range of activities which will encourage children's interest and curiosity, both indoors and outdoors'* (14, p75)

What issues / tensions / policy criticisms exist?

The Science National Curriculum emphasises the skills and understandings associated with Scientific Enquiry and the importance of teaching scientific enquiry through contexts related to the subject content specified (1, p78). The importance of the interconnections between process and concepts was also highlighted in a recent evaluation of science education in England 2007-2010, 'Successful Science' conducted by Ofsted (2011). It reported that '*key factors in promoting students' engagement, learning and progress were more practical science lessons and the development of the skills of scientific enquiry*' (p6). However Ofsted also indicated that there had been *'insufficient professional development in science to tackle the lack of confidence among primary teachers, particularly in their understanding of enquiry skills and the physical sciences*' (p7). In schools where progress was only satisfactory *'opportunities for pupils to plan and evaluate their own investigative work were more limited*' (p12) and teachers lacked sufficient understanding of '*how development in scientific enquiry promotes effective learning*' (p4).

The recent report of the Impact of the Early Years Foundation Stage (Ofsted 2011) does not include specific commentary on teaching and learning in relation to Knowledge and Understanding of the World, however of relevance to the project is that the report noted that in some settings the development of children's language for thinking was weaker than language for communication. They suggest ' *this was usually because practitioners missed opportunities to encourage children to explain and extend their thinking, or simply did not allow time for children to think*' (p16). An earlier Ofsted review of practice in primary schools, Success in Science (Ofsted 2008) noted the need to recognise young children's capabilities and the important role of the teacher in extending children's explorations and thinking of *'it is easy to underestimate what pupils can do in the early stages of science education. The natural curiosity of young children leads them to ask a wide range of questions about the world. With the help of an interested teacher, they can develop these into ideas to be tested and can arrive at explanations for phenomena* observed'. (p 9)

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

In what ways is the role of creativity emphasised?

In the current National Curriculum (1) there are strong connections to creative dispositions in the requirements for Scientific Enquiry indicated for example in the focus on children *raising questions* and *testing out ideas* both are important features of *problem finding* and *problem solving*. *Making connections* between evidence and explanations and *reviewing ideas* also involve *reasoning and evaluating skills*. These elements are less prominent in proposals for the new curriculum and a role for creativity much less evident. The main creative emphasis in the EYFS is on encouraging *questioning* and children *exploring their own ideas*.

What are the main differences between preschool and school?

While the EYFS and the National Curriculum both address elements of scientific inquiry, the National Curriculum includes much greater emphasis on subject specific content, in its focus on conceptual development and strong emphasis on the development of a wide range of skills and understandings associated with scientific enquiry.

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

The stated aims of the draft primary mathematics curriculum are to ensure all pupils:

- '*become fluent in the fundamentals of mathematics so that they are efficient in using and selecting the appropriate written algorithms and mental methods, underpinned by mathematical concepts;*
- *can solve problems by applying their mathematics to a variety of problems with increasing sophistication, including in unfamiliar contexts and to model real-life scenarios*
- *can reason mathematically by following a line of enquiry and develop and present a justification, argument or proof using mathematical language.*' (6 Mathematics, p1).

In the current curriculum the second and third of these are emphasised in developing pupils', '*logical reasoning, problem solving skills, and the ability to think in abstract ways'* (1, p.60). Although fluency in calculation was not highlighted in the introductory statement for the mathematics curriculum, it was well represented in the programme of study. In both the current and draft curriculum there is a disconnect between the aims with their emphasis on problem solving and reasoning and the programmes of study which emphasise content and process knowledge related to number, shape, space and measures and data handling. 'Using and applying' which relates to problem solving and reasoning does appear in each of these sections (1) but this is generally reduced to '*solve word problems'* in the draft curriculum (6) presenting a very limited concept of problem solving.

There is a similar trend in preschool with a move away from problem solving and towards fluency in calculation in the aims and programmes of study. The current EYFS framework states, '*…they seek patterns, make connections and recognise relationships through finding out about and working with numbers and counting, with sorting and matching and with shape, space and measures. Children use their knowledge and skills in these areas to solve*

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

problems, generate new questions and make connections across other areas of Learning and Development' (13, p.63) Whereas the new EYFS Framework starting in September 2012 notes that, '*Mathematics involves providing children with opportunities to develop and improve their skills in counting, understanding and using numbers, calculating simple addition and subtraction problems; and to describe shapes, spaces, and measures*.' (11,p5).

This is similar to the direction of travel in science.

4.3 Content

What are the key summary points?

In the National Curriculum for primary schools science is presented as a separate subject as indicated in section 4.2 above (1). The content areas addressed are as follows:

Programme of Study	Themes
Sc1 Scientific Enquiry	Ideas and evidence, investigative skills – planning, obtaining and presenting evidence, considering evidence and evaluating
Sc2 Life processes and living things	Life processes, humans and other animals, green plants, variation and classification, living things in their environment
Sc3 Materials and their properties	Grouping materials, changing materials
Sc4 Physical processes	Electricity, forces and motion, light and sound (and Earth and Beyond at Key Stage 2)

In contrast in the EYFS Framework (11, 13) science is included as part of an areas of learning entitled Knowledge and Understanding of the World, alongside history, geography, ICT and technology and as indicated in the previous section, science ideas to be introduced are not specified.

What issues / tensions / policy criticisms exist?

First, there has been ongoing debate associated with the content and presentation of the curriculum (Alexander 2010) reflected in recent discussion of revisions to the National Curriculum under the past Labour and current coalition governments in particular about whether the content of the curriculum should be presented as subjects or as broader areas of learning. The Rose Review (DCSF 2008) that set out new proposals for the National Curriculum under the previous Labour government presented the curriculum in terms of broad areas of learning and in so doing to strengthen connections to the EYFS. This it argued, was not was not deny the importance of subjects but to provide children with opportunities for cross-curricular study to use and apply knowledge and deepen understanding. In the new proposals the curriculum is presented according to subjects underpinned by a concern to concentrate on 'essential knowledge in key subjects' (Oates 2010). Whether presented as subjects or broader areas of learning there is scope for teachers to organise both thematic and subject specific learning opportunities.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

A second issue that has fuelled debate about the National Curriculum is concern about overload of content and its impact on learning and teaching (Alexander 2010). In response to pressures of curriculum content and priority given to literacy and numeracy associated with the introduction of the National Strategies in Literacy and Numeracy in 1998 (DfEE 1998), time allocated to science in schools has reduced and an increasing number of schools adopted a cross-curricular approach to teaching science alongside the Foundation subjects.

In what ways is the role of creativity emphasised?

As indicated in the previous section there is potential for fostering skills and dispositions associated with creativity in the emphasis both in the EYFS and the National Curriculum on skills and processes associated with exploration and investigation.

What are the main differences between preschool and school?

The requirements for pre-school do not specify science ideas to be addressed.

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

In the National Curriculum (1) the programmes of study for both subjects identify knowledge, skills and understandings to be addressed. In the current curriculum science has a separate programme of study for Scientific Enquiry whereas in mathematics Using and Applying Mathematics (linked to problem solving, communicating and reasoning) is threaded through the content areas specified. In the proposals for the new curriculum (6) the scope both for scientific enquiry and for problem solving in mathematics is reduced.

In the EYFS (13) mathematics is represented in the area of learning entitled Problem solving, Reasoning and Numeracy. In contrast to Knowledge and Understanding of the World the Early Learning Goals specify particular concepts and knowledge children are expected to acquire.

4.4 Learning Activities

What are the key summary points?

At the time of writing there is limited official guidance on learning activities or teaching approaches in science. Brief indications are given of expectations in the margins of the National Curriculum (1) and in the breadth of study accompanying the programmes of study. Under the previous government guidance was provided by non-statutory schemes of work produced by the Qualifications, Curriculum and Assessment Authority (4). This is no longer government policy but the schemes of work continue to be used by schools and to influence current practice.

In the primary school, the emphasis on scientific enquiry in the current National Curriculum (1) is reflected in the learning activities advocated. Teachers are encouraged to provide opportunities for observing, questioning, investigating, using equipment, analysing and explaining data and communicating. In the proposals for the new curriculum (6) '*working*

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

scientifically' is included in the programmes of study but with more limited emphasis on children's own questions and investigations, analysis of data or communication.

