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

www.creative-little-scientists.eu

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

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D3.2 Report on Mapping and Comparing Recorded Practices

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EXECUTIVE SUMMARY

Introduction

This main aim of this report is to map and compare 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 science and mathematics, within and between European partner countries. This report contributes to existing work not only by investigating how creativity in science is conceptualised across policy documentation, but through its focus on the early years: both in pre-school and the first years of primary education.

This report builds on prior work in the *Creative Little Scientists* project, drawing upon the *Conceptual Framework* (D2.2), and *List of Mapping and Comparison Factors* (D3.1). As well as informing the deliverable for Work Package 3 (WP3), the *Comparative Report* (D3.4), this report provides implications for field work in the next stage of the project by drawing attention to possible areas of focus, as well as providing policy recommendations.

The report addresses the wider research questions identified in the *Conceptual Framework* (D2.2), namely: How is teaching, learning and assessment of Science and Mathematics conceptualised? What role does creativity play in these?

These questions were then adapted in this report to focus on comparing national policies between partner countries. The following overarching question and sub questions were identified:

- What are the main similarities and differences in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?
- What are the main similarities and differences in the role of creativity in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?
- 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 the partner countries?
- What are the main similarities and differences between preschool and early primary school phases in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

These questions were examined by considering the following components of the curricula based on those defined by van den Akker (2007); these are currently structuring subsequent work in the *Creative Little Scientists* project.

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- 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?
- Pedagogy: 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, and how is s/he using this information to inform planning and develop practice?

Policy documentation relating to Teacher Education was also examined, as prior work identified the significance of Teacher factors. Two key questions were identified:

- Initial teacher education: what are the requirements for training to teach in the early years?
- Continued Professional Development: what opportunities exist for teachers to develop their skills in the early years?

Methodology

The research for this Deliverable was carried out in two stages. First, all partners created their own National Reports. These 13 reports (Belgium (Flanders), Belgium (Wallonia), Finland, France, Germany, Greece, Malta, Portugal, Romania, UK (England), UK (Northern Ireland), UK (Scotland), UK (Wales)), which are attached as addenda, were then drawn upon in order to identify similarities and differences in approaches that are reported in this deliverable.

Several methodological challenges were identified for this research. Firstly, it was important to identify what was meant by national policies. For most partners this was straightforward, as the whole country is governed by one national policy. However in the countries of the UK and Belgium there are distinct jurisdictions with completely separate educational policies, therefore separate National Reports were produced for England, Northern Ireland, Scotland, and Wales in the UK and for Flanders and Wallonia in Belgium. In the case of Germany, although each federal state has a different policy, they operate within a common framework of guidelines set at national level. Therefore one National Report was completed that identified common dimensions in policy across the country, illustrated by applications of national policy in two federal states: Hesse and North-Rhine Westphalia.

A second challenge was agreeing what documents to examine. Due to wide variation in available documentation, partners were advised to use their judgement as to the formal written policy documents that best capture approaches to early science and mathematics,

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even if the documents do not have this specific focus; for example, they might be documents focusing on science, or areas such as assessment, more generally.

Questionnaire

In order to compare approaches, a questionnaire was designed, to be completed by each partner. This questionnaire required partners to rate the extent to which a number of approaches, identified in the *Conceptual Framework* (D2.2) and *List of Mapping and Comparison Factors* (D3.1), were emphasised across policy documents (if at all). Similarly, partners were asked to rate the extent to which the role of creativity was emphasised within these approaches. Partners were asked to draw upon the *List of Mapping and Comparison Factors* (D3.1) to support their judgements.

An important limitation is that approaches discussed in policy documents need to be considered in relation to the unique contextual factors in which they are articulated. Such contextual information is not easily captured through the use of a questionnaire, therefore partners were asked to draw out and discuss key themes in their National Reports. This more qualitative approach provided important contextual information with which to interpret ratings provided in the questionnaire.

This report then drew upon the information provided in National Reports in order to map and compare national approaches. As well as illustrating the distribution of ratings by partners for each questionnaire, a thematic analysis was carried out, structured around the curriculum components by van den Akker listed previously.

Key Findings

National Reports from partner countries illustrated the different policy contexts for early years education in partner countries, with variation for example in starting ages for compulsory schooling, the organisation of phases in education, and the extent of policy documentation and guidance.

The comparison of national policies revealed similarities but also significant differences in approaches to learning, teaching and assessment. Key themes are presented below in relation to the main research questions that were identified for this Work Package (WP3).

What are the main similarities and differences in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

- Two common emphases are evident in the rationale provided for early years science education in partner policies: the need to develop socially and environmentally aware citizens and the importance of fostering skills and dispositions to support future learning. In only a small minority of countries was the need to provide a

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foundational education for future scientists or to develop more innovative thinkers prioritised in policy.

- Science is represented in different ways within the curriculum: in some countries and phases within a broad area of learning such as 'Knowledge of the World' or 'Study of the Environment', in others as a single subject.
- The aims, objectives, and content of the science curriculum in partner countries give considerable emphasis to the development of knowledge and understanding of science ideas and to process skills associated with scientific inquiry. More limited attention is afforded to social and affective dimensions of learning and few countries highlight understandings related to the nature of science.
- Approaches to teaching and learning associated with inquiry and creativity are widely included in policy guidance in partner countries. In preschool, priority is given to play and fostering autonomy is strongly advocated. In early primary school greater importance is afforded to investigation and problem solving. In most countries, limited references are made to the role of imagination or the discussion of alternative ideas.
- Policy in relation to assessment showed the widest variation across partner countries. In many partner countries limited guidance is provided for science assessment. Greatest emphasis is given to the assessment of science ideas. Understandings and competencies in relation to scientific inquiry are emphasised in assessment policy in a minority of countries and in only a few instances are attitudes a priority for assessment in science.

What are the main similarities and differences in the role of creativity in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

- Explicit references to creativity in partner policy documentation for science are limited, however, implicit links to creativity were identified in the attention given to learning dispositions and teaching approaches associated with creativity. In both instances links to creativity were identified in the concern to promote skills of inquiry and positive attitudes to science, in particular curiosity and critical evaluation. In most countries a very limited role for creativity was identified in relation to the development of science ideas. There is very limited evidence in policy of a role for creativity either in the priorities or methods for assessment advocated across partner countries. In particular, little attention is paid to multimodal forms of assessment or the involvement of children in assessment processes often associated with creative approaches to learning and teaching in the early years.

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 the partner countries?

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- Mathematics is generally represented in the curriculum as a single subject with a greater emphasis on subject content, particularly in early primary school. Statutory requirements for assessment and testing are more common in mathematics than in science. However, similar references are made in policy to a range of skills and attitudes associated with inquiry and problem solving and no substantial differences were noted in comparison to the teaching approaches advocated for science.

What are the main similarities and differences between preschool and early primary school phases in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

- There are many similarities in policy for preschool and early primary school across partner countries that suggest a role for creativity, for example, in their focus on skills associated with inquiry, fostering children's interests and on collaboration. However, a number of differences could also be identified. There was evidence of a greater emphasis on play and autonomous learning in preschool. Policy related to early primary school often makes much greater reference to specific subject content and includes a wider range of skills associated with inquiry-based learning in science, such as planning, reasoning and evaluation skills associated with the generation and evaluation of data. However more limited attention is generally given to social and affective factors in learning.

Issues and tensions

The comparison of National Reports for this Deliverable highlighted a range of issues and tensions in policy as follows:

- The changing policy context in many partner countries with the introduction of new curricula, standards for teacher education or assessment and evaluation, often resulting in practical difficulties and challenges associated with implementation of policy change.
- Questions of control in policy, in particular how to provide guidance while at the same time retaining teacher autonomy.
- Lack of coherence or contradictions in policy in a number of countries as a result of, for example, a mismatch between aims and assessment or lack of connection between generic policy on creativity or teaching approaches and documentation for science and mathematics.
- Scope to explore in more detail the opportunities for creativity, for example: creativity associated with the development of science ideas, the role of the teacher in providing support, as well as opportunities for the development of creative skills and dispositions, and strategies for promoting and capitalising on self and peer assessment in science and mathematics in the early years.

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Implications

A number of implications for policy were highlighted in National Reports. The significant role of professional development was emphasised in supporting teachers in the new approaches and changes in roles associated with creative and inquiry-based approaches to learning. Particular priorities identified for teacher professional development were formative assessment, the role of digital technologies, strategies and tools to support self-evaluation and collaborative approaches to the development of practice. These priorities will directly inform the development of teacher education curriculum principles and guidelines in Work Package 5. Moreover, the processes and instruments developed for the next research phase of the project, i.e. the fieldwork in Work Package 4, will also have the potential to contribute to this development of practice by providing a repertoire of tools that teachers might use to assess children's learning and reflect on their practice.

Additional implications for the next research phase of the project were identified from the comparison of National Reports. This highlighted the need to gain a more detailed sense of the nature of inquiry and opportunities for creativity in science and mathematics in early years classrooms, focusing for example through:

- Case studies of children's explorations and the nature of investigations in the early years (to support a wider definition of creativity than reflected in much policy documentation).
- The design, use and resourcing of the classroom environment – indoors and out including opportunities offered by digital technologies, and roles and collaboration of teachers and support staff.
- Support for assessment processes both inside and outside the classroom involving multimodal assessment tools, approaches to assessment of social and affective as well as cognitive factors assessment, and the potential for peer and self-assessment in preschool.
- Changing classroom dynamics over time in terms of groupings and the role of the teacher to foster independence and inquiry.

Limitations

The report identifies key limitations, predominately methodological issues, arising from attempting to compare such varied national documentation and the problem of only having one main researcher to complete questionnaires, where responses are likely influenced by their own experiences and knowledge.

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1. Introduction

1.1 Aims of this report

The main aim of this report is to map and compare 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, within and between European partner countries. As well as examining overarching similarities and differences in approach between countries, this report further seeks to identify any significant differences in approaches between science and mathematics.

1.1.1 Positioning of report within the 'Creative Little Scientists' project

This report is a deliverable in the European project '*Creative Little Scientists*' and builds directly upon prior project work. In particular, the report draws substantially upon the *List of Mapping and Comparison Factors* (Deliverable D3.1) that provides the structure with which to map and compare approaches. In line with the project aims, this report draws attention to the potential for creativity and the role of inquiry-based education in the approaches advocated in policy drawing on the *Conceptual Framework* (Deliverable D2.2).

This report is intended to contribute to the project deliverable the *Comparative Report* (D3.4), where it will provide a basis for comparison and synthesis with parallel work examining approaches reported by teachers in the *First Survey of School Practice* (D3.3). Findings from this report are intended to inform the plan and design of subsequent empirical research in schools associated with the subsequent Work Package (WP4).

Ultimately, this report intends to contribute to the project aims of informing policy and teacher education by identifying influential themes, gaps, and tensions in existing documented approaches surrounding the role of creativity in early science and mathematics education.

1.2 Recorded approaches: policy

Defining policy

In order to begin any comparison of recorded approaches, or policy documentation, it is important to consider the meaning and scope of this term. According to Lerner and Lasswell (1951, p.ix) policy can be defined as "*a body of principles to guide action*"; action in this context refers to children's education. Rizvi and Lingard (2011) discuss how these principles are communicated through a range of message systems. The authors adopt Bernstein's (1971) idea of a symbiotic relationship among the three main "message systems" of schooling—curriculum, pedagogy and evaluation/ assessment—and add a fourth,

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standardized testing. Consequently, these aspects need to be considered when making comparisons between national approaches.

Policy in relation to context

Policy cannot be considered outside the context in which it is written: historical, political, geographic or economic. A policy may be written, for example, to distinguish itself from prior governmental approaches, or to acknowledge increasing economic competition resulting from globalisation. Policy may wish to embody a particular rhetoric that has gained currency in a broader context, or attempt to address current points of contention such teacher empowerment. Often, it is what is not said, or not emphasised in a particular document that speaks louder than what is actually said.

Understanding the intricate context of different policies is clearly complex and would require more resources than available in this project. However, it is important to recognise how national policies often need to be interpreted within a particular context, particularly when making comparative judgements. This notion is well presented in the following quote from Rizvi and Lingard (2011):

> *"An analysis of education policies therefore requires not only an examination of their specific content but also an investigation of the context that provides them with their meaning and legitimacy.* Since *education policies cannot simply be inferred from a particular value position, policy analysis requires an understanding of how multiple, sometimes competing values are brought together, organised and configured in a policy statement and are allocated in an authoritative manner. Policy analysis needs to show how some values are glossed over while others are highlighted, re-articulated or sutured together in any given policy text*."(p.75)

It is also important to recognise that policies are often in a state of transition. Indeed, as illustrated later, this is the case in many of the policies of national partners. According to Rizvi and Lingard, policy should be considered more as a process than a product. This is to say that the process of negotiating and renegotiating policy can often be more influential than the finished outcome. Consequently, whilst the report focuses on a comparison of available documents (outcomes), attempts are made to present these within the ongoing contexts in which they arise.

National approach

Policy can be articulated on a range of levels; for example, at national or school levels. In relation to curriculum, van den Akker (2007) identifies five levels: Supra (international/ comparative); Macro (system/society/nation/state); Meso (school/institution); Micro (classroom); and Nano (individual/personal). The current report therefore, by comparing national approaches, can be related to the Macro level. However, comparison of national documentations could hold the assumption that policies are only made at this level. Yet, even within the partner countries of this project this is not the case. In Germany for

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example, approaches differ between federal states. In Belgium, education is regulated separately by the French, Flemish and German speaking communities. The different countries of the UK, England, Northern Ireland, Scotland and Wales have their own distinct policy frameworks.

Whilst considering the differences between national policies, it is also important to recognise their shared influence. As European countries, it is to be expected that they are influenced by the wealth of educational policy messages at this 'Supra' level.

Forms of communication

Key messages about schooling can be shared in various ways; this is particularly the case in current times given emerging forms of multimedia. Nevertheless, the format of authoritative messages continues to be formal text documentation published by the government. Whilst this is the dominant focus of this report, it is important to recognise how key messages are communicated in other ways, for example, through text books or less formal online resources. The use of online communication presents various other benefits ranging from the ability to update or amend documents quickly, reduce costs of printing, and the ability to incorporate more interactive/dynamic sources of information, such as links to video recordings of exemplar case studies. Whilst these other forms of communication are not the focus of analysis, they do contribute to the background in which policies are interpreted and are often drawn upon to illustrate arguments.

1.2.1 Policy analysis in the 'Creative Little Scientists' project

The *Literature Review of Science and Mathematics in the Early Years* (Addendum 1 of D2.2) highlighted that policy is one the major external influences shaping the classroom context. The significance of policy was consequently emphasised in the *Conceptual Framework (D2.2)* developed in Work Package 2, which emphasised the key role of policy in conceptualising approaches to science and mathematics in the early years and the potential for creativity.

Van den Akker (2007) provides a further theoretical rationale for considering policy in this project. According to the author, it is possible to distinguish between three broad forms of curriculum representation as illustrated in Table 1.1.

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Table 1.1 Typology of curriculum representations (van den Akker, 2007, p.38)

Intended	Ideal	Vision (rational or basic philosophy underlying a curriculum)
	Formal/Written	Intentions as specified in curriculum documents and/or materials
Implemented	Perceived	Curriculum as interpreted by its users (especially teachers)
	Operational	Actual process of teaching and learning (also curriculum in action)
Attained	Experimental	Learning experiences as perceived by learners
	Learned	Resulting learning outcomes of learners

In trying to understand and shape the role of creativity in early science and mathematics learning, it is necessary to consider each of these different interconnected aspects. Policy is highly relevant to the first of the three levels: the *Intended Curriculum*. Consequently, this report, in trying to understand the 'ideal' and 'formal/written' aspects of curriculum, aims to provide a window into what is implemented and ultimately attained. And by identifying ways to inform policy, this report intends to stimulate beneficial changes to children's learning in science and mathematics.

1.3 Existing work: research into policy in early science and mathematics education and the role of creativity

By focusing on the role of creativity in early science and mathematics education, the *Creative Little Scientists* project has a particular focus that draws together different aspects of Education: Early Years, Science and Mathematics, and Creativity. The *Conceptual Framework* (D2.2) highlighted that, whilst there was ample research in these different fields, there was much more limited work drawing the three areas together. Policy research with a similar focus appears even more limited, particularly with respect to attempts to compare national approaches.

A scan of existing research into policy illustrates that much work has been commissioned on a national level in order to inform policy development, illustrating also the increasing role of international perspectives and comparisons in policy development. For example in the UK, Scotland commissioned the report *Early years education: Perspectives from a review of the international literature* (Stephen, 2006). Often reports are funded by more independent national organisations such as the CfBT Education Trust (England) which commissioned the *International comparative study in mathematics teacher training* (Burghes, 2008) providing recommendations for initial teacher training in England. The Nuffield Trust provided funding

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for a report (based on discussion in two seminars) *Science Education in Europe: Critical Reflections* (Osborne & Dillon, 2008) which emphasised the need to 're-imagine science education so it can fit the modern world and the needs of all students'.

The European Union has also commissioned work comparing policy and practice between nations; for example, *Science Teaching in Schools* (Eurydice, 2006) which provided a comparative analysis of official regulations relating to science teaching across 30 European countries, focusing in particular on teacher education programmes, the school curriculum and standardised pupil assessment. More recently, the EU commissioned the report: *Science Education: National Policies, Practice, and Research* (Eurydice, 2011b) which highlighted a range of successful strategies across European nations including school partnerships, career guidance initiatives, and professional development opportunities for teachers. Comparable European projects into Mathematics can also be found, such as the *Mathematics Education in Europe: Common Challenges and National Policies* (Eurydice, 2011a).

The perceived importance of science education in Europe is further illustrated by more focused projects, particularly those into inquiry approaches which has particular resonance with the *Creative Little Scientists* project. Recent work includes the S-TEAM project looking into Teachers Skills in Inquiry Methods (S-TEAM, 2010) and the PRIMAS project looking at promoting inquiry-based learning in mathematics and science education across Europe (Primas, 2010).

1.3.1 Creativity

A central feature of the *Creative Little Scientists* project is to examine the role of creativity in science and mathematics education. As identified in the *Conceptual Framework* (D2.2), the notion of creativity has gained increasing currency in education, and it is possible to find a range of work from national organisations such as Futurelab's (a UK charity promoting innovative education practice) *Expert Perspectives on Creativity and Innovation in European Schools and Teacher Training* (Shakuntala Banaji, Cranmer & Carlo Perrotta, 2010).

Creativity in education is also a focus for the European Commission that has funded a range of reports including: *Creativity in Schools in Europe: A Survey of Teachers* (Cachia et al., 2009); *The Role of Creativity and Innovation in School Curricula in the EU27: A content analysis of curricula documents* (Heilmann & Korte, 2010); or *Innovation and Creativity in Education and Training in the EU member States: Fostering Creativity Learning and Supporting Innovative teaching* (Ferrari, Cachia & Punie, 2009).

However, as indicated by the titles of these reports, the focus on creativity is more general across education rather than having any subject specific focus on science. This is not to say that the role of creativity in science has not been recognised, see for example the STENCIL

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(Science Teaching European Network for Creativity and Innovation in Learning) network funded by the European Commission between 2011-2013[1].

1.3.2 Early Years

Another notable absence across the reports identified above is the focus on early years. Whilst primary education may be distinguished, there is little emphasis on children in the first years of school, and particularly on preschool. This is so, despite the impact of these phases on later learning (as identified in literature review conducted by the *Creative Little Scientists* project (Addendum 1 of D2.2). This is not to say that there are no reports examining the early years. Indeed, examples would include *Early Childhood Education and Care in Europe: Tackling Social and Cultural Inequalities* (Eurydice, 2009) or the OECD report *Starting Strong III: A Quality Toolbox for Early Education and Care (*OECD, 2012*).* However, these reports tend to focus on the more general, social, aspects of education rather than any particular aspects of the curriculum such as science or mathematics.

1.4 Summary

There exists therefore a range of work examining policy in mathematics and science, and even creativity in education. Yet, there appears much more limited work into early years education in the respective areas of science, mathematics and creativity. This is significant considering that the *Conceptual Framework* of the *Creative Little Scientists* project elucidated the impact of children's early experiences on their future learning (see Sylva, Melhuish, Sammons, Siraj-Blatchford & Taggart, 2009). It is the gap that this current report intends to address.

1.5 Research questions for this report

This report addresses the first research questions identified in the D2.2 *Conceptual Framework* in relation to policy: *How is teaching, learning and assessment of Science and Mathematics conceptualised? What role does creativity play in these?*

With a focus on policy, this first question becomes: *How is teaching, learning and assessment of science and mathematics in the early years conceptualised in policy in the partner countries?*

This question was then adapted in this report to focus on comparing national policies between partner countries.

- What are the main similarities and differences in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

[1] http://www.stencil-science.eu/

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The sub questions identified within this overarching research question were:

- What are the main similarities and differences in the role of creativity in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?
- 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 the partner countries?
- What are the main similarities and differences between preschool and early primary school phases in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

The *Conceptual Framework* (D2.2) also identified the need to examine different aspects of teaching, learning and assessment by considering the following dimensions: Aims/purpose/priorities, Contextual factors, and Teaching and learning. With this aim, this review of policy drew upon the framework of curriculum components 'the *Vulnerable Spider Web'* (see van den Akker, 2007, p.39) in identifying 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?
- Pedagogy: 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 and how is s/he using this information to inform planning and develop practice?

As well as factors relating to teaching, learning and assessment in the classroom, the *Conceptual Framework* (D2.2) identified teacher factors as a significant. This is further indicated in The *List of Mapping and Comparison Factors* (D3.1) derived from the *Conceptual Framework*. Consequently, this project further intended to examine teacher factors in relation to policy concerning teacher education to address the following questions:

What approaches are documented in relation to both:

- Initial teacher education: what are the requirements for training to be a teacher in the early years?
- Continued Professional Development: what opportunities exist for teachers to develop their skills in the early years?

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2. Methodology

2.1 Methodological issues in policy analysis

The aim of this review is to map and compare recorded approaches in policies between European countries. This aim indicates the need to identify certain dimensions for comparison drawing upon similar data sources from each country. Herein lies the significant challenge of comparative policy analysis: not only do the data sources (policy documents) vary considerably in terms of what exists and how it is presented, but analysis needs to take into account the unique linguistic and cultural context of the data. Methodological issues associated with these aspects are considered in turn.

2.1.1 Data sources

Defining national policies

The *Creative Little Scientists* project involves 11 partners across 9 countries. These countries differ significantly in political structure with consequent implications for what might be defined as a national policy. In most partner countries this is straightforward as the whole country is governed by one national policy. However in the countries of the UK and Belgium there are distinct jurisdictions with completely separate educational policies. In these cases it was therefore necessary to review policy for the different jurisdictions. As a result separate National Reports were produced for England, Northern Ireland, Scotland, and Wales in the UK and for Flanders and Wallonia in Belgium. In the case of Germany, although each federal state has a different policy they operate within a common framework of guidelines set at national level. There are also agreements across the federal states in relation to the new educational standards. Therefore one National Report was completed that identified common dimensions in policy across the country, illustrated by applications of this policy in two federal states, Hesse and North-Rhine Westphalia.

Scope of documents

As previously discussed, it is often common to find work focusing in the areas of science, mathematics, early years and sometimes even creativity in education, but less usual to find documentation that draws these areas together. Therefore, in order to examine the role of creativity in policy related to early science and mathematics, it is necessary to consider a range of policy documents. This presents the challenge of determining what documents to include in analysis. It is also important to bear in mind the significance of what is not mentioned, and devise a means to record this.

With respect to the sub questions to be addressed in this report, there is not only the challenge of identifying the role of creativity in policy but also identifying which documents allow comparisons of approaches to science and mathematics, as well as pre-school and school.

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Type of records

Whilst reference has been made to policy documentation, policy messages are often conveyed through a range of media. Whilst there may exist formal written documents, key messages may also be presented in other formats such as textbooks. The Internet has also affected the way in which documentation is presented. It is now possible to communicate through other forms of representation such as video or audio. Hyper-linking text also impacts on the way individuals will be guided through documentation. Finally, compared to printed reports, it is much easier to change or update online documents. This is significant considering that governments in some nations (e.g. England) are choosing to provide only online documentation. Therefore, a decision needs to be made as to how far to include different media in analysis of key messages.

Consistency within documents

As well as examining differences between national approaches, it is important to consider tensions or inconsistencies *within* national documents. Educational policy can often involve competing elements, for example, how to measure progress without constraining practice through assessment requirements.

Statutory or Guidance

One important issue to consider is whether particular documents are statutory or guidance as this may indicate the authority of the document and the extent to which practices advocated are monitored. Although there are other factors that make such a dichotomy less clear, it is important to account for the legal position of documents.

2.1.2 Approach to analysis

Deciding on the appropriate methods for analysing and comparing national approaches to teaching, learning and assessment will depend upon the theoretical and hence methodological paradigm adopted. Lor presents an illustration of key methodological approaches in Figure 2.1 (Lor, 2012).

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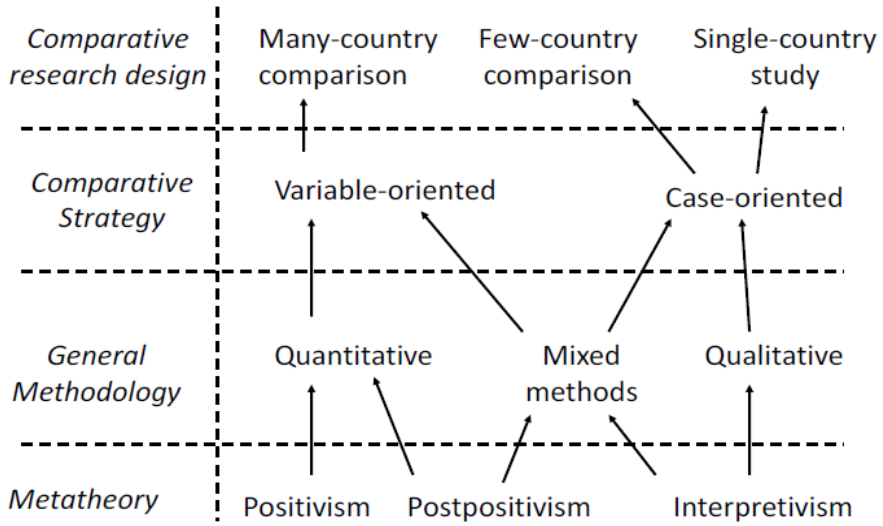

Figure 1.1: Relationship of comparative methodological choices to metatheory (Lor, 2012, p.5)

With 13 National Reports to compare, this work package might be described as falling between 'Many country comparison' and 'Few-country comparison' using Lor's descriptors. This presents the option of adopting either a variable-orientated or case-orientated comparative strategy.

