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 12 of 13:

National Report on Approaches in Scottish Policy

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D3.2 Report on Mapping and Comparing Recorded Practices

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Executive Summary

This National report examines the way in which teaching, learning, and assessment is conceptualised in Scottish 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 Scottish policy, as well as allow comparisons with other nations, this report draws upon a survey instrument used to rate the extent to which certain approaches, and the role of creativity is emphasised across relevant policy documents in this area. In the case of Scotland, this was largely based upon the Curriculum for Excellence documentation, particularly the 'Experience and Outcomes' and the 'Active Learning in the Early Years' documents. The survey tool was designed drawing on two key sources. Firstly, approaches were distinguished according to nine curriculum themes: Rationale, Aims, Content, Learning Activities, Teacher Role / Location, Materials and Resources, Groupings, Time, and Assessment. Secondly, specific approaches within these dimensions were identified from prior work in this project (the D2.2 Conceptual Framework and D3.1 List of Mapping and Comparison factors). The ratings given from the survey were then discussed in sections within this report that drew upon other sources / commentaries to interpret approaches with the particular context of Scottish Education and policy.

The report highlights how many of the approaches identified as being support of creativity in early years science and maths are emphasised across policy documents. On one level, therefore, the analysis supports the purported aims of the Curriculum for Excellence to foster more creative teaching and learning approaches. The extension of more hands-on, play based approaches from pre-school into the early years of school, further exemplifies this, and echoes the policy aims of supporting transition between phases. However, echoing various criticisms of the new curriculum, there are tensions in the level of guidance provided. The learning objectives blend experience with outcome: thereby prescribing the type of activity expected. Yet they do not provide a clear indication of how children's scientific thinking progresses. There is an emphasis on children's exploration and articulation of ideas, but limited reference to developing inquiry skills search such as formulating questions or reasoning with data. Creativity is prominent in the generation of ideas, but less so in reflecting upon and evaluating these ideas. Children are encouraged to discuss thinking, but it is not clear what expectations there are for reasoning between alternative possibilities.

Many of the key messages in the policy documents are commendable for fostering creativity in early years science and mathematics, notably, the rationale and the approach to assessment. However, the decisions to maintain science as a stand-alone subject: one of nine, and to prescribe topic areas may limit the flexibility to build upon children's meaningful

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activity over time. Moreover, providing arguably vague objectives may have the unintended consequence of encouraging practitioners to seek more concrete statements that address these. Another approach would be to provide more concrete guidance on how to develop children's inquiry skills, building upon their ability to evaluate as well as generate new ideas about science. This guidance would not aim to limit children's play but rather guiding teachers in how to detect and build upon the skills children demonstrate in such activity.

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

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1. Aims of national report

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 Scotland. 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 Scottish 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 Scottish policy.

1.1 Defining terms

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

1.1.1 Policy

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

1.1.2 Curriculum

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

1.1.3 Creativity

As reported in the *Conceptual Framework* (D2.2), the Creative Little Scientists project indicates a focus on little c, or personal, or everyday, creativity, i.e. 'purposive imaginative

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activity generating outcomes that are original and valuable in relation to the learner'. In the Review of Science and Mathematics education in pre-school and early years of primary school (Task 2.2), an appendix to the *Conceptual Framework*, the following definition is used in relation to creativity in Science and Mathematics: 'generate alternative ideas and strategies as an individual or community, and reason critically between these'.

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2. Overview of National early years Education provision and policy

2.1 Phases

In Scotland, children start primary school (compulsory education) aged between 4½ and 5½ depending on the child's birthday: all those born between March of a given year and February of the following year in the same year group. The Scottish systems does, however, have an element of flexibility in that children born between September and December can defer a year, whilst children born between January and February can wait to start the following August. This flexibility may be significant given research indicating the educational impact related to the age at which children start school (Bell & Daniels, 1990). The first year of primary school is P1, and the last is P7 when children leave aged 11-12. Although the class sizes limit for Primary is 30, recently (in 2011), this was reduced to 25 for P1. In fact, a stated aim of the Scottish Government is to reduce sizes in P1-P3 to 18[1], although it is unclear over what time period.

Although compulsory education starts between 4½ and 5½, local authorities are under a duty to secure a pre-school education place for all three and four-year-olds whose parents want one. Figure 1 illustrates the age phases of education in Scotland. Scotland's early education settings are very diverse. There is a wide variety of pre-school provision in the public, private and voluntary sectors. In the early years of primary school, children are taught in settings ranging from large primary schools, with and without nursery provision, to schools with different kinds of composite classes ((1), p.3). In 2010, 74% of pre-school children had access to a qualified teacher[2]. It is a stated aim to ensure that all children in pre-school setting will have access to a qualified teacher [3]. In both pre-school and school, children will have a class teacher for the year who tends to teach all subjects including science and mathematics.

[1] http://www.scotland.gov.uk/News/Speeches/Speeches/smarter/class-sizes

[2] http://www.scotland.gov.uk/Publications/2010/09/28130623/1

[3] http://www.scotland.gov.uk/News/Speeches/Speeches/smarter/class-sizes

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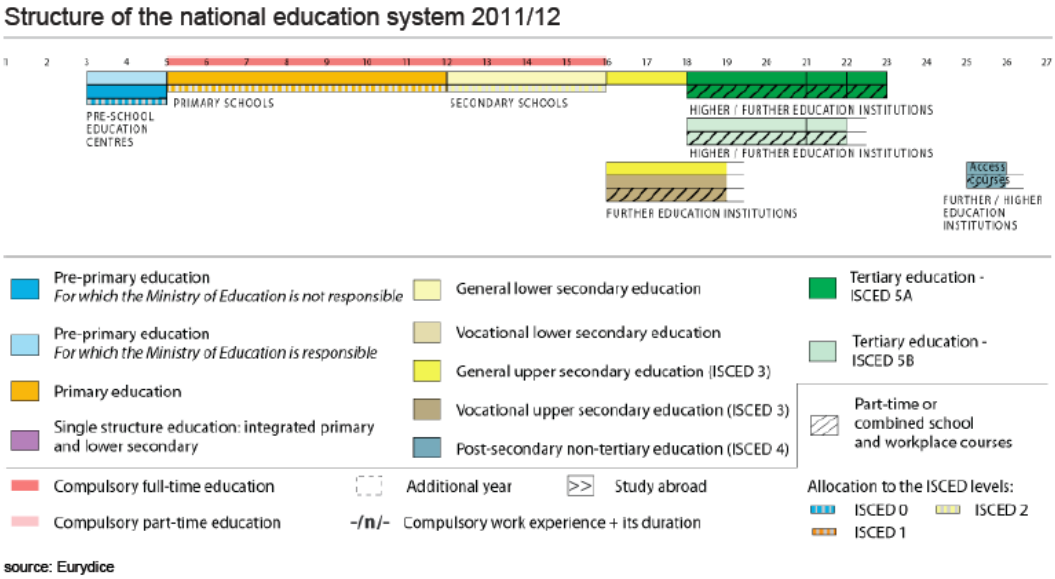

Figure 1: Scottish Education Phases (Eurypedia, 2012)

2.2 Regulation

The Care Inspectorate regulates all pre-school settings and inspects the quality of care in these. Where the pre-school setting belongs to, or is in partnership with the local authority, Education Scotland and the Care Inspectorate inspect jointly. The Scottish Government set up Education Scotland in July 2011 as the national development and improvement agency for education. This agency brought together the functions of Learning and Teaching Scotland (LTS), HM Inspectorate of Education (HMIE), the National CPD Team and the Scottish Government's Positive Behaviour Team. According to the Scottish Government website[4], Education Scotland is intended to support development and improvement in Scottish education by:

- Leading and supporting the implementation of Curriculum for Excellence
- Promoting high quality professional teaching and leadership
- Identifying and stimulating innovation and sharing successful approaches
- Providing independent scrutiny of education provision

2.3 Inspection

Inspection of schools in Scotland remains the responsibility of Her Majesty's Inspectorate of Education (HMIE), however, significant changes have been implemented in the inspection process. From 2011-12, inspections will move from a generational cycle of inspection (where a school is inspected every six to seven years) to a sampling model where around 240 inspections will take place each year across all sectors. Schools will be given two weeks

[4] http://www.scotland.gov.uk/News/Releases/2011/07/01114648

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notification for the inspection, however, inspections intend to place more emphasis on the role of the school's self-evaluation.