In the EYFS too there is a strong emphasis on '*exploration and investigation'*. This is the subtitle for the EYFS Practice Guidance for science within Knowledge and Understanding of the World (14). Learning activities advocated link to features of scientific inquiry, in particular observation, raising questions and communication. In the new EYFS there is much more limited focus on children conducting their own investigations.

What issues / tensions / policy criticisms exist?

While there is considerable emphasis in the early years on inquiry-based learning activities, a number of factors affect the extent to which these are employed in practice. In the primary school lack of time is an issue with the recent concentration on literacy and numeracy in national policy (Boyle and Bragg 2005). In pre-school settings, while there are often considerable opportunities for inquiry-based learning, their potential may not be recognised or realised by teachers (Feasey, 1994, Siraj-Blatchford, 2004) As indicated in 4.2 teacher confidence and understanding of scientific enquiry are also influential.

In what ways is the role of creativity emphasised?

Inquiry-based learning activities promoted in the EYFS (13 and 11) and current National Curriculum for primary science (1) offer considerable potential for the use and development of creative skills and dispositions. For example the focus on children's own investigations provides opportunities for building on children's *curiosity*, for *possibility thinking* and for *enquiry and problem solving skills*. The emphasis in the primary curriculum on considering evidence, evaluating and explaining to others fosters *reasoning, critical thinking and collaboration*. These themes come through less strongly in the proposals for the new primary science curriculum (6).

What are the main differences between preschool and school?

Both phases emphasise inquiry-based activities. In the primary school there is greater emphasis on reasoning from data, on explaining and making connections with scientific knowledge and understanding.

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

Learning activities in science and mathematics advocated in the EYFS give similar importance to fostering curiosity, following children's interests, exploring and problem solving. In mathematics there is a greater emphasis on learning through stories, songs and games. In contrast to science there is more limited focus on children asking questions or observing.

In the primary school learning activities promoted in mathematics do not feature asking questions and designing or planning investigations but there is a great emphasis on practical activity and problem solving. There are many similarities for example in use of data to construct explanation and communicating reasoning.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

4.5 Teacher Role / Location

What are the key summary points?

Very little guidance on teaching contexts and approaches is given for primary science. There are some slight indications in marginal notes and in the 'breadth of study' section of the National Curriculum (1). There are mentions of encouraging different ways of communicating and using digital technologies. These both relate to overarching skills which teachers were required to develop across the curriculum, not just in science. There are references to relating science to everyday life by using familiar contexts. The QCA Schemes of Work (4), which were never statutory, include a section on building on children's prior learning. The draft science curriculum contains some brief guidance notes, but emphasizes that teaching approaches should be decided by the teacher (6). However, they do emphasise that teachers should make use of the local environment throughout the year. The physical exploration of materials is the main approach emphasized in science. This includes both observing and manipulating the materials.

The approaches advocated for primary science, with the exception of building on prior learning, also feature in the EYFS, with a particular emphasis on physical exploration of materials. However, much more guidance about teaching approaches and contexts is given for pre-school. Much of the guidance applies across all areas of learning, while some is specific to science. This is the case in relation to both the current EYFS framework (13) and guidance (14) and the incoming framework (11) and non-statutory guidance (12). There is a strong message in all of these documents that open / unstructured and child-initiated play is a key approach. Role play also features across the areas of learning, although there is less emphasis on this in the science section. Teachers are encouraged to play and learn alongside the children, following the children's interests. The focus on inquiry skills rather than science content knowledge gives considerable scope for teachers to respond to children's individual interests in science. Teachers are instructed to, '*Model being a thinker, showing that you don't always know, are curious and sometimes puzzled and can think and find out*' (12, p7). This contributes to the development of autonomous learners, which is another strong theme in the EYFS.

Teachers are encouraged to use open-ended questions across the areas of learning, but also specifically in science. Possibility thinking (as discussed by Cremin, Burnard and Craft 2006) is promoted through questions such as '*What would happen if*…?' (14, p7; 12, p.40) and '*What else is possible*? (12 p7). Questioning is not reserved for the teacher though. Children are also encouraged to ask questions to identify problems. They then attempt to answer these by undertaking practical tasks and investigating their own ideas.

What issues / tensions / policy criticisms exist?

In their study of primary science across the UK, Murphy and Beggs (2005) identified the need to make science more relevant to pupils' experience. They noted that the children's enjoyment of science had deceases across the primary school and that funding and teacher

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

training for primary science was limited.

In her study of the mathematics curriculum in the UK Munn concluded '*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*.' (Munn 2006: 109)

Ofsted (2012) found that in schools with outstanding mathematics teaching, *'Pupils of all ages and abilities tackled varied questions and problems, showing a preparedness to grapple with challenges, and explaining their reasoning with confidence." p.7* In contrast weaker schools were more focused on passing tests and *"presented mathematics as sets of disconnected facts and methods that pupils needed to memorise and replicate.' p.7* This is a clear indication that Ofsted are valuing creative aspects of mathematics. They have called for greater emphasis on using and applying mathematics and recognition that standard word problems do not sufficiently develop problem solving skills. (Ofsted 2012: 46, 47)

The use of hands-on experiences and exploration of practical resources was acknowledged as important for children's understanding of mathematics at KS2 as well as EYFS and KS1 (Ofsted 2012). However, in some schools resources were focused on the early years and not used with older children, not recognizing the importance of representation in deepening understanding of mathematics .

In what ways is the role of creativity emphasised?

Although very few teaching approaches are presented in policy, those that are do relate to creativity, particularly the physical exploration of materials. However, there are also links to motivation and affect in making links to everyday life and prior experiences. The use of digital technologies may link to play and exploration and multimodal communication is encouraged.

There is a greater emphasis on creative approaches in pre-school science, in addition to those mentioned for primary. Play and exploration are the strongest elements, relating to the open / unstructured play and physical exploration of materials. Questioning and curiosity and problem solving and agency both feature strongly. Motivation and affect relate to the frequent references to following the children's interests. There are some references to reflection in the development of the autonomous learner. The creative approaches which are least represented are dialogue and collaboration. These are not discouraged but there is little mention of children working and talking with each other.

Inquiry approaches, related to the items in the survey concerning: *questioning, giving priority to evidence, analyzing evidence, formulating explanations, connecting explanation to scientific knowledge, communicating and reflecting,* are evident throughout in policy for both preschool and primary science. The EYFS approach generally is a combination of child-initiated and teacher-led learning so the enquiry approaches would be experienced in both open and guided activities. Questioning, explaining and connecting are still guided at KS1 but

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

the others are open. There is much more limited mention of any inquiry approaches in the draft science curriculum (6).

What are the main differences between preschool and school?

Much more guidance about teaching approaches and contexts is given in preschool. The emphasis in the EYFS on responding to children's interests may be easier to follow in preschool than primary, due to the more process orientated science curriculum, discussed previously.

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

In pre-school the emphasis on play, following children's interests, problem solving and teacher questioning is similar in mathematics and science. There is greater use of stories, songs, rhymes, games, role-play and everyday routines in mathematics, but less emphasis on using the outdoor environment. One difference is the suggestion that the teacher be a bit silly be asking silly questions and pretending to be a robot (14, p 72, 2, p 36),

In primary school, mathematics is similar to science in emphasising physical exploration of materials, building on prior experiences, encouraging different ways of recording, relating to everyday life and using digital technologies.

Mathematics has far more emphasis on problem solving, although the nature of these problems is not always specified. They are to include problems related to number / calculation; shape, space and measures; data handling and should include practical contexts. There is considerable emphasis on making decisions about problem solving strategies and trying different ways to overcome difficulties, which relate to fostering autonomous learning, although this does not feature in the new drafts (6).

Teachers are urged to help children make connections between different aspects of mathematics. As with science, there are also several suggestions for links to the English curriculum and use of ICT, while the breadth of study says that mathematics should be used in other subjects as well. There is less emphasis on using outdoor learning activities. There is only one reference to using the 'immediate environment' but it is unclear whether this includes the outdoor environment.

The National Numeracy Strategy, which was introduced in 1999 (DfEE 1999), (later part of the Primary National Strategy) contained explicit guidance about teaching approaches, including the organisation of the lesson, the use of resources (including ICT) and how to teach the four operations using mental methods, informal approaches and written algorithms. Although the strategy is no longer in place, its influence is still evident in many schools.