The *Conceptual Framework* (D2.2) advocated an interpretive paradigm for this project in order to understand how creativity is conceptualised in early science and mathematics. This would suggest a more qualitative, case-orientated methodology and strategy. However, in this particular phase of the project, the aim was to map and compare approaches described in 13 different National Reports. Such comparison suggested the benefit also of a more quantitative value-orientated approach in order to help identify and reflect on similarities and differences between policies.

Subjectivity

A significant challenge of comparing dimensions in policy across different countries is that messages need to be considered in relation to their unique linguistic, historical, geographical, political and economical context. For example, if a particular approach is not discussed explicitly in policy documents, is this because it is not considered important, or because it is considered so commonplace as to not warrant re-iteration? Terms such as 'creativity' may be particularly susceptible to political discourse in relation to the economic value of innovation. Identifying approaches within the context that messages are presented requires the knowledge and interpretative skills of the researcher. This will inevitably increase levels of subjective interpretation into analysis.

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Variation in language and context between national documents adds to the challenge of ensuring a consistent approach to interpretation. This can be addressed to a certain extent by providing a framework within which to guide judgements about messages in policy. However, researchers' interpretation of messages in policy, even if guided by a clear framework, will be influenced by their own knowledge and experiences. Whilst the reliability of judgements can be examined by using multiple coders (providing data for inter-coder reliability), this does have implications for resources available.

Language

Language presents a key challenge in comparative policy analysis across countries. Particular terms, such as 'Inquiry' or 'Creativity' in this project may not translate easily between countries. And even if terms appear comparable, they may differ in the meaning attributed.

Therefore, comparing policies by measuring the use, or absence, of particular terms is problematic. Furthermore, it is very possible that educational practice in a country embodies much of what is signified by a word without using this word explicitly. This is highly relevant for examining the term 'creativity', where its role in policy may not be reflected by explicit use of the term. The following sections outlines the methodology used in this project, and how methodological issues, such as how to identify the role of creativity in policy, were addressed.

2.2 Methodological approach

The main research question for this report is:

What are the main similarities and differences in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

In order to address this research question, research was carried out in two phases. First, having identified the scope of relevant documents, partners carried out an analysis of these. The results of this first layer of analysis were presented in individual National Reports (addenda to this report). Information from these reports was then drawn upon to identify similarities and differences between policies in partner countries, the findings of which are presented in this final report.

2.2.1 Phase 1: National Reports

Defining National Policy

As mentioned previously, 'national policies' were reviewed with respect to the separate educational jurisdictions in each country. Therefore partner researchers in most countries drew on one national policy framework. Within the limited resources of the project, partners in Belgium focused on Flanders and Wallonia. In the UK National Reports were produced for the separate nations of England, Northern Ireland, Scotland and Wales. In

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Germany, one National Report was completed focusing on guidelines set at national level and including illustrative examples of applications of this policy in the federal states of Hesse and North-Rhine Westphalia.

Identifying Documents

As discussed in previous sections, the ten curriculum components proposed by van den Akker (2007) were adopted as a basis to examine policy in relation to Teaching, Learning and Assessment. These components are: *Rationale; Aims; Content; Location; Learning activities; Teacher role; Materials and resources; Grouping; Time, Assessment*. Documents were chosen that addressed these aspects in relation to science and mathematics for children in the early years. However, in most cases, there is no single document focusing on early science and mathematics, therefore, reasoned judgement had to be made about which documents to include that were relevant, for example, an early years policy document that makes general reference to approaches; or a document for assessment policy that discusses science for all age groups.

Analyses

In order to analyse and compare how teaching, learning and assessment of science and mathematics in the early years is conceptualised in national policy documents, a mixed methods approach was adopted, consisting of:

- A questionnaire to assess the extent to which certain approaches were promoted in policy documents. Therefore this contributed to a variable-orientated comparative strategy (as illustrated in Figure 1.1)
- A thematic analysis of policy documents drawing upon researchers' familiarity with their national documents and policy context. Therefore this reflected a more case-orientated comparative strategy.

Questionnaire

A questionnaire was devised in order to assess the extent to which certain approaches are promoted in national policy. The questionnaire is provided in Appendix A. In most cases two questionnaires were filled out for each National Report: one for pre-school and one for school (although often the responses were highly similar where common policy documents applied to both phases of education.) The challenges of mapping the distinction between preschool and school for each National Report are discussed in the findings.

The questionnaire was separated into two main sections: Approaches to Teaching, Learning, and Assessment, and Approaches to Teacher Development. The first section was further sectioned according to the nine curriculum components (Rationale, Aims, etcetera).

Each section included a series of questions *(e.g. What purposes of assessment are included?),* followed by a number of items relating to this question. These items drew upon approaches that were identified in the *Conceptual Framework* (D2.2) and the *List of*

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Mapping and Comparison Factors (D3.1) as being relevant to the role of creativity in early science and mathematics. The items also drew largely upon the questionnaire used in the *Teacher Survey* (Task 3.3) in the project. The *Teacher Survey*, also conducted in this phase of the project, aimed to identify teachers' conceptions of teaching, learning and assessment of science and mathematics in the early years. By aligning the two surveys, the aim was to facilitate subsequent comparisons of conceptions promoted in policy with those held by teachers for whom policy is largely intended (focused upon on in the subsequent D3.4).

The relationships between strands in the *Conceptual Framework* (D2.2), the curriculum components, the questionnaire items and the List of Mapping and Comparison Factors (D3.1) are shown in Appendix B. Researchers were asked to respond to each item by identifying the extent to which each aspect was emphasised across policy documents. A 4-point Likert scale was used: *Not Mentioned; Single Mention; Various Mentions; Emphasised.*

Creativity

The questionnaire also included items focusing more explicitly on the extent to which the role of creativity was emphasised in policy documents for particular approaches. Responses used a similar 4-point Likert Scale, however, the ratings were adapted to allow for how approaches may seem to hinder creativity: *Counter Creative Emphasis; No Creative Emphasis; Slight Creative Emphasis; Highly Creative Emphasis.* Interpretations of creative emphasis were made by drawing upon the dimensions of the list of factors *List of Mapping and Comparison Factors* (D3.1).

Therefore, as well as addressing the main research question, the questionnaire addressed the first research sub-question:

What are the main similarities and differences in the role of creativity in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

Partners were asked, where appropriate in the different sections of the questionnaire, to comment on any differences between science and mathematics in relation to the different curriculum components. This addressed the second sub-question:

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 the partner countries?

Furthermore, by completing a questionnaire for each phase, the data created was able to address the second research question:

What are the main similarities and differences between preschool and early primary school phases in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

A single researcher generally completed the questionnaires. However, for each item they were required to document evidence for their judgement. This could be commentary or

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more specific quotes from documents. For each National Report, a second researcher checked the evidence for each item response and where queries were raised, would discuss and resolve the judgement with the first researcher. In some instances partners consulted local experts to discuss details of policy about which they were unsure.

Thematic analysis

As previously emphasised, the messages articulated in policy documents need to be interpreted in relation to context. As it is not possible to capture this context within relatively closed questionnaire ratings, researchers in each partner country were also asked to complete a National Report where they could comment on this information more freely, drawing upon their familiarity with policy documents and the national context. The National Reports therefore constituted a set of case studies providing contextual information to help interpret quantitative information from the questionnaire.

To facilitate comparisons, the structure of each National Report was the same (see Reports in Addenda). This structure included:

- A section to provide an overview of the historical context of the policy (e.g. when policy documents were written, any major impetus for policy change).
- A section to discuss key themes under the headings used in the questionnaire (spider headings). Within each section, researchers were encouraged to address the different research questions, in other words, articulate key themes relevant to: the main issues/tensions; the role of creativity; differences between phases; and differences between science and mathematics. Researchers were encouraged to use the National Reports as an opportunity to provide context for the responses they had provided in the questionnaire.
- A section in which to summarise the themes in the National Report and their implications for the role of creativity in early science and mathematics.

2.2.2 Phase 2: Whole report

Comparisons between policies in partner countries drew upon both the questionnaire data and partners' thematic analyses. Comparisons of ratings for each item indicated similarities and differences in approaches between national policies. The thematic analysis provided further insights into such similarities and differences.

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3. Findings

This section summarises the findings from the National Reports, drawing upon both the questionnaire data and commentary provided by partners. These are interpreted in relation to the key research question:

- *What are the main similarities and differences in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?*

The following sub-questions are also addressed:

- *What are the main similarities and differences in the role of creativity in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?*
- *What are the main similarities and differences between mathematics and science in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?*
- *What are the main similarities and differences between preschool and early primary school phases in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?*

As discussed in the previous section, it is important when reporting these findings to acknowledge the unique characteristics of different educational systems across the consortium and to review findings in this context. Consequently, a summary of key features of national early years provision and policy is first provided. (This draws on the *Overview of National Early Years Education Provision and Policy* provided in each National Report). This informs the commentary on findings and in particular the implications for national policy makers in Section 5 of this report.

3.1 Overview of key characteristics of the national educational systems and provision across the consortium

From the National Reports and Policy Questionnaires, it was possible to identify a range of characteristics that distinguish the nature of educational provision and policy in partner countries as outlined below.

3.1.1 Organisation of ages and phases in preschool and primary education

Table 3.1 below illustrates the ways in which the organisation of phases of education and the age ranges associated with each phase differ between partner countries. It also indicates the varying starting ages for compulsory schooling and the extent of access to free preschool provision.

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Table 3.1: The organisation of preschool and primary education across partner countries

Partner country	Compulsory schooling	Preschool	Primary
Belgium (Flanders)	Full time from 6 years plus minimum one year pre school part time	2.5-6 years Free provision from 2.5 years	6-12 years
Belgium (Wallonia)	From 6 years	2.5-6 years Free provision from 2.5 years	6-12 years
Finland	From 7 years	3-5 Early Childhood Education Preschool 5-6 years – all children have the right to attend	7 – integrated primary and lower secondary
France	From 6 years	2-6 years Free provision from 3 years	6-11 years
Germany	From 6 years	2/3-6 years (Ministry of Education not responsible) In some federal states pre-school classes (5-7 years Ministry of Education responsible)	6-10 years In some Federal states 6-12 years
Greece	From 5 years	Children can attend Infant Centres (6 months- 2.5 years) and Child Centres (2.5 – 4 years) (Ministry of Education not responsible) Pre-school 4-6 years	6-12 years
Malta	From 5 years	Kindergarten 3-5 years Children are able to enter pre-school at the 3 main beginning of each term so can start schooling as soon as they as they are 3 (rather than waiting until the start of the next school year). Majority attend (85% 3 years, 90% 4 years)	5-11 years
Portugal	From 6 years	3-5 years Universal pre-school education from 5 years but not compulsory	6-10 years
Romania	From 6 years	3-6 years	6-10 years
UK (England)	From 5 years	3-5 years (Foundation Stage) Entitlement to free part time education from 3 years	5-11 years
UK (Northern Ireland)	From 4 years	3-4 years (preschool) 4-6 years (Primary Foundation Stage)	6-11 years

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Partner country	Compulsory schooling	Preschool	Primary
UK (Scotland)	Between 4.5 and 5.5 years depending on birth date	3-5 years Entitlement to preschool education for all children.	5-12 years
UK (Wales)	From 5 years	3-5 years Free part time provision for all 3 and 4 year olds	5-11 years

Primary schooling starts at age 6 in the majority of partner countries. The exceptions are Finland where primary school starts at 7 and Malta and UK (England, Scotland, and Wales) that have a lower starting age for primary school of age 5. In this document the term *Preschool* generally refers to educational provision prior to compulsory schooling and *School* to refer to point where children make the transition into full time compulsory education. However, in Belgium (Flanders) and Greece, attendance in the last year of preschool is compulsory. In Northern Ireland, schooling is compulsory from 4 at the start of the Foundation Stage of primary education. In all three instances, these have been relatively recent developments with the aim of providing a good foundation for primary education. For example, in Flanders the intention was to ensure that 'children should have a better knowledge of Dutch language speaking when entering primary education' (Flanders National Report). Access to free preschool education varies but in the majority of countries at least part time provision is available from age 3.

The nature and range of provision across countries and phases includes a varying mixture of publicly funded state, independent, and voluntary schools and privately funded provision. This often has implications for the degree and nature of regulation of the different forms of provision. In partner countries the great majority of children in early years education attend publicly funded provision. This review of policy focuses on policy as it applies to publicly funded early years education.

3.1.2 The degree of regulation and levels of decision making also vary across countries and phases.

This is reflected in the varied extent and nature of policy documentation, including what aspects are covered by policy and whether the policy is statutory or in the form of guidance. A related issue is that across partner countries decision-making rests at a variety of levels for example national, regional, and school levels. This is illustrated in Table 3.2 below.

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Table 3.2: Curriculum policy in partner countries

Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
Belgium (Flanders) Preschool and early primary	Statutory General rationale and vision in Core curriculum for each phase	Statutory objectives (primary) Developmental aims (preschool) for World orientation and Mathematics	Statutory Inclusion of World Orientation and Mathematics But room for teacher selection of content	School decision Generic guiding principles in core curriculum	School decision Generic guiding principles in core curriculum	School decision in accord with developmental aims List of materials that need to be provided free	School decision Core curriculum generic guidance	School board has full autonomy	School decision Monitoring by inspectorate and national sample surveys
Belgium (Wallonia) Preschool and early primary	Statutory General objectives	Statutory Competencies 'socles de compétences' in science and mathematics to be achieved by 8.	Statutory Defined by competencies in science and mathematics	School decision Statutory directions at a general level. Guidance for approaches in science and mathematics for early years (to 8)	School decision Guidance documents for mathematics and science in early years.	School decision Guidance documents refer to materials.	School decision	School decision	School decision Formative assessment mandatory Assessment guidance and tools for 3rd and 5th years of primary External tests at end of primary school

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
Finland Preschool	National guidance provides general rationale or vision Municipal pollcy	National guidance in relation to general aims and objectives for preschool Municipal policy	National guidance for scientific and mathematical orientation Municipal policy	National guidance on general approaches Municipal policy	National guidance on approaches in preschool Municipal policy	National guidance – holistic orientation Municipal policy	School decision No specific guidance	School decision No specific guidance – integrated approach to learning	School decision National guidance in relation to assessment approaches
Finland Early Primary	National guidance Municipal regulations provide rationale for science and mathematics education	National guidance in relation to aims and objectives for environmental & natural studies and mathematics Municipal regulation and policy	National guidance for environmental and natural studies and mathematics Municipal regulation and policy	National guidance for environmental and natural studies and mathematics Municipal regulation and policy	National guidance on environmental and natural studies and mathematics Municipal regulation and policy	National guidance – separate handbook concerning science – less detailed advice in mathematics Municipal regulation and policy	School decision No specific guidance	National regulations	School decision National guidance in relation to assessment approaches and descriptions of good performance at end of 4th grade for science and mathematics

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
France Preschool	Statutory Rationale for education encompassing science and mathematics	Statutory objectives	Statutory No specific subject content – science and mathematics encompassed in 'discovery of the world'	School decision General guidance regarding activities	School decision General guidance regarding teaching approaches	School decision General guidance and support regarding materials	School decision General guidance regarding groupings	School decision Flexible	School decision National bank of assessment materials includes elements of science and mathematics Some guidance on approaches
France Early Primary	Statutory Rationale for education including science and mathematics	Statutory objectives for science and mathematics	Statutory Includes requirements for science and mathematics	School decision Guidance & support (ASTEP) especially in relation to 'hands on' learning	School decision Guidance & support (ASTEP) especially in relation to 'hands on' learning	School decision General guidance and support regarding materials	School decision General guidance	National time allocation This time can be adapted by the teachers according to their educational project	Statutory Diagnostic assessments of progress and bank of assessment tools in mathematics but not in science

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
Germany Preschool	National guidance to inform policy in federal states	National guidance to inform policy in federal states for science and mathematics	National guidance on science and mathematics as learning areas, school decision	National guidance regarding learning activities, school decision	National guidance regarding teaching approaches, school decision	National guidance School decision	National guidance School decision	School decision	National guidance School decision
Germany Early Primary	National guidance to inform policy in federal states	National guidance to inform policy in federal states for science and mathematics	National standards only for mathematics Statutory Ministries of Education in the federal states: New Standards	Guidance Ministries of Education, general examples of activities	Guidance Ministries of Education, general advice on teaching approaches	Guidance Ministries of Education, mostly generic	Guidance Ministries of Education, generic	Statutory Ministries of Education, specific hours for mathematics and science encompassed with other subjects.	Statutory Ministries of Education General guidance on assessment approaches

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
Greece Preschool	Statutory General rationale for education	Statutory Aims and objectives linked to science and mathematics	Statutory within 'Child and the environment'	Guidance within curriculum for 'Child and the environment'	Guidance within curriculum 'Child and the environment'	Guidance within curriculum 'Child and the environment'	Guidance within curriculum 'Child and the environment'	School decision No guidance	Guidance on generic assessment approaches
Greece Early Primary	Statutory General rationale for education	Statutory Aims and objectives linked to science and mathematics	Statutory content for 'Study of the Environment' and Mathematics	Guidance within curriculum for 'Study of the Environment' and Mathematics	Guidance within curriculum for 'Study of the Environment' and Mathematics	Guidance within curriculum for 'Study of the Environment' and Mathematics	Guidance within curriculum for 'Study of the Environment' and Mathematics	Guidance on time allocations related to curriculum document	Guidance on assessment methods – generic and some limited subject specific

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
Malta Preschool	Statutory rationale for education with references to science and mathematics	Statutory Aims and objectives for science and mathematics	Statutory Holistic approach – no subject specifications but links to science and mathematics in Intellectual development	Guidance focused mainly on inquiry based activities with some references to science and mathematics content	Guidance General guidance on teaching approaches	Guidance General rather than subject specific	Guidance within National Curriculum Framework	School decision no official timetable or planned time	No official assessments Record of progress Guidance in relation to principles and approaches Proposals for formative assessment
Malta Early Primary	Statutory rationale for science and mathematics education	Statutory Aims and objectives for science and mathematics	Statutory requirements for science and mathematics	Guidance focused mainly on inquiry based activities some references to science and mathematics content	Guidance General guidance on teaching approaches	Guidance General rather than subject specific	Guidance within National Curriculum Framework	School decision for first two years. Guidance for older years of 1.5-2 hours per week.	Record of progress Guidance in relation to principles and approaches

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
Portugal Preschool	Statutory General objectives for education	Statutory Objectives for 'Knowledge of the World' and goals for end this phase	Guidance For 'Knowledge of the World' and mathematics	Guidance Contained in guidelines for Knowledge of the World and mathematics	Guidance Set of roles defined for each curriculum area	Guidance General guidance including reference to some science-specific materials	Guidance Within general principles that underlie curriculum organisation	School decision No national guidelines	Statutory Learning goals Suggested approaches to assessment
Portugal Early Primary	Statutory General objectives for education	Statutory Objectives for 'Environmental Studies' and Mathematics	Statutory Guiding principles, objectives and learning blocks for Mathematics and Environmental Studies	Guidance Contained in guiding principles for 'Environmental Studies' and Mathematics	Guidance Set of roles defined for each curriculum area	Guidance General guidance with some specific advice in relation to 'Discovery of materials and objects'	Guidance Within general principles that underlie curriculum organisation	School decision No national guidelines	Statutory Learning goals assessment criteria for each cycle

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
Romania Preschool	Statutory General aims for early childhood education	Statutory Objectives for early education include reference to science and mathematics	Statutory Mathematics and science studied together in an integrated approach	Guidance Integrated - Mathematics and science studied together	Guidance Includes specific references to science and mathematics	Guidance Subject specific suggestions	Guidance	Guidance Specific recommendations for areas of learning	Statutory Assessment criteria Guidance regarding methods
Romania Early Primary	Statutory Rationale for science and mathematics education	Statutory Objectives for science and mathematics	Statutory National curriculum identifies content for science and mathematics	Guidance For science and mathematics	Guidance Subject specific	Guidance Subject specific suggestions	Guidance	Guidance Specific recommendations for areas of learning	Statutory Assessment criteria Guidance regarding methods

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
UK (England) Preschool	Statutory General aims for pre-school - limited subject references	Statutory for Learning goals for mathematics and for science within Knowledge & understanding of the World	Statutory Learning goals. include specific mathematical content. Science content related to inquiry, limited reference to concepts.	Guidance For areas of learning for pre-school practice guidance	Guidance Much is generic but some suggestions for areas of learning	Guidance Focus mainly generic – greater detail in relation to mathematics than science	School decision No specific advice	School decision Previous National Numeracy Strategy recommended time for numeracy in last year of pre-school	Statutory Early Learning Goals Guidance in relation to assessment approaches
UK (England) Early Primary	Statutory Rationale for Science and Mathematics General aims for education	Statutory Programmes of study for science and mathematics	Statutory Content prescribed in programmes of study for science & mathematics	Guidance Within National Curriculum and subject specific non-statutory guidance	Guidance Some limited guidance for science much greater focus on mathematics	Guidance Limited advice in National Curriculum and guidance documents	School decision No specific advice	School decision for no guidance for science recommended daily mathematics lesson	Statutory Attainment targets for assessment in science and mathematics Testing in mathematics at 7

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
UK (Northern Ireland) Preschool and Early Primary	Statutory General rationale	Statutory In National Curriculum Generic Thinking Skills & capabilities subject content	Statutory National Curriculum for Mathematics and numeracy and science within the World Around Us	Guidance Examples of activities within the curriculum	Guidance	Guidance but very limited	Guidance but very limited	School decision No time suggestions in guidance	Statutory Levels of progression in Areas of Learning Guidance on Assessment for Learning Testing in mathematics at 7
UK (Scotland) Preschool and Early Primary	Guidance Rationale for science and mathematics from 3-18	Guidance Aims & objectives across 3-18 – experience and outcomes for each phase	Guidance Sciences and Mathematical Technologies	Guidance Illustrating expectations in Curriculum for Excellence Generic guidance Active Learning in Early Years	Guidance Teaching approaches not distinguished for subjects in Early Years	Guidance Limited and mostly generic	Guidance	Guidance No time allocations recommended	Guidance Assessment priorities and approaches

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Partner country	Rationale	Aims and objectives	Content	Learning activities	Teaching approaches	Materials	Groupings	Time	Assessment
UK (Wales) Preschool and Early Primary	Statutory General rationale for education	Statutory For mathematics and science within Knowledge and Understanding of the World (3-7) For science and mathematics (7-11)	Statutory For Mathematics and Knowledge and Understanding of the World (3-7) for science and mathematics (7-11)	Guidance Generic guidance on learning and teaching approaches (3-7) subject specific (7-11)	Guidance Generic guidance on learning and teaching approaches (3-7) subject specific (7-11)	Guidance Limited and mostly generic	Guidance Limited	School decision	Statutory Steps in profile (3-7), targets (7-11) Guidance on assessment approaches Testing in mathematics to be introduced.

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In the majority of partner countries the *rationale for education* and the *aims, objectives,* and *content* of the curriculum are set out in official national policy. Exceptions include Finland and Germany where national guidance is provided but decision-making is at a regional level, in the hands of municipalities in Finland and federal states in Germany respectively. In Scotland, the *Curriculum for Excellence* is not statutory. There is some variation also in how far national policy provides a specific rationale for the inclusion of science and mathematics in the curriculum. In most countries, a rationale for education is provided at a general level, particularly in relation to pre-school, that may include some reference to science and mathematics. Only a minority of countries provide a specific rationale for mathematics and science education. Examples in relation to early primary education include Finland, Malta, Romania and UK (England). Aims, objectives and some areas of content for mathematics are outlined across all countries and phases. Science aims, objectives and content are often incorporated within broader areas of learning such as 'World Orientation' (Flanders), 'Social Studies and Science' (Germany) or 'Study of the Environment' (Greece, Primary phase).

Across partner countries decision-making in relation to implementation, associated with *learning activities, teaching approaches, materials and grouping* are generally in the hands of teachers. Most countries provide some form of guidance about learning activities and teaching approaches. In pre-school this is often in the form of generic advice, with some references to science and mathematics. In a number of countries more detailed guidance is provided in relation to specific areas of learning for the early primary age phase for example, France, Greece, Portugal, Romania. *Materials* and *grouping* tend to be covered to a more limited extent in either generic or subject-specific guidance. In relation to *time* allocation for science and mathematics within the curriculum, only a few countries set requirements or provide national guidelines for science and only in relation to early primary education for example in Finland, France, Germany, Malta.

Assessment is an area of policy where the degree of regulation varies widely. In some countries approaches are entirely in the hands of teachers (for example Flanders). In others, statutory assessment criteria and requirements are set out in policy for example, Portugal, Romania, UK (England and Wales).

3.1.3 Regulations governing staffing and class sizes

Regulations governing staffing and class sizes also vary to some extent across phases and partner countries. Qualifications required for teaching are outlined in section 3.2 (Teacher Education) and indicate some differences between requirements for teaching in preschool and early primary school in a number of countries. There are also differences in terms of regulations governing class size between countries and phases as shown in Table 3.3 below.

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Table 3.3: Class and group size in preschool and primary education across partner countries

Partner country	Pre school provision	Primary provision
Belgium (Flanders)	No regulations	No regulations
Belgium (Wallonia)	No regulations	No regulations
Finland	4 children per adult. So in the group there is always an assistant as well as the teacher.	No regulations
France	Average number 25 with classroom assistance (reduced from 40 since 1970s)	Average number 22 – (reduced to 23 from 26 since 1970s)
Germany	20 -25 children per group Children under 3, 6-8 children per childminder	Varies according to federal state Usually minimum of 16 to maximum of 28
Greece	25 with one teacher and an assistant	Up to 25 children
Malta	Kindergarten 1 – one assistant for 15 children Kindergarten 2 – one assistant for 25 children	Maximum 30 children per class In practice average is 17, and reduction for classes including children with statement of special educational needs
Portugal	Minimum 20 and maximum 25. For class of 3 year olds maximum 15 per educator	26 children provided they cover only one year of schooling, mixed years 18 children (or up to 22 with more than one teacher)
Romania	Generally Groups of 15 children – no less than 10 no more than 20	Mean number of children 20, not less than 12, no more than?
UK (England)	I member of staff to 13 children Out of school hours or with no suitably qualified staff ration 1:8	Commitment to maximum 30 (4-7years) but may exceed this in certain permitted circumstances related to individual needs
UK (Northern Ireland)	1 adult to 13 children (1 to 8 in playgroups and private nurseries) Reception classes no more than 25 children	Statutory responsibility to ensure class sizes for pupils in years 1-4 do not exceed 30.
UK (Scotland)	1:10 for children 3 and over in non-domestic settings	Maximum of 30 reduced to 25 for first year of primary
UK (Wales)	Commitment to rolling out 1:8 adult child ration for 3-5 year olds from September 2008	Maximum of 30 pupils Reception, Year 1 and Year 2 but may exceed this in certain permitted circumstances related to individual needs

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The National Reports for partner countries suggest that class sizes and adult to child ratios are regulated in the majority of partner countries either at national or regional level. In pre-school, it is common for teachers to be working with assistants with ratios of between 13 to 15 children per educator, although there are higher adult to child ratios in some countries notably Finland where the ratio is 1 adult to 4 children. Maximum recommended class sizes in primary school range from 30 in the UK to 25 in Greece. In Portugal, class sizes are lower for mixed age classes and in Malta class size is reduced if the class includes children with a statement of special educational needs. In England, the maximum recommended can be exceeded to take account of the particular needs of individual children. Partner commentary indicates that in practice class sizes may vary. In all partner countries the most common practice is for mathematics and science to be taught by the generalist class teacher. This is reflected in the content of training for early years teachers discussed in section 3.3 Approaches to Teacher Education.