2.4 Curriculum

In 2002 the Scottish Executive undertook an extensive consultation on the state of school education through the National Debate on Education. According to the Scottish Government, features of the existing curriculum that people like included the:

- Flexibility which already exists in the Scottish system - no one argued for a more prescriptive national system
- Combination of breadth and depth offered by the curriculum
- Quality of teaching
- Quality of supporting material that helps teachers to deliver much of the current curriculum
- Comprehensive principle

Features that people wished to change included:

- Reduce over-crowding in the curriculum and make learning more enjoyable
- Better connect the various stages of the curriculum from 3 to 18
- Achieve a better balance between 'academic' and 'vocational' subjects and include a wider range of experiences
- Equip young people with the skills they will need in tomorrow's workforce
- Make sure that assessment and certification support learning
- Allow more choice to meet the needs of individual young people

This debate, along with an account of current research and international comparisons informed a Curriculum Review Group set up in 2003 by Scottish Ministers. As well as educational factors, the Group considered global factors such as changing patterns of work, increased knowledge of how children learn, and the potential of new technologies to enrich learning. In addition, the Group was asked to take a broad view of children's development, within the wider framework of Integrated Children's Services, bearing in mind the wide range of adults directly involved in the education of children and young people, in early years centres, schools, colleges and out of school learning (Gillies, 2006).

The Curriculum Review Group reported at the end of November 2004 and presented the document: A Curriculum for Excellence for children aged 3-18. This replaced previous curricula such as the Curriculum Framework for three to five year olds. However, the document has aroused significant controversy as it has not be subjected either to parliamentary scrutiny or to public consultation (Gillies, 2006). There have been other criticisms, for example by the Royal Society of Edinburgh who point out what they feel is a significant shortcoming in relation to science:

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"There appears to be no recognition in the documentation that there is a structure to human knowledge that has been built up over centuries, and is the means by which we understand the world around us and ourselves. In the last two centuries, the evolution of disciplines has been the means whereby the nuts and bolts of reality have been analysed and understood. They are still powerful drivers of new knowledge." (The Royal Society of Edinburgh, 2008)

Although teachers are broadly supportive of the principles behind the new curriculum, there has been anxiety caused as a result of ambiguity over how these principles translate into practice (Priestley, Biesta, & Robinson, 2012). There have also been issues raised about the burden the implementation of the new curriculum places on schools, in particular changes to examinations. As a result, the timetable for the new examinations has been put back a year to 2013-2014[5].

2.4.1 Curriculum Documents

In 2006 the Building the Curriculum series began to be published which provides more tangible guidelines for implementing the Curriculum for Excellence. Table 1 summarises 5 key documents:

Title	Summary	Published
Building the Curriculum 1: The contribution of curriculum area	Introduces the curriculum areas and their contributions to developing the four capacities of children and young people.	2006
Building the Curriculum 2: Active learning in the early years	Practical ways to introduce a more active approach to learning and teaching in the early years.	2007
Building the Curriculum 3: A framework for learning and teaching	The framework for planning a curriculum which meets the needs of all children and young people from 3 to 18.	2008
Building the Curriculum 4: Skills for learning, skills for life and skills for work	Key messages about how children and young people develop and apply skills as part of Curriculum for Excellence.	2009
Building the Curriculum 5: A framework for assessment	Guidance on the main areas of the assessment strategy for Curriculum for Excellence.	2011

Table 1: core Building the curriculum documents (summaries from the Education Scotland website[6]

[5] http://www.bbc.co.uk/news/uk-scotland-17452071
[6] http://www.educationscotland.gov.uk/thecurriculum/howdoyoubuildyourcurriculum/curriculumplanning/whatisbuildingyourcurriculum/btc/

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2.5 Science and mathematics attainment

The Trends in International Mathematics and Science Study (Martin, et al., 2008), revealed that Scotland fell 10 points in S2 mathematics (12-13 years old) and 16-point fall in S2 science between 2003 and 2007. This prompted the government to argue that this would be addressed through the new curriculum[7]. According to a 2009 issue of the *Children in Europe* journal entitled "*Exploring the world and beyond: young children as scientists*" [8], Scotland's poor performance in international mathematics and science league tables could be improved through innovation in nurseries and primary schools [9].

[7] http://www.journal-online.co.uk/article/5254-scotland-slipping-in-mathematics-and-science-rankings
[8] http://www.childreninscotland.org.uk/html/pub_tshow.php?ref=PUB0302
[9] http://www.nurseryworld.co.uk/news/895094/early-years-teaching-science-mathematics-improve-Scotlands-performance/

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3. Research Questions and Methodology

3.1 Research Question

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

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

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 Scotland?*
- *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 Scotland?*
- *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 Scotland?*

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

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

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

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

3.2 Method

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

3.2.1 Data selection

Policy documents were chosen that captured the different aspects of curriculum according to the nine dimensions identified by Van den Akker (listed in the previous section) in relation to early science and mathematics. As there are no specific early years science and mathematics documents in Scotland, this meant drawing upon documents that related more generally to the early years, as well as more generally to science and mathematics.

Therefore this review draw predominately on the five key *Building the Curriculum* documents listed in Table 1. Reflecting the aims of the Scottish Curriculum for Excellence, these documents cover children aged 3-18 years and are therefore quite general, although more specific examples for younger children are given. An exception is the Building the Curriculum 2 document, which focuses on the early years. The document embodies the government's attempt to support the transition between pre-school and school by promoting the same learning and teaching approaches for these phases. This is reflected in the Experiences and Outcomes document which groups together pre-school and P1 (first school year) as the 'early' Level (age 3-5 years). The next level, called 'First' is for children in P2-P4 (aged 5-8 years).

Further documents were drawn upon to identify policy messages concerning teacher professional development including: Teaching Scotland's Future: a review of Teacher Education in Scotland (Donaldson, 2010).

As well as formal documentation from the Scottish Government, this review draw upon other sources, including the Education Scotland website http://www.educationscotland.gov.uk/ or media reports (e.g. BBC), to reflect upon key message presented in the formal written documentation.

3.2.2 Survey tool

A survey tool was developed in order to quantify judgments about the extent to which particular approaches were emphasised in Scottish policy documents. Whilst quantifying approaches is problematic, this was considered important in order to support comparisons

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between European partners, as well as provide an informative representation of approaches within Scottish documents.

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

The sections were comprised of a series of questions about approaches advocated in national policy. In each section researchers in partner countries were asked to provide background information or evaluate the extent to which particular approaches were, or were, not emphasised across policy documents, and also the extent to which the role of creativity is emphasised in these approaches. These approaches listed were carefully drawn from prior work in the Creative Little Scientists project, namely the D2.2 the *Conceptual Framework* and the D3.1 *List of Mapping and Comparison factors*, which drew attention to significant approaches characteristic of creativity in early years science and mathematics. A summary of the emphasis ratings given for Scottish 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 author of this report, one of the Creative Little Scientists project team, completed the Survey tool. Inter-rater reliability was not possible due to project limitations and the importance of the local expertise of researchers completing the survey tool for their national documents. Therefore, it was required that each project member completing the survey provided justifications for their responses alongside specific references to the policy documents to support judgements made. These justifications were assessed and discussed with a second project team member.

3.2.3 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.

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4. Approaches to Teaching, Learning and Assessment

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

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

4.1 Rationale or Vision

What are the key summary points?

The Curriculum for Excellence makes great efforts to connect learners across phases. As a result, the vision for science and other subjects addresses children all the way from 3 to 18 years. Although there is as document for children in the early years, this does not refer to any specific subjects.

The vision for science is predominantly expressed in two key documents: the main Curriculum for Excellence document and the Building the Curriculum 1: The contribution of curriculum area. In the former document, under the heading "What are the main purposes of science" the document provides points about learning in science followed by a summary of the role of science according to the four overarching objectives of the curriculum: Developing successful learners, Developing confident individuals, Developing responsible citizens, Developing effective contributors.

Table 1, taken from Appendix A summarises how much certain aims are mentioned throughout documents focused upon. As illustrated, all of the aims listed are evident in documents. Another theme that seemed relevant was working with others, where several mentions are made of communicating ideas with others and working on tasks collaboratively. There is greater emphasis on two aspects: being socially and environmentally aware and developing more innovative thinkers. The former seems to echo the government's emphasis on promoting green issues, and is evident in various statements, e.g. "*develop an understanding of the Earth's resources and the need for responsible use of them*" (CfE: Experience and Outcomes, p.253), and "*recognise the impact science makes on*

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their lives, on the lives of others, on the environment and on culture" (CfE: Contribution of Curriculum Areas, p.30).