4.6 Materials and Resources

What are the key summary points?

Several types of resources are mentioned in the EYFS guidance but none is particularly

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

emphasized. To go with the emphasis on physical exploration of materials, there are various mentions of materials for hands-on exploration, both inside and outside. There are also mentions of children using digital technologies and audio-visual resources. In addition to providing resources for the children, teachers are expected to *'Create a stimulating environment that offers a range off activities which will encourage children's interest and curiosity, both indoors and outdoors'* (14, p 75).

Just as there was little guidance on teaching approaches in primary science, there is no specific policy regarding resources. The only resources mentioned were ICT equipment (1).

What issues / tensions / policy criticisms exist?

Murphy and Beggs (2005) and Collins et al (2010) found that a lack of resources was a problem in science in many schools. They also identified a lack of classroom assistance as an issue. Use of support staff was not discussed in the documents analysed and there were limited references to resources generally, so it is unclear whether these are still concerns. Ofsted (2012) identified that the use of resources in mathematics was important for KS2 as well as younger children.

In what ways is the role of creativity emphasised?

The use of resources in preschool science relates to play and exploration, motivation and affect, and questioning and curiosity. They are intended to stimulate children's curiosity and interest in science. The few resources mentioned with respect to primary science do not particularly relate to creativity.

What are the main differences between preschool and school?

There is a much greater emphasis on resources in preschool.

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

There is a much greater emphasis on the use of story-books, games and props for role play in preschool mathematics. Specific mathematics resources, such as 100 squares and number cards, are identified. In primary there are also various references to concrete objects and practical resources to explore number, calculations, shape, space and measures. This is particularly emphasised in shape, space and measure. Play and exploration are key aspects of creativity here.

In primary policy, similar to science, there are quite a few references to ICT in mathematics, including references to particular types of software. However, there are also mentions of other digital equipment such as programmable toys and digital weighing scales. There are contradictory messages about calculators. (6) They are generally viewed with suspicion, being perceived as an inappropriate crutch for calculations but their use is approved in certain circumstances. There were no mentions of ICT in preschool mathematics.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

4.7 Groupings

What are the key summary points?

Grouping was not discussed in either the preschool or primary science documents.

What issues / tensions / policy criticisms exist?

Grouping practices have for some time been the focus of considerable debate, in particular the use of 'ability grouping' that has been increasingly adopted in Mathematics but is much less commonly employed in science. Key issues are well represented by the following comments by Ofsted in relation to ability grouping in mathematics

'An increasing minority of schools were starting to place Key Stage 2 pupils **in sets** for mathematics, particularly in Years 5 and 6. Sometimes an extra teacher or teaching assistant was employed to teach an additional Year 6 class thereby making all the Year 6 classes smaller. The rationale behind such setting was to allow teachers to concentrate on a narrower range of attainment, especially in the run up to national tests. Rarely, however, were such strategies evaluated in terms of the gains in progress for different groups of pupils.'(Ofsted 2012: 64)

Ofsted (2012) noted that when children were set by ability for mathematics, the lower sets received the least experienced and often temporary teachers, while the upper sets were taught by mathematics specialists. This had a negative effect on the lower sets, resulting in a widening attainment gap. This may have been a key factor in their finding that mixed-ability classes rather than ability sets were more likely to be outstanding.

'In primary schools, no marked difference in learning and progress was noted between mixed-age and single-age classes. ***Outstanding learning and progress occurred more often in mixed-ability primary classes than in those set by ability.*** *However, the* ***most able pupils*** *in nearly a quarter of primary schools were i****nsufficiently challenged, often because they were set very similar work to their middle-attaining peers before moving to extension tasks.'*** *(Ofsted 2012: 18)*

In what ways is the role of creativity emphasised?

As indicated above, there is little explicit discussion of grouping in official policy of grouping practices.

What are the main differences between preschool and school?

None noted in policy documentation.

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

Grouping is not discussed in the current and upcoming preschool or primary mathematics curriculum documents. However, the Primary National Strategy (no longer in use) discussed groupings for mathematics. There was an emphasis on whole class activities for several parts of the lesson. However, during the main part of the lesson teachers could have children work as individuals, in pairs, in small groups or as a whole class. Group work could be used to differentiate activities for children working in ability groups. In some schools children are put

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

into ability sets for mathematics (and English), where the classes are organised to contain children with similar attainment. This is not a common practice for science.

4.8 Time

What are the key summary points?

Time allocations were not given for any areas of learning in the EYFS. There was no recommended amount of time for teaching science at primary level either, although its designation as a 'core subject' would imply that it should get more time than the individual 'foundation subjects'.

What issues / tensions / policy criticisms exist?

Recent evidence based on a longitudinal study of school practices indicates that time allocated to science varies a good deal in primary schools and has reduced in recent years. (Boyle and Bragg 2005) Reasons for this are the subject of debate. The introduction of the National Strategies and removal of statutory testing both may have contributed to reduction in emphasis. Murphy and Beggs (2005) and Collins et al (2010) identified lack of time as a problem in science, especially inhibiting carrying out investigations.

Ofsted (2012) noted that the best schools allowed sufficient time for pupils to engage deeply with mathematics.

'Critically, pupils were directly engaged in mathematics for a substantial portion of each lesson. As a result, they had time to develop a high degree of competence and to tackle challenging, varied questions and problems that helped to deepen their understanding. Pupils worked on a mix of group tasks, exploratory activities in which they tried to devise their own methods, and exercises completed individually. The exercises allowed pupils to progress from routine practice of skills to two-step questions, where the method was not immediately apparent, and questions with unusual twists that required some adaptation to the standard method.' (Ofsted 2012: 23)

Ofsted (2012) also found that time was not always well used in lessons. One issue they raised was whether copying learning objectives into books was a productive use of time.

In what ways is the role of creativity emphasised?

The lack of recommended time could mean that there is not sufficient time to dwell and for ideas to incubate (Wallas, 1945) which could inhibit the creative process. The importance of time for children's own ideas, projects and inquiries was emphasized in the Conceptual Framework (D2.2)

What are the main differences between preschool and school?

None

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

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

The Primary National Strategy (no longer in use) had recommended 45 minutes per day (although not necessarily all at once) of mathematics teaching for early years children, gradually increasing to lessons of 60 minutes per day for older primary children. Although the Primary National Strategy is no longer in place, it is still common for schools to have a daily mathematics lesson of around 1 hour.

4.9 Assessment

What are the key summary points?

Purposes of assessment

The statutory requirements for assessment in primary school (2) focus on the summative purposes of assessment in monitoring progress of individual children and cohorts of children against assessment criteria and reporting results to parents and the local education authority. There is some indication of use of patterns in data to support school improvement processes. These purposes are also indicated in the EYFS (11, 12) but in official guidance greater attention is given in addition to formative purposes of assessment to inform planning and provide feedback to children based on ongoing observational assessment for example '*ongoing assessment (also known as formative assessment) is an integral part of the learning and development process'* (13 p10).

The previous Labour government introduced the Assessment for Learning Strategy (5) designed to support schools in developing assessment of pupils to enhance learning. This drew on the definition of assessment for learning provided by the Assessment Reform Group (2002)

> 'Assessment for learning is the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there'.

The Strategy and its associated materials are no longer government policy but many of the approaches and resources suggested continue to be promoted by local education authorities and used in schools. The Strategy emphasised the importance of children's involvement in assessment processes for example '*the teacher routinely explores with pupils how their learn most effectively*' or '*the teacher and pupils develop lessons together to meet learning needs'* (p17).

Priorities for assessment

In the primary school priorities for assessment are indicated in the National Curriculum attainment targets (1). These consist of eight level descriptions of increasing difficulty 'describing the types and range of performance that pupils working at that level should characteristically demonstrate' (p1). The majority of children aged 5-8 would be expected to be working within levels 1-3 with expected attainment at 7 of level 2 (upper primary levels 2-

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

5 with expected level at 11 of level 4). In Key Stage 1 (5-7) assessment Scientific Enquiry is given a weighting of 3 in comparison to the three attainment targets associated with Knowledge and Understanding of scientific ideas, each given a weighting of 1. This indicates priority to knowledge and understanding of skills and understandings associated with scientific processes alongside concepts. Attitudes are not included in the level descriptions.