3.1.4 Systems and extent of monitoring and accountability vary across the partnership

There is wide variation in systems of monitoring and evaluation of school and teaching quality and children's outcomes, however, National Reports indicate that these issues have been receiving increased attention in recent years in the context of the globalisation of assessment and international comparisons. There are national systems for inspection and evaluation of schools in a number of partner countries for example Belgium, France, Romania and UK (England, Wales and Scotland). In Finland and Germany evaluation takes place at a regional level.

Some national assessment of children's progress has been introduced for example in Belgium (Wallonia), France, Romania and UK (England and Wales) to monitor standards. In Belgium (Flanders) there is a periodic national survey of attainment levels to provide feedback on progress at a system level. Processes of monitoring and accountability are significant in their impact on the status of policy and its implementation and interpretation. They also define opportunities for teacher autonomy and decision-making. These issues are discussed further in the final sections of this report.

3.1.5 Status of existing documents

Differences between national education systems were echoed in the type and nature of accessible policy documents. In addition in several partner countries, including Germany, Greece, Malta, Romania and UK (England), policy is currently in the process of significant change. Importantly, policy documents needed to be interpreted in relation to national context, where they often embodied significant modifications in educational approach, for example, re-addressing the role of the teacher or approaches to assessment.

3.2 Approaches to teaching, learning and assessment

This section presents an overview of approaches to early years science and mathematics in public policy documents across partner countries. It draws together themes identified in qualitative data

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provided in partner commentary on policy in their National Reports with summaries of quantitative data from the National Policy questionnaires.

Results are presented according to the framework of curriculum components (van den Akker, 2007) used to structure the National Policy Reports and Questionnaires. Commentary is provided on similarities and differences in the ways in which each component is represented in partner policy. This is accompanied by a review of the emphases identified by partners in relevant policy documentation and recorded in the questionnaires.

Emphases in relation to each component were judged in the relation to a series of items based on the *List of Mapping and Comparison Factors* (Deliverable D3.1) that characterise the common ground that early years science and mathematics can share with creativity, used in developing the policy questionnaire and teacher survey. These judgments are summarised in the tables included in the sections that follow.

3.2.1 Rationale or vision: Why are children learning?

Similarities and differences in policy

The National Reports indicate that varied attention is given to issues of vision and rationale across policy documentation in partner countries. In some countries, and often in preschool, no specific rationale is provided for the place of science and mathematics in the curriculum. For example, in Greece and Portugal the rationale and purposes for education are indicated at a general level only. In other national policies, a more specific rationale is provided for particular areas of learning. In some instances sciences are grouped within broader areas of learning such as 'World Orientation' (Belgium Flanders), 'Knowledge of the World' (Portugal) or 'Study of the Environment' (Greece), 'Environmental Studies' (Romania). Purposes for science education are reflected within these broader areas of the curriculum. In others, and more common in early prrimary, a specific rationale for science education is indicated in policy (for example Belgium (Wallonia) France, UK (England)). (See Figure 3.2 for specific details.)

Emphases in the rationale and vision for science in the early years vary between countries and phases of education as evidenced in the range of partner responses to the different items in this section of the policy questionnaire (see Figures 3.1 and 3.2).

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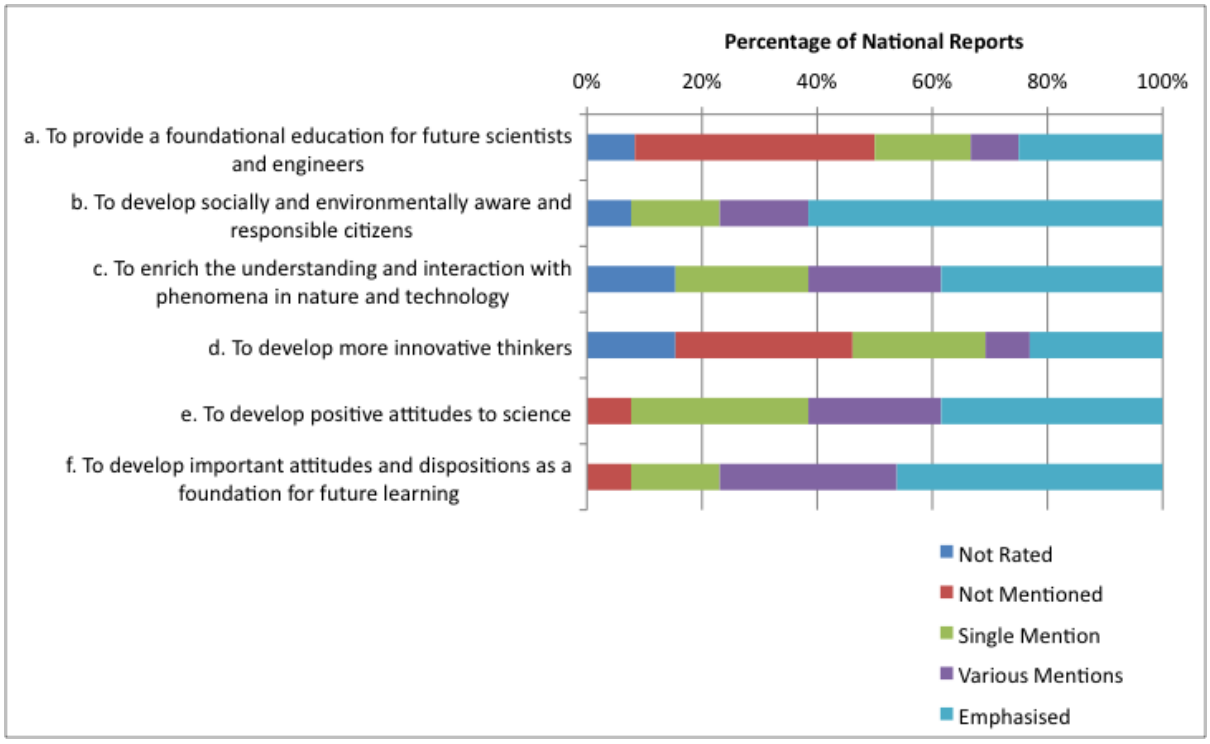

Figure 3.1: What are the purposes of Science Education? (Preschool)

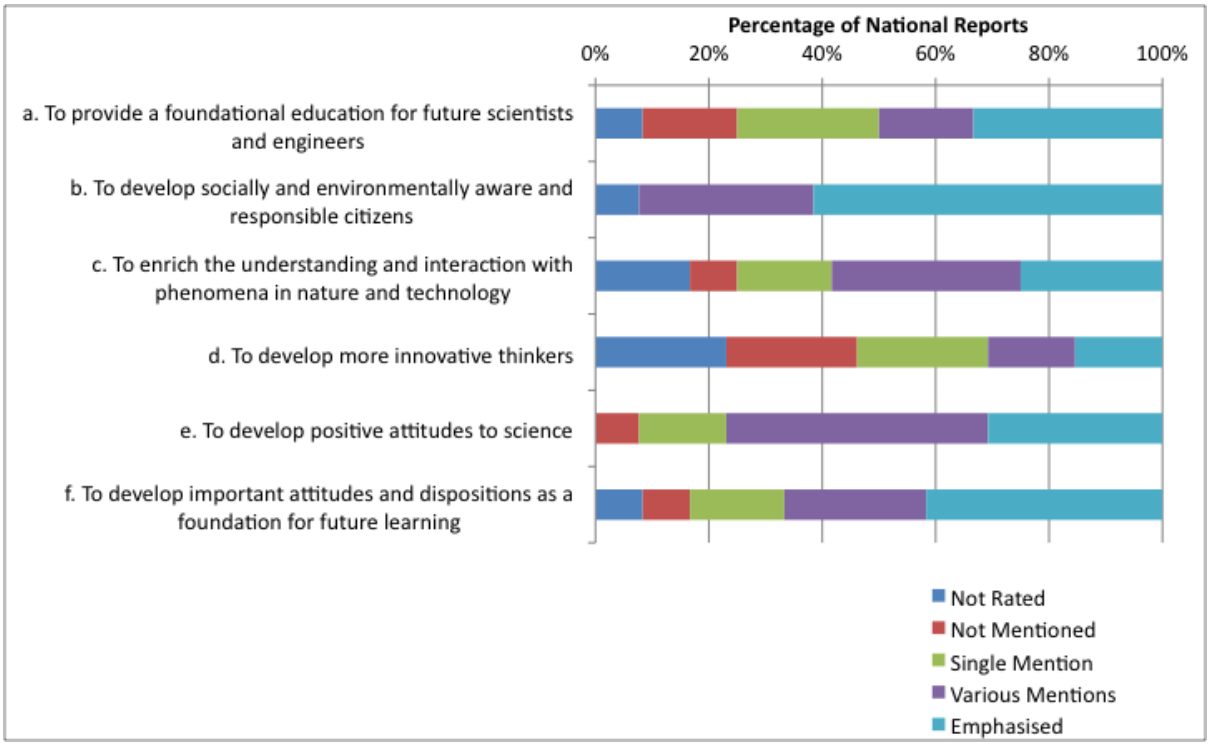

Figure 3.2: What are the purposes of Science Education? (Early Primary School)

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The development of socially and environmentally aware citizens is most commonly emphasised across both preschool and early primary phases. The need to enrich understanding and interaction with phenomena, the development of important attitudes and dispositions for future learning and the need to develop positive attitudes to science are either emphasised or given various mentions in the majority of countries, again across both phases. Few countries focus on education for supply of future scientists and engineers, or on developing more innovative thinkers. Here partner researchers indicate some difference in emphasis between preschool and early primary school, with greater attention in the early primary phase to policy related to providing a foundational education for future scientist and engineers.

More detailed partner commentary in National Reports indicates varied kinds of justification for the rationale and vision outlined in partner policy. In some instances, for example in Belgium, Finland, Germany and Greece, the role of education in enhancing children's personal lives and their roles as citizens is highlighted, often with a particular emphasis on environmental awareness. The importance of developing skills and dispositions for future learning is underlined for example in Finland or Germany. In some instances, for example in the UK (England, Northern Ireland) attention is drawn to the economic benefits of developing children's basic skills and dispositions. Where a specific rationale and vision for science education is articulated, the most common focus is on the combination of skills, attitudes, knowledge and understanding associated with scientific literacy (for example Malta, Portugal, Romania, UK).

Role for creativity

In their National Reports, partners identify varying roles for creativity articulated in policy related to the purposes for science education in their countries. Their commentary indicates some explicit reference to 'creativity' or 'creative' dispositions in partner policy. For example, policy in Belgium (Flanders) mentions 'creative functioning in society' and in France the development of pupils' 'curiosity, creativity and critical thought' is advocated. In some countries, creativity is included explicitly as a cross-curricular theme or capability for example in Greece, Malta, or UK (Northern Ireland). However in many cases, references to creativity in partner documentation are implicit in the creative dispositions mentioned in relation to the purposes of education such as curiosity, imagination or sense of initiative. The list of factors D3.1 provided a list of creative dispositions that were utilised in identifying links to creativity implicit in policy. Of these almost all policy across the partnership makes reference to curiosity, exploration and investigation, indicating some role for creativity.

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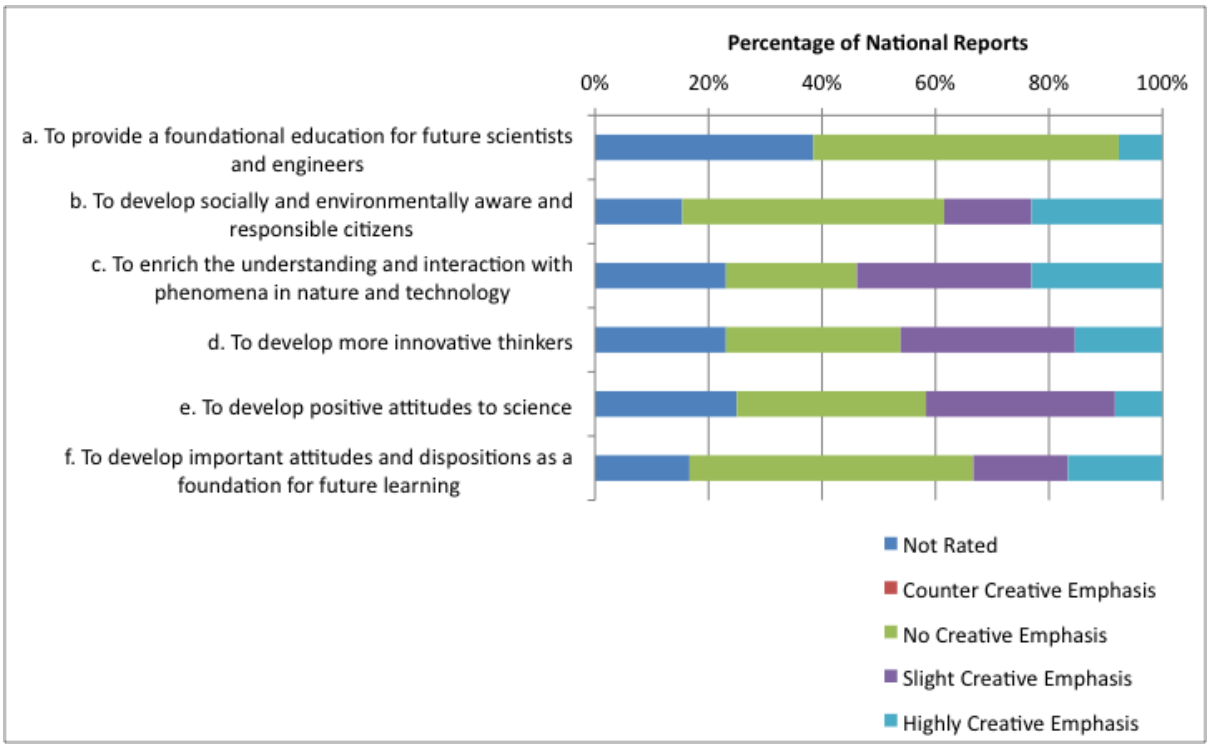

Figure 3.3: What is the role of Creativity, if any, in the purposes of Science Education? (Preschool)

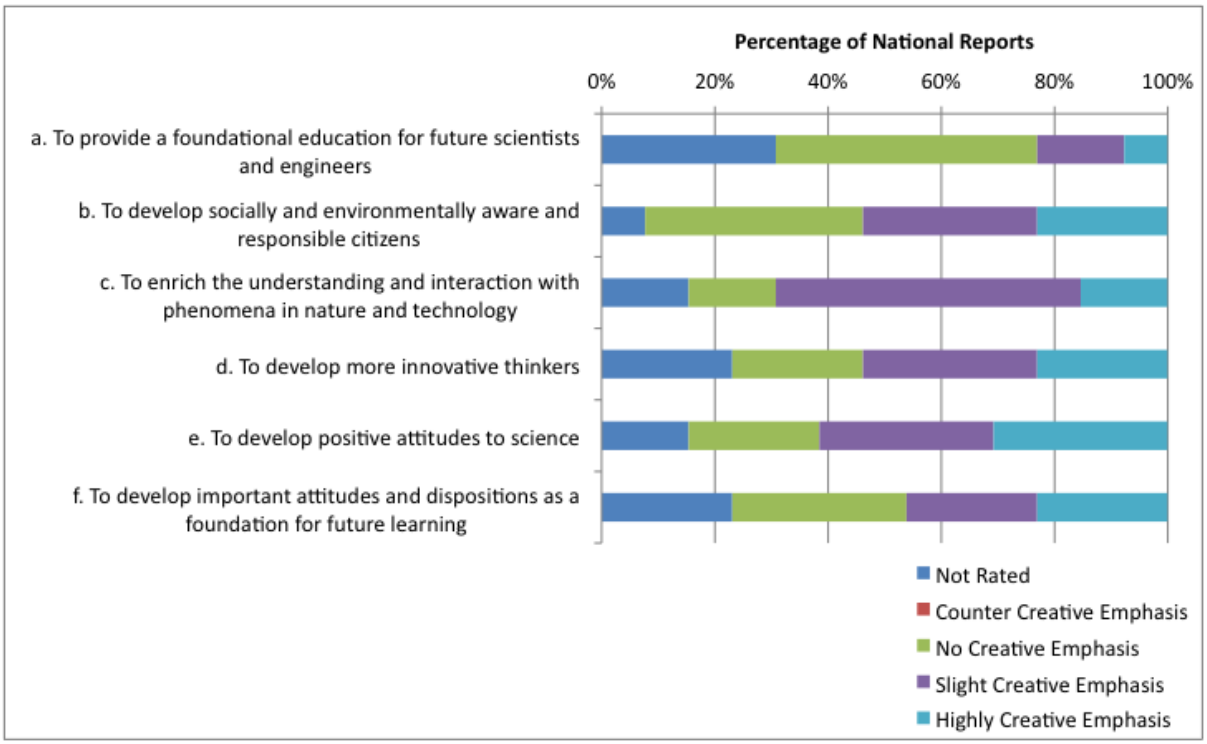

Figure 3.4: What is the role of Creativity, if any, in the purposes of Science Education? (Early Primary School)

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In the Policy Questionnaire, partners recorded varying roles for creativity in policy statements about the purposes of science education. The majority of partners identify some emphasis on creativity in policy in relation to 'enrich the understanding and interaction with phenomena in nature and technology'. In contrast, only a very small minority (especially preschool) note any creative emphasis in purposes related to 'provide a foundation for future scientists and engineers' (examples include UK (England) and France). Responses vary widely across the other dimensions. Overall responses related to preschool suggest a greater role for creativity in that a majority of partner policies give some emphasis to creativity for all the purposes for science education evaluated apart from 'provide a foundational education for future scientists and engineers'.

Differences between science and mathematics

No significant differences are noted in the rationale provided for science and mathematics in policy within the majority of partner countries. Where differences are noted, they are in relation to the greater attention to specific purposes for mathematics education (for example in Greece) and or the importance of basic skills and knowledge in mathematics (for example in UK (England, Northern Ireland)) for future employment.

Differences between Preschool and Early Primary School

In relation to the majority of countries, partner responses indicate no substantial differences in the rationale for science education between early primary school and preschool. Where differences are mentioned, they related to a more general and holistic approach to the rationale for early years education, more limited attention to subject-specific detail and a slightly greater role for creativity.

3.2.2 Aims and objectives: Toward which goals are children learning?

Similarities and differences in policy

All countries specify aims and objectives for early years education. As indicated in the introduction to this section, in most instances these are set out in official policy. The exceptions are Finland, Germany and Scotland, where national guidance is provided but decision-making rests at the level of municipalities, federal states and schools respectively. In most instances, specific aims and objectives are set out, either for science as a single subject (more common for the primary age phase) for example for primary education in Belgium (Wallonia), France, UK (England) or for science within broader areas of learning such as 'World Orientation' (Belgium Flanders), 'Discovery of the World' (France), 'Social Studies and Science' (Germany), 'Study of the Environment' (Greece), 'Environmental Studies' (Portugal) or 'Knowledge and Understanding of the World' (UK (Wales)). In Finland (for preschool) and in UK (Northern Ireland), aims and objectives provided are of a general nature focusing on the development of skills dispositions and understandings across the curriculum. No specific aims are outlined for science and mathematics.

The National Policy Questionnaires indicate varied emphases on cognitive, social and affective factors across countries and phases as shown in Figures 3.5 and 3.6.

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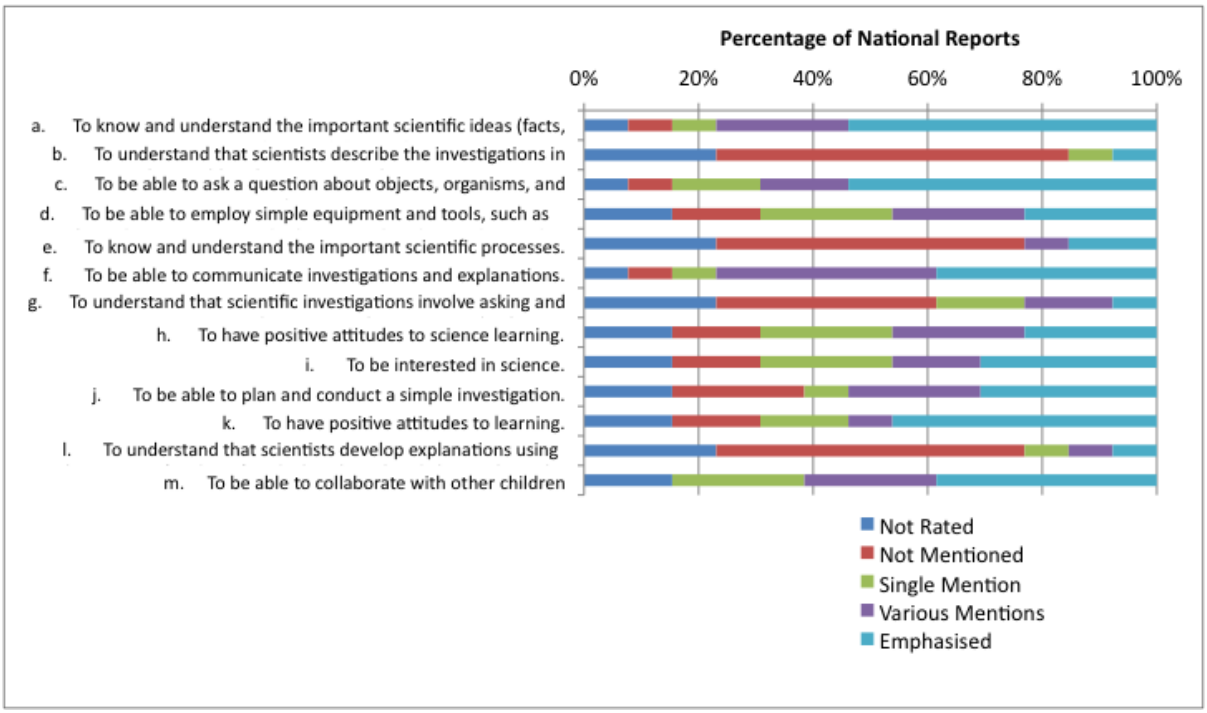

Figure 3.5: What views are indicated about the importance of the following Science learning outcomes? (Preschool)

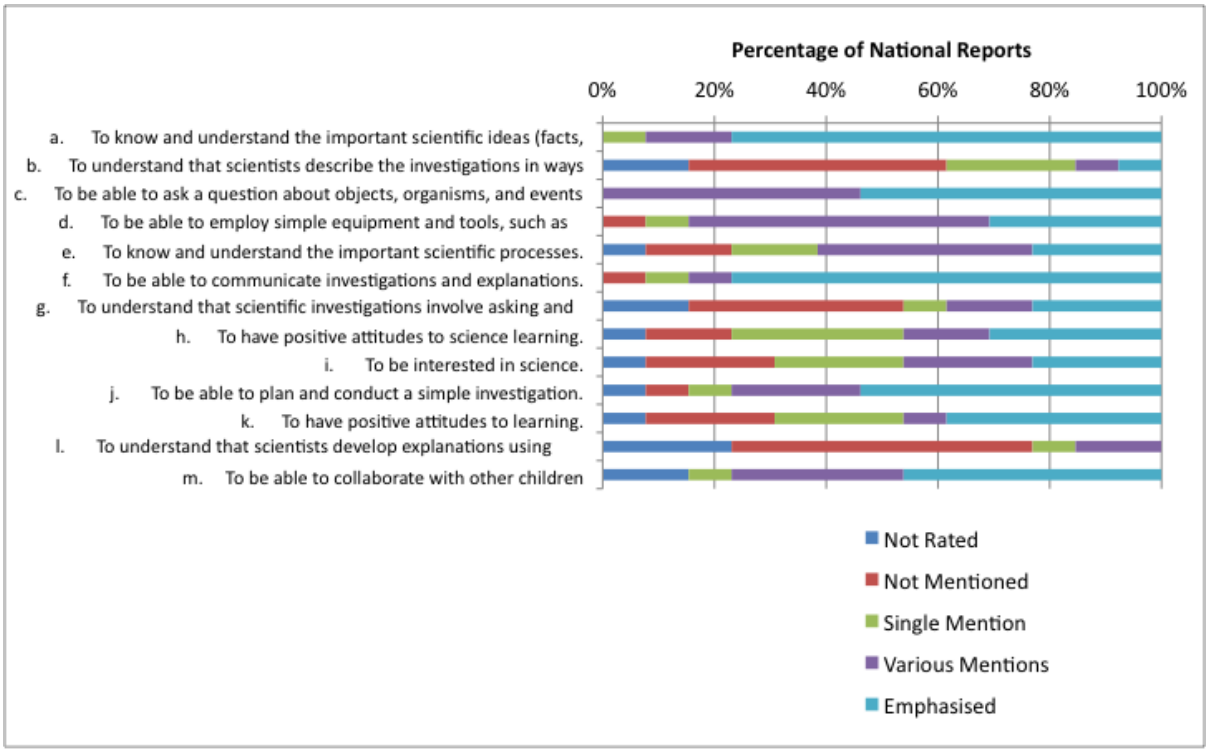

Figure 3.6: What views are indicated about the importance of the following Science learning outcomes? (Early Primary School)

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Understanding of science ideas is given considerable emphasis in both preschool and early primary phases in most partner policies. There is more varied attention to skills associated with inquiry. Questioning and communication are given greatest priority in both phases. Conducting simple investigations also feature in aims for science education in the majority of countries and more strongly in early primary school policy. In primary school, there is also greater focus on the use of equipment and knowledge and understanding of scientific processes. Other items related to knowledge and understandings associated with the nature of science are not strongly emphasised (items b, g and l) in either phase of education. Social and affective dimensions also feature in aims and objectives across partner policy. The promotion of positive attitudes to learning, interest of science and importance of collaboration are mentioned in the majority of documentation.