The emphasis on innovative thinkers seems to reflect the wider emphasis on creativity thinking (see section below). For example, one explicit aim is to "*recognize the role of creativity and inventiveness in the development of the sciences"* (CfE: Experience and Outcomes, p.253). Also, "*The most important goal for science education is to stimulate, nurture and sustain the curiosity, wonder and questioning of children and young people*." (CfE: Contribution of Curriculum Areas, p.30).

Unlike Mathematics, Literacy, and Health and Wellbeing, science is not a cross curriculum subject. However, although the attitudes and dispositions developed in science for other subjects are not emphasised, there are various mentions, for example under the heading 'Successful Learners': "*can develop a range of skills in critical thinking as well as Literacy, communication and numeracy*" (CfE: Contribution of Curriculum Areas, p.31). Also in CfE: Experience and Outcomes (p.254): "*support the development of a range of skills for life and skills for work, including Literacy, numeracy and skills in information and communications technology (ICT).*"

Aims	**Prevalence across documents**
a. To provide a foundational education for future scientists and engineers	Various mentions
b. To develop socially and environmentally aware and responsible citizens	Emphasised
c. To enrich the understanding and interaction with phenomena in nature and technology	Various mentions
d. To develop more innovative thinkers	Emphasised
e. To develop positive attitudes to science	Various Mentions
f. To develop important attitudes and dispositions as a foundation for future learning	Various Mentions
g. Other: Work with Others	Various Mentions

Table 1: Prevalence of rationale across documents

What issues / tensions / policy criticisms exist?

The curriculum is relatively new and there has been limited time in which to evaluate the impact of particular subject changes. However, it is relevant to note higher-level criticisms of the curriculum. For example, Gillies (2006) questions the overarching four aims of the curriculum (Developing successful learners, Developing confident individuals, Developing responsible citizens, Developing effective contributors), how these had been derived and the

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lack of public consultation given that these drive the whole curriculum. Priestly and Humes (2010) argue that the curriculum lacks conceptual clarity:

"*The operational end of CfE is thus arguably inimical to the underlying purposes of the curriculum as expressed in the four capacities. There are thus tensions between convergent and divergent modes of learning, between teleological and open-ended conceptions of education, which may be unhelpful to the process of enactment in the classroom*" (p.15).

These concerns are relevant later in discussing how particular learning outcomes echo the rationale/vision put forward.

In what ways is the role of creativity emphasised?

For several aims, it is difficult to detect any particular emphasis on creativity. The aim 'Innovative thinkers' arguably embodies a notion of creativity, and indeed, the statement: "*become creative, inventive and enterprising adults in a world where the skills and knowledge of the sciences are needed across all sectors of the economy*" (CfE: Experiences and Outcomes, p.253) does seem to support this. Likewise, in relation to positive attitudes to science, the statement "*tap into children's and young people's natural curiosity and their desire to create and work in practical ways*" (CfE: Experiences and Outcomes, p254) reflects the theme of active, enjoyable learning through the curriculum, in particular in the early years.

What are the main differences between preschool and school?

As discussed previously, the rationale and vision for science is expressed for children aged 3-18. Moreover, there is a concerted attempt in the documents to bridge children's learning between pre-school and school. Indeed, even the outcomes, discussed later, unite pre-school and the first year of school.

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

The rationales for mathematics and science seem quite similar. Indeed, both are structured around the four curriculum goals. One difference may arguably be that mathematics emphasises the importance of its history: "*its impact on our society past and present, and its potential for the future*". This is not the case for science. Indeed, this reflects one of the criticisms made by the Royal Society of Edinburgh (The Royal Society of Edinburgh, 2008):

"*There appears to be no recognition in the documentation that there is a structure to human knowledge that has been built up over centuries, and is the means by which we understand the world around us and ourselves*."

A small but significant difference may also be in the way the documents talk of how mathematics can be applied to the 'real world' where science goes beyond this to highlight the social and environmental aspects of science for citizens. Whilst this largely reflects

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differences in the domains, some might consider that mathematics is also fundamental to everyday conversation and understanding of global issues.

4.2 Aims and Objectives

What are the key summary points?

A difficulty in deducing the aims and objectives for early years science is that the documents generally make reference to all children aged 3-18. In this regard, the aims for science cover a good range of objectives. In the main CfE document, the skills children are expected to learn are listed according to two headings: *Inquiry and Investigative skills* and *Scientific and Analytical thinking*. These skills emphasise the importance of children knowing big ideas, asking questions, carrying out investigations, evaluating evidence and importantly, presenting their work with others.

It can be argued that the general sciences aims focus more on being capable to carry out certain skills rather than an ability to reflect upon and understand how these embody the process through which we have come, and continue to understand the world over time. There is also little mention here of collaborating with others (as opposed to presenting and discuss ideas with others) or of motivation, although in fairness, the documents do promote positive attitudes in many other places.

It is more difficult to identify from the documents what the more particular aims and objectives are for younger children. It is interesting to note that the CfE document (Experience and Outcomes) provides a summary of how skills are expected to develop in the second, third and fourth phases; but not in the early and First. Whilst there is a special document just for young children (CfE Active Learning in the early years), this describes the more general approaches and aims for young children (although many such as 'fostering hands-on exploration' and 'positive attitudes' are clearly relevant; there is also reference to fostering children's natural tendency for questioning).

One window into the aims and objectives for younger children can be deduced from looking at the Experience and Outcome statements for science. These are separated according to phase, thereby also providing an opportunity to compare aims between phases: early years (including pre school and the first school year) and children in their 2nd, 3rd and 4th school year (5-8/9 years). Each outcome statement offers a verb indicating what skills children are to demonstrate; these action verbs are illustrated in Table 2.

The experiences and outcomes paint a slightly different picture of aims for younger children. There seems a greater emphasis on children knowing scientific ideas through various experiences (e.g. observe, explore, recognise, identify), and sharing their ideas with others (e.g. talk, explain, describe) rather than certain inquiry processes such as making predictions, designing and carrying out investigations, and evaluating evidence in light of their ideas.

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early (3-5 years)	1st (5-8 years)
Aware of	Aware of
Aware of	Choose
Describe	Combine
Describe	Contribute
Experience	Contribute
Experience	Demonstrate
Explore	Describe
Explore	Describe
Help	Describe
Help	Discuss
Identify	Discuss
Know	Discuss
Learn	Distinguish
Link	Explain
Name	Explain
Observe	Explore
Recognize	Explore
Recognize	Grow
Recognize	Help
Relate	Know
Say	Make
Say	Make
Share reasoning	Observe record
Talk	Observing
Talk about	Predict
Use	Recording
Use	Relate
	Relate
	Relate

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	Show Show Sort Test Understand

Table 2: Main verbs used in science Experience and Outcomes for early years phases

What issues / tensions / policy criticisms exist?

There seems to be a significant difference between the general aims espoused for learners of all ages and the particular expectations made explicit for each phase. In particular, there does not seem to be the same emphasis on inquiry skills and scientific process in the early years aims. This tension is discussed by Priestley & Humes (2010) who identify a contradiction between a curriculum promoting change through overarching ambitions whilst maintaining specified objectives at different levels:

"Nevertheless, it is our contention that the decision of policymakers to retain a feature of 5–14, namely outcomes organised into sequential levels, has resulted in a curriculum which is incoherent structurally and which contains epistemological and pragmatic contradictions" (p.12)

In what ways is the role of creativity emphasised?

Echoing the emphasis on creativity throughout the documents, creativity is referred to in the science aims several times, for example, "*thinking creatively and critically*" or "*recognise the role of creativity and inventiveness in the development of the sciences*" (CfE: Experiences and Outcomes, p. 253). However, creativity in this context is quite vague and it is not clear how creativity plays out in particular aims. Indeed, creativity is a lot less evident in the explicit outcomes for phases. Where the term creativity is used, for example, "*Through creative play, I explore different materials*" (CfE: Experiences and Outcomes, p. 253), it refers more to the activity than the aim. There is no reference to how children can put forward, explore and discuss alternative ideas.

What are the main differences between preschool and school?