In the EYFS the current Early Learning Goals (11, 13) focus on skills associated with scientific inquiry. While there is reference to assessing children's awareness of features or patterns in their environment there are no specific criteria related to scientific ideas. Attitudes are not included in the Early Learning Goals related to science but are a key feature of the goals related to Personal, social and emotional development. These refer for example to interest, motivation and confidence (13, p12). In the new EYFS framework there is reference to confidence, but not to interest and motivation (11, p8).

Approaches to assessment

The statutory requirements for assessment in the primary school provide no guidance on approaches to assessment apart from the need to base summative assessment on performance '*over time and across a range of contexts'* (p10). The previous guidance associated with Assessment for Learning (5) highlighted the importance of dialogue, children using their own success criteria and identifying next steps in their learning.

The current EYFS framework (13) gives high priority to the role of observation during day to day activities and the practice guidance makes reference in particular to the use of checklists to record observations and the collection of a wide range of evidence including '*observations, photographs, video, things children have made or drawn and information from parents*' (14 p12). The new EYFS framework indicates the importance of interactions with children to inform teaching (11, p10).

What creative attributes are addressed in assessment?

Official assessment policy and guidance in relation to primary science do not refer to the assessment of social or affective factors in general or in science. The emphasis is on cognitive factors. The attainment targets for Scientific Enquiry (1) include reference to a number of important thinking skills in the context of science such as *reasoning, evaluation, hypothesising (use of imagination, making connections), information processing*.

In contrast the new guidance for the EYFS makes reference to a number of creative attributes linked to sense of *initiative, motivation or ability to come up with something new*, for example '*Be specific when you praise – tries different approaches, persists, solves problems, has new ideas' or 'showing high levels of energy, fascination'* (12, p6). Curiosity and questioning are more strongly featured in the current EYFS '*shows curiosity and interest by exploring surroundings' 'ask question about why things happen and how things work'* (13, p47).

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

What issues / tensions / policy criticisms exist?

The most recent inspection survey of science education in England (Ofsted 2010) highlighted recurring weaknesses in relation to formative use of assessment in science and suggested that guidance associated with the Assessment for Learning Strategy had not yet made a substantial impact on schools. The commented for example that '*too often, in planning science activities, teachers did not take sufficient account of what pupils had already learned at previous key stages and did not give them advice on how to improve further. As a result, pupils lost interest and made insufficient progress'* (p10). The report indicated that the had only observed children involved in peer and self assessment in a third of primary schools and that '*practice* (in assessment) *was consistently good in only one in ten of the primary schools*' (p16).

In what ways is the role of creativity emphasised?

In the primary school the attainment targets for Scientific Enquiry (1) make reference to a number of thinking skills associated with reasoning, evaluation, hypothesising (linked to use of imagination, making connections) and information processing.

In the EYFS the new guidance provided in 'Development Matters' suggests the importance of teachers noting and praising a number of creative dispositions such as problem solving, curiosity, motivation (being prepared to persevere), '*thinking of new ideas, finding new ways to do things'* (12 p7)

What are the main differences between preschool and school?

Formative assessment practices and the importance of positive attitudes and dispositions are given greater emphasis in pre-school. In primary school there is greater focus on summative assessment and on subject content.

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

The processes and purposes of assessment in the EYFS are the same for mathematics and science. The main focus of the current assessment for mathematics is on skills in counting and basic calculations and language related to shape, space and measure. However, each of these areas also contains the statement '*Uses developing mathematical ideas and methods to solve practical problems*.' (13) The new EYFS is similar, although it is not clear whether the term 'solve problems' means the same thing as before. The statements, '*They solve problems, including doubling, halving and sharing*,' and '*children use everyday language to talk about size, weight, capacity, position, distance, time and money to compare quantities and objects and to solve problems*'(p.9, 11) might refer to more straightforward word problems rather than open-ended investigations.

The assessment of mathematics in the primary years is different because there are statutory National Curriculum tasks and tests which must be given to children working at level 1 or above towards the end of Year 2 (6 to 7 years old). These are to be used to support teacher assessment judgments and to determine an overall level of attainment in mathematics. The

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

results are reported to parents and the local authority for monitoring and accountability purposes. The results are also used internally as a baseline against which to measure children's progress during key stage 2. Children taking the level 2 tests are allowed to use hundred squares, number lines and tens and units apparatus but children taking the level 3 test are not allowed any resources. The reasoning behind this is not explained. The tests and tasks mainly focus on basic number and calculation skills and knowledge about shape, space and measure but some of the questions are set in the context of problems. Many of these are word problems but some are more complex and involve pattern finding and reasoning.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

5. Approaches to Teacher Education

5.1 Initial teacher education

There are many routes into teaching in England. Students may follow: a 2, 3 or 4 year undergraduate programme, resulting in a bachelor's degree with recommendation for QTS; a one year post-graduate programme (PGCE), with or without credits at master's level; a flexible route PGCE over two or more years; or a one year Graduate Teacher Programme which is more school based and might not include academic credit. The undergraduate and PGCE routes are based in universities working in partnership with schools. However, the GTP, School-centred training programmes (SCITT) and Teach First have schools as the main provider, although some are affiliated to universities. The current government is promoting school-based ITE and is developing Teaching Schools that would run ITE and CPD in clusters of schools.

Prospective teachers are required to have at least Grace C at GCSE (or equivalents) in English, mathematics and science and have passed an interview intended to determine their suitability to teach. From August 2013 they will also need to have passed skills tests in professional use of English and mathematics. However, the number of A levels (or equivalents), the subjects studied and the grades required are determined by the individual universities rather than determined centrally. Students following a PGCE or GTP route need to have an undergraduate degree, which includes 60 credits at level 6.

Students are assessed in schools through observation, discussion and scrutiny of work by school mentors and university tutors. The academic assignments are the responsibility of the university, although the assessment may be carried out in conjunction with school staff. The format of these assignments is up to the individual institution but the levels must be in line with national criteria.

There are no specific requirements for tutors on ITE programmes. However, the Ofsted inspection framework for ITT looks for appropriate qualifications that can include QTS, subject qualifications and Master's level qualifications to support teaching and assessment at Level 7. Similarly there are no specific requirements for school mentors other than being practising teachers, although it is implied that teachers in their induction year should not act as mentors.

The recent teaching standards (there will be new standards in operation from September 2012) included different levels for assessing Qualified Teacher Status (QTS) in Initial Teacher Education and for practising teachers. Those for the award of QTS focus on:

Professional attributes

- Relationships with children and young people
- Frameworks (duties, policy)
- Communicating and working with others
- Personal professional development

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Professional Knowledge and Understanding

- Teaching and learning
- Assessment and monitoring
- Subjects and curriculum
- Literacy, numeracy, ICT
- Achievement and diversity
- Health and well being

Professional skills

- Planning
- Teaching
- Assessing, monitoring and giving feedback
- Reviewing teaching and learning
- Learning environment
- Team working and collaboration (8)

The new standards, which come into effect in September 2012, generally address the same issues but will apply to all teachers both those in training and practicing teachers.

Part 1 - Teaching

- Set high expectations which inspire, motivate and challenge pupils
- Promote good progress and outcomes by pupils
- Demonstrate good subject and curriculum knowledge
  - *includes: if teaching early mathematics, demonstrate a clear understanding of appropriate teaching strategies*
- Plan and teach well structured lessons
  - *includes: promote a love of learning and children's intellectual curiosity*
- Adapt teaching to respond to the strengths and needs of all pupils
- Make accurate and productive use of assessment
  - *both formative and summative*
- Manage behaviour effectively to ensure a good and safe learning environment
- Fulfill wider professional responsibilities

Part 2 - Personal and Professional Conduct

- Uphold public trust in the profession and maintain high standards of ethics and behaviour within and outside school …
- Have proper and professional regard for the ethos, policies and practices of the school in which they teach, and maintain high standards in their own attendance and punctuality
- Have an understanding of and always act within the statutory frameworks which set out their professional duties and responsibilities pp.7 – 9 (9)

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

From September 2012 the standards listed above (9) will apply to practising teachers as well as student teachers. The statement about teaching early mathematics implies that there is a particular set of teaching strategies that are appropriate for early mathematics. For reading, systematic synthetic phonics is listed specifically as the approved method that teachers must use. No parallel has been presented for teaching early mathematics yet.