Commentary in the National Reports adds to this picture in highlighting some further differences between preschool and early primary school. Often aims and objectives for preschool are expressed in more experiential terms with an emphasis on the development of skills and dispositions associated with inquiry, for example questioning, observing and curiosity are mentioned in many partner policies. In primary school aims and objectives often make much greater reference to specific subject content and include a wider range of inquiry skills such as planning, reasoning and evaluation skills associated with the generation and evaluation of data; whereas obtaining data tends to be the prime focus in preschool policy (see for example policy in Finland, Germany, Greece, UK (England and Wales)).

Role for creativity

As in other areas of policy, comments in the National Reports indicate that references to creativity in aims and learning outcomes for science education are generally implicit rather than explicit in their varied emphases on social, affective and cognitive dimensions associated with the factors identified in D3.1. Figures 3.7 and 3.8 indicate the role for creativity identified by partners in the science learning outcomes set out in policy.

In partner policy in relation to preschool, the strongest links to creativity were connected with questioning, being interested in science, investigating and collaboration, all given some emphasis in the majority of partner documentation. Very limited mention of opportunities for creativity is made in relation to knowledge and understanding of scientific concepts and procedures, with a considerable number of non-rated responses in relation to items related to the nature of science (b, e, g, and l). This may be a consequence of their limited inclusion in learning objectives for this phase of education. Similar patterns were recorded in relation to aims and objectives for the early primary age phase. A role for creativity was most strongly identified with the development of skills of inquiry and social and affective factors of learning, with policy in only a minority of partner countries indicating a role for creativity in relation to the development of understandings of science ideas or the nature of science.

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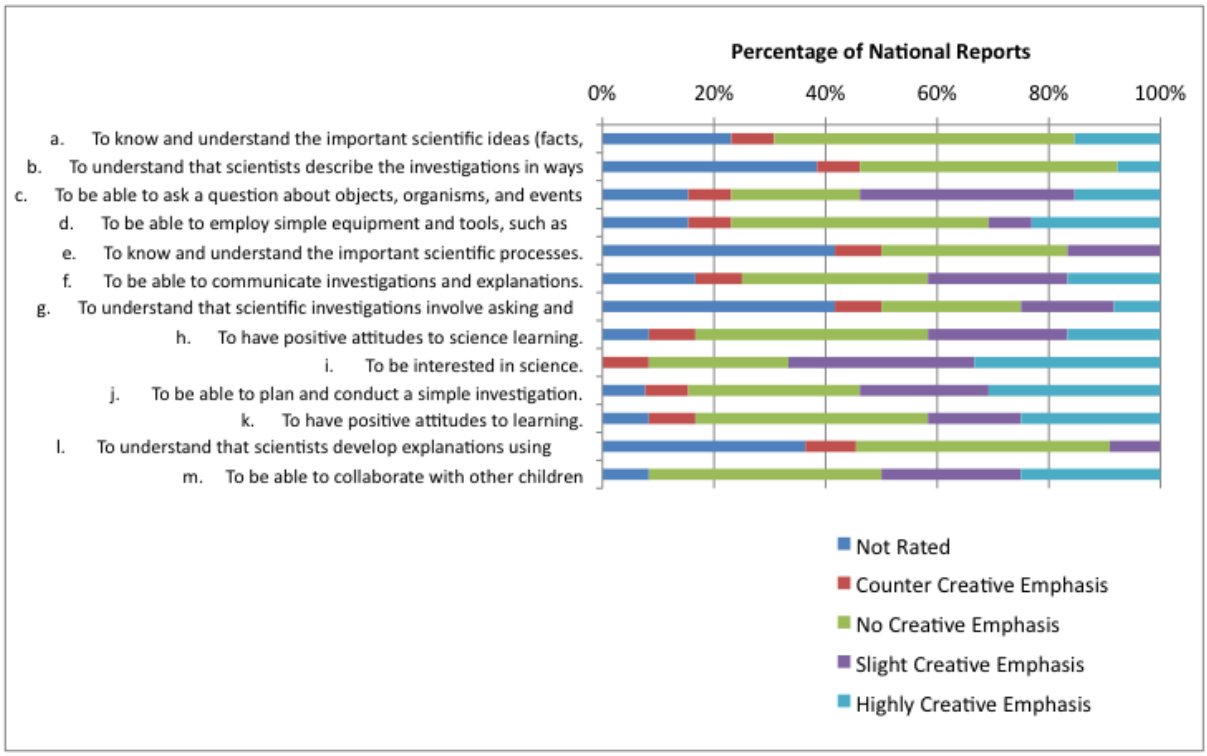

Figure 3.7: What is the emphasis, if any, on the Role of Creativity in the following Science Learning Outcomes? (Preschool)

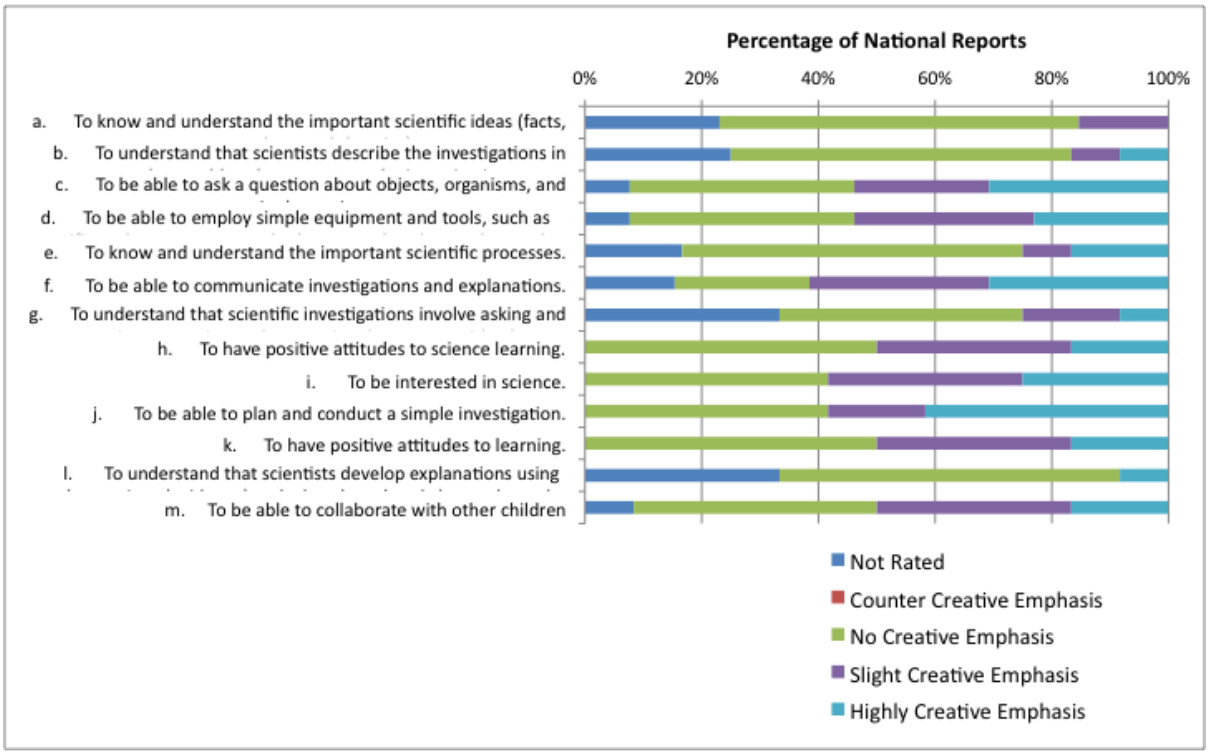

Figure 3.8: What is the emphasis, if any, on the Role of Creativity in the following Science Learning Outcomes? (Early Primary School)

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Differences between science and mathematics

In the majority of partner policies' learning outcomes for mathematics, similar reference is made to a range of skills and attitudes associated with inquiry and problem solving and to the development of social skills associated with collaboration and the communication of ideas. In contrast to science, there is often greater emphasis on subject content, in both preschool and early primary phases.

Differences between Preschool and Early Primary School

As indicated above, there are many similarities in policy for preschool and early primary school across partner countries in their focus on skills associated with inquiry, fostering children's interests and on collaboration that suggest a role for creativity. The main differences noted are in the greater emphasis in primary school on subject specific concepts and a wider range of process skills associated with the different phases of scientific inquiry. For example, in primary school processes such as planning (associated with generating ideas) or reasoning and evaluation (associated with evaluating evidence) are more commonly included alongside processes such as observing and recording mentioned across phases (Duschl, Schweingruber & Shouse, 2007).

3.2.3 Content: What are children learning?

Similarities and differences in policy

As highlighted in commentary in previous sections, a review of the National Reports suggests a number of differences in the presentation and nature of curriculum content for science in partner policy. In preschool, science is generally included within broader areas of learning such as 'Discovery of the World' (France) or 'Child and the environment' (Greece) or 'Knowledge and Understanding of the World' (UK (Wales)) and integrated cross- curricular approaches to learning and teaching are advocated. In addition, in a number of instances there is limited specification of subject specific content for science in this phase of education. The emphasis is rather on the development of skills and attitudes in the context of content selected to build on children's interests and prior experiences (for example Belgium (Flanders), France, Finland, Germany, Malta and UK (England)).

In early primary school, many countries continue to specify science within broader areas of learning (Belgium (Flanders), Finland, Germany, Greece, UK (Northern Ireland and Wales)). In others, science is presented as a separate area of learning (for example Belgium (Wallonia), France, Malta, Romania). In both cases, there is much greater emphasis on the development of specific concepts associated with learning objectives for the primary age phase. There is also variation in the ways in which skills and processes associated with inquiry are included within the content specified in policy. In some countries there are separate sections devoted to inquiry (for example UK (England) 'Scientific Enquiry' or Belgium (Flanders) 'General skills in science') or requirements may be integrated within subject content for example in Portugal 'Conducting experiments with Light' as part of the area of learning 'Discovering objects and materials'. A further approach to the inclusion of skills and processes within requirements for curriculum content is that of specifying skills and processes within cross-curricular themes and competencies (Belgium (Wallonia) or UK (Northern Ireland)) to be developed across all areas of learning.

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There are only limited references to the development of social and affective dimensions in curriculum content for primary school. In preschool, affective dimensions are given greater attention: for example curiosity is mentioned in the majority of National Reports. Other examples include references to 'aesthetic sensitivity and imagination' (Portugal) and 'motivation to learn' (Romania). Social factors are little mentioned within the content specified for particular areas of learning but often feature within generic curriculum requirements or guidance.

Role for creativity

National Reports indicate limited explicit references to creativity in policy related to curriculum content. Explicit references include for example 'develop pupils' curiosity, creativity and critical thought' (France), 'develop creative approaches to problems' (Germany), 'stimulate creative potential', 'develop creativity' (Romania)or in UK (Northern Ireland) 'learning experiences that encourage creativity'. However partners identified roles for creativity implicit in the widespread promotion of skills and experiences associated with inquiry and problem solving both in preschool and early primary school and in references to curiosity and other affective factors.

Differences between science and mathematics

In comparison to science, mathematics is more commonly set out as a distinct area of learning in partner policy at both phases of education. As in science, mathematical content specified in the curriculum includes both concepts and processes with increasing focus on concepts and higher order thinking skills across the primary school. Mathematical content of the curriculum receives greater attention in preschool in comparison to science, and in mathematics reference is often made to problem solving rather than inquiry or investigation. In general there is a similar focus on affective and social factors. Mathematics in some countries is also treated as a cross-curricular dimension (UK Wales). In Romania, the application of mathematics to general science knowledge is emphasised. This is not the case in science although generic inquiry or thinking skills for example may feature in cross-curricular dimensions.

Differences between Preschool and Early Primary School

Differences in the conception and presentation of the curriculum between preschool and early primary school vary across partner countries. In some countries, there are common frameworks for the curriculum (including curriculum domains) that apply across both phases of education, so there is continuity in approach for example in Belgium and UK (Northern Ireland, Scotland and Wales). In others, while there are separate regulations for each phase, presentation and emphases show many similarities for example in Germany, Greece and Portugal. In the remaining cases, there is a shift from curriculum content presented within broad areas of learning in preschool to specific subjects in primary school; for example in Malta or UK (England). While skills and processes related to inquiry feature strongly at both phases, in general a more specific focus on the development of concepts and on a broader range of investigative skills and processes is evident in primary curriculum content. Affective factors tend to be emphasised more strongly in preschool. At both phases social factors receive very limited attention in curriculum content. In preschool, a greater role for creativity was

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generally identified as implicit in policy, indicated for example in the common presentation of the curriculum in terms of experiences, the importance given to play and exploration building on children's interests and the greater attention to affective and social factors within curriculum content.

3.2.4 Location: Where are children learning?

Similarities and differences in policy

There was no specific section in the Policy Questionnaire focusing on where children are learning, incorporating the different settings for learning and the social and physical characteristics of the learning environments provided. However the sections that follow 3.2.6 *How is the teacher facilitating learning*? 3.2.7 *With what are the children learning*? and 3.2.8 *With whom are the children learning*?, and related information in the Policy Questionnaires and the National Reports indicate some relevant features of policy in relation to the physical and social environments provided for science learning. Key features are summarised here with any notable differences in policy related to pre-school and early primary phases of education. Reflections on the role of creativity and differences between science and mathematics are addressed in the following sections 3.2.6 to 3.2.8.

In relation to all aspects of pedagogy, across partner countries the levels of guidance vary, with very limited guidance in some instances as reflected in Table 3.2 *Curriculum Policy in Partner Countries* and in the sections that follow. In terms of the physical environment, the importance of physical exploration of materials, the provision of equipment and use of digital technologies are mentioned in policy in the majority of countries. In most cases attention is also given to the social environment with working in small groups and collaboration both featuring in guidance for both preschool and school phases of education. In terms of different settings for learning, outdoor learning is mentioned in most countries and features more strongly in preschool guidance. However, more limited attention is given to opportunities for learning offered by field trips or visits to science museums. Countries where such opportunities were particularly highlighted include France, Germany and Greece.

3.2.5 Learning activities: How are children learning?

Similarities and differences in policy

In general, decisions about learning activities are made by teachers in the light of the rationale, learning objectives and curriculum content specified for areas of learning. In all countries some form of guidance is provided about appropriate activities. This is in different forms, including suggested types of activity for each area (or theme) of learning (Portugal, UK (Northern Ireland), Greece), schemes of work (for example UK (England)), or increasingly through online resources and advice (for example in Belgium (Flanders), France, UK (Scotland)). Methodological guides are also provided in some countries related to specific areas of learning or new initiatives, for example in Belgium (Wallonia) and France related to inquiry activities, in Greece a teacher guide to support the

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implementation of curriculum reform, or in Romania for 'Environmental Education and Protection'. Generic guidance on learning and teaching approaches in a number of countries also recommends the kinds of activities and experiences for a particular phase of education. The National Reports indicate a common emphasis in policy on hands on approaches and activities linked to children's everyday lives. In preschool providing a broad range of experience and making links across the curriculum is widely recommended. In primary school greater attention is paid to the processes of scientific inquiry and scientific concepts, reflecting aims, objectives and content identified in partner policy.

Responses to the Policy Questionnaire shown in Figures 3.9 and 3.10 indicate varying emphases on different aspects of inquiry across partner countries. Observation and communication feature strongly in learning activities recommended for both phases (although they may be referred to in generic documentation to be applied across the curriculum, rather than in subject or area specific documentation). Questioning is also commonly mentioned, particularly in relation to preschool. In the majority of countries conducting investigations or projects and using simple equipment are also included in guidance provided. There is more variation in relation to planning investigations and using data to construct reasonable explanations. These activities feature more strongly in early primary school policy.

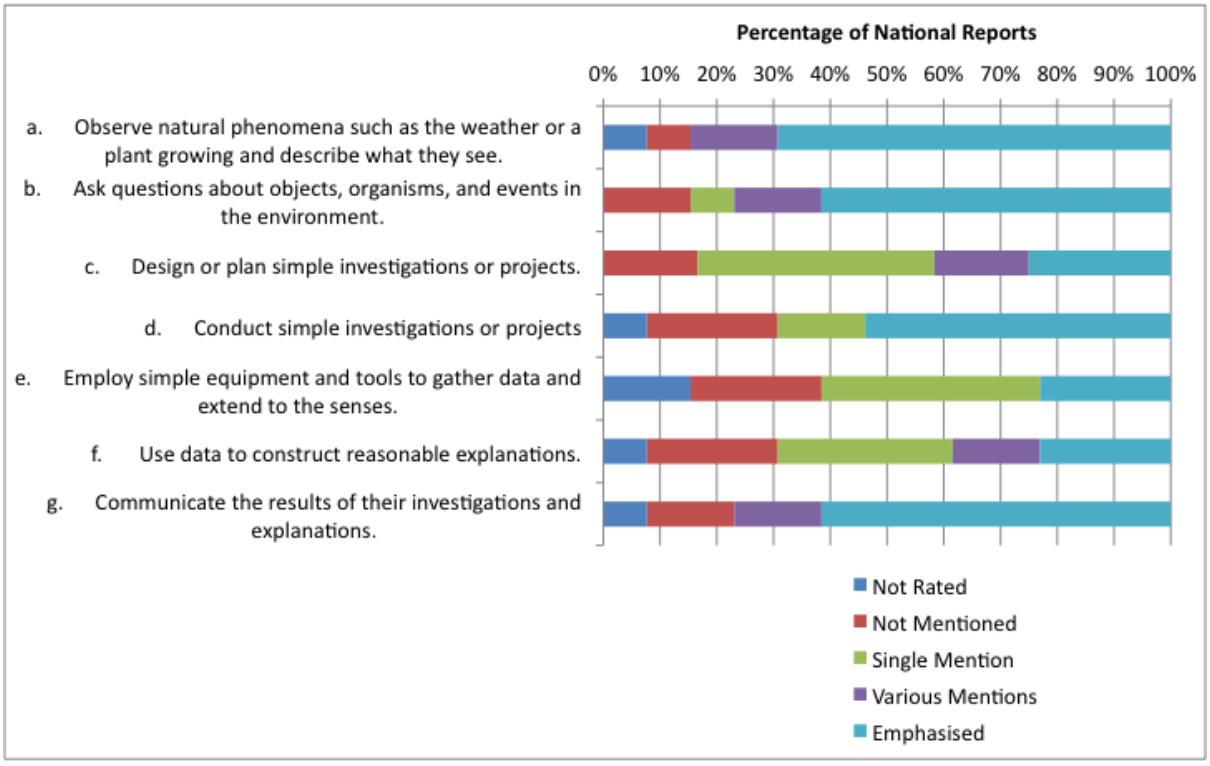

Figure 3.9: What activities are encouraged? (Preschool)

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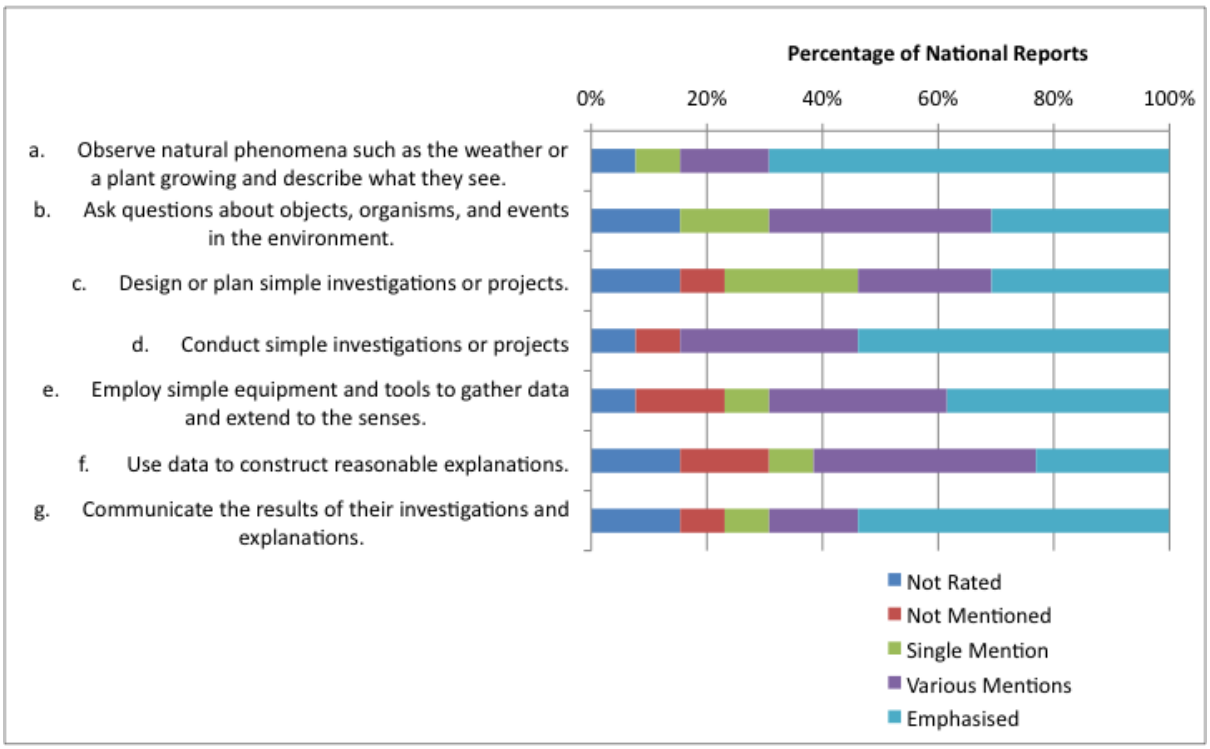

Figure 3.10: What activities are encouraged? (Early Primary School)

Role of creativity

Figures 3.11 and 3.12 summarise the roles for creativity identified by partners in the Policy Questionnaire related to learning activities recommended across policy in partner countries. Responses indicate some considerable variation, with no item emphasised across a majority of partner countries for either age phase. The activities most associated with creativity (either emphasised or mentioned) were questioning and observing in both phases, conducting investigations in preschool and planning investigations in primary school. Those least associated in policy documents with creativity were employing simple equipment (both phases) and use of data to construct explanations (in preschool). Commentary in National Reports commonly referred to the creative potential in the active learning approaches recommended in policy.

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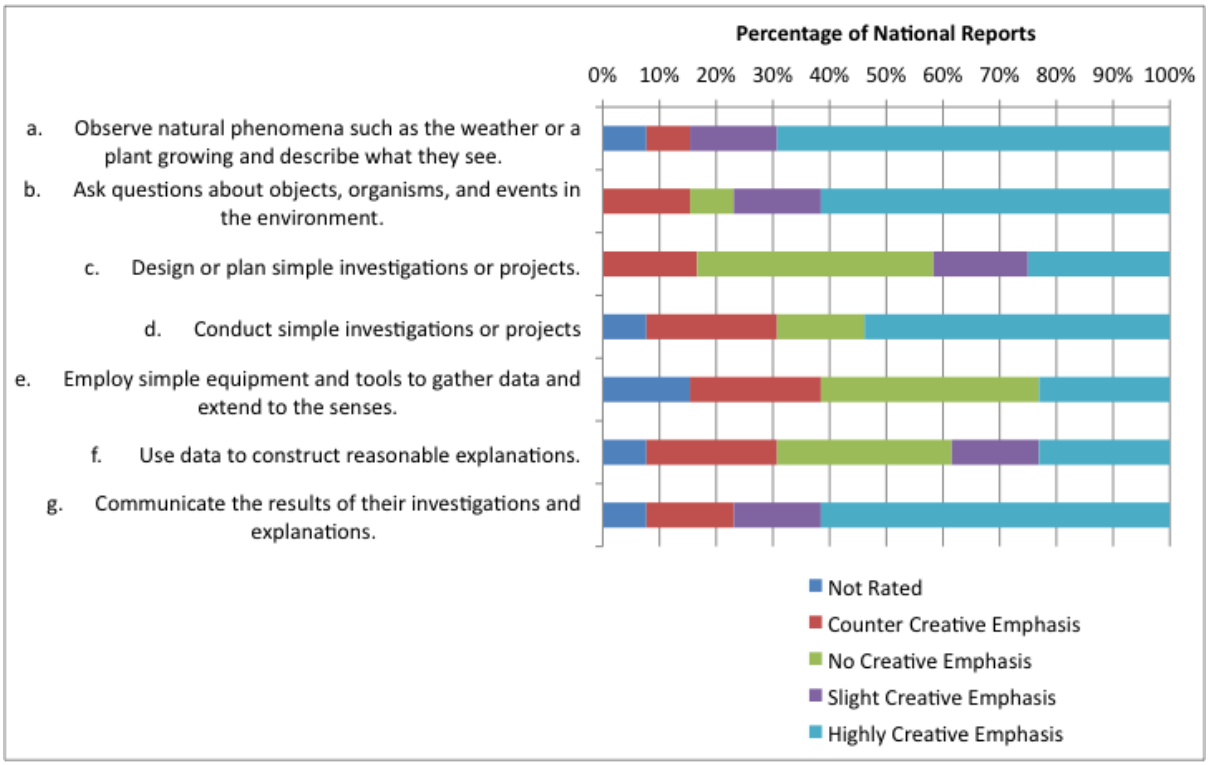

Figure 3.11: What is the emphasis, if any, on the role of Creativity in the following activities? (Preschool)

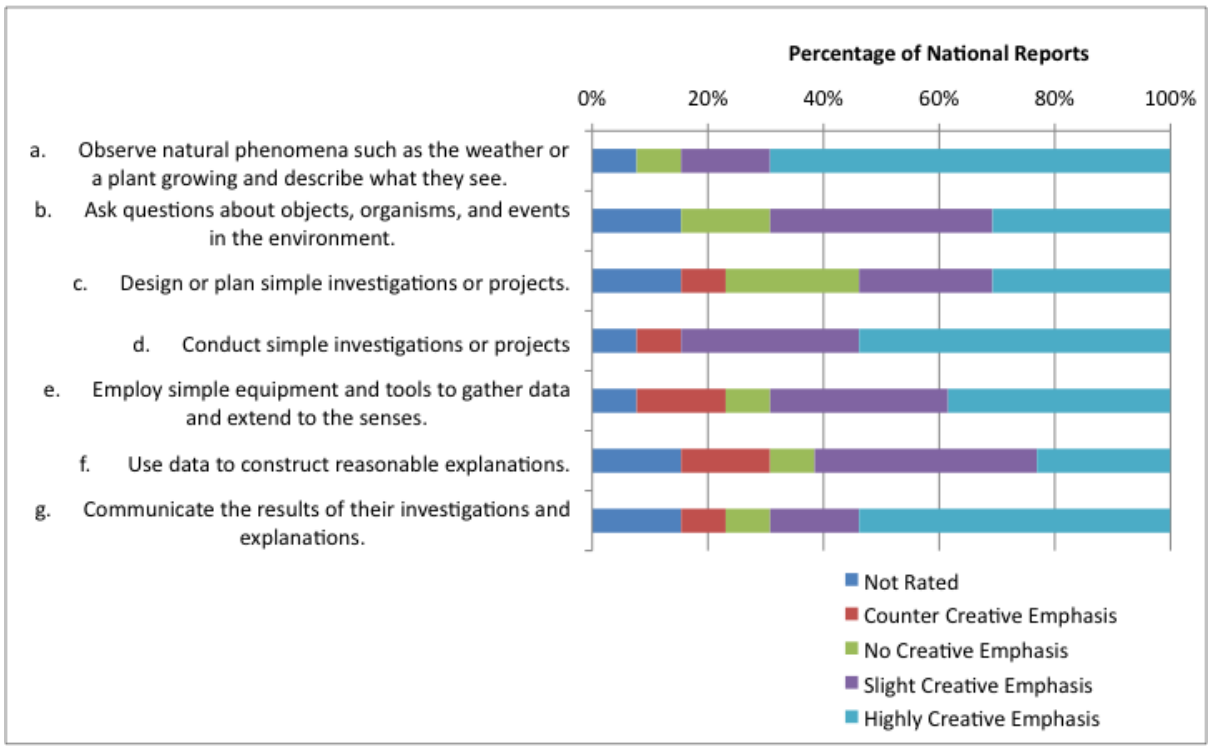

Figure 3.12: What is the emphasis, if any, on the role of Creativity in the following activities? (Early Primary School)

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Differences between science and mathematics

In many countries no strong differences were indicated between the kinds of activities suggested for science and mathematics in preschool (for example Belgium, France, UK (Wales and Scotland)). However, differences in activities suggested for early primary school were highlighted in some National Reports. For example, partners commented on greater emphasis on experimentation in science (for example Germany, Greece) and greater attention to attitudes (for example in Romania), the promotion of creativity (for example in Germany) and subject specific content (for example in UK (Northern Ireland)) in mathematics.