The Experience and Outcomes are differentiated for children in the early Phase and Phase 1. The action verbs in these are illustrated in Table 2. This table illustrates certain patterns. The early Phase emphasises children's exploration, experience, and description of what they experience. In Phase 1, there seems more emphasis on children working in a community, where they contribute to activities and discuss their thinking. There is also more evidence that they are expected to take a more active role in investigations, predicting, choosing, making, and recording for example. The use of the term 'relate' also indicates that children

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are expected to go beyond simply reporting their observations to considering the implications of these.

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

Whilst it is difficult to compare objectives in different domains, one significant point is that mathematics has aims both as one of the learning areas but also as a cross-curricular subject (along with Literacy and Health and Wellbeing). Another key difference, echoing the nature of mathematics, is that the aims are often more specific in terms of what children are able to do, for example use certain types of representation (graphs) or carry out particular procedures (e.g. counting).

4.3 Content

What are the key summary points?

Curriculum guidance in the Curriculum for Excellence is structured under the headings of the eight curriculum areas:

- Expressive arts
- Religious and moral education
- Health and Wellbeing
- sciences
- Languages
- Social studies
- Mathematics
- Technologies

Therefore, science has its own learning area, although it is entitled 'Sciences' possible to emphasise how it draws together more holistically the traditional distinctions in science learning (e.g. Biology, Chemistry, Physics).

Unlike, literacy, numeracy and health and wellbeing, science is not put forward as a cross-curricular theme (although there is mention of how science links to other curriculum areas). There are, however, a few Sciences outcomes that are linked to Health and Wellbeing, for example:

"I am aware of my growing body and I am learning the correct names for its different parts and how they work" (CfE: Experiences and Outcomes, p.270).

In sciences, key concepts are organised according to 5 areas:

- Planet Earth
- Forces, electricity and waves
- Biological systems
- Materials

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- Topical science

What issues / tensions / policy criticisms exist?

Priestly and Humes (2010) argue that by having particular curriculum areas with specified outcomes (that will guide assessment), the Curriculum for Excellence contradicts the aims of a more open, creative, curriculum for teachers. The authors argue that the eight curriculum areas simply echo prior curricula approaches, supporting their argument by presenting Table 3. This illustrates how the areas are little changed from the English and Welsh areas in 1998 and indeed the areas from the 1904 orders in England.

Table 1. Comparison of content

1904 orders (England)	1988 National Curriculum (England and Wales)	Curriculum for Excellence
English	English	English
Maths	Maths	Maths
Science	Science	Science
History	History	Social studies
Geography	Geography	Modern language
Modern language	Modern language	Expressive arts
Drawing	Art	Health & well-being
PE	PE	Technology
Housewifery/Manual	Technology	Gaelic
	Music	RME/RE
		Cross curricular (Lit/Num)

Adapted from Goodson & Marsh, 1996

Table 3: Adapted from Goodson and Marsh (1996), presented in Priestly and Humes (2010, p.357)

In what ways is the role of creativity emphasised?

To a certain extent the science topics indicate how the curriculum encourages young children, as well as older learners, to be involved in issues that are important in society: "*Planet Earth*" or "*Topical science*" although the extent to which children are encouraged to discuss such contemporary issues is less clear in the detail. Moreover, as Priestly and Humes argue, by deciding particular curriculum areas and topics (and corresponding outcomes) the curriculum may hinder teachers' focus on the wider aim of science, represented in the documents in the following quite: "*The most important goal for science education is to stimulate, nurture and sustain the curiosity, wonder and questioning of children and young people" (CfE: Contribution of Curriculum areas, p.30).*

What are the main differences between preschool and school?

The curriculum areas and topics apply for children from 3-18 years. Children begin each topic at the earliest age (demonstrated by the Experiences and Outcomes).

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

As discussed previously, mathematics, unlike science is treated as a cross-curriculum domain as well as a separate curriculum area. Mathematics is separated into three lines of development: *Information handling, Number, money and measurement, Shape, position and movement.* It is interesting to note that unlike any of the development areas in Science, two of the three areas in Mathematics indicate certain skills: handling information and measuring.

4.4 Learning Activities

What are the key summary points?

In the Curriculum for Excellence document, Experiences and Outcomes (p.254), a range of Inquiry and Investigative skills are listed that illustrates the type of science learning activities expected. These are:

- Ask questions or hypothesise
- Plan and design procedures and experiments
- Select appropriate samples, equipment and other resources
- Carry out experiments
- Use practical analytical techniques
- Observe, collect, measure and record evidence, taking account of safety and controlling risk and hazards
- Present, analyse and interpret data to draw conclusions
- Review and evaluate results to identify limitations and improvements
- Present and report on findings.

However, similar to the arguments discussed in 4.2, there is a difficulty in evaluating how much these are emphasised in the early years. This is because these relatively broad descriptions are skills expected for children 3-18, and there is limited information of the particular focus in science for young children. In this respect, conclusion have to be drawn from two other sources: the Active learning in the early years document that discusses approaches and activities for young children, and the Experiences and Outcomes for each phase that provide a window onto the type of activities in science.

The Active Learning in the early years document emphasises play as an activity, where children have hands-on activities. Whilst science is not mentioned, important activities for science are indicated, such as observing, conducting investigations, using tools / senses and talking about their ideas. Other activities are not so clearly indicated, such as asking questions about the environment, designing investigations, or using data to construct explanations. Arguably, these activities are cognitively more demanding.

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This impression of what science activities are implied is reflected in the learning experiences and outcomes, where the key action verbs are illustrated in the previous Table 2. These experiences and outcomes tend to mix activities with outcome. Indeed, many outcomes are preceded by the expected activity, e.g. "*through play…*" (p.269), "*through exploring activities..*" (p.273), or "*By investigating…*" (p.263). These implied activities reinforce the playful, exploratory nature of activities, but again, perhaps not others that are more planful or reflective. The emphasis on children talking about ideas does indicate an emphasis on dialogue in the classroom.

What issues / tensions / policy criticisms exist?

In 2008 Glasgow University was commissioned by Learning and Teaching Scotland to survey responses to the Experience and Outcomes in the Curriculum for Excellence (University of Glasgow, 2009). One oft-voiced concern by teachers was how the Outcomes indicated types of activity without providing a clear indication of how children would develop thinking:

"A lack of confidence was expressed in the Draft Experiences and Outcomes as 'the basis of planning how children and young people will progress in their learning'. This was particularly marked in relation to mathematics, science, numeracy, technologies and RME." (p.7)

"*Schools. Teachers and other informed stakeholders expressed serious misgivings about the capacity of the draft science Experiences and Outcomes to support conceptual development*" (p.7)

One issue put forward is that in the aims of fostering creative, policy documents have been reluctant to prescribe particular activities. This tensions is exemplified in one teacher quote:

"It is a problem in that people do want and are used to having exemplification, especially in subject areas like science where if they want a new course they get someone to write it for them. People are used to having off the shelf courses and they want benchmarking and standards that they should follow. So it's quite a difficult situation. How do we not stifle creativity and flexibility but at the same time maintain standards? p.37

In what ways is the role of creativity emphasised?

As discussed previously, the policy documents do highlight the important of creativity, using the term explicitly. This is also evident implicitly in the emphasis on certain themes such as child-directed exploration. Indeed, in the Experiences and Outcome one outcome for children in the Early Phase is:

"Through creative play, I explore different materials and can share my reasoning for selecting materials for different purposes."

However, reflecting the tensions previously mentioned, teachers have found interpretation of activities difficult without clear guidelines for concepts children are exploring:

"*I saw great techniques in terms of AifL and really good classroom organisation and good*

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engagement with children. Great dialogue and excellent open-ended questioning, in fact a variety of questioning techniques but they were teaching the wrong science. So we ended up with children who were confidently wrong." (University of Glasgow, 2009), p.40

It should be noted, however, that the Learning and Teaching Scotland website does provide more detailed information and examples, for creative approaches to learning. Indeed, the webpage for Learning approaches[10] has the following subheadings with further information:

- Active learning
- ICT in education
- creativity
- Co-operative and collaborative learning
- Peer education
- Reggio Emilia

Nevertheless, these are more general approaches and provide limited guidance of how these can be applied to science and mathematics.

What are the main differences between preschool and school?

An explicit aim of the curriculum was to support the transition from preschool to school by extending more child-centred play activities of pre-school to early school. The Curriculum for Excellence documents highlight how previously this transition was difficult due to the nature of activities in school:

"In Primary 1 there is a stronger emphasis on teaching, with children sitting and listening for longer periods, and working on activities such as writing and reading. There are fewer opportunities for them to talk to adults and sometimes to other children, and adult support is more limited. Too often, completing and colouring worksheets feature prominently. There tend to be fewer opportunities for children to choose or initiate activities. Children spend more of the day on individual tasks. (CfE: Active Learning in the early years, p.13).