Very little of the curriculum content for ITE is prescribed, although the content must prepare the students to meet the QTS standards listed above. Courses must prepare teachers to teach across two or more consecutive age phases [or primary these are Ages 3-5 (Foundation Stage); Ages 5-7 (KS1); Ages 7-9; Ages (9-11) (KS2)]. The university-based courses are concurrent models with at least 120 days in school for PGCE (from August 2013) and for 2 or 3 year undergraduate programmes and 160 days in school for 4 year programmes. The move to 120 days for PGCE programmes represents a considerable challenge as this is a marked increase and considerably reduces the time for university-based elements that often play a significant role in the development of students pedagogical and subject knowledge in science. The student does not need to be teaching during all of the days in school, so some of the curriculum will be taught through students observing and other kinds of activities in schools.

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. Ofsted (2012) have called for the inclusion of more subject knowledge and subject-specific teaching skills in mathematics in all types of primary ITE.

It should be noted that preschool settings are not required to have qualified teachers. Some early years settings may be staffed by people with only level 2 or 3 qualifications. They may be assisted by people without any relevant qualifications. A recent review of early years qualifications (15) determined that there should be more rigorous qualification requirements, including a focus on child development.

'*Good qualifications, taught well, ensure that those training to enter the early years workforce, and those already working with babies and young children, can be supported to develop the right blend of theoretical knowledge and practical skills. When these are combined with the commitment and passion evident across the sector we can expect to see better outcomes for children, in the early years phase and in their later life as well.*' (15, p5)

5.2 Continuing professional development

During the first decade of this century there was a considerable investment of money and time in professional development for teachers, headteachers and ITE tutors related to the National Strategies in Numeracy and Literacy. The focus was on promoting the content, concepts and processes related to the Primary National Strategy. With the demise of the

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Primary National Strategy this opportunity for Continuing Professional Development has ceased. In science there have been much more limited opportunities for professional development highlighted by a survey carried out by the Wellcome Trust (2008).

There are few national CPD initiatives for science and mathematics. However there is the Science Learning Centre Network which has a wide range of CPD, including courses related to inquiry, play and exploration, and creativity in early years and primary. In 2012 -13 The Wellcome Trust is piloting and evaluating a longer term CPD programme to support primary science that may be rolled out nationally. A report to the Wellcome Trust (Murphy and Beggs, 2005) found that lack of subject knowledge and confidence were major issues in science teaching. They also determined that those teachers who had undertaken CPD in science were significantly more confident to teach science. Confidence is important because they found that a lack of confidence constrained the use of investigations in the classroom.

In mathematics there is the Mathematics Specialist Teacher programme (MaST) which is a two year, master's level course aimed at deepening mathematical knowledge and extending knowledge of mathematical pedagogy. This has been funded centrally but delivered by consortia of universities working in conjunction with the Local Authority staff. In addition to subject and pedagogy sessions in the university, MaST teachers participate in peer observation, professional discussion, coaching and mentoring. Ofsted (2012) have recommended that this approach be extended for other CPD to share good practice. MaST resulted from recommendations in the Williams Review (2008). The recent Ofsted report (2012) has also called for CPD in mathematics, specifically:

- *"in choosing teaching approaches and activities that foster pupils' deeper understanding, including through the use of practical resources, visual images and information and communication technology*
- *in checking and probing pupils' understanding during the lesson, and adapting teaching accordingly*
- *in understanding the progression in strands of mathematics over time, so that they know the key knowledge and skills that underpin each stage of learning" (Ofsted 2012: 10)*

They noted that weak subject knowledge inhibits teachers from anticipating misconceptions, recognise errors and using questioning effectively. (Ofsted 2012: 36)

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

6. Summary

Approaches to teaching, learning, assessment and teacher education

Key features of policy related concerning approaches to teaching, learning, assessment and teacher education in early years science and mathematics in England are as follows:

- The main purpose for science education highlighted in primary science policy is to develop the knowledge and understanding, skills and attitudes associated with scientific literacy. In the preschool phase there is a greater focus on childhood in its own right and children making sense of their own environment, alongside developing skills and knowledge to participate in society and for future learning.
- The aims and content of the curriculum for both phases of early years education place considerable emphasis on practical activity and opportunities for exploration and investigation based on children's interests and questions. In the current primary curriculum features skills and understandings related to inquiry are prioritised and well represented. New policies to be introduced also incorporate aims and objectives associated with inquiry but children's agency is less strongly featured and the range of inquiry skills featured is more limited. Attitudes and dispositions are not highlighted in the aims and content of the curriculum but there are references to attitudes in practice guidance, particularly for preschool education.
- Guidance on approaches to teaching and learning for the primary phase is limited. There is more detailed advice for preschool. In both phases there are strong emphases on exploration and investigation, physical exploration of materials and use of the environment and making connections to children's everyday lives.
- The focus on exploration and investigation, both in pre-school and primary school provides a potential role for creativity for example in relation to skills and dispositions associated with problem finding, problem solving, reasoning, or evaluation. In pre-school there is also a recognition in policy of important roles of attitudes associated with inquiry and with creativity such as motivation, initiative, curiosity and risk taking.
- English policy since the introduction of a National Curriculum has been characterised by a high focus on standards, particularly in recent years on standards in literacy and numeracy. This is reflected in a high focus on summative assessment and external testing in the primary school.
- Formative assessment, in particular the involvement of children in assessment, is under-developed in primary schools and very little attention is paid in policy to the importance and assessment of social or affective aspects of learning. These are given greater priority in the Early Years Foundation Stage.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

- Teacher education programmes include opportunities for beginning teachers to develop subject knowledge and pedagogical skills and knowledge in science and mathematics. In recent years there has been considerable attention in policy to the provision of Continuing Professional Development for teachers in mathematics, however opportunities for CPD in science have been much more limited.

Issues and tensions in policy

- Longitudinal studies of the curriculum suggest that the combination of an overloaded curriculum, high stakes assessment and an emphasis on standards in numeracy and literacy has reduced the time allocated to science and in particular the opportunities for investigation emphasised in the National Curriculum. A recent survey of teachers undertaken by the Wellcome Trust (2011) provides further support for this view. It may also have contributed to the decline in attitudes to science across the primary school found in recent studies.

- While there is growing evidence in research of the importance of social and affective aspects of science learning, there is very limited reference to attitudes in policy related to aims and objectives, curriculum content or assessment in primary science.

- The influential Robinson report All our Futures: Creativity, Culture and Education (DfEE 1999) argued for the vital importance of creative and cultural education for pupils' lives in the present and to prepare them challenges of an ever changing future. In 2003 the then government published Excellence and Enjoyment: a strategy for primary schools (DfES 2003) that suggested that enjoyment would follow from excellent (creative) teaching and that this was not in conflict with the focus on standards, rather such teaching would help promote high standards. Indeed the QCA produced its own website on how to promote creative, cross-curricular learning experiences (QCA 2005). These documents, initiatives such as Creative Partnerships and discussion surrounding the Rose Review prompted some schools to review the nature of their curriculum to include a more explicit focus on fostering skills and dispositions associated with creativity. However the findings discussed in this report echo commentary by Brehony (2005) and Hartley (2006) that suggest irresolvable contradictions between 'excellence' and 'enjoyment' within recent government policy.

- While there are suggestions that teacher subject knowledge is improving as a result of improvements in school science education since the introduction National Curriculum, research and inspection indicates there is still concern that limitations in teachers' confidence, subject knowledge and understanding of young children's learning in science continues to restrict opportunities for exploration and investigation and for the development of children's own ideas and explanations.

- An audit of in-service training undertaken by the Wellcome Trust (2008) revealed low take up of opportunities for Continuing Professional Development in science.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Over recent years Ofsted has commented on lack of specialist training for science coordinators and weaknesses in the quality of leadership in a substantial number of schools (Ofsted 2008, 2011).

- The greater focus on skills and dispositions in pre-school education – reflected in the Early Learning Goals and practice guidance offer more positive opportunities than in primary education for the promotion of inquiry-based approaches to learning and a potential role for creativity. Recent research and inspection related to pre-school provision suggests that the challenges at this phase of education are more associated with teachers' views, knowledge and confidence in relation to science, their perspectives on their role in early years science and their knowledge and understanding of the nature of young children's learning in science.