Differences between Preschool and Early Primary School

As indicated in earlier sections most National Reports comment on a more experiential approach in preschool and a greater emphasis on scientific concepts and procedures in learning activities recommended for the early primary age phase.

3.2.6 Pedagogy: How is the teacher facilitating learning?

Similarities and differences in policy

In common with policy in relation to learning activities, the National Reports indicate that the extent and nature of guidance in relationship to pedagogy in early years science and mathematics varies across partner countries. Guidance is provided in a range of forms and its focus may be subject specific (more common in the primary phase) or generic (more common in preschool). However in a number of countries official guidance is limited. This is reflected in the number of not rated responses in the Policy Questionnaire. The summary of findings needs to be reviewed in this light.

Responses to the Policy Questionnaire shown in Figures 3.13 and 3.14 provide an indication of similarities and differences in emphasis in the approaches advocated in policy for science in the early years.

In preschool most of the approaches listed are either emphasised or mentioned on several occasions in policy in the majority of partner countries. There is a considerable focus on play and fostering autonomous learning. Encouraging problem solving and children trying out their own ideas in investigations are emphasised in the majority of countries. Approaches given the least attention include the use of drama, stories, history, field trips and everyday experiences as contexts for learning. Fostering imagination or the discussion of alternative ideas also do not feature strongly in policy guidance. The remaining approaches are either given various mentions or emphasised in policy in the majority of countries.

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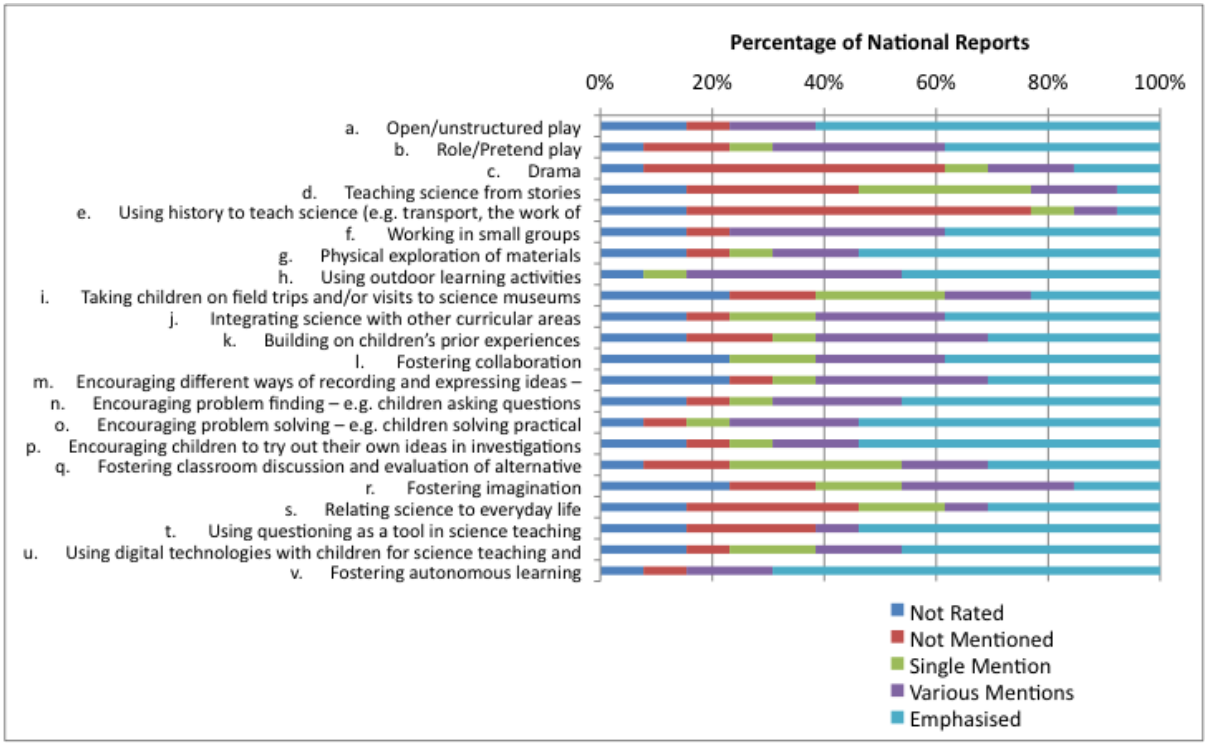

Figure 3.13: What learning/teaching contexts and approaches are mentioned? (Pre-school)

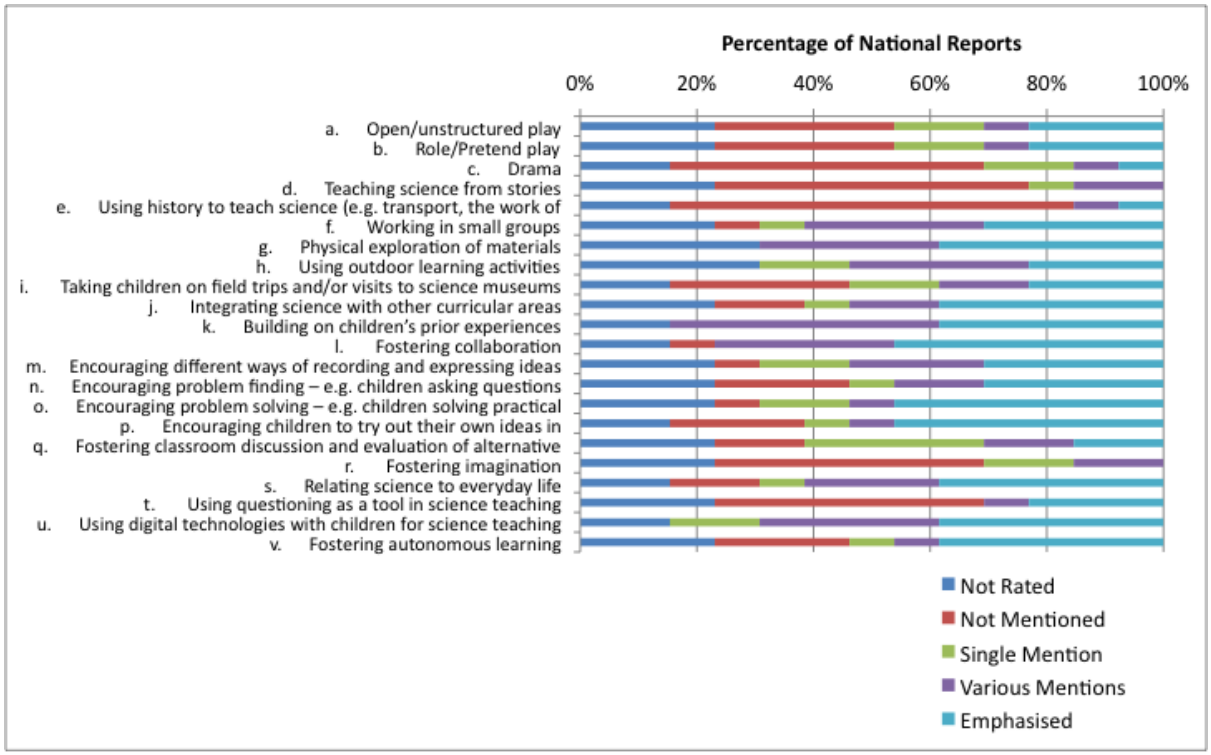

Figure 3.14: What learning/teaching contexts and approaches are mentioned? (Early Primary School)

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In relation to the early primary age phase, responses to the Policy Questionnaire indicate that overall, the range of teaching approaches listed features less strongly in policy. None of the approaches listed are emphasised in a majority of countries. Least attention is given, as in the preschool phase to drama, stories and history as contexts for learning and to fostering imagination and discussion of alternative ideas. However in contrast to preschool, more limited emphasis is also given to play, questioning and fostering autonomous learning. In relation to the remaining items, while differences across policy in partner countries are evident, all are either emphasised or given various mentions in the approaches advocated in most partner countries.

Policy across partner countries also shows varied attention to inquiry approaches as shown in Tables 3.4 and 3.5 below. In some countries and phases inquiry approaches are not discussed explicitly in policy, for example they are not addressed in both preschool and early primary policy in Belgium (Flanders) and Portugal, or in preschool policy In France and Germany. Where references are made to inquiry approaches, considerable differences are evident in the aspects of inquiry listed across countries and phases. In preschool policy, questioning, explaining and communicating feature most strongly, 'give priority to evidence' and 'analyse evidence' are also mentioned in policy in many countries. The features of inquiry least emphasised across policy are children 'connect explanations to scientific knowledge' and 'reflect on the inquiry process and their learning'. In both cases, these aspects of inquiry do not feature in policy in eight of the partner countries. The pattern in relation to early primary policy is similar with items related to 'Question', 'Explain', 'Communicate', most represented with least attention to 'Connect' and 'Reflect'.

Policy in partner countries mostly suggests open and/or guided approaches should be adopted. Generally guided approaches predominate, except in relation to questioning. Where policy exists in this area, only a small minority of countries advocate structured approaches. No strong differences are evident in relation to the level of guidance. It is notable that policy in Finland and the UK gives the greatest emphasis to open approaches for both phases of education, although both countries also recommend guided approaches.

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Table 3.4 What if any inquiry approaches are discussed? (Preschool)

	A (Open)	B (Guided)	C (Structured)	N/A
QUESTION: Children investigate scientifically oriented question	5	4	2	4
EVIDENCE: Children give priority to evidence	3	6	0	6
ANALYSE: Children analyse evidence	3	7	1	5
EXPLAIN: Children formulate explanations based on evidence	5	7	0	4
CONNECT: Children connect explanations to scientific knowledge	1	4	1	8
COMMUNICATE: Children communicate and justify explanation	3	8	1	4
REFLECT: Children reflect on the inquiry process and their learning	1	5	0	8
Other	1	0	0	1

Table 3.5 What if any inquiry approaches are discussed? (Early Primary School)

	A (Open)	B (Guided)	C (Structured)	N/A
QUESTION: Children investigate scientifically oriented question	4	8	3	3
EVIDENCE: Children give priority to evidence	4	6	0	5
ANALYSE: Children analyse evidence	4	9	2	3
EXPLAIN: Children formulate explanations based on evidence	6	7	1	2
CONNECT: Children connect explanations to scientific knowledge	2	3	0	7
COMMUNICATE: Children communicate and justify explanation	5	8	2	2
REFLECT: Children reflect on the inquiry process and their learning	2	5	0	7
Other	0	0	0	0

Role of creativity

Figures 3.15 and 3.16 indicate the role for creativity identified by partners in the learning and teaching contexts and approaches set out in policy.

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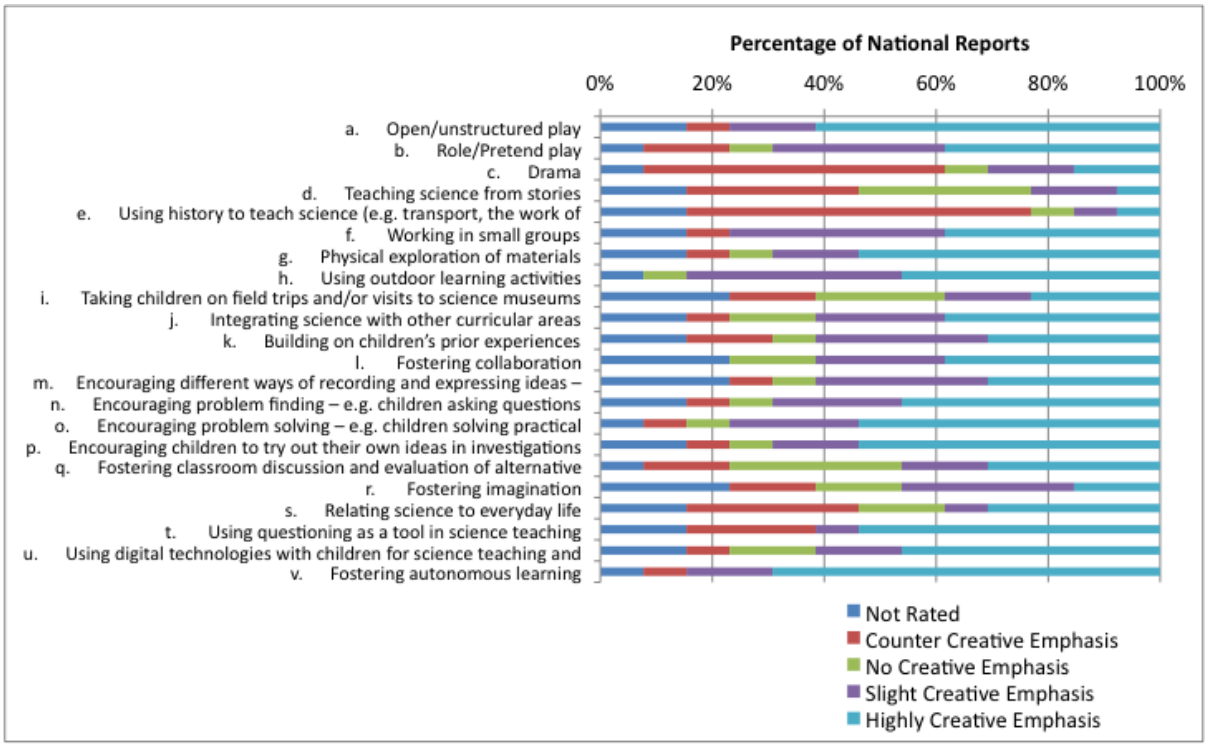

Figure 3.15: What is the emphasis, if any, on the role of Creativity in the following learning / teaching contexts and approaches? (Preschool)

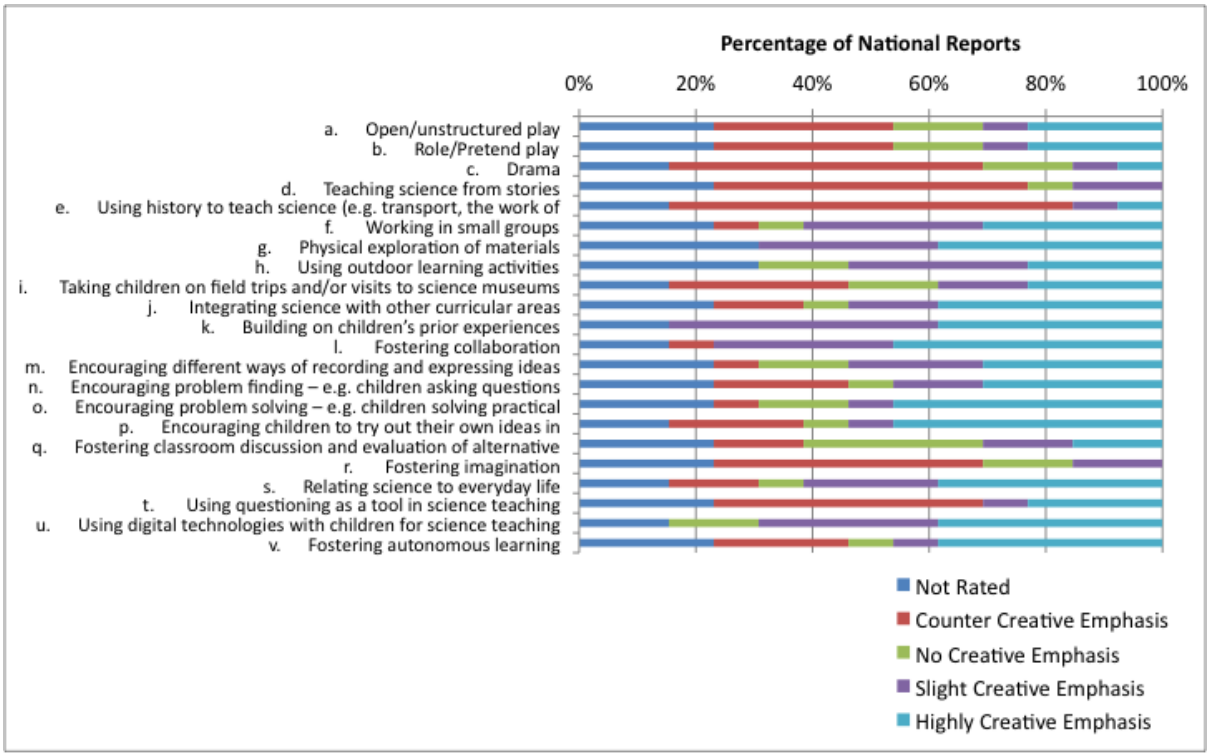

Figure 3.16: What is the emphasis, if any, on the role of Creativity in the following learning / teaching contexts and approaches? (Early Primary School)

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Responses to the Policy Questionnaire varied considerably across partner countries. Responses for the preschool phase highlight in particular the role for creativity in relation to play. This was the only item considered to have a highly creative emphasis in policy in the majority of partner countries. Other areas most strongly associated with creativity for this phase (although not in a majority of countries) were problem finding, problem solving and using questioning. The approaches judged to be given the least creative emphasis in policy were use of stories, history and field trips as contexts for teaching, building on children's prior experiences and fostering discussion of alternative ideas. Some similar patterns were evident in the evaluation of the role of creativity in policy related to the early primary age phase. There were no items that were rated as having a highly creative emphasis in a majority of partner countries, however a role for creativity was again most strongly associated with play, problem solving and children trying out their own ideas in investigations. As in preschool very low ratings were given for the use of stories, building on children's prior experiences and evaluation of alternative ideas. Group working and fostering autonomous learning were given lower rating in the early primary age phase in terms of the role for creativity. Slightly higher ratings were recorded for the use of drama and history. Comments in the National Reports indicate again very limited explicit reference to creativity. They however identify a strong implicit role for creativity in relation to opportunities for play in pre-school and problem solving in primary school.

Differences between science and mathematics

In a number of National Reports, no substantial differences were noted in approaches advocated for science and mathematics (for example France, Portugal, Romania, UK (England)). In others, some differences in emphasis were highlighted; for example in mathematics, greater attention to the development of concepts and abstract ideas (Finland), more teacher-led activity (Greece, UK (Scotland)), use of story, rhymes and songs (UK (Scotland and Wales)) and in science greater use of outdoor learning (Germany, UK (England)) and observation of phenomena (UK (Wales)).

Differences between Preschool and Early Primary School

Responses to the Policy Questionnaire and partner commentary in their National Reports suggest much greater emphasis on play, the use of questioning and the importance of autonomous learning in preschool. In comparison to early primary school, ratings of items in the questionnaire suggest more widespread promotion of a range of approaches to learning and teaching. Although as indicated in some National Reports, as children progress from preschool to school, greater attention to discussion of alternative ideas and independence might be expected. This is not reflected in the emphases identified in policy across partner countries either in relation to the range of teaching approaches or aspects of inquiry discussed in policy. The range of inquiry approaches mentioned in policy is also similar across the different phases of early years education with the greatest attention to questioning, explaining and communicating and limited reference to connecting explanations to scientific knowledge or reflection. In both phases open and guided approaches to inquiry are advocated.

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3.2.7 Materials and resources: With what are children learning?

Similarities and differences in policy

The National Reports indicate that limited advice is given about materials in many partner countries. Where advice is provided, reference is often made to equipment associated with inquiry, such as materials to explore, equipment for measuring, and digital technologies (for example Belgium (Wallonia), Finland, Germany, Greece, Romania)

National Reports also indicate a range of resources provided for teachers such as text-books (Finland, Greece) and assessment tools online (France). In France, there is an innovative project ASTEP (Accompaniment Science and Technology in Primary School) that seeks to foster the involvement of scientists in primary education to benefit both teachers and pupils in helping to portray science issues as alive and exciting.

The National Policy Questionnaires highlight materials that are given particular priority in curriculum policy documents as shown in Figures 3.17 and 3.18.

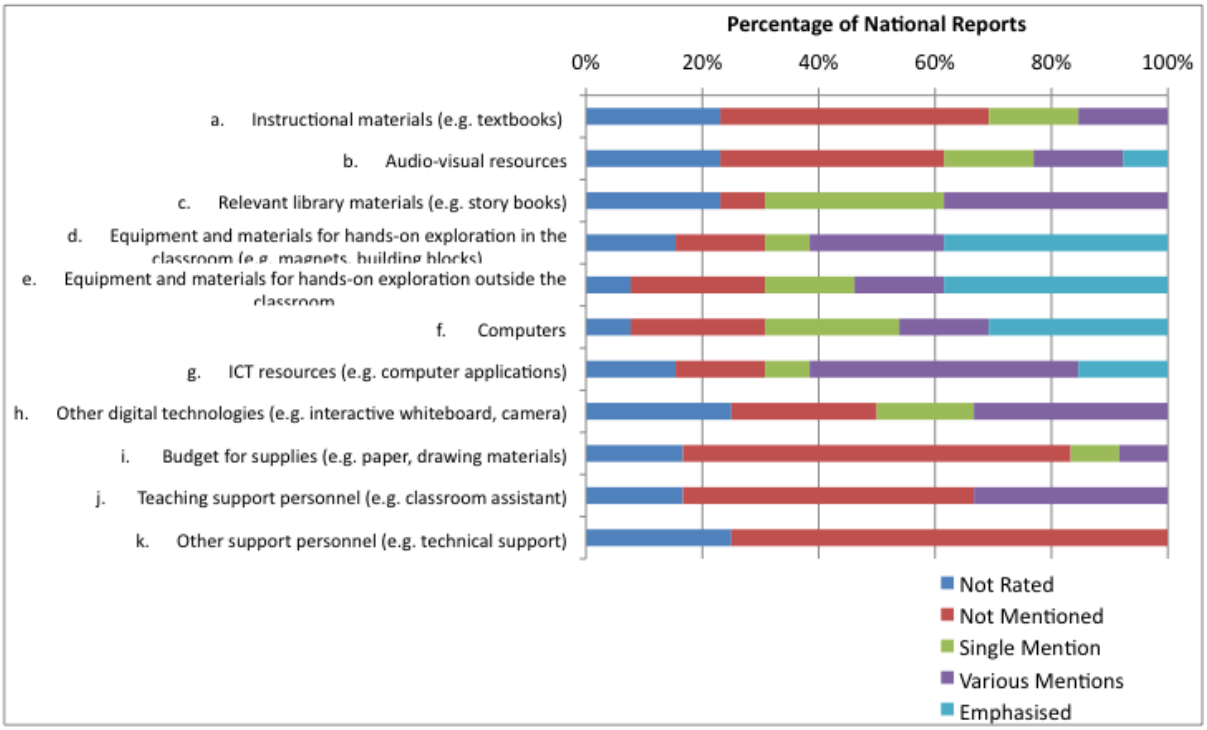

Figure 3.17: What materials are suggested? (Preschool)

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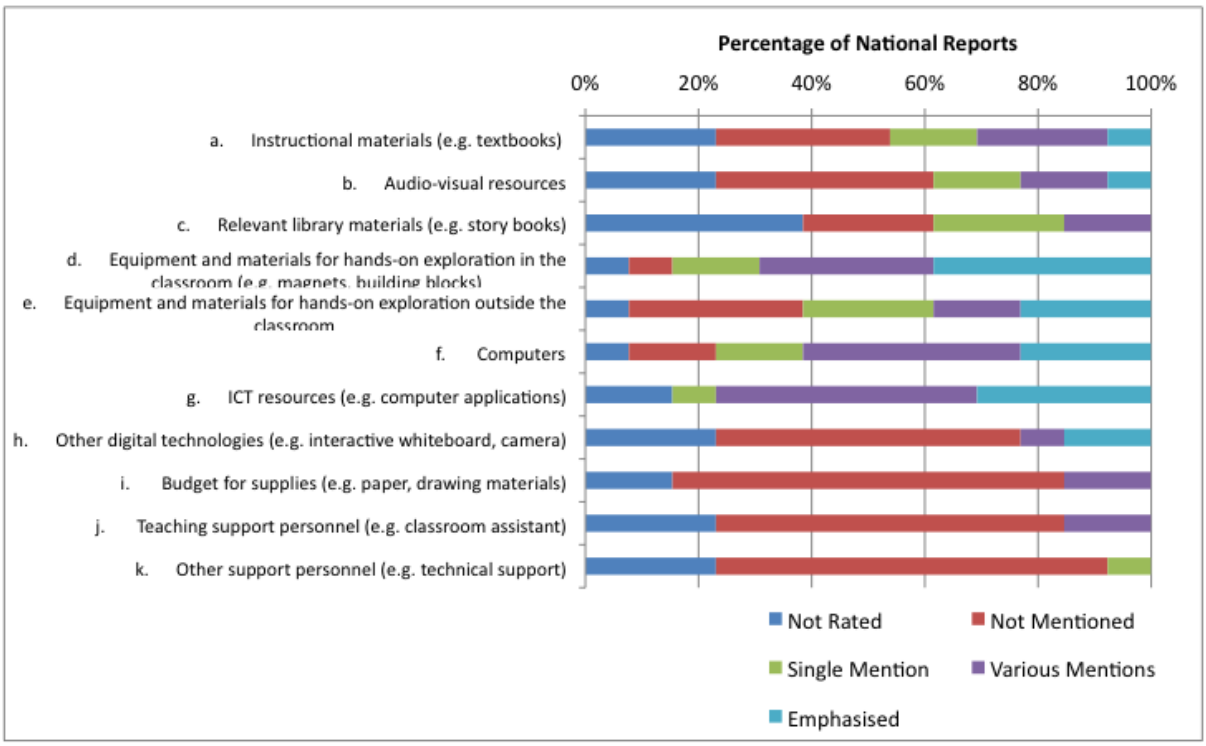

Figure 3.18: What materials are suggested? (Early Primary School)

No item is emphasised in policy in the majority of partner countries. However, equipment for hands on experience (both inside and out), computers and ICT resources are the materials most strongly featured in partner policies for science in both preschool and early primary school. In preschool, materials for exploration outside the classroom and in primary school computer resources are also given some emphasis. It is notable that there is very little emphasis on a budget or teaching or technical support for science. Emphases on instructional materials and audio-visual resources vary across partner countries. There is a greater emphasis on relevant library materials in preschool policy.