The Experience and Outcomes, which differentiates between early (3-5 years) and First phase (5-9 years), does indicate a difference in the type of activities for phases. As argued previously, the action verbs used for respective phases (Table 2), suggest that children in first phase, unlike early, are expected to be involved in activities such as predicting, testing, recording, and relating their findings.

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

The CfE document 'Active Learning in the early years' refers to activity for all subjects; therefore it is difficult to contrast activities between science and mathematics. However, one observation may be that similar to the science, the mathematics Experiences and

[10] http://www.educationscotland.gov.uk/learningteachingandassessment/approaches/index.asp

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Outcomes make much reference to exploring and discussing experiences, but limited reference to more reflective planning or reasoning.

4.5 Teacher Role / Location

What are the key summary points?

One key source informing early years policy was the report: *'early years education: Perspectives from a review of the international literature'* (Stephen, 2006). This report provided strong support for the important role of play in young children's learning. This influence is evident through policy documentation for the early years. Moreover, the role of play is extended from being associated with pre-school to early school. Children are very much encouraged to try out their own ideas.

Reflecting the emphasis on play, policy documents highlight the importance of children's hands exploration of materials–in class, and also outdoors. This is illustrated by the existence of a separate policy document*: Curriculum for excellence through outdoor learning* which highlights the significance of experiences outside of the classroom, both within the school grounds and in the community (although more specific visits such as museums are not mentioned).

There is also an emphasis on children problem solving, and linking science problems in the class to everyday life. However, there is less emphasis on problem finding (articulating problems not just encountering them in the course of play). As discussed in the later section 4.7, policy documents reinforce the importance of children working in different sized groups as well as individually. Collaboration is promoted although it is not clear how this is achieved beyond children simply working on tasks in groups. Likewise, discussion is encouraged, but more in terms of children articulating their thinking rather than responding to, and building upon, alternative ideas from peers.

There is more limited reference to particular teaching strategies; for example, the use of stories, drama, or role-play. There is also not much reference to how to bridge science with other domains beyond a general statement. In this general statement, ICT is mentioned but no guidance on how to used digital technologies to support science – although it should be noted that Scotland can boast a unique portal for all teachers: Glow, that provides ideas and examples for using technology across the curriculum.

What issues / tensions / policy criticisms exist?

The policy document for the early years emphasises the role of play for young children in learning in all areas. Play is seen as providing a platform to build upon children's own ideas.

"When children are involved in self-directed play, staff have an opportunity to observe their learning and, if appropriate, take it forward through sensitive intervention or using a more direct teaching approach." (p.13)

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What is less clear is the nature of 'sensitive intervention' or 'more direct teaching approaches'. Moreover, more direct teaching approaches can seem to be framed in terms of something to introduce when children are ready:

"At this stage, most children are ready for more teaching, especially where it is interactive and linked with high quality activities." (3), 13.

One criticism might therefore be that teaching is regarded as something to introduce following children's more undirected open play. This may not highlight the importance of the teacher's role in creating the conditions for productive play, or supporting children's thinking within play.

In what ways is the role of creativity emphasised?

Play is an important dimension within creative approaches, and in this regard, the clear emphasis on play, as well as many references to terms related to creativity (e.g. wonder), suggest a great role for creativity in teaching activities. However, there is a danger that creativity is simply framed as something that can flourish by children's space to play. Whilst this is an important element, the *Conceptual Framework* (D2.2) highlighted ways teachers could actively support creativity through particular approaches and activities; for example, supporting children in expressing their ideas using different media, helping children articulate questions, or engage with the ideas of peers. These more specific aspects of promoting creativity are not that clearly identifiable within policy documents.

What are the main differences between preschool and school?

With an emphasis on smoothing the transition between phases, it is less clear how teaching approaches should change. Instead, this implied from reference to how children's need develop over the early years. The quote below from the Active learning in the early years policy suggests that children require less teacher support to work alone or with peers. Interestingly, the also become "more able to imagine" as well as concentrate, listen and talk.

"As children progress, their confidence grows and their skills as independent and cooperative learners develop. They are able to take decisions about their play, at times to initiate it and organise it, and to ask questions and find information. Their experience of a range of learning broadens. They become less reliant on adult support as part of their emotional, personal and social development and become increasingly interested in their friends. They become more able to imagine, concentrate, listen and talk for longer periods. (CfE: Active Learning in the early years, p.8).

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

As teaching approaches are not distinguished for subjects in the early years (or distinguished for early years in subject documentation) it is difficult to identify differences. However, the Experiences and Outcomes for mathematics do imply slightly different teaching approach

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than for science in that the objectives suggest more teacher-directed activities: for example, sorting groups of objects, measuring, playing with clocks.

4.6 Materials and Resources

What are the key summary points?

There is limited reference to specific materials or resources. Resources such as published materials or storybooks are mentioned, but the emphasis is on general materials that support hands-on learning: implying more tangible materials, particularly everyday materials: "*There is much potential for learning in everyday familiar objects and natural materials*" (CfE: Active Learning in the early years, p.17). There is not much mention of digital technology: only generally of ICT as a cross curricula link and a brief mention of using it "*where appropriate*".

One resource that is emphasised for the early years is space. This is referred to several times as a resource to foster children's directed exploration of their environment". More specific guidance on other resources is provided through a termly early years online magazine *early years Matters.* (http://www.educationscotland.gov.uk/earlyyearsmatters/downloads/index.asp).

What issues / tensions / policy criticisms exist?

There are no clear issues or tensions identified concerning materials.

In what ways is the role of creativity emphasised?

The use of physical materials is intended to foster child-directed exploration of the world and hence reflects an emphasis on creativity. At times this intention is made more explicit, for example these reflection questions provided in the Active learning Document: *"How do you include beautiful, interesting and curious things to prompt creativity?", "How do you use these types of resources to support learning in imaginative ways?"* (CfE: Active Learning in the early years, p.17). Space is emphasised as a resource to support creativity: "*Space should be arranged to provide opportunities for children to learn through social, sensory, creative, constructive and dramatic activities"* (CfE: Active Learning in the early years, p.18).

Interesting, there are materials to support the early years on the Education Scotland website. These include materials for fostering creativity. However, from the examples given (six) refer to the arts: for example opera or painting, and none explicitly to mathematics or sciences.

What are the main differences between preschool and school?

No differences were identified for materials between phases.

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

The Experiences and Outcomes for mathematics refers to more particular resources, e.g. clocks, 3d shapes, money, number lines.

4.7 Groupings

What are the key summary points?

"*The child's day should provide a suitable mix of opportunities for work with the class, in a group or individually.*" (CfE: Active Learning in the early years, p.17). As this quote suggests, there is reference throughout the documents to children working in different groupings as well as independently. As evidence of any change, the Active Learning document does refer to a prior difference between pre-school and school: *"Children play for much of the session in small groups – making contrast to School".* (CfE: Active Learning in the early years, p.13). By trying to address this difference, it is suggested that previously, children in school had less opportunities for working in small groups: something that the Curriculum for Excellence seeks to address.

What issues / tensions / policy criticisms exist?

As children get older, they are more able to work independently. However, this does not mean they should be working more on their own. As discussed above, the Curriculum for Excellence purports to encourage more group work in the transition from pre-school to school.

In what ways is the role of creativity emphasised?

There was no clear emphasis on creativity in discussions of grouping, although the emphasis on encouraging small groups does imply a move away from more direct individual teaching to more collaborative interaction, which was identified in the *Conceptual Framework* (D2.2) as supportive of creativity.

What are the main differences between preschool and school?

Whilst the aim is to emphasise a merge between pre-school and school approaches and groupings, the documents do describe how children progress, namely more confidence and responsibility in working with others, although it is not clear how this is fostered beyond more experience of working in groups.

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

No clear differences were identified between science and mathematics for groupings.

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4.8 Time

What are the key summary points?

In Scotland, the curriculum is not statutory and the responsibility for its delivery and management rests with education authorities and school managers. There are therefore no statutory guidelines for amount of time for science education. National guidelines on the curriculum, however, are provided by the Scottish Executive Education Department and by Learning and Teaching Scotland.