6.1 Limitations

At the time of writing this report policy in England related to both preschool and primary education was in the process of change. This presented a number of challenges. In relation to primary education proposals for the new curriculum were only in draft. The status of a number of guidance documents in place under the previous government was either unclear or no longer official policy, although they continued to inform current practice. In relation to preschool the situation was more straightforward in that the new EYFS framework and practice guidance were published, ready to be implemented in September 2012. To try to represent the current policy context a decision in our review of policy, a decision was made to refer both to current policy, being used by the teachers who would be completing the teacher survey, and to new proposals (for primary education) or new policy (for preschool education) that would influence practice during the later phases of the project.

Making judgments about the emphases in policy was challenging and subject to personal interpretation influenced by the experience and views of the researchers. The List of Mapping and Comparison Factors D3.1 and the Conceptual Framework D2.2 provided important guidance in making judgements. Ratings in the surveys were peer reviewed by the research team.

6.2 Implications

6.2.1 How could in-depth field study work build upon this report?

This report highlights the strong emphasis on inquiry-based approaches in policy but also some of the challenges of realising this in practice. In relation to primary education it would be useful to study examples of the different ways in which teachers create opportunities for inquiry and foster children's autonomy. In preschool examples would be useful to illustrate the nature and potential for inquiry at this age phase.

The report indicates that in both phases of early years education, approaches to formative assessment of science learning are underdeveloped. It would be useful if more in-depth study in Work Package 4 could help exemplify varied, multimodal approaches to assessment

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

utilised in schools and ways in which children can be involved in assessment from an early age.

There are on-going concerns about teachers' lack of confidence and subject knowledge in science. Classroom observation and peer and self-evaluation play important roles in teacher professional development. The in-depth field study has not only the potential to provide examples of approaches to inquiry opportunities for the development of skills and attitudes associated with creativity but also to provide the basis for frameworks that might be used by teachers to support processes of reflection and evaluation.

6.2.2 Policy recommendations

The review of English policy suggests a number of recommendations for policy including:

- The need to develop curriculum specifications that continue to prioritise the development of knowledge and understanding, skills and attitudes associated with inquiry alongside the development of concepts and give greater recognition of the critical roles of affective and social factors in learning. There is a need to ensure that these dimensions are reflected across all aspects of curriculum policy and are not undermined by curriculum content or statutory assessment requirements.
- The importance of support and guidance for formative assessment in policy, building on the growing recognition of the key roles of assessment for learning and of children's involvement in assessment in children's learning and progress.
- The need to extend opportunities for Continuing Professional Development in science.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

7. References

Alexander, R. J. (Ed.). (2010). *Children, their world, their education: Final report and recommendations of the Cambridge Primary Review*. Abingdon: Routledge.

Assessment Reform Group (2002). *Testing, Motivation and Learning* – available at www.assessment-reform-group.org

Boyle, B. and J. Bragg (2005). "No science today - the demise of primary science." *The Curriculum Journal* **16**(4): 423-437.

Collins, S., M. Reiss, et al. (2008). *The Effects of National Testing in Science at KS2 in England and Wales.* London, The Wellcome Trust in association with the Association for Science Education.

Cremin, T., Burnard, P. and Craft, A. (2006). "Pedagogy and possibility thinking in the early years." *Thinking Skills and Creativity* **1**(2): 108–119.

DCSF (2008) *The Assessment for Learning Strategy* available to download from https://www.education.gov.uk/publications/eOrderingDownload/DCSF-00341-2008.pdf

Department for Education and Employment (1998). *The National Literacy Strategy: framework for teaching*. London: Department for Education and Employment.

Department for Education and Employment (1999). *Framework for teaching mathematics from reception to year 6*. London: Department of Education and Employment.

DFE (2012) *Draft proposals for the National Curriculum* available to download from http://www.education.gov.uk/schools/teachingandlearning/curriculum/a00210036/sosletter

DFE (2012) *Statutory Framework for the Early Years Foundation Stage*. Runcorn: DFE.

DFE (2012) *Statutory requirements for assessment and testing* available to download from http://www.education.gov.uk/schools/teachingandlearning/assessment

DFE (2012) *Teachers Standards* available to download from www.education.gov.uk

DfEE (1999) *The National Curriculum: Handbook for primary teachers in England*. London: DfEE/QCA

DfES (2007) *Practice Guidance for the Early Years Foundation Stage*. Nottingham: DfES

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

DfES (2007) *Statutory Framework for the Early Years Foundation Stage*. Nottingham: DfES

DfES (2007) *Statutory Framework for the Early Years Foundation Stage*. Nottingham: DfES.

Early Education (2012) *Development Matters in the Early Years Foundation Stage*. London: Early Education.

Feasey, R. (1994). "The Challenge of Science." In C. Aubrey (Ed.) *The Role of Subject Knowledge in the Early Years of Schooling* (pp. 73-88). London, Falmer Press.

Hall, K. and Øzerk, K. (2009) "Primary curriculum and assessment: England and other countries." In R. Alexander (ed) *The Cambridge Primary Review Research Surveys*. London: Routledge

Munn, Penny (2006) "Mathematics in early childhood - the early years maths curriculum in the UK and children's numerical development. " *International Journal of Early Childhood*, **29** (1): 99-111.

Murphy, C. and Beggs, J. (2005). *Primary science in the UK: a scoping study*. London, The Wellcome Trust.

Nutbrown, C. (2012) *Review of Early Education and Childcare Qualifications*. Interim report available to download from http://www.education.gov.uk/nutbrownreview

Ozga, J. (2000). *Policy Research in Educational Settings: Contested Terrain*. Buckingham, UK: Open University Press.

QCA/DfEE (2000) *QCA Scheme of work for science*. London: QCA.

QCDA (2005) *Aims, values and purposes* ,available to download at http://media.education.gov.uk/assets/files/pdf/c/curriculum%20aims.pdf

Qualifications and Curriculum Authority (2000). *Curriculum guidance for the foundation stage.* London, QCA/DfEE.

SCORE (2007) *SCORE response to House of Commons Education and Skills Committee Inquiry into Testing and Assessment* June 2007 available at http://score-education.org/media/3846/assessjune2007.pdf

Siraj-Blatchford, I. and K. Sylva (2004). "Researching pedagogy in English pre-schools."

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

British Educational Research Journal **30**(5): 713-730.

Teaching Agency (2012) *Initial Teacher Training Criteria* available to download from http://www.education.gov.uk/schools/careers/traininganddevelopment/initial/b00205422/qtsanditt

Training and Development Agency (2008) *Professional Standards for Qualified Teacher Status and Requirements of Initial Teacher Training* available to download from https://www.education.gov.uk/publications/standard/publicationDetail/Page1/TDA0600

van den Akker, J. (2007). Curriculum Design Research. In T. Plomp & N. Nieveen (Eds.), *An Introduction to Educational Design Research* (pp. 37-52). Enschede: Netherlands institute for curriculum development.

Whetton, C., Ruddock, G. and Twist, L. (2009) "Standards in English primary education: the international evidence." In R. Alexander (ed) *The Cambridge Primary Review Research Surveys*. London: Routledge

White J. (2009). "Aims as policy in English primary education." In R. Alexander (ed) *The Cambridge Primary Review Research Surveys*. London: Routledge.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Appendix A: Survey Ratings:

Analysis of Approaches to Teaching and Learning in Pre-school policy

Note – responses in the tables below relate to the current Statuory Framework for the Early Years Foundation Stage (DfES 2007). Significant differences in the new framework to be introduced from Septembr 2012 (DfE 2012) are indicated in some tables by the word 'new' next to the rating.