Role of creativity

In most countries no particular references to creativity are identified in relation to materials. In a few countries connections to creativity are identified in relation to affective factors for example use of materials to 'extend experience, develop imagination and possibilities of expression' (Portugal), 'choice of materials to foster curiosity and interest in science' (UK (England)) or encouragement to 'include beautiful, interesting and curious things to promote creativity' (UK (Scotland)).

Differences between science and mathematics

In general, National Reports suggest no strong differences in the guidance provided in relation to materials for mathematics. Differences identified in policy in particular countries included the more limited use of materials to support exploration and investigation in the more formal approaches to mathematics education (for example in France), greater provision for outdoor investigation in science (for example in Germany), greater detail in specific resources for mathematics education

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such as number squares, number lines, materials for shape, space and measures (for example in UK (England, Scotland, Wales)).

Differences between Pre-school and Early Primary School

Comments in National Reports indicate that there are often differences between preschool and school in the nature and extent of advice given. In some countries, greater emphasis is given in preschool guidance to materials and provision (for example in Germany, UK (England)) and in others more detailed subject-specific guidance is provided in relation to resources for early primary science (for example Finland, Greece, Portugal). This makes it difficult to summarise differences between preschool and school or identify any particular trends in policy. The Policy Questionnaire responses suggest that in both phases the materials for hand-on exploration (both inside and outside the classroom), computers and digital technologies are the materials most strongly emphasised.

3.2.8 Grouping: With whom are the children learning?

Similarities and differences in partner policy

The National Reports indicate that this is an aspect of practice where advice in policy is limited and teachers are able to make their own decisions about groupings for particular purposes. There are a number of common themes in the guidance provided. In some countries a variety of approaches are advocated in policy, appropriate for particular tasks or learning needs (for example in Finland or UK (Scotland)). The benefits of collaborative working in pairs or groups are most commonly highlighted (for example in France, Germany, Greece, Portugal and Romania). References are also made in policy guidance to opportunities for individual work (Finland, Germany, UK (Wales)) and whole class teaching (UK (England and Scotland)).

As shown in Table 3.6, responses to the Policy Questionnaire also indicate that varied approaches are advocated within and between partner countries. Small group work is emphasised most strongly.

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Table 3.6: What groupings, if any, are suggested for teaching Mathematics and Science?

	Not Mentioned		Single Mention		Various Mentions		Emphasised	
	Preschool	Early Primary	Preschool	Early Primary	Preschool	Early Primary	Preschool	Early Primary
Individual work	3	6	2	1	6	3	2	1
Pair work	5	6	2	1	3	3	3	0
Small group work	2	2	1	1	4	4	6	5
Whole class activities	6	5	0	0	5	6	3	0

Role of creativity

In a number of National Reports, implicit links to creativity are identified; for example in the use of group work in fostering 'a spirit of collaboration' (France) or the role of individual work in encouraging autonomy and self reliance (for example in Germany). In UK (Wales), connections to creativity were evident in the emphasis on dialogue and collaboration enabling 'learners to take risks without fear of self-failure'. Explicit references to creativity were also noted for example the role of individual and group projects in allowing 'the child to develop personally their expressive and creative abilities' (Portugal) or making possible both individual and team work 'to encourage creativity and initiative' (Romania).

Differences between science and mathematics

In almost all National Reports, no differences are identified in policy related to grouping in science and mathematics. The only exception is in UK (England) where previous policy associated with the National Numeracy Strategy (DfEE 1999) discussed the advantages of grouping by attainment to support the differentiation of activities to meet individual needs. In England this practice is still widely adopted in mathematics but is not common in science.

Differences between Preschool and Early Primary School

Few differences are also identified between preschool and school. Where these are noted there are no common patterns across countries. For example in a few instances commentary in National Reports suggests greater emphasis on group work in one phase; for example greater emphasis in pre-school (for example in Greece, Portugal) while in others, greater emphasis on group work in primary school was noted (for example in Germany).

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3.2.9 Time: When are children learning?

Similarities and differences in policy

Table 3.7 below summarises policy requirements across partner countries in relation to the amount of time allocated teaching mathematics and science.

Table 3.7 How much time should be planned for teaching mathematics and science per week?

	Science		Mathematics	
	Preschool	**Early Primary**	**Preschool**	**Early Primary**
Less than an hour				
1-2 h		3 +		
3-4 h		2 +	2	5
More than 4 h				2 +
N/A (Please explain)	13*	11*	11*	8*+

* In almost all instances N/A was selected, as there are no specific time allocations in policy.
+ in Germany time allocation differs between Lander so two choices were selected. Note also that the time allocated for science is within the broader area of 'Social studies and Science'.
In Romania the time allocation is 4/5 hours for combined mathematics and science.

As can be seen from the table, in almost all countries there are no specific time requirements for either science or mathematics in preschool. The exceptions are in Romania where there is a requirement of 4/5 hours of teaching combined mathematics and science and in the UK (England and Northern Ireland) where daily mathematics teaching is advocated. In the early primary age phase, again in many countries there are no set requirements for the time to be allocated to science teaching each week. In Germany, Finland, France and Malta there are specific time allocations for science. As in preschool, in Romania, 4/5 hours of combined mathematics and science teaching are required and there are more specific recommendations in relation to the time to be spent on mathematics. Seven countries recommend a specific time allocation (Finland, France, Germany, Malta, UK (England and Wales)).

Differences between science and mathematics

In preschool policy, the differences between science and mathematics are limited. In the majority of countries there is no specific time allocation for both subjects. In two countries there are time allocations for mathematics only. Differences are more apparent in the early primary age phase where policy guidance in relation to time allocation is more common for both subjects but a greater number of countries set specific time requirements for mathematics in comparison to science.

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Differences between Preschool and Early Primary School

In most countries there are no specific time allocations for science and mathematics in preschool. As indicated above, in primary school specific time allocations in policy are more common, particularly in mathematics.

3.2.10 Assessment: How to measure how far children's learning has progressed, and how is s/he using this information to inform planning and develop practice?

Similarities and differences in partner policy

While assessment is an increasing focus of policy internationally and in partner countries, the National Reports indicate considerable differences in assessment policy across partner countries and phases of education. In some instances, decisions about priorities and approaches in assessment are left to teachers; although guidance may be provided in relation to methods or criteria. (Examples include pre-school policy in Finland, France, Germany, Greece and UK (Scotland)). In other countries, statutory assessment criteria or requirements are set at national level, for example for early primary school in France, Portugal, Romania and UK (England and Wales).

In a number of partner countries, national assessments and tests are used to monitor standards and evaluate school effectiveness. For example in Belgium (Flanders) national sample surveys are carried out of children's attainment. In France there are statutory diagnostic assessments to be undertaken at the end of each cycle of education and in the UK (England and Wales) national testing in mathematics at the end of each stage of education. In Germany, national standards and testing have recently been introduced for mathematics.

In the Policy Questionnaires varied purposes of assessment are identified in policy related to assessment in preschool and early primary school across partner countries (Figure 3.19 and Figure 3.20).

In preschool education, the most common purposes either emphasised or mentioned on various occasions in the majority of partner countries are to inform parents and monitor progress against learning outcomes. Assessment to improve children's learning is also given some emphasis in policy in a number of countries. Assessment for grouping for instruction and for setting targets with children are purposes given the most limited emphasis. The other items related to the use of assessment, to support improvement in the curriculum or teaching, for providing feedback to children and monitoring year on year progress of individuals are all emphasised in only a small number of partner countries. Similar patterns are evident in the purposes noted in policy for the early primary phase. Identifying ways to improve science learning is given greatest priority alongside monitoring progress against learning outcomes and informing parents of children's progress. In comparison to preschool, greater priority is given to providing feedback to children. In common with preschool assessment to inform grouping or for setting targets with children is little emphasised.

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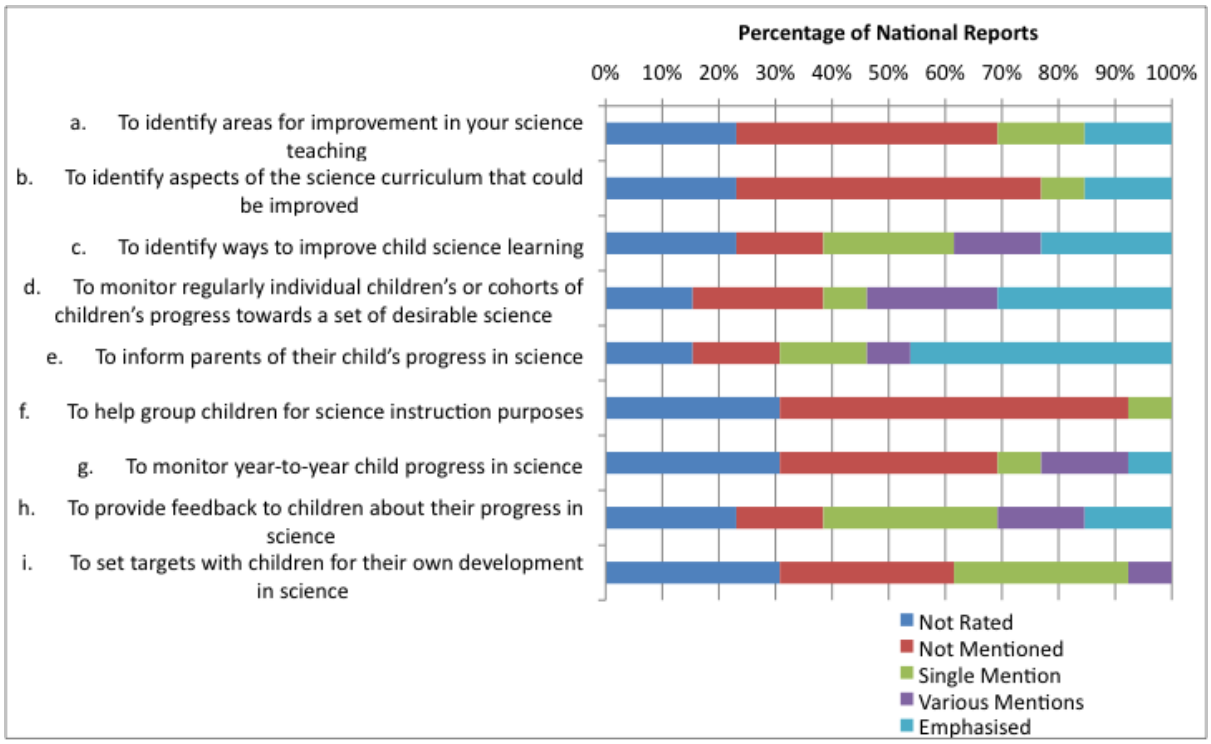

Figure 3.19: What purposes of assessment are included? (Preschool)

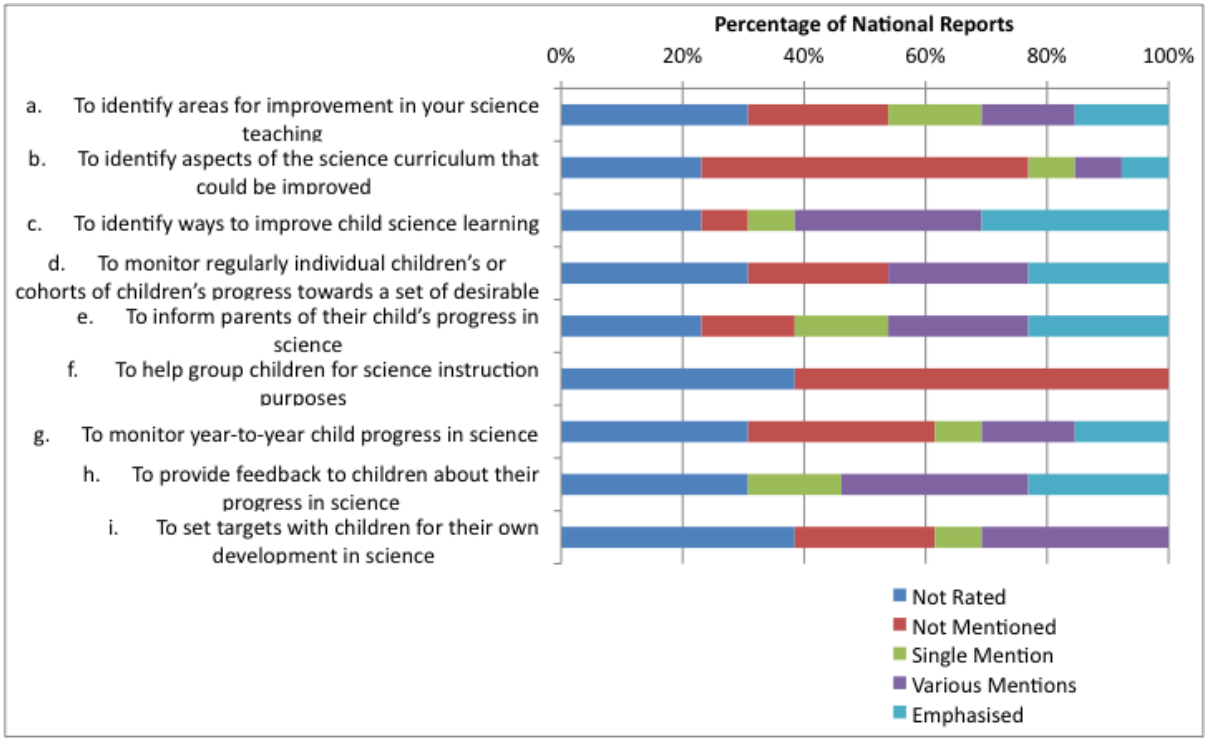

Figure 3.20: What purposes of assessment are included? (Early Primary School)

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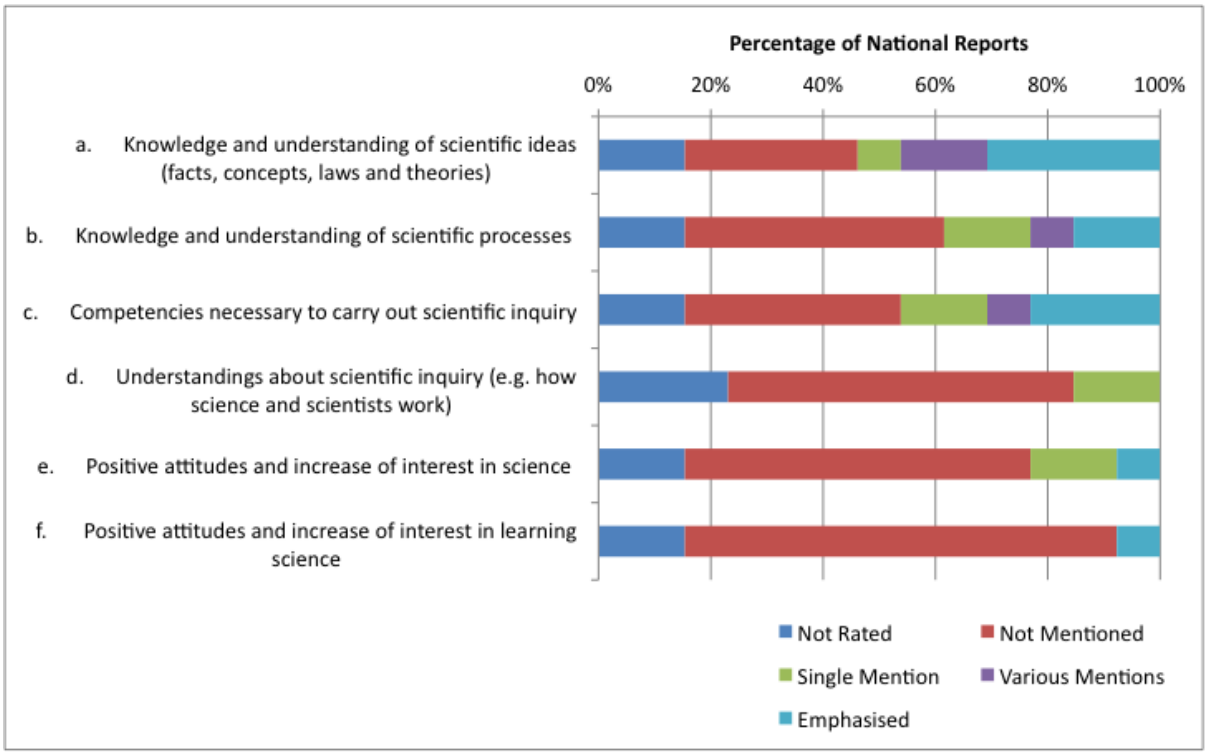

Figure 3.21: What importance is given to the following priorities for children's assessment in Science? (Preschool)

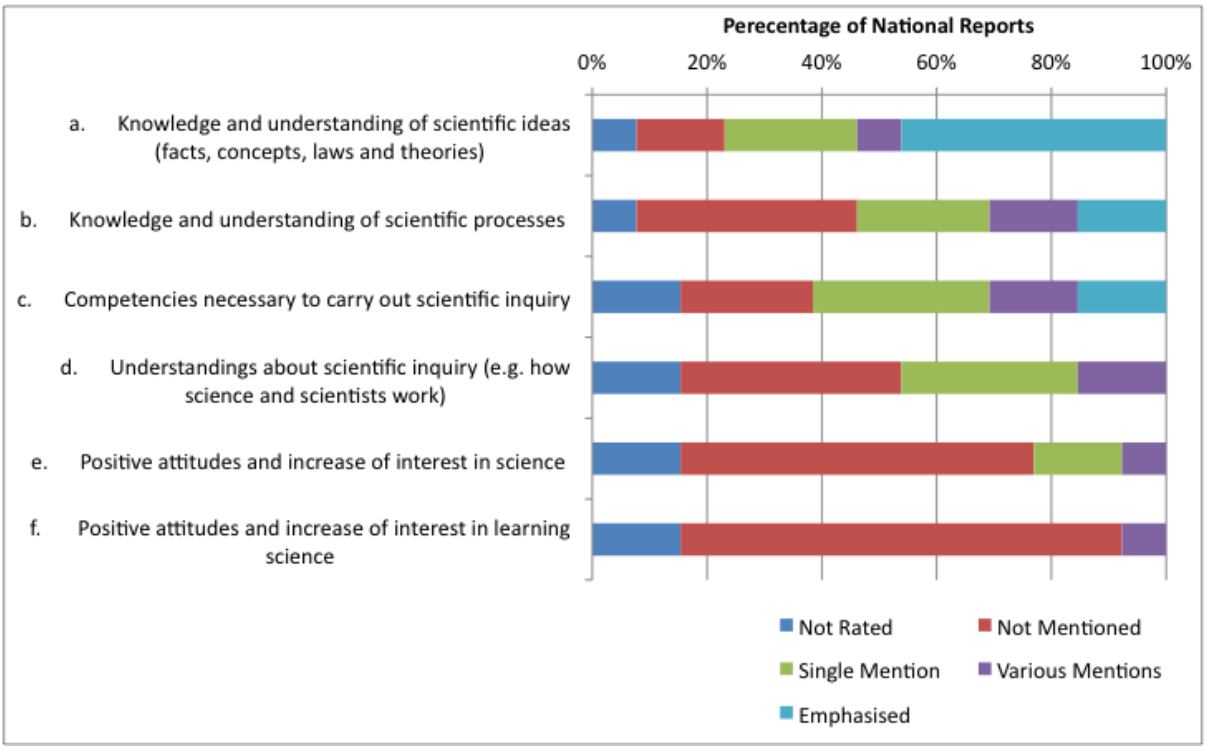

Figure 3.22: What importance is given to the following priorities for children's assessment in Science? (Early Primary School)

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As indicated in Figures 3.21 and 3.22 above, the Policy Questionnaires also indicate variation in the priorities identified for science assessment in partner countries. No item is emphasised in a majority of countries. Knowledge and understanding of ideas is given greatest priority for assessment in both phases, and greater priority in early primary than in preschool across partner countries. Knowledge and skills associated with scientific processes also feature strongly in some countries. More limited focus on attitudes is indicated and attitudes feature as a priority for assessment more strongly in preschool than in primary school. Assessment of understandings about science inquiry is mentioned in only a few countries.

Figures 3.23 and 3.24 below indicate the ways of assessing emphasised in policy across partner countries. Policy across partner countries provides limited specific guidance in this area reflected in the number of not rated or single mentions recorded in partner questionnaires. In preschool use of checklists to record observations, classroom interaction and portfolios feature most strongly. They are also represented, but with more limited emphasis, in policy at primary level. Asking children to reflect on their progress is also an approach mentioned in some countries – more strongly at primary level. However there was little reference to children correcting each other's work and giving each other feedback. Other items were also represented to a limited extent in partner policy.

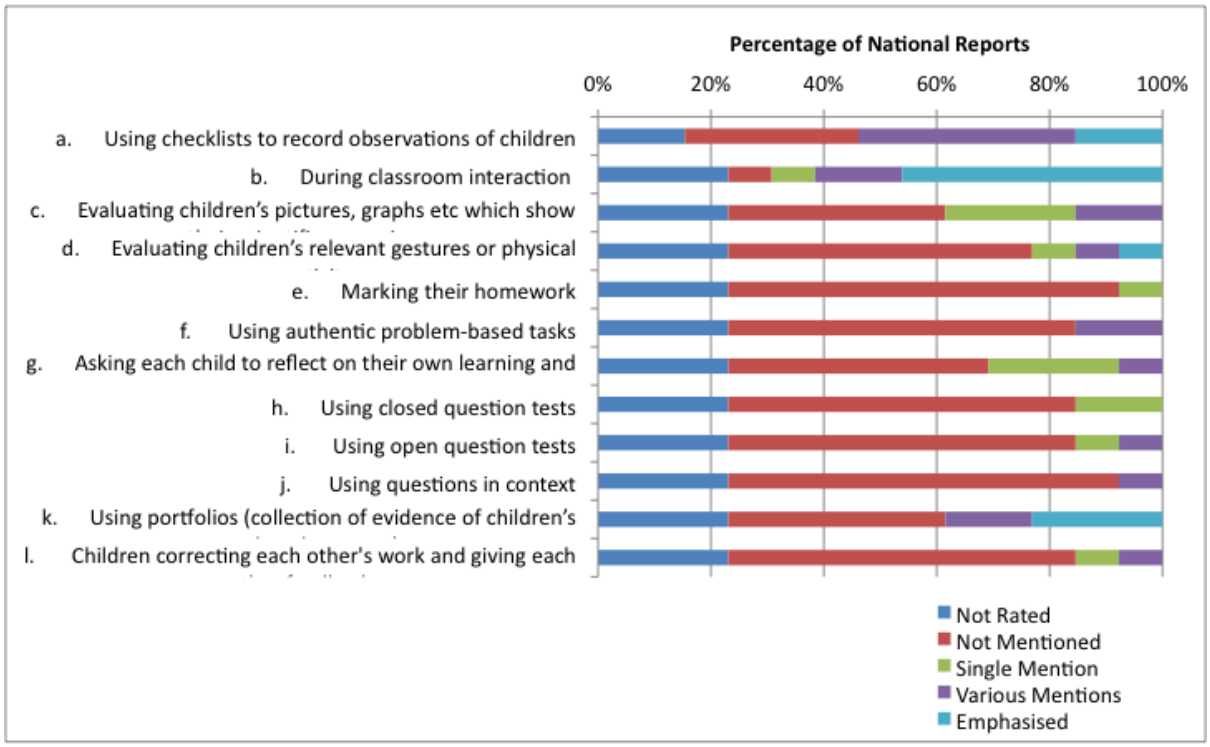

Figure 3.23: What ways of assessing are advocated? (Preschool)

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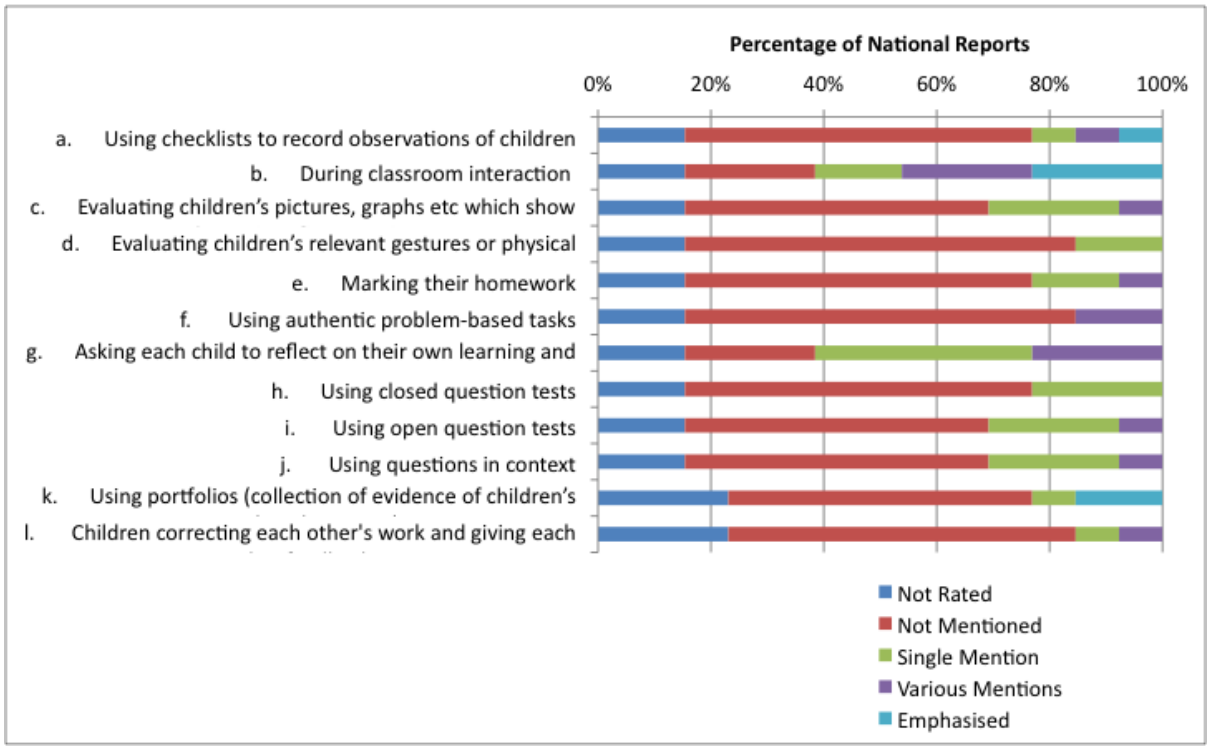

Figure 3.24: What ways of assessing are advocated? (Early Primary School)

Figures 3.23 and 3.24 above indicate the ways of assessing emphasised in policy across partner countries. Policy across partner countries provides limited specific guidance in this area reflected in the number of not rated or single mentions recorded in partner questionnaires. In preschool use of checklists to record observations, classroom interaction and portfolios feature most strongly. They are also represented, but with more limited emphasis, in policy at primary level. Asking children to reflect on their progress is also an approach mentioned in some countries – more strongly at primary level. However there was little reference to children correcting each other's work and giving each other feedback. Other items were also represented to a limited extent in partner policy.