On a different note, time is an important dimension in documents surrounding early learning in Scotland. Time is emphasised as a resource with which to allow children to carry out in-depth investigations, as illustrated by these examples of practitioners reflective questions provided:

"How do you encourage children to take time to persevere with their enquiries?" "How do you build in time to allow children to continue a project over several days or re-explore the same experience?"

What issues / tensions / policy criticisms exist?

A challenge for teachers is finding the time for certain activities, especially when given a busy curriculum to follow. For this reason, the Curriculum for Excellence intended to reduce the focus on particular activities and learning content:

"The review of the curriculum is aiming to declutter the curriculum significantly, particularly in key areas of primary, to free up more time for children to achieve and to allow teachers the freedom to exercise judgement on appropriate learning for children." (CfE: Contribution to curriculum areas, p.16)

In what ways is the role of creativity emphasised?

Providing time for investigations is very much seen as increasing opportunities for children to engage in their own interests: *"How do you provide opportunities and time to engage children's curiosity and prompt enquiry (children asking and answering their own questions)?"* (CfE: Active learning in the early years, p.17). Time to explore and build on their interests was important aspects of creativity identified in the *Conceptual Framework (D2.2).*

What are the main differences between preschool and school?

Formal education is not compulsory before school, although Scotland has made clear attempts to increase and promote the number of hours paid for the state in pre-school settings. The amount of time in these settings will clearly affect how much access children have to more formal science education.

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

As mathematics is a cross curricula theme as well as subject, it might be expected to involve more time in children's week.

4.9 Assessment

What are the key summary points?

Information about assessment is provided through a separate Curriculum for Excellence document: a Framework for Assessment. This document presents the general aims and approaches to assessment for all learners across all ages. There is, however, a section on assessment in the main Curriculum document that focuses on science. There is no information on assessment in the Active Learning in the early years document.

The framework for assessment identifies three principles for assessment: supporting learning; learner engagement; and ensuring appropriate support. These principles represent the emphasis on assessment for learners, and indeed there is limited discussion of the purpose of assessment for improving teaching or the curriculum, or even as a way to group children.

Assessment for learners is put forward in relation to two main aims: day-to-day learning and progress at key points, in particular transitions (e.g. into secondary school). The documents emphasise the importance of involving learners in assessment, and also involving parents; although there is limited detail on how this extends beyond simply communicating assessment information.

With regard to more specific priorities in science, the main curriculum document assessment section for science starts with the following:

"Assessment in the sciences will focus on children and young people's knowledge and understanding of key scientific concepts in the living, material and physical world, inquiry and investigative skills, scientific analytical and thinking skills, scientific Literacy and general attributes." (CfE: Building on Curriculum areas, p.257)

This quote indicates that assessment should focus on science process skills as well as content, and importantly, cover affective factors. Furthermore, by highlighting the need for children to demonstrate these skills practically, for example "*How well do they contribute to investigations and experiments?*" "*To what extent do they recognise the impact the sciences make on their lives, on the lives of others, on the environment and on society*?" Assessment also seems to capture more social aspects.

Whilst these assessment priorities are broad in scope, they represent the approach for all learners. For more specific focus on younger children, the Experiences and Outcomes document provides a more tangible guide to progress. Yet, according to Learning and Teaching Scotland, these outcomes are not intended to '*the new drafts are not designed as assessment criteria in their own right*' (LTS, 2007a).

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The framework for assessment highlights the multiple sources of evidence for children's learning. These include (CfE: A Framework for Assessment, p.30):

- Observations of learners carrying out tasks and activities, including practical investigations,
- Performances, oral presentations and discussions
- Records (oral, written, audio-visual) created by children and young people which may include
- Self assessment and/or peer assessment or may be assessed by the teacher
- Information obtained through questioning in high quality interactions and dialogue
- Written responses
- A product, for example, piece of artwork, report, project
- Accounts provided by others (parents, other children or young people, or other staff) about what learners have done

According to the main curriculum document, children can demonstrate their progress *"…through investigations, inquiries and challenges, and through how well they apply scientific skills in increasingly complex learning situations*." (CfE: Experiences and Outcomes, p.257).

Therefore, many modes of assessment are presented, although it is possible to identify strategies not identified, for example, children's self or peer assessment, or even drawing upon knowledge from other adults such as parents. Moreover, the curriculum documents do not provide examples of how these approaches apply to science in the early years, although it is possible to find exemplar practice through other resources accessed via the Education Scotland Portal; for example one case study in the magazine "Early Years Matters' talks about assessment in an Infant school:

"*Assessment of learning included observations of play experiences, talking with children, peer and self-evaluation by children and for children and parental evaluation*"[11]

What issues / tensions / policy criticisms exist?

Priestly and Humes (2010), in their discussion of curriculum theory in relation to the Curriculum for Excellence, refer to the tension in how the experiences and outcomes are presented. The authors highlight how the intention for them not to be prescriptive stands in contrast to the following statement:

"They should allow for evaluation. In other words, it should be clear from the draft outcome or experience what evidence might be observed to demonstrate progress by the child or

11 http://www.educationscotland.gov.uk/earlyyearsmatters/e/genericcontent_tcm4628173.asp?id=educationaltheme%5C%7Cpresentation%20subject%5C%7Cearly%20Years%20Matters%5C%7CAssessment

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young person: evidence of what they can achieve with appropriate pace and challenge, setting higher expectations where there is evidence to support this (LTS (Learning and Teaching Scotland), 2007)"

In what ways is the role of creativity emphasised?

With an emphasis on different modes of assessment, assessment approaches in Scottish policy documents appears to support creativity. Indeed, the Education Scotland website explicitly states that practitioners can support creativity by: "*Ensuring that assessment procedures reflect and reward creativity, enterprise and innovation*."[12] However, whilst sources of evidence are broad, there is little direction on what is being assessed beyond the knowledge and skills presented in the Experiences and Outcomes. Whilst these refer to 'creative' activities such as play, they do not make explicit particular creative attributes such as children's motivation, imagination, or curiosity.

What are the main differences between preschool and school?

There is no discussion of different assessment approaches between school and preschool.

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

It was suggested previously that the Experiences and Outcome are more specific for mathematics than science. As a result, assessment may be more focused upon these objectives. Interestingly, in the summary section on assessment for mathematics in the main curriculum document, it is possible to detect slightly more emphasis on more affective factors, seen in these example questions (bold added to highlight affective focus):

- Do they **relish** the challenge of number puzzles, patterns and relationships?
- As they tackle problems in unfamiliar contexts, can they **confidently** identify which skills and concepts are relevant to the problem?
- Are they developing the capacity to **engage** with and complete tasks and assignments?

One might speculate that this emphasis on affective factors in mathematics reflects the oft-voiced concern of children's lack of motivation in this subject.

12 http://www.educationscotland.gov.uk/learningteachingandassessment/approaches/creativity/about/index.asp

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5. Approaches to Teacher Education

5.1 Initial teacher education

As illustrated in Figure 3 taken from the Teach in Scotland website [13], there are two main routes for initial teacher education: undergraduate and postgraduate. Undergraduate is a four-year course resulting in a Bachelor of Education. The minimum requirements for this course are: Three Highers (or equivalent)- one of these must be English at Grade C or above. Two Standard Grades (or equivalent) - one of these must be mathematics at Credit level or Intermediate 2.