Rationale or Vision

Ai. What are the purposes of Science Education? *(Adapted from T survey Q23)*

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

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		X		
c. To enrich the understanding and interaction with phenomena in nature and technology			X	
d. To develop more innovative thinkers				X
e. To develop positive attitudes to science			X	
f. To develop important attitudes and dispositions as a foundation for future learning		X		
g. **Other**			X	

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Aims and Objectives

Ai. What views are indicated about the importance of the following Science learning outcomes? *(Adapted from T survey Q24)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.	X			
b. To have positive attitudes to science learning.	X			
c. To be interested in science.		X		
d. To be able to plan and conduct a simple investigation.	X			
e. To have positive attitudes to learning.	X			
f. To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).	X			
g. To be able to collaborate with other children		X		
n. **Other – develop scientific vocabulary**				X

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
a. To know and understand the important scientific ideas (facts, concepts, laws and theories).		X		
b. To understand that scientists describe the investigations in ways that enable others to repeat the investigations.				
c. To be able to ask a question about objects, organisms, and events in the environment.				X
d. To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.		X		
e. To know and understand the important scientific processes.				
f. To be able to communicate investigations and explanations.		X		
g. To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.				
h. To have positive attitudes to science learning.				
i. To be interested in science.			X	

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

j. To be able to plan and conduct a simple investigation.				
k. To have positive attitudes to learning.				
l. To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).				
m. To be able to collaborate with other children		X		
n. **Other – scientific vocabulary**			X	

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		X	
Mathematics	X		

B. What are the key Science and Mathematics topics/strands/themes? (*Adapted from T survey Q26)*

	Science p.14 (3), p. 40 (2)	**Mathematics** p.14 (3) p.33, 34 (2)
1	Investigate materials *Similarities and differences in…objects, materials*	Counting and recognising numbers to 10 *Recognising numbers to 10, counting to 20*
2	The living world *Living things*	Simple addition and subtraction
3	Close observation and comparing *Make observations*	Comparing quantities (number and measure)
4	Asking questions *(less prominent in new version)*	Describing, sorting and naming 2-D and 3-D shapes *"They explore characteristics of everyday objects and shapes and use mathematical language to describe them." P.36 (2)*
6	Technology	Describe position
7		Pattern
8		Problem solving

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Learning Activities

Ai. What activities are encouraged? *(Adapted from T survey Q29)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. Observe natural phenomena such as the weather or a plant growing and describe what they see.				X
b. Ask questions about objects, organisms, and events in the environment.				X
c. Design or plan simple investigations or projects.		?		
d. Conduct simple investigations or projects		X - new		X – old
e. Employ simple equipment and tools to gather data and extend to the senses.		X		
f. Use data to construct reasonable explanations.		X		
g. Communicate the results of their investigations and explanations.				X
h. Other				

Aii. What is the emphasis, if any, on the role of Creativity in the following activities? *(Adapted from T survey Q30)*

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

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Teacher Role / Location

Ai. What learning/teaching contexts and approaches are mentioned? (*Adapted from T survey Q25)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. Open/unstructured play				XXXX
b. Role/Pretend play			X	
c. Drama	X			
d. Teaching science from stories		X		
e. Using history to teach science (e.g. transport, the work of scientists)	X			
f. Working in small groups	?			
g. Physical exploration of materials				X
h. Using outdoor learning activities			X	
i. Taking children on field trips and/or visits to science museums and industry		X		
j. Integrating science with other curricular areas				??
k. Building on children's prior experiences	X			
l. Fostering collaboration		X		
m. Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical			X	
n. Encouraging problem finding – e.g. children asking questions			X	
o. Encouraging problem solving – e.g. children solving practical tasks			X	
p. Encouraging children to try out their own ideas in investigations		X	?	
q. Fostering classroom discussion and evaluation of alternative ideas		X		
r. Fostering imagination				
s. Relating science to everyday life		X	?	
t. Using questioning as a tool in science teaching				X
u. Using digital technologies with children for science teaching and learning			X	
v. Fostering autonomous learning			X	
w. Other – learning alongside the child				X
More other – responding to children's interests				X

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Aii. What is the emphasis, if any, on the role of Creativity in the following learning/teaching contexts and approaches? (*Adapted from T survey Q26/27)*

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
a. Open/unstructured play				X
b. Role/Pretend play				X
c. Drama				
d. Teaching science from stories		X		
e. Using history to teach science (e.g. transport, the work of scientists)				
f. Working in small groups				
g. Physical exploration of materials			X	
h. Using outdoor learning activities			X	
i. Taking children on field trips and/or visits to science museums and industry		X		
j. Integrating science with other curricular areas				
k. Building on children's prior experiences				
l. Fostering collaboration		X		
m. Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical				X
n. Encouraging problem finding – e.g. children asking questions				X
o. Encouraging problem solving – e.g. children solving practical tasks				X
p. Encouraging children to try out their own ideas in investigations				X
q. Fostering classroom discussion and evaluation of alternative ideas			X	
r. Fostering imagination				
s. Relating science to everyday life			X	
t. Using questioning as a tool in science teaching				X
u. Using digital technologies with children for science teaching and learning		X?		
v. Fostering autonomous learning				X
w. Other				X

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

C. What, if any, Inquiry Approaches are discussed? (*Adapted from T survey Q31)*

	A (Open)	B (Guided)	C (Structured)	N/A
a. QUESTION: Children investigate scientifically oriented question	X	X		
b. EVIDENCE: Children give priority to evidence	X	X		
c. ANALYSE: Children analyse evidence	X	X		
d. EXPLAIN: Children formulate explanations based on evidence	X	X		
e. CONNECT: Children connect explanations to scientific knowledge	?	?		
f. COMMUNICATE: Children communicate and justify explanation	X	X		
g. REFLECT: Children reflect on the inquiry process and their learning		X		
h. Other				

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Materials and Resources

A. What materials are suggested? *(Adapted from T survey Q38)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. Instructional materials (e.g. textbooks)	X			
b. Audio-visual resources			X	
c. Relevant library materials (e.g. story books)		X		
d. Equipment and materials for hands-on exploration in the classroom (e.g. magnets, building blocks)		X less emphasis in new	X	
e. Equipment and materials for hands-on exploration outside the classroom			X	
f. Computers		X		
g. ICT resources (e.g. computer applications)	X			
h. Other digital technologies (e.g. interactive whiteboard, camera)			X	
i. Budget for supplies (e.g. paper, drawing materials)	X			
j. Teaching support personnel (e.g. classroom assistant)	X			
k. Other support personnel (e.g. technical support)	X			
l. Other				

Groupings

A. What groupings, if any, are suggested for teaching Mathematics and Science?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Individual work			*	
Pair work			*	
Small group work			*	
Whole class activities				*

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Time

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

	Science	Mathematics
a. Less than an hour		
b. 1-2 h		
c. 3-4 h		*X*
d. More than 4 h		
e. N/A (Please explain)	X	X

Assessment

A. What purposes of assessment are included? (*(Adapted from T Survey Q36)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. To identify areas for improvement in your science teaching	X			
b. To identify aspects of the science curriculum that could be improved	X			
c. To identify ways to improve child science learning				X
d. To monitor regularly individual children's or cohorts of children's progress towards a set of desirable science learning outcomes				X
e. To inform parents of their child's progress in science				X
f. To help group children for science instruction purposes	X			
g. To monitor year-to-year child progress in science	X			
h. To provide feedback to children about their progress in science		X		
i. To set targets with children for their own development in science		? (see above)		
j. Other – Accountability			X	

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

B. What importance is given to of the following priorities for children's assessment in Science? *(Adapted from T Survey Q33)*

To assess the development of children's:

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. Knowledge and understanding of scientific ideas (facts, concepts, laws and theories)			X	
b. Knowledge and understanding of scientific processes	X			
c. Competencies necessary to carry out scientific inquiry			X less prominent in new	X
d. Understandings about scientific inquiry (e.g. how science and scientists work)	X			
e. Positive attitudes and increase of interest in science		X		
f. Positive attitudes and increase of interest in learning science	X			
g. Other				

C. What ways of assessing are advocated? *(Adapted from T Survey Q34)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. Using checklists to record observations of children			X	
b. During classroom interaction				XXXX
c. Evaluating children's pictures, graphs etc which show their scientific reasoning	X			
d. Evaluating children's relevant gestures or physical activity	X			
e. Marking their homework	X			
f. Using authentic problem-based tasks	X			
g. Asking each child to reflect on their own learning and progress	X			
h. Using closed question tests	X			
i. Using open question tests	X			
j. Using questions in context	X			
k. Using portfolios (collection of evidence of children's work and progress)				X
l. Children correcting each other's work and giving each other feedback	X			
m. Other – information from parents			X	

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

D. What Creative attributes are addressed in assessment?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. Sense of initiative			X	
b. Motivation			X	
c. Ability to come up with something new			X	
d. Ability to connect what they have learnt during your lessons with topics in other subjects		X		
e. Imagination	X			
f. Curiosity			X	
g. Ability to work together	X			
h. Thinking skills		X		
i. Other				