Role of creativity

Figures 3.25 and 3.26 indicate the extent to which creative attributes are addressed in assessment policy.

Responses to the Policy Questionnaire suggest that there is limited representation of creative attributes and in assessment policy across partner countries, indicated in the high number of not rated or not mentioned responses in partner questionnaires. In terms of the creative attributes identified in partner policy, thinking skills feature most strongly. In the early primary age phase these are mentioned in the majority of countries. The other most common creative attributes emphasised or mentioned include curiosity (greater emphasis in preschool), ability to work together (greater emphasis in primary) and ability to make connections with learning in other subjects.

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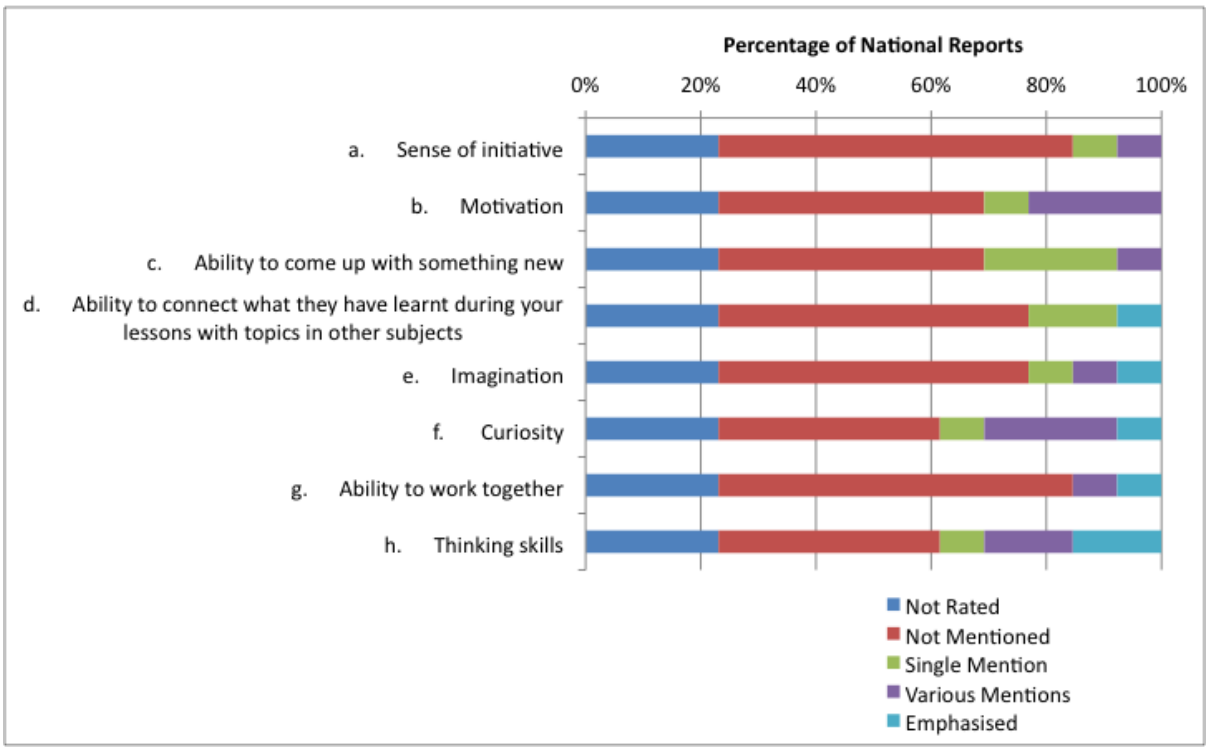

Figure 3.25: What Creative attributes are addressed in assessment? (Preschool)

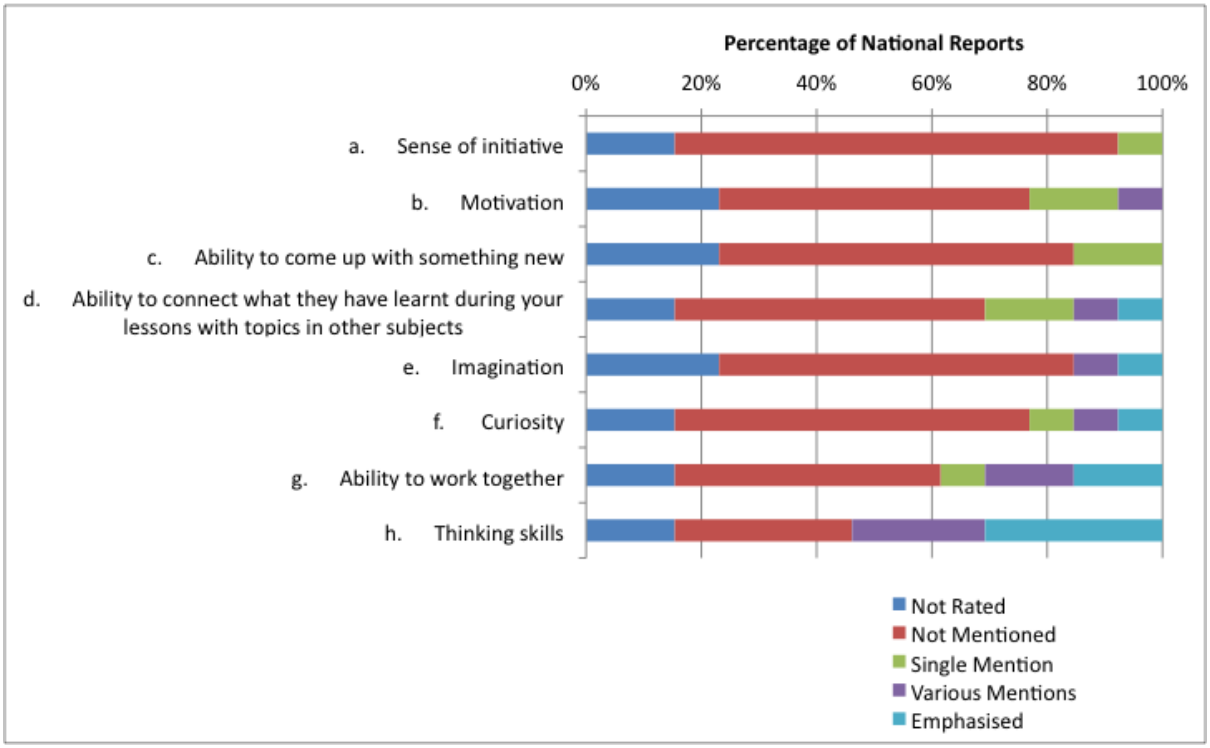

Figure 3.26: What Creative attributes are addressed in assessment? (Early Primary School)

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In terms of the purposes and methods of assessment, in the *Conceptual Framework* (D2.2) the involvement of children in assessment and the use of multimodal approaches were highlighted as important features of creative approaches to teaching in science and mathematics. These features are not represented strongly in policy across partner countries. In relation to the purposes of assessment, there is some emphasis on feedback to children but limited mention of setting targets with children. The ways of assessing advocated in policy across partner countries give limited attention to asking children to reflect on their own learning and very little to children correcting each others' work. Many of the varied approaches to assessment listed in the questionnaire are only mentioned in policy in a very small minority of countries. In part this reflects the limited guidance provided in policy to support assessment.

Differences between science and mathematics

National Reports indicate limited differences in assessment policy in preschool. In primary school, one key difference in some countries is the requirement to test children in mathematics (for example in France and UK (England, Northern Ireland)) another noted by a number of partners is the greater focus on knowledge and understanding of facts

Differences between Preschool and Early Primary School

The National Reports indicate differences in assessment policy between preschool and early primary school across partner countries. One common difference between preschool and early primary school is the much greater extent of guidance and regulation related to assessment in the early primary age phase, particularly in specific learning goals or criteria provided for assessment and in national and statutory requirements for assessment and testing. The Policy Questionnaires also suggest some differences in emphasis in the purposes, priorities and ways of assessing advocated in policy. In the early primary phase there is greater focus on improvement in children's learning and the provision of feedback. In terms of priorities for assessment, there is greater attention to knowledge of understanding of scientific ideas in the early primary phase and a stronger focus on the development of attitudes in preschool. Limited guidance is provided on ways of assessing for either phases of education. Where guidance is provided, there was some indication that a broader range of assessment approaches is advocated in preschool.

3.3 Approaches to teacher education

The survey of policy in relation to teacher education builds on the literature review and information obtained from an initial review of policy in partner countries undertaken for Task 2.4 Teacher Education (see D2.2 *Conceptual Framework Addendum 3 of 4: Literature Review of Teacher Education*).

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3.3.1 Initial teacher education

Table 3.8 below summarises some general features of teacher education programmes for preschool and primary education associated with the length and levels of training, associated entry requirements and providers of training.

What is the level of training?

Training in most partner countries is at Bachelor or Masters level in accordance with EU frameworks - exceptions are Malta and Germany where training for pre-school education is provided at Diploma level. However policy is in the process of change. In Malta the intention is that by 2015 all teachers will have a degree. In Germany, policy varies according to the different federal states. In some states training at University level is beginning to be introduced although currently only 3% of kindergarten teachers have received academic training. In some partner countries training is at Masters level for example in France, Portugal and Finland (primary only). Again policy is the process of change with Malta and Belgium (Flanders) considering the provision of teacher education at Masters level.

In all the countries of the UK, there are two possible training routes, either a degree in education with Qualified Teacher Status, or a degree in any subject followed by a one year course of teacher training leading to either a Professional or Postgraduate Certificate in Education. The Professional Certificate is at Bachelor level. Programmes leading to a Postgraduate certificate include modules that award Masters level credits that can contribute to a Masters degree.

What is the length of training?

The length of training in partner countries generally varies from three to five years. A longer period of training often associated with the award of qualifications at Masters level.

What kinds of institutions are authorised to provide training?

The majority of cases training programmes are linked to Universities. In some partner countries there has been a shift to Universities from teacher training schools or colleges. In the UK, varied school-based routes for postgraduate training are being introduced.

What are the entry requirements?

Entry requirements focus on examination performance in secondary education. In some partner countries there are specific requirements in relation to particular subjects for example in Malta (Mathematics, English, Maltese) or UK (England and Wales) (English, mathematics and science). In the case of postgraduate programmes in UK (England and Wales) applicants also need a good degree.

In a number of partner countries there may also be additional entrance tests or examinations (Finland, France, UK (England and Wales), Portugal). Interviews to assess suitability for teaching are employed in some partner countries (for example Belgium (Wallonia), Finland, Romania, UK (England and Wales)). In Malta interviews are conducted in the case of students applying under the

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maturity clause. Previous experience in schools may also be required as for example in Germany and UK (England and Wales).

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Table 3.8 Teacher Education programmes in partner countries – key features

Partner Country	Phase of education	Length of training	Degree	Institution(s)	Entry requirements
Belgium (Flanders)	Early childhood and primary	3 years	Bachelor	University colleges	Anyone who has a Diploma of secondary education
Belgium (Wallonia)	Pre- primary and primary	3 years	Bachelor 'section normale préscolaire' or 'section normal primaire'	Haute écoles	Upper secondary education certificate or equivalent, or Special exam for admission to engineering science or admission exam organised by a university. Some 'haute écoles' also arrange interviews to assess motivation and suitability.
Finland	Early childhood education	3 years	Bachelor	University	Matriculation examination and passed entrance examination (written test and interviews)
Finland	Primary education	5 years	Master	University	Matriculation examination and passed entrance examination (written test and interviews)
France	Early childhood education	5 years	Master	First three years university; last two years -''University Institutes of Teacher education'' IUFM (which will be gradually integrated into the universities).	Students must have the degree of 'Licence' obtained after the first 3 years of university study. After entrance to the IUFM is through examination.

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Partner Country	Phase of education	Length of training	Degree	Institution(s)	Entry requirements
France	Primary education	5 years	Master	First three years university; last two years -''University Institutes of Teacher education'' IUFM (which will be gradually integrated into the universities).	Students must have the degree of 'Licence' obtained after the first 3 years of university study. After entrance to the IUFM is through examination.
Germany **Varies from State to State**	Early Childhood education	Minimum 3 years up to 5 years	National diploma or Bachelor in Childhood Education	Specific Berufsschulen (vocational schools) includes 2 years internship in kindergarten. New in some federal states: University	Either lower secondary school level 1 or level 2 certificate plus vocational training. General upper secondary school certificate 'Abitur' for university studies. Seldom entry examinations or personal interviews.
Germany **Varies from state to state**	Primary education	Minimal 5 and a half years	State examination for accreditation as primary school teacher (or in some states Bachelor or master degrees e.g NRW) followed by practical training	Two consecutive phases 1st phase – University, degree: bachelor/master or 1st state examination 2nd phase -Teacher training colleges and schools 2nd State examination (needed by all primary teachers regardless of degree gained in 1st phase)	Final secondary school examination 'Abitur'. Often internship at a school (e.g. Hesse and North Rhine Westphalia (NRW)).
Greece	Early childhood and primary	4 years	Bachelor	State University	Pan-hellenic examinations following completion of primary education.

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Partner Country	Phase of education	Length of training	Degree	Institution(s)	Entry requirements
Malta	Early Childhood education 2 to 8 years	2 years full time 5 years part-time	BTEC - National diploma Bachelor	University of Malta	For MCAST-BTEC Diploma in Children's Care – Diploma in Health and Social Care or 4 Sec/O level passes including English language, Maltese and Mathematics. For MCAST-BTEC Higher National Diploma in Advanced Study in Early years Diploma in Children's care plus O level passes English Language, Maltese and Mathematics OR 2 A level and 2 1 level passes – including Mathematics, English and Maltese. For Bachelor degree in Early Years see requirements for primary below.
Malta	Primary education 5 to 11 years	5 years part -time	Bachelor	University of Malta	General entry requirements – Matriculation certificate and Secondary Education Certificate passes at Grade 5 or above in Maltese English Language and Mathematics. Special course requirements - one Advanced Level pass at grade C or better, 2 passes at intermediate level grade C or better, passes in proficiency tests in English and Maltese (or their equivalent). Certificate or logbook showing pass in all 7 European Computer Driving Licence modules. Interviews may also be used for selection for mature students.

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Partner Country	Phase of education	Length of training	Degree	Institution(s)	Entry requirements
Portugal	Early childhood and primary education	5 years 3 years – degree + 2 years - Masters	Master	University and Higher Education Schools	Pass in upper-secondary education course or legally equivalent qualification. Minimum mark of 95/200 in entrance exams for the course plus other pre-requisites for particular courses/institutions.
Romania	Pre-school and primary education (new regulations)	3 years	Bachelor	University	Baccalaureate (higher school examination) degree. Different criteria established by each institution concerning marks obtained in Baccalaureate examinations or a subject test (e.g. Psychology, linguistic competence in foreign language, physical education). Interviews to assess communication skills and motivation.

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Partner Country	Phase of education	Length of training	Degree	Institution(s)	Entry requirements
UK (England and Wales)	Early childhood and primary education	3 or 4 years	Bachelor or Master All teachers must have a degree and Qualified Teacher Status (QTS) gained through Bachelor degree in education with QTS or Bachelor degree (3 years) followed by either Professional Graduate Certificate in Education (PGCE) (Bachelor level – 1 year) or Postgraduate Certificate in Education (Master level credits) or school-based training.	University – in varied partnerships with schools Routes for school-based training are being expanded where following their degree they gain QTS through a programme of experience in school. Assessment of QTS is usually carried out in conjunction with a Higher Education Institution.	For all programmes Grade C or equivalent in English, mathematics and Science. Entrants after 1 August 2013 will also need to have passed QTS professional skills tests in literacy and numeracy. In addition – rigorous selection processes to assess suitability to teach, Criminal records check and fitness to teach test. For undergraduate programmes at least 2 passes at A level (but varies according to institution) For graduate programmes first degree of UK higher education institution or equivalent qualification.
UK (Northern Ireland)	Pre-school and primary education	4 years	Bachelor 4 years BEd degree or 3 years degree followed by 1 year Postgraduate Certificate in Education (PGCE)	University	Minimum of 2 A levels plus 3 GCSEs for BEd courses Undergraduate degree for PGCE

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Partner Country	Phase of education	Length of training	Degree	Institution(s)	Entry requirements
UK (Scotland)	Nursery (3-5) and primary education (5-12)	4 years or 1 year	The four year Bachelor of Education (BEd) degree course in Primary Education or the one-year Professional Graduate Diploma in Education (PGDE) course.	University – in varied partnerships with schools	For BEd - 3 Higher grades, one must be English pass at grade C or above and Standard Grade Mathematics at Level 1 or 2 For PGDE – Degree from UK university or the equivalent, Higher grade English at C or above, Standard grade mathematics at Level 1 or 2 (Entry is competitive for both routes so Universities often ask for higher grades e.g. BBBB).

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What are the standards and competencies to be achieved?

In some partner countries, national requirements or guidelines are provided for the competencies to be achieved, to be interpreted and implemented by the different providers for example in Belgium, France, Germany, Portugal, Romania, UK (England, Wales, Scotland). In others, there are no national regulations for example in Finland, Greece, Malta (preschool).

The EU Study of Science Education across Europe (EU 2011) identified the following categories of knowledge and competencies in initial teacher education programmes for generalist and specialist science/mathematics teachers:

- Knowing and being able to teach official mathematics and science curriculum
- Creating a rich spectrum of teaching situations
- Dealing with diversity
- Collaboration with peers and research

Generalist and specialist programmes were found to be rather similar.

Science Teaching in Schools across Europe (EU 2006) identified some similar categories related to general teaching knowledge and skills:

- Theories of child development
- Creation and management of learning situations
- Working with diverse pupil groups
- Collaborative approaches to teaching.

These are reflected in knowledge and competencies promoted in teacher education programmes in partner countries. The themes most commonly represented in standards and competencies for initial teacher education are:

- Subject and curriculum knowledge
- Pedagogical knowledge and skills - approaches to planning, teaching and assessment of learning
- Building partnerships and relationships with children, parents, school staff, team working, collaboration
- Commitment to on-going professional development, reflection, research, innovation

The following areas of knowledge and competence were also included in many countries

- Knowledge of child development and learning
- Identifying and meeting individual needs – recognising diversity, special educational needs
- Creating a positive learning environment
- Ethics and professional values

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What are the models of training?

As indicated in D2.2 *Conceptual Framework Addendum 3 of 4: Literature Review of Teacher Education*, two models of training are commonly found in Europe that combine theory and practice in different ways – the *concurrent* model and the *consecutive* model. In the *concurrent* model theory and practice are combined across a teacher education. In the *consecutive* model students first attend a theoretical course followed by practical training once this is complete. Different models are used across partner countries as follows:

- Concurrent – Belgium, Finland, Greece, Malta, Romania, UK.
- Consecutive – France, Germany, Portugal.

What is the curriculum content?

In many partner countries, general guidance or requirements to be met by curriculum content are set out in policy, in relation for example to the overall structure of programmes, standards or competencies to be achieved, requirements for field experiences in schools or sometimes minimum time to be spent on different programme elements. Specific requirements are commonly provided in relation to

- School placements/experience – for example Belgium (Flanders), Germany, UK (England and Wales)
- Content areas - for example Belgium (Wallonia), Finland, Germany, Portugal, Romania

In some partner countries, there are no national guidelines of requirements such as Greece, UK (Northern Ireland). However, in all partner countries, detailed curriculum content to meet requirements or guidance for initial teacher education (if they exist) is determined by individual institutions.

What are the qualifications and/or experience to be a teacher educator?

Requirements across partner countries vary. In some partner countries there are no specific requirements. Examples of expectations are as follows:

- Belgium (Flanders) – At least Bachelor degree and Masters degree for lecturer status
- Finland – lecturers require PhD, competence in subject area, teacher qualifications, experience of teacher/basic education
- France (in IUFM) – Master trainers – with at least 5 years effective classroom experience
- Germany – preschool – certified educator; primary - practical teaching experience and or subject knowledge
- Greece - no specific standards but PhD for all members of teaching staff. No standard amount of school experience required
- Malta - MA – for lecturer status
- Portugal – degree of doctor or teacher

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- Romania - Teacher/tutor certificate
- UK – Qualified Teacher Status, higher qualifications (MA, PhD desirable)

This reflects the limited attention that has been given to the status and qualifications for the teacher education profession, highlighted in 2.4 Review of Teacher Education

What are the qualifications and/or experience to be a school mentor?

This term has different meanings in different partner countries. In some countries this refers to members of staff from higher education institutions that support students in schools. In other cases (as in the UK) this refers to school staff working in partnership with higher education tutors in mentoring students on school field placements. In some countries (Malta) the role of school mentor does not exist.

Where the role exists qualifications are little specified apart from general expectations of teaching qualifications and experience. Exceptions are:

- Finland – University schools require (1) Masters degree, (2) competence in subject area or class teacher qualifications (3) at least 2 year experience teacher education or basic education. Other schools require (1) Masters degree (2) teacher competence in subject area or class teacher qualification.
- Romania where official documents detail the competences required of the teacher-mentor: didactical competences; competences for planning and organising the mentoring activities; communication competences; evaluation competences.

What are the modes of assessment?

A wide range of modes of assessment is employed in institutions of teacher education in partner countries. Common elements to assess the combination of academic requirements and the requirements in relation to practical teaching include:

- Observation of teaching
- Classroom research projects
- Presentations
- Portfolios
- Reflective journals
- Written assignments
- Examinations
- Audits of subject knowledge

The approaches adopted are governed by academic regulations in individual institutions and at national level and by any national requirements in terms of standards and competencies associated with qualified teacher status.

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Note in relation to the promotion of inquiry- based approaches and the role for creativity.

Given the independence still afforded to programmes of initial teacher education and their varied nature in partner countries, it would be challenging to identify potential for the promotion of inquiry and role for creativity in initial teacher education without more detailed study of guidelines in relation to teacher competencies, standards and requirements for ITE. This might be helpful to inform policy recommendations from the project.

3.3.2 Continuing professional development

A. National initiatives for teacher professional development

The need for provision of appropriate training to support continued development and support new initiatives and practices in science and mathematics associated with inquiry and creativity is a theme that emerged across a number of country reports.

- Entitlement and requirements in relation to CPD vary across partner countries. In a number of countries opportunities and support for teachers to participate in CPD is limited.
- In some countries teachers are entitled to certain number of days CPD per year for example Belgium (Wallonia) (6 half days), Finland (3 days per year) and in Malta (set number of half days for professional or school development).
- In some cases teachers are required to undertake training for example (Romania every 5 years, Malta every 2 years)
- In other countries CPD is voluntary, depends on personal initiative and takes place at weekends, evenings for example France, Germany.

In some countries, CPD is accredited; for example Romania (accredited by Ministry of Education), UK (England) (some CPD is accredited by association with Universities). In some federal states in Germany CPD programmes have to be accredited by the federal 'Institute for quality development'. Regulations vary from state to state and there is no such institute at a national level.

Much CPD experienced by teachers is focused on the needs of schools, school networks, or national initiatives, rather than individual professional needs and aspirations. Common areas of focus include ICT, Literacy and Numeracy. Concern was expressed that effective CPD needs to be co-constructed by participants, rather than just imposed, emphasising the value of opportunities for networking and action research

Country reports indicated a number of large scale national initiatives for teacher education, some related to science and mathematics including:

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- *Greece* – very large scale 2011-2013 to promote values and guidance associated with the new curriculum – focus on creators of educational planning, new methods, ICT, environmental awareness, safe productive collaborative environment, holistic view of education.
- *Portugal* – major initiatives in mathematics (teachers' knowledge and skills, attitudes, promote collaboration and networking between schools and groups) and experiential science teaching (to enhance scientific literacy and professional skills of teachers).
- *Romania* - two CPD accredited courses for primary and secondary school teachers in relation to Science teaching by inquiry-based methods, delivered by the Center for Science Education and Training at the National Institute for Laser, Plasma and Radiation Physics (http://education.inflpr.ro/ro/Descopera.htm). These courses include both face-to-face sessions and an e-learning platform, and are assisted by a videoconference system through which educational videos can be accessed. CPD in Science and Mathematics for primary school is also offered by some Romanian higher education institutions, for example a course on 'modalities to stimulate creativity through primary school curriculum'.
- *UK (England)* - MaST 2 year programme accredited at Masters level to extend teachers subject and pedagogical knowledge in mathematics and National Science Learning Centre network offering CPD in science for teachers across age phases (including inquiry, play, exploration, creativity in science) – however only a minority of teachers are able to participate as attendance and costs need to be agreed by their schools.
- *UK (Wales)* – Early Professional Development programme. This is a 2-year programme following the induction year based on core national priorities including literacy, numeracy, reducing impact of poverty on attainment, additional learning needs, behaviour management and reflective practice.