The post-graduate route is a one-year course. This requires: a degree from a UK university (or an equivalent degree from outside the UK); Higher English at Grade C or above (or equivalent); Standard Grade mathematics at Credit level (or equivalent)

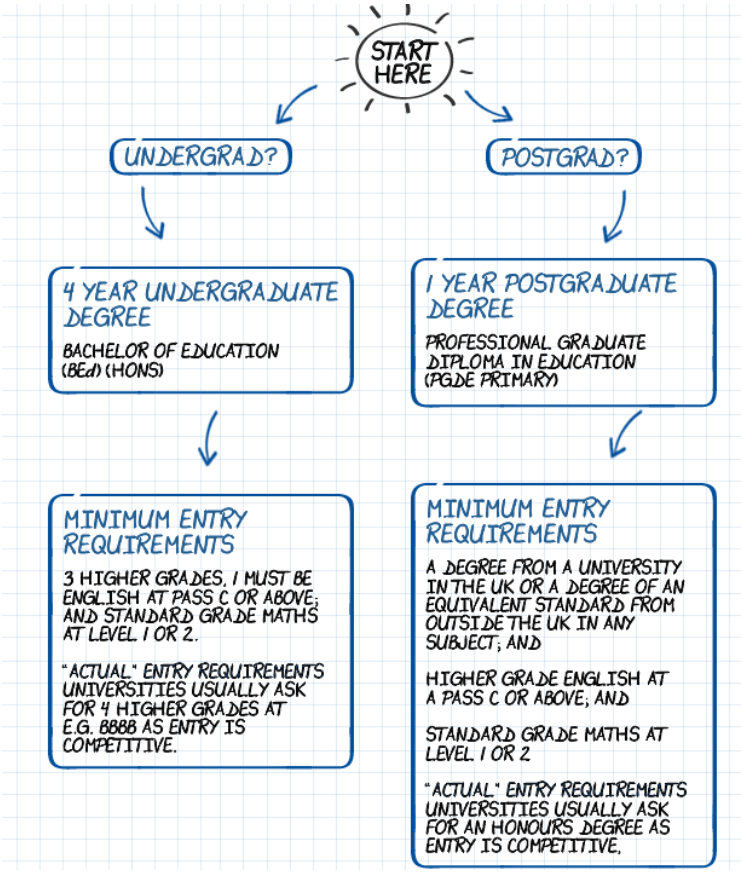

Figure 3: Routes to Initial Teacher Education (from Teach in Scotland website)

[13] http://www.teachinginscotland.com/

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Main competencies

The General Teaching Council for Scotland provides the standard for Initial Teacher Education. The standards are articulated in a set of statements organised around three themes:

- Professional knowledge and understanding
- Professional skills and abilities
- Professional values and personal commitment

An example Standard is: "*1.1.2 Acquire the knowledge and understanding to fulfil their responsibilities in respect of cross-curricular themes including citizenship, creativity, enterprising attitudes, Literacy and numeracy; personal, social and Health education; and ICT, as appropriate to the sector and stage of education.*"

The statements are the requirements for each programme of Initial Teacher Education in Scotland.

Training content and time

In the Guidelines for Initial Teacher Education Courses in Scotland (2006), initial teacher education programmes must:

- have effective partnership arrangements;
- have an appropriate balance of professional studies, subject studies and relevant school educational placement experience;
- contain clear arrangements for updating in line with national developments and new perspectives arising from educational research;
- meet the QAA Benchmarks which are within the Standard for Initial Teacher Education; and
- allow student teachers to meet the Standard for Initial Teacher Education.

Following successful initial teacher education, teachers have one-year induction in school. Since 2004, the Scottish Government guarantees the offer of a one-year teaching post in a Scottish local authority, with teachers being allocated to one of five local authorities of their choosing. Teachers on the programme have a maximum class commitment time equal to 82% to that of a full-time teacher, allowing additional time to be devoted to their professional development. All have access to the services of an experienced teacher as a mentor. By the end of their one-year induction, teachers should be ready to gain full registration with the General Teaching Council for Scotland14.

[14] http://www.scotland.gov.uk/Topics/Education/Schools/Teaching/ITE

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Training providers

Accredited universities provide initial Teacher Education. The table below illustrates the seven Scottish Universities providing initial teacher education and the training provided, including part-time and the Professional Education Bachelors run by Stirling.

UNIVERSITY	BEd PRIMARY	POSTGRADUATE (PGDE) PRIMARY	PGDE PART-TIME & DISTANCE LEARNING	BA (Hons) IN PROFESSIONAL EDUCATION (PRIMARY)
ABERDEEN	★	★	★	
DUNDEE	★	★		
EDINBURGH	★	★		
GLASGOW	★	★		
WEST OF SCOTLAND	★	★		
STRATHCLYDE	★	★	★	
STIRLING				★

Table 3: Initial Teacher Education provided by Universities in Scotland (Taken from xx)

5.2 Continuing professional development

The Teachers' Agreement of 2001 included a requirement for teachers to continue to develop and improve their skills throughout their careers. According to the Scottish Government website continued professional development can be accessed through in-service provision, networks or post-graduate study.

There are a number of organisations that support science Teaching and Education in Scotland. These include[15]: Association for science Education (ASE)*;* European Space Education Regional Office for Scotland (ESERO Scotland); HMIe*;* LTS*;* National Museums (of Scotland, of Flight etc)*;* National science Learning Centre (UK)*;* Royal Zoological Society*;* Royal Botanical Gardens (Edinburgh)*;* Royal Observatory of Edinburgh*;* Scottish science Advisory Group (for Local Authorities)*;* SSERC*;* STEM ED*;* STEM NET. Other sources of support included Universities, science Centres (e.g. Glasgow science Centre); science Festivals (e.g. Edinburgh International science Festival), as well as Industry support.

In 2012, the science and Engineering Education Advisory Group – SEEAG published an independent report setting out a range of recommendations for the Scottish Government and key stakeholders on how to improve the profile of science in the community and enhance science and engineering learning. One recommendation is "*ensuring teachers have access to high quality professional development in STEM (science, Technology, Engineering*

[15] www.scotland.gov.uk/Resource/0038/00386235.doc

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and mathematics) subjects, particularly within the primary sector".

The SEEAG report echoes other calls for developing continued professional development for science teachers in Scotland. According to the Royal Society of Edinburgh for example:

"*science and mathematics teachers should undertake subject-specific continuing professional development (CPD) as part of their overall CPD entitlement. Funding should be maintained for the National science Learning Centre, the National Centre for Excellence in the Teaching of mathematics and the Scottish Schools Equipment Research Centre, to allow these bodies to continue to support effective subject- specific CPD for science and mathematics teachers" (RSE, 2011 p.21)*

At the time that the SEEAG report was release, the Scottish Minster for Learning announced an investment of £600,000 per annum for the next three years for dedicated science teacher Continual Professional Development (CPD) provision in Scotland.

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6. Summary

Since 2004, the Scotland Government has invested much energy in transforming the curriculum through the Curriculum for Excellence. One of the explicit aims of this change is to provide a less prescribed curriculum that cultivates more creative teaching and learning approaches. As a result, Scottish policy, where key messages are presented, offers an attractive opportunity to examine the role of creativity in the approaches conceptualised for early years science and mathematics.

The main research question for this report was as follows*: How is teaching, learning and assessment of science and mathematics in the early years conceptualised in policy in Scotland?* This question was addressed by examining the curriculum according to nine dimensions. By considering each dimension in turn, this report provides a more thorough evaluation of Scottish policy, and importantly, helps re-iterate some of the inconsistencies described in critical appraisals by other authors; for example between the rationale and learning outcomes.

A significant challenge for this report has been the absence of particular documentation focusing specifically on science or mathematics in the early years. Instead, messages had to be drawn from across more generic writing on the subjects or this age group. This is important, as a significant tenet of the Creative Little Scientist project is that the need to consider the particular needs and opportunities for teaching and learning science and mathematics in the early years.

Many of the approaches identified in the *Conceptual Framework* were prominent across the documents. The rationale for science and mathematics addressed a range of aspects, with particular focus on its social importance and ability to foster innovative thinkers. The main objectives for science are expressed for all aged children and identify many of the key dimensions of inquiry approaches. The important role of materials is acknowledged, particularly in the early years where hands-on learning is a reoccurring theme. Even assessment approaches focus on informing learning, and recognise the need to capture a wider range of evidence. Most significantly for the early years, there is a large emphasis on play, where children are encouraged to develop ideas through exploration and to express their personal thinking. These are important themes for the role of creativity.

Another important objective for the Curriculum for Excellence is coherence between phases of education: embodied in documents for children from 3 to 18 years. Reflecting this aim, there is a particular focus on the transition between pre school and school. The early years document describes a existing disjoin between children's preschool playful activities, and the more teacher directed, structured and individual approaches of early school. To address this, the document advocates that the more play-based approaches of pre-school be extended into the early years of school, particularly the first year. Emphasising the need for consistency in the early years is welcomed, and addresses oft-voiced concerns about introducing directed approaches too early, particular in comparison to other European

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nations. However, a question that this prompts is how do we recognise and support children's progress in areas such as science in the early years?

An answer to such a question might be found in the learning outcomes for science, which are differentiated for phases: between 'early' (3-6 years) and 'first' (6-9 years). These objectives provide a window onto how science and mathematics in the early years is conceptualised. The outcomes tend to blur outcome with activity. There is great emphasis as might be expected on children exploring and verbalising their thinking. With respect to creativity, these aspects address the notion of generating ideas. However, there is much more limited reference to evaluating these ideas: through dialogue with the teacher or peers. There is no mention of understanding how predicting, testing and evaluating reflects the nature of science. There is a discernable difference in expectations for children in first compared to early, but this is more about specific skills in using equipment and discussing ideas, rather than evaluating them in light of evidence. In this regard, the *Conceptual Framework* (D2.2) highlights potential for scientific thinking in the early years that is not fully realised in the stated learning outcomes.