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Analysis of Approaches to Teaching and Learning in Primary School Policy

Key

✓ relates to current policy documentation

✓ proposed - relates to proposed policy documentation under consultation

Rationale or Vision

Ai. What are the purposes of Science Education? *(Adapted from T survey Q23)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
a. To provide a foundational education for future scientists and engineers		✓		
b. To develop socially and environmentally aware and responsible citizens			✓ ✓proposed	
c. To enrich the understanding and interaction with phenomena in nature and technology			✓	
d. To develop more innovative thinkers		✓		
e. To develop positive attitudes to science			✓ ✓ proposed	
f. To develop important attitudes and dispositions as a foundation for future learning				
g. Other recognise the cultural significance of science and trace its worldwide development (1) p76 'power of rational explanation' (6) p1		✓ ✓ proposed		

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			✓	
c. To enrich the understanding and interaction with phenomena in nature and technology				✓
d. To develop more innovative thinkers				✓
e. To develop positive attitudes to science			✓ proposed	✓
f. To develop important attitudes and dispositions as a foundation for future learning				✓

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Aims and Objectives

Ai. What views are indicated about the importance of the following Science learning outcomes? *(Adapted from T survey Q24)*

	Not Mentioned	Single Mention	Various Mentions	Emphasised
To know and understand the important scientific ideas (facts, concepts, laws and theories).				proposed
To understand that scientists describe the investigations in ways that enable others to repeat the investigations.	(KS1) proposed	(KS2)		
To be able to ask a question about objects, organisms, and events in the environment.	proposed			
To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.				proposed
To know and understand the important scientific processes.		proposed		
To be able to communicate investigations and explanations.		proposed		
To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.	proposed		(KS1) (KS2)	
To have positive attitudes to science learning.		proposed		
To be interested in science.				
To be able to plan and conduct a simple investigation.			proposed	
To have positive attitudes to learning.		proposed		
To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).	proposed			
To be able to collaborate with other children	proposed			

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

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).	✓ proposed		☐	
To understand that scientists describe the investigations in ways that enable others to repeat the investigations.		☐ proposed	☐	
To be able to ask a question about objects, organisms, and events in the environment.		☐ proposed	☐	
To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.		☐ proposed	☐	
To know and understand the important scientific processes.			☐ proposed	☐
To be able to communicate investigations and explanations.		☐ proposed		☐
To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.		☐ proposed		☐
To have positive attitudes to science learning.		☐ proposed	☐	
To be interested in science.		☐ proposed	☐	
To be able to plan and conduct a simple investigation.		☐ proposed		☐
To have positive attitudes to learning.		☐ proposed	☐	
To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).		☐ proposed		☐
To be able to collaborate with other children		☐ proposed	☐	

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Content

A. How are Science and Mathematics presented as learning domains?

	As its own learning area	Encompassed within other social sciences (e.g. geography)
Science	☐	
Mathematics	☐	

B. What are the key Science and Mathematics topics/strands/themes? (*Adapted from T survey Q26)*

	Science	Mathematics
1	Sc*1 Scientific enquiry* includes: Ideas and evidence, Investigative skills (Planning, Obtaining and presenting evidence, Considering evidence and evaluating) Proposed - Working Scientifically is not a separate Programme of Study - but integrated into the overall programme of study for each year group.	*Ma2 Number* including: Using and applying number (problem solving, communicating, reasoning), Numbers and the number system (counting, number patterns and sequences, the number system), Calculations (number operations and the relationships between them, mental methods) Solving numerical problems Processing, representing and interpreting data Proposed: **Number**: Number and place value; addition and subtraction; multiplication and division; fractions (decimals and rounding from Year 4; estimation and percentages from Year 5; ratio, proportion and algebra from Year 6)
2	*Sc2 Life processes and living things* includes: Life processes, humans and other animals, green plants, variation and classification, Living things in their environment. Proposed Y1 Plants, Animals, Y2 Living things, Plants, Animals Habitats, Y3 Plants, Animals	*Ma3 Shape, Space and Measures* including: Using and applying shape, space and measures, Understanding patterns and properties of shape, understanding properties of position and movement, understanding measures. Proposed: **Geometry and Measures**: properties of shapes; position, direction and motion; measures (standard SI units) The emphasis is on identifying and naming the shape and their properties – they only start making shapes in Year 3
3	*Sc3 Materials and their properties* includes: Grouping materials, changing materials Proposed Y2 Everyday materials, Uses of everyday materials Y3 Every day materials, rocks	*Ma4 Handling data* is a separate programme of study at KS2. Proposed: **Data** (from Year 2) construct and interpret (probability from Year 6)
4	*Sc4 Physical processes* includes: Electricity, Forces and motion, light and sound (plus Earth and Beyond at KS2)	Ma1 Using and Applying Mathematics is threaded through the other areas above and does not have its own programme of study but

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

	Proposed Y1 Light Y2 Forces and Motion Y3 Sound, Forces and Magnets	does have its own level descriptors for assessment Proposed: the aims talk about solving problems and applying mathematics but there is very little of this throughout the programme of study – just references to solving word problems

Learning Activities

Ai. What activities are encouraged? *(Adapted from T survey Q29)*

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

Aii. What is the emphasis, if any, on the role of Creativity in the following activities? *(Adapted from T survey Q30)*

	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.		proposed		
Ask questions about objects, organisms, and events in the environment.	proposed			
Design or plan simple investigations or projects.		proposed		
Conduct simple investigations or projects			proposed	
Employ simple equipment and tools to gather data and extend to the senses.			proposed	
Use data to construct reasonable explanations.		proposed		
Communicate the results of their investigations and explanations.		proposed		

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Teacher Role / Location

Ai. What learning/teaching contexts and approaches are mentioned? (*Adapted from T survey Q25)*

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

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Aii. What is the emphasis, if any, on the role of Creativity in the following learning/teaching contexts and approaches? (*Adapted from T survey Q26/27)*

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

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

C. What, if any, Inquiry Approaches are discussed? (*Adapted from T survey Q31)*

	A (Open)	B (Guided)	C (Structured)	N/A
QUESTION: Children investigate scientifically oriented question		☐		
EVIDENCE: Children give priority to evidence	☐			
ANALYSE: Children analyse evidence	☐			
EXPLAIN: Children formulate explanations based on evidence	☐	✓KS1		
CONNECT: Children connect explanations to scientific knowledge	☐	✓KS1		
COMMUNICATE: Children communicate and justify explanation	☐			
REFLECT: Children reflect on the inquiry process and their learning	☐			

2.6 Materials and Resources

A. What materials are suggested? *(Adapted from T survey Q38)*

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

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Groupings

A. What groupings, if any, are suggested for teaching Mathematics and Science?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Individual work			☐	
Pair work			☐	
Small group work			☐	
Whole class activities			☐	

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)	☐	

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

Assessment

A. What purposes of assessment are included? (Adapted from T survey Q36)

	Not Mentioned	Single Mention	Various Mentions	Emphasised
To identify areas for improvement in your science teaching			▯	
To identify aspects of the science curriculum that could be improved	▯			
To identify ways to improve child science learning			▯	
To monitor regularly individual children's or cohorts of children's progress towards a set of desirable science learning outcomes				▯
To inform parents of their child's progress in science				▯
To help group children for science instruction purposes	▯			
To monitor year-to-year child progress in science			▯	
To provide feedback to children about their progress in science			▯	
To set targets with children for their own development in science			▯	
To submit assessment levels to the local authority To monitor teacher judgments To meet statutory requirements for transfer of records To make provision for SEN To support school self evalution				▯ ▯ ▯ ▯ ▯

B. What importance is given to of the following priorities for children's assessment in Science? *(Adapted from T Survey Q33)*

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)				▯ ▯ proposed
Knowledge and understanding of scientific processes			▯ proposed	▯
Competencies necessary to carry out scientific inquiry			▯ proposed	▯
Understandings about scientific inquiry (e.g. how science and scientists work)	▯ proposed	▯		
Positive attitudes and increase of interest in science	▯			
Positive attitudes and increase of interest in learning science	▯			

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

C. What ways of assessing are advocated? *(Adapted from T Survey Q34)*

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

D. What Creative attributes are addressed in assessment?

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

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.