The learning outcomes reflect the teaching approaches advocated. There is great emphasis on child-directed play, and stepping back. Indeed, reference is even made to children being ready for 'more teaching' as they mature. This could be interpreted as underestimating the role of the teacher for scaffolding children's thinking. Similarly, there is arguably less reference to more specific teaching strategies, such as using drama or role-play, or certain assessment techniques such as self or peer assessment. The use of questioning is recognised, but no guidance on how to develop children's ability to respond to, as well as generate their own, open questions. There is also hardly any mention of the role digital technologies plays in not only helping children express, but also capture, their thinking. There is also the problem of whether the aim to provide general outcomes that to not constrain teaching, are interpreted by practitioners as too ambiguous. Indeed, a quick look at forum discussion about the outcomes illustrates an appetite for 'unpacking' them – providing more concrete statements about knowledge and skills.

As discussed in the *Conceptual Framework (D2.2)*, scaffolding children's scientific thinking does not necessitate directing children's activity, but rather needs time and space for opportunities to arise with which to leverage children's meaningful experiences. In this regard, one of the limiting factors of the Curriculum for Excellence is the way that science continues to be conceptualised as one of nine distinct subject areas. And unlike Numeracy, Literacy and Health and Wellbeing, it is not integrated across the curriculum. Furthermore, the curriculum identifies five areas in science that should be 'covered'. Adhering to this curriculum structure may hinder the flexibility that the Curriculum strives to promote.

6.1 Limitations

Policy messages need to be interpreted in relation to context: a complex background of historical, economical, geographic, political and likely other factors. Certain expressions, or

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terms such as 'creativity', hold particular currency within this context. Consequently, evaluating messages is challenging, particularly using the rather blunt survey tool adopted in this analysis. Whilst the survey provided a useful structure with which to examine messages, this methodological approach was selected predominately in order for comparisons to be made between national policies: where the data from this analysis will contribute along with 13 other nations. Articulating policy in terms of how pre-determined approaches are emphasised is a limitation of this report.

The survey was completed by only one researcher, due to project limitations and the need for a broad understanding of the national background. Although all ratings were qualified and these qualifications checked by a co-researcher, this dependence on an individual researcher presents a potential source of bias. A further source is the decision over what documents to draw upon. Although the five Curriculum for Excellence documents were clear choices, this report drew upon other sources, including critical commentaries that influenced reporting.

6.2 Implications

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

6.2.1 In-depth field study

Policy was identified in the *Conceptual Framework (D2.2)* as one of various factors shaping practice in the classroom. Therefore, alongside the Teacher survey (D3.1), it will be important to evaluate the extent to which policy messages filter into practice in Scotland. As well as the formal documentation, this will possibly require more attention to messages presented through other media such as the Education Scotland website.

This report describes a tension between the purported aims of the Curriculum for Excellence, and the impact of structured curriculum topics and specific learning outcomes. Fieldwork will provide the opportunity to see how this tension plays out in practice: whether the admirable aims of the curriculum are indeed frustrated. It will also present the opportunity to examine the extent to which practitioners draw upon the more specific guidance in the documents, for example, what materials or assessment methods to use, and whether absence from policy is echoed by an absence in class.

6.2.2 Policy recommendations

Investigating how messages in policy play out in practice will help evaluate their impact and understand how particular identified tensions are resolved. Unfortunately, many tensions identified in the Scottish policy documentation reflect longstanding areas of debate in policy, for example, how to provide criteria for progress without constraining practice through prescribed outcomes. However, this report identifies another, perhaps, more tenable implication: the need to provide more specific guidance on how young children's scientific

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develops and how teacher approaches can scaffold these processes without becoming over-directed teaching.

It is possible that written messages are not the best format for conveying this information: video materials for example may provide an ideal way to illustrate suggestions. Indeed, a brief investigation of the multimedia professional resources provided by the Education Scotland website for promoting creativity in the early years certainly indicates potential for illustrating for how this might be achieved in areas such as science and mathematics.

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7. References

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

Bell, J. F., & Daniels, S. (1990). Are summer,Äêborn children disadvantaged? The birthdate effect in education. *Oxford Review of Education, 16*(1), 67-80.

Donaldson, G. (2010). *Teaching Scotland's Future: a review of Teacher Education in Scotland*

Eurypedia. (2012). Structure of the Scottish Education System. from https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/United-Kingdom-Scotland:Overview

Gillies, D. (2006). A curriculum for excellence: a question of values. *Scottish Educational Review, 38*(1), 25.

Goodson, I. F., & Marsh, C. J. (1996). *Studying school subjects: a guide*. London: Falmer Press.

LTS (Learning and Teaching Scotland). (2007). *Introduction to draft experiences and outcomes.*

Martin, M. O., Mullis, I. V. S., Foy, P., Olson, J. F., TIMSS, Center, P. I. S., et al. (2008). *TIMSS 2007 international mathematics report: Findings from IEA's Trends in International Mathematics and Science Study at the fourth and eighth grades*.

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

Priestley, M., Biesta, G., & Robinson, S. (2012). Teacher Agency, Performativity and Curriculum Change: Reinventing the Teacher in the Scottish Curriculum for Excellence?

Priestley, M., & Humes, W. (2010). The development of Scotland's Curriculum for Excellence: amnesia and déjà vu. *Oxford Review of Education, 36*(3), 345-361.

Stephen, C. (2006). *Early years education: Perspectives from a review of the international literature*: Scottish Executive Education Department Edinburgh.

The Royal Society of Edinburgh. (2008). *Curriculum for Excellence – Numeracy, Science and Mathematics, and Wider Issues*.

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

University of Glasgow. (2009). CURRICULUM FOR EXCELLENCE DRAFT EXPERIENCES AND OUTCOMES: Collection, analysis and reporting of data.

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.

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

Key

E: Early (Nursery and P1)

F: First (P2, P3 and P4)

Rationale or Vision

Ai. What are the purposes of science Education?

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

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		E / F		
b. To develop socially and environmentally aware and responsible citizens		E / F		
c. To enrich the understanding and interaction with phenomena in nature and technology			E / F	
d. To develop more innovative thinkers			E / F	
e. To develop positive attitudes to science			E / F	
f. To develop important attitudes and dispositions as a foundation for future learning		E / F		

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Aims and Objectives

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

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

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

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

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Content

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

	As its own learning area	**Encompassed within other social sciences (e.g. geography)**	**Encompassed within more general understanding**
science	Yes		
mathematics	Yes		Yes – mathematics, Literacy and well-being

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

	science	**mathematics**
1	Planet Earth	Information handling:
2	Forces, electricity and waves	Number, money and measurement:
3	Biological systems	Shape, position and movement
4	Materials	
5	Topical science.	

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Learning Activities

Ai. What activities are encouraged?

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

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

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

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Teacher Role / Location

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

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

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

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
Open/unstructured play				E / F
Role/Pretend play				E / F
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				E / F
Using outdoor learning activities				E / F
Taking children on field trips and/or visits to science museums and industry			E / F	
Integrating science with other curricular areas				
Building on children's prior experiences			E / F	
Fostering collaboration			E / F	
Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical		E / F		
Encouraging problem finding – e.g. children asking questions		E / F		
Encouraging problem solving – e.g. children solving practical tasks				E / F
Encouraging children to try out their own ideas in investigations				E / F
Fostering classroom discussion and evaluation of alternative ideas		E / F		
Fostering imagination		E / F		
Relating science to everyday life				E / F
Using questioning as a tool in science teaching				E / F
Using digital technologies with children for science teaching and learning		E / F		
Fostering autonomous learning		E / F		

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

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

Materials and Resources

A. What materials are suggested?

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

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Groupings

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

	Not Mentioned	Single Mention	Various Mentions	Emphasised
Individual work			E	F
Pair work			E / F	
Small group work				E / F
Whole class activities			E / F	

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	N/A	N/A
1-2 h		
3-4 h		
More than 4 h		
N/A (Please explain)		

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Assessment

A: What purposes of assessment are included?

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

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

To assess the development of children's:

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

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C. What ways of assessing are advocated?

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

D. What Creative attributes are addressed in assessment?

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

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