B. Standards and competencies for in-service teachers

In most countries there are no official standards for in-service teachers apart from those needed to gain teacher status. However there are varied ways in which teachers may extend their knowledge and skills, gain further qualifications and recognition of their developing knowledge and competence as illustrated by the examples below.

- In *Belgium (Flanders)* the Professional Profile, a common profile for all teachers is designed to provide a description of teachers' knowledge, skills and attitudes as they develop across a career in teaching.
- In *Greece* competencies have been set out in relation to the 'Major Professional Development Programme', which began in June 2011 and aims to promote the aims and values associated with the emerging curriculum:

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- To be able to create educational schemes of work and not just follow ready-made lesson plans.
- To incorporate new teaching methods into their repertoire in order to be able to move away from traditional ways of teaching.
- To be able effectively to utilise ICT, environmental awareness and Arts in teaching.
- To think and act towards forming a safe and productive collaborative environment.
- To possess a holistic view of education.
- To be able to maintain sustainable links with society and current events by teaching about topics relevant to school settings and recent developments.

- In *Romania* teachers' developing competencies are assessed through the results of their participation in different types of courses and activities such as sessions or courses run by scientific societies, teacher organisations, internships; mentoring programmes offered by professional associations or professional exchange across schools or the wider science education community.
- In *UK (England)* there is a Career Entry and Development Profile used to guide and record teacher development in their first years teaching, identifying both strengths, areas for development and career aspiration.
- In the *UK (Scotland)* teachers can chose to participate in the Chartered Teacher programme. It includes modules such as self-evaluation, learning and teaching, education for all and working together. Successful completion of the programme leads to a Masters degree and professional award of Chartered Teacher.

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4. Conclusions

This section provides an overview of key themes emerging from the research findings summarised in section 3. These are presented in relation to the main research questions identified for this deliverable, D3.2 Report on Mapping and Comparing Recorded Practices. This is followed by a synthesis of the issues and tensions in policy highlighted in individual National Reports and additional issues arising from this comparison of policy across partner countries. Finally, limitations of the research are discussed and implications for the findings considered.

4.1 Emerging Themes

4.1.1 Similarities and differences in partner policy

The main research question for this report was:

What are the main similarities and differences in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

The comparison of national policies revealed similarities as well as significant differences in approaches to learning, teaching and assessment advocated in partner countries as outlined below.

Policy frameworks

There are considerable differences in the ways in which phases of education are organised across partner countries. Starting ages for compulsory schooling range from 5 years to 7 years. There is varied access to pre-school provision and in some cases the last year of preschool provision is compulsory. Analysis of policy documentation indicated that the degree of regulation and levels of decision making also vary considerably across partner countries and phases of early years education. This was reflected in notable differences in the type and nature of accessible policy documents

Rationale for early years science and mathematics

Two common emphases are evident in the rationale provided for early years science education in partner policies: the need to develop socially and environmentally aware citizens, and the importance of fostering skills and dispositions to support future learning. In both instances, links to creativity were identified in the concern to promote skills of inquiry and positive attitudes to science, in particular curiosity and critical evaluation. In only a small minority of countries was the need to provide a foundational education for future scientists or to develop more innovative thinkers prioritised in policy.

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Curriculum aims and content

Science is represented in different ways within the curriculum: in some countries within a broad area of learning such as 'Knowledge of the World' or 'Study of the Environment', in others as a single subject. The aims, objectives, and content of the science curriculum in partner countries emphasise the development of process skills associated with scientific inquiry and of knowledge and understanding of science ideas (the latter particularly in primary school). More limited attention is afforded to social and affective dimensions of learning and few countries highlight understandings related to the nature of science. A role for creativity was most strongly indicated in the focus on questioning and investigating and the importance given to curiosity. In most countries a very limited role for creativity was identified in relation to the development of science ideas.

Approaches to teaching and learning

Approaches to teaching and learning associated with inquiry and creativity are widely emphasised in policy guidance in partner countries for both preschool and school. For example problem solving and children trying out their own ideas are mentioned. Promoting inquiry skills such as questioning, observation and communication is widely advocated. Approaches given the least attention include the use of drama, stories, history, field trips and everyday experiences as contexts for learning. There were also differences in the aspects of inquiry discussed, with most limited reference to connecting explanations to scientific knowledge and reflection on inquiry processes and learning. It is notable that in most countries limited references are made to the role of imagination or the discussion of alternative ideas – also linked with creative approaches to learning and teaching. Some differences were evident between phases of early years education. In preschool, play is strongly emphasised and greater attention is given to questioning and fostering autonomous learning. In primary school greater importance is afforded to investigation and problem solving.

Physical and social environment

In general, limited advice is given in policy in terms of the physical and social environment for learning. Where advice on materials is provided, it mostly related to the provision of equipment for inquiry and use of digital technologies. There was very little emphasis on a budget for teaching or technical support for science. In terms of forms of grouping, common themes include the recommendation of a variety of approaches to suit particular tasks and learning needs and the benefits of collaborative learning.

Assessment

Policy in relation to assessment showed the widest variation across partner countries. In many cases findings reflected the limited guidance for science assessment and inconsistencies in emphasis across different elements in curriculum policy. There is very

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limited evidence in policy of a role for creativity either in the priorities or methods for assessment advocated across partner countries. Greatest emphasis is given to the assessment of science ideas. Understandings and competencies in relation to scientific inquiry are emphasised in assessment policy in a minority of countries and in only a few instances are attitudes a priority for assessment in science. In general, guidance in relation to assessment methods is limited, with little attention to multimodal forms of assessment or the involvement of children in assessment processes often associated with creative approaches to learning and teaching in the early years.

4.1.2 Role of Creativity

A further research question for this project was:

What are the main similarities and differences in the role of creativity in the way teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

The National Reports indicate that explicit references to creativity in policy documentation for early years science and mathematics are limited, however, implicit links to creativity were identified in the attention given to learning dispositions and teaching approaches associated with creativity. For instance partners provided some limited examples of explicit references to 'creativity' or 'creative' dispositions in policy for early years science and mathematics. In addition they indicated that in some countries creativity is included explicitly as a cross-curricular theme or capability, however, often without indicating how this might be reflected in science and mathematics. However in most cases a role for creativity in partner documentation is implicit, for example in the creative dispositions mentioned in policy such as curiosity, imagination or sense of initiative or in teaching approaches advocated including play and problem solving.

4.1.3 Differences between science and mathematics

A further research question was:

What are the main similarities and differences between mathematics and science in the teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

In a number of countries, differences are evident in the wider policy context for mathematics. It is generally represented in the curriculum as a single subject. In the primary age phase there is more likely to be guidance or regulations concerning the time allocation and assessment of mathematics. Mathematics in some countries is also treated as a cross-curricular dimension. This is not case in science although generic inquiry or thinking skills for example may feature in cross-curricular dimensions.

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In the majority of partner countries policy in relation to the aims and content of the curriculum for mathematics make similar references to a range of skills and attitudes associated with inquiry and problem solving and to the development of social skills associated with collaboration and the communication of ideas. In contrast to science there is often greater emphasis on subject content, in both preschool and primary phases. In many partner countries no substantial differences were noted in relation to the teaching approaches advocated for science. However some differences in emphasis were evident in greater attention to the development of concepts and abstract ideas and more teacher-led activity (reflecting differences in regulations, aims and content for mathematics). In some countries greater emphasis was noted on the use of outdoor learning and on observation of phenomena.

4.1.4 Differences between Preschool and Early Primary School

The final research question was:

What are the main similarities and differences between preschool and early primary school phases in how teaching, learning and assessment of science and mathematics in the early years are conceptualised in policy in the partner countries?

As indicated above, there are many similarities in policy for preschool and primary school across partner countries in their focus on skills associated with inquiry, fostering children's interests and on collaboration that suggest a role for creativity. However a number of differences could also be identified. One key difference between the phases is that the preschool phase is not compulsory in many partner countries. There are often more limited statutory requirements, for example regarding time allocation for science and mathematics or assessment. The approach to education is often more holistic in emphasis. Guidance in relation to many aspects of preschool policy is often generic rather than subject-specific in focus. In contrast, partners noted that policy related to primary school often makes much greater reference to specific subject content and includes a wider range of skills associated with inquiry-based learning in science, such as planning, reasoning and evaluation skills associated with the generation and evaluation of data. (Whereas in preschool policy, obtaining data tends to be the prime focus.) In addition in the primary phase, more limited attention is generally given to social and affective factors in learning. While there were similarities in teaching approaches advocated for preschool and primary phases, there was evidence of a greater emphasis on play and autonomous learning in preschool.

4.2 Issues and Tensions

The National Reports highlighted a range of issues and tensions in policy. Common themes highlighted are discussed below.

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Changing policy contexts

A number of National Reports drew attention to their changing policy contexts. In many countries new policies are being introduced, often associated with increasingly centralised steering of education systems. These often create new tensions associated for example with mismatch to current teacher practices and beliefs (Germany), lack of CPD to support requirements or initiatives (France, UK (England)) or lack of coherence between different aspects of policy developed in different time periods. Examples of systems undergoing major policy change include:

- Belgium (Wallonia) - introduction of a new system of educational cycles and phases, associated competencies for pupils and teacher education, external testing.
- Germany – introduction of national standards for mathematics, German and Initial Teacher Education.
- Greece, Malta, Portugal, Romania, UK (England) – introduction of new curricula.

A number of different factors have contributed to policy change in these countries, however performance in national and international tests is having an increasing impact on policy. For example in some counties assessment of use and application of knowledge, for example in PISA, has prompted greater focus on inquiry. In others there is concern not just about general standards but the wide range of attainment, in particular differences in attainment between different socio-economic groups (for example UK (England and Wales)).

Control and autonomy

Another theme evident in National Reports was that of control of policy and its implementation. For example in some countries strong direction in policy has restricted opportunities for teachers to make decisions about learning, teaching and assessment approaches. On the other hand limited guidance can result in variability in local interpretation and lack of teacher confidence in implementation. In a number of reports the issue was raised of how to provide guidance while at the same time retaining teacher autonomy and strengthening schools' and teachers' self-evaluation processes in a climate of accountability. Finally in systems with control of education at a regional or local level, national guidance may also be interpreted in different ways in different localities creating varied priorities and contexts for teaching and learning.

Coherence in policy

A related issue that featured strongly in National Reports was lack of coherence in policy, for example a mismatch between rationale or aims that might emphasise the promotion of inquiry skills and creative dispositions and assessment methods and criteria that allow limited opportunities for children to show their capabilities, and pay limited attention to social or affective factors or features of inquiry. This also reflects tensions between process and product. In many partner countries greater attention is paid to the processes of education and the development of young children's skills and dispositions in pre-school

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education. In the primary phase, with the more widespread specification of learning outcomes, teachers become more accountable for the products of learning.

Connection between different policy elements

A further dimension of coherence is the degree of connection between policy documents that might apply to a particular age phase and between policy documents across different phases in early years education. Lack of connection can often originate from the formulation of policy documents by separate groups. For example in countries where there are separate specifications for science, connections with mathematics or with history and geography are often not well articulated. Generic guidance may be offered in relation to teaching approaches without explicit attention to how this might be reflected in aims and practices in particular areas of learning such as science and mathematics. Often aspects such as creativity are promoted without more specific guidance on how this is characterised in terms of more particular activities, for example 'creative exploration'. In some instances, policy for science and mathematics covers a wide age range with limited indication of its application in early years settings. Finally making connections between policy in preschool and primary school was of particular concern in many of the countries that have separate policy frameworks for these different phases of education. In Belgium and UK (Northern Ireland Wales and Scotland) there are common curriculum frameworks for early years education across pre-school and primary to try to address issues of transition.

Policy implementation

National Reports also raised a range of issues related to the implementation of policy, particularly in relation to inquiry-based learning approaches. Factors such as lack of time as a result of pressures of curriculum content or assessment requirements or the lack of specified time for science within broad areas of learning can have an impact on opportunities for inquiry and children's autonomy. Resources, lack of classroom assistance and class size were also cited as reasons for difficulties with implementing inquiry or fostering creativity. However lack of teacher knowledge and confidence was the most common factor mentioned. The need for guidance and continuing professional development to support implementation of new practices was emphasised, for example in relation to the sensitive role of the teacher in supporting play or in taking on new roles as co-constructor or guide (as opposed to leader) in primary education.

Assessment

As highlighted in section 4.1 above, assessment, especially formative assessment, was widely highlighted as a particular area for development in both policy and practice in both preschool and primary phases. The most common theme to emerge was lack of policy guidance in terms of both methods of assessment and criteria for assessing on-going progress, resulting in considerable variability in teacher judgements. There are particular challenges in assessment related to inquiry and creativity. This is linked to the tendency to

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focus on products rather than processes in assessments, as indicated above, allied with the pressures of statutory summative assessment processes in a number of partner countries.

Teacher education

Finally the importance of teacher education was underlined across all the National Reports. Lack of teacher subject and pedagogical knowledge and confidence and the need to promote positive attitudes to science featured in much of the commentary on policy. The importance of sufficient attention to science in initial teacher education programmes and wider provision and entitlement to opportunities for CPD were identified as key priorities.

Some additional issues emerged in the comparison of National Reports that also have implications for the future phases of the project

Identifying a broader and more nuanced role for creativity

National Reports indicated a role for creativity in early years science and mathematics, generally associated with the fostering of skills and dispositions linked to creativity. It was also identified in the widespread promotion of play in preschool and problem solving in the primary phase. It was notable however, that partners reported that policy documents rarely indicated roles for creativity associated with the development of science ideas, reflected in limited attention given to fostering imagination or discussing alternative ideas in the teaching approaches advocated. In more general terms, connections to creativity in policy were associated with the generation, rather than the evaluation of ideas. It would be valuable in Work Package 4 to seek out examples that illustrate the potential for creativity in developing new understandings in science and mathematics. This might also give children a flavour of the nature of science in sharing and discussing ideas within a classroom community. In a similar way it would also be useful to examine the potential role for creativity in other curriculum components given limited attention, such as children making choices about the use of equipment and materials.

Another dimension that it would be valuable to explore further in Work Package 4 is the role of the teacher in supporting as well as providing opportunities for the development of creative skills and dispositions. For example scope for creativity in partner policy was often identified in relation to problem solving or use of digital technologies, although it is possible to employ both approaches in ways that restrict children's autonomy or opportunities for creativity. Play, questioning and scope for autonomy were also widely associated with a role for creativity in preschool, often with an implicit assumption that this comes 'naturally' to all children. This is an important issue to address as children's attitudes to science are formed at an early age. Examining the role of the teacher here would be valuable, for example in supporting young children's capacities and willingness to participate in play, drawing on insights from the *Conceptual Framework* (D2.2). Identifying ways in which teachers can promote play within the primary age phase would also make an important contribution to early years practice in science and mathematics.

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Opportunities for peer and self-assessment

The National Reports indicated that policy in relation to assessment gave limited emphasis to the involvement of children in peer or self-assessment or to opportunities for children to reflect on their learning. The *Conceptual Framework* highlights ways in which both of these processes can make an important contribution to learning, particularly in relation to children evaluating ideas or the processes of inquiry or in reflecting on social or affective factors associated with their learning, also much neglected in assessment policy. This too would be a valuable area to explore across future phases of the project.

Contexts for learning

The National Reports suggest that limited attention is given in policy to the contexts for learning such as drama, stories, historical projects or everyday experiences in the environment. Here too exemplification would be valuable of the kinds of contexts teachers can provide and ways of capitalising on them to foster inquiry and creativity.

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5. Implications

5.1 Implications for policy

As suggested in the introduction to this report (section 1.2), policy needs to be developed and implemented within the particular local context of its application. As a result, implications and priorities for policy, building on this mapping and comparison of recorded practices, will vary across partner countries. However themes and issues discussed in this report offer some general areas for consideration in policy to enhance opportunities for inquiry and creativity in early years science and mathematics. These are outlined below.

Aims and content of the curriculum

The findings from this review of policy suggest that the aims and content of curricula for early years science and mathematics could pay more explicit attention to social and affective dimensions of learning, both also inextricably connected with cognitive dimensions. Greater recognition could also be given to young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, and with understandings related to the nature of science.

Approaches to learning and teaching

Policy implications for learning and teaching approaches in early science and mathematics are interlinked with recommendations concerning the aims and content of curricula. Approaches to learning and teaching involving play, practical exploration and investigation feature strongly in policy across most partner countries. However, reflecting the need for attention to affective dimensions in the aims and content of curricula, policy guidance and exemplification could pay greater attention to the provision of varied contexts for science learning shown to promote children's motivation, interest and enjoyment in science and mathematics, such as drama, stories, history projects, field trips and children's everyday experiences.

This report also suggests that in seeking to foster opportunities for inquiry and a role for creativity, greater recognition could be given in policy to the roles of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures. Consideration of alternative ideas is also connected to social factors in learning and the provision of opportunities for development of understandings associated with the nature of science. As highlighted above, both these important dimensions of learning deserve greater attention.

Assessment

This report indicates a number of common issues for consideration in the development of policy requirements and guidance in relation to assessment.

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It highlights the need for a closer match between the aims and rationale for science education and assessment priorities and approaches. For example while assessment of science ideas is widely prioritised in policy, more limited attention is given to assessment of inquiry processes and even less to social and affective dimensions of learning, although these dimensions are often highlighted in the rationale and aims set out for early science and mathematics education.

While the importance of formative assessment is increasingly recognised in policy, the National Reports indicate that further guidance would be valuable to support classroom practices in assessment. Areas highlighted in particular include: examples of multimodal forms of assessment to give young children opportunities to show best what they understand and can do; ways of involving children in peer and self assessment to support children's reflection on inquiry processes and outcomes and criteria to assess progression in learning, particularly in relation to inquiry and the development of dispositions associated with creativity.

Role of creativity

Findings from this report suggest that a more explicit and detailed focus in policy on the role of creativity in early science and mathematics would be helpful. Where explicit references are made to creativity in policy they are often in very general terms without provision of guidance about what this might mean in the context of early science and mathematics. The review of policy across partner countries identified implicit connections to creativity in policy for early years science and mathematics, but these need to be drawn out and exemplified to support teachers in translating policy priorities concerning creativity into specific classroom practices. Furthermore, while certain teaching approaches are often signaled as associated with creativity, such as problem solving and the use of digital technologies, there is often limited indication of how such approaches might be used to foster creativity or inquiry in early science and mathematics.

Teacher Professional Development

Commentary in the National Reports underlines a number of implications for policy in relation to teacher education. The reports highlight for example, the importance of the Inclusion of science in programmes of initial teacher education, including inquiry based learning and the role of creativity in early years mathematics and science. The need for teachers' entitlement and opportunity for continuing professional development is emphasised to support new initiatives and approaches related to inquiry based and creative approaches to teaching.

The potential contribution of school based research and inquiry to teacher professional development is highlighted in a number of National Reports. They suggest the need to develop strategies and tools to support self-evaluation by schools and teachers and collaborative approaches to professional development within and between schools.

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The empirical work of the project has the potential to contribute to policy development in these areas through exemplification of teaching, learning and assessment approaches associated with inquiry and creativity in early science and mathematics and the development of tools and materials to support teacher professional development.

5.2 Implications for empirical work in this project

The National Reports suggested a range of areas for further investigation including:

- Opportunities to study policy implementation processes – how schools and teachers take ownership of new initiatives related to inquiry and creativity in education (for example in Greece, UK (Northern Ireland and Scotland)).
- The need to gain a more detailed sense of the nature of inquiry and opportunities for creativity in science and mathematics in early years classrooms – classroom examples to exemplify possibilities, case studies of children's explorations and investigations (to support wider definition of creativity than reflected in much policy documentation) as indicated in the previous section.
- Approaches to cross- thematic, cross-curricular and project work in preschool and primary school.
- More information about the design, use and resourcing of the classroom environment – indoors and out including opportunities offered by digital technologies and roles and collaboration of teachers and support staff.
- Observation and discussion with children – their perspectives – impact of policy on their experiences.
- Support for assessment processes – multimodal assessment tools, approaches assessment of social and affective as well as cognitive factors including the potential for peer and self-assessment in preschool, assessment in the outdoor environment.
- Teachers' views and attitudes to early science and mathematics, the contribution of initial teacher education, opportunities for CPD and policy and other resources they use to support their teaching.
- Planning and evaluation processes in school including the extent of collaboration, support of specialist staff.

In addition the methods employed in the in depth case studies have the potential to offer:

- Approaches to subject specific classroom observation (opportunities for inquiry and creativity) that could be used for peer review with colleagues in school, with school mentors or university partners.
- Evaluation tools that provide frameworks to support to support the processes of reflection and evaluation in schools.
- Strategies for classroom assessment, including the involvement of children in assessment.

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- Approaches to collaborative classroom research and inquiry.
- Materials and recommendations for Teacher Education.

5.3 Limitations

Nations and Educational policy

The aim of this report was to map and compare recorded practices between European partners on this project. One key issue this raised was how to identify appropriate national policies for review. In countries where policy was governed by more than one educational jurisdiction there were separate policy frameworks of each jurisdiction. In the UK there were resources to make it possible to complete a National Report for each of the nations within the UK: England, Northern Ireland, Scotland and Wales. In the case of Belgium policy was reviewed for Flanders and Wallonia. It was not possible to produce National Report for the German-speaking jurisdiction in Belgium. In relation to Germany, one National Report was completed covering national policy guidance for the different federal states accompanied by a review of policy in two of the states Hesse and North-Rhine Westphalia. The limitation of basing reports on representative regions within these countries needs to be recognised. National policies also differed in terms of their educational structure, where provision and ages for 'pre-school' and 'primary school' differ. This needs to be taken into consideration where comparisons are made of different phases between nations.

'Recorded practices'

There were also limitations associated with the decisions of how to consider 'recorded practices'. In this report, 'recorded practices' were interpreted as formal written policy documents. However, key messages about approaches are often communicated through other media such as webpages or textbooks. Another issue concerned what policy documents to include in analysis. Whilst guidelines were provided to researchers, messages were often spread across a range of documents that varied in their direct relevance to the particular focus of this report. Indeed, one important aspect not made explicit is the extent to which messages had to be gleaned from different documents. Another issue to consider is the status of policy documentation, as for many countries, documents were in a phase of transition, with the result that analysis may soon be outdated. Finally, it should be noted that policy documents often apply only to compulsory phases of education. Therefore in some countries there was no policy documentation for the part of the pre-school phase that is not compulsory.

Science

One challenge of this report was how best to capture conceptualisations of science and mathematics in early years, whilst mapping approaches in way that could compare national policies. This report was able to benefit from prior work that generated a *List of Mapping*

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and Comparison Factors (D3.1) with which to map and compare approaches. However, this framework was not developed specifically for policy analysis, and hence raised questions of how easily it could be adapted. A further issue to arise concerned how science and mathematics are presented in curriculum documents. For many partner countries, science in the early years is presented within a broader area of study, with implications for how approaches to 'science' can be compared.

Questionnaire

In order to map and compare policies, the framework of D3.1 was drawn upon to develop a questionnaire. This form of methodology provided measures for comparison but raised methodological issues, concerning both its limitations in capturing the complexities of policy context, and the subjectivity of researcher's responses.

Many of the items in the questionnaire required researchers to rate the extent to which particular approaches were emphasised: using a scale of 0-3. This posed significant difficulties, as often it was not clear how to interpret policy wording in terms of these items. A particular issue to arise was how to rate an item if this area was not covered by policy documents. Whilst some researchers would rate this as 'not emphasised', others left the item not coded. Whilst this is taken into account in commentary, clearer definitions may have clarified coding.

Subjectivity

Rating the degree of emphasis will inevitably involve a degree of subjectivity. In this regard, a significant limitation of this work is that a sole researcher, for the most part, completed questionnaires. Validation was partly provided by checking the evidence for each response (and in some cases with local informants) but it is likely that the ratings can only be treated as broad indications of emphases in policy.

Possibly a greater challenge was how to rate the extent to which creativity was emphasised in approaches. Whilst prior work was able to identify the *List of Mapping and Comparison Factors* (D3.1) to draw on, characteristic of opportunities for creativity in early years science and mathematics, ratings would again be susceptible to the particular experiences and knowledge of the different partners completing this work. There was also the significant challenge of language, where translation into English may have lost important aspects of how science and mathematics is conceptualised in documentation.

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Appendix A: National Policy Questionnaire

Dear CLS partners. The aim of this questionnaire is two-fold: a) to help map approaches in your policy documents that will inform your national report and b) to obtain data to allow us to compare national approaches. This requires a tradeoff between open and closed questions. Following feedback, we think it works well to use the headings from the 'Spider Framework' to structure the survey. These can be seen in the Table of Contents. We have also tried to map the policy questions with the Teacher Survey to aid comparisons.

As mentioned previously, we propose this **method** for the main questions: to rate **how much a theme is emphasised** across your documents and then to reflect on the **extent to which creativity is emphasised** in this theme. Please note you can only do the latter if the theme is present in policy documents (i.e. we expect many blank boxes!). The **Synergies** from the conceptual framework (Appendix A1 this document) provide a guide to reflecting upon the role of Creativity. Importantly, each question has a box called **Evidence**. This is where we provide justification for our choices, **using short notes and quotes**, providing an easy reference to policy documents (i.e. number reference from section 1C). Our responses to the questionnaire and notes in Evidence will help writing the sections in our National Reports and producing the overall report for Work Package 3.2.

Advice on completing the questionnaire

- You will need to complete a questionnaire for pre-school provision and another for primary school drawing on the documents selected.
- The evidence box is important for transparency and will support the writing of your national report. However evidence recorded should be brief – the number of the policy document and short phrases or words to indicate the basis for your judgment.
- It is important to focus on what is represented in official policy. You are not being asked to draw on your experiences in practice.

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- We recognise some sections will be difficult to tackle. Please answer the questions as best you can in the light of your national context. For example in many countries you will need to consider opportunities for science within broad areas of learning such as environmental studies or world orientation.
- We fully expect that there will be no policy reference for a number of sections. Please make this clear (rather than just leave blank), as in itself this is interesting.
- Keep in mind that the purpose of the detail in the different sections is to support your national report and comparisons with the teacher survey.
- Do use the 'OTHER' box in many tables and commentary in the main sections of your national report to highlight any important issues outside those covered in the questionnaire. It will be helpful to indicate sections that cause particular difficulty and the reasons why they are difficult to complete.
- Mirroring approaches adopted in the literature reviews and the teacher survey the emphasis is on science but comparisons with mathematics are included where possible – particularly in relation to learning, teaching and assessment approaches.

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1. Context of Questionnaire

A. What nation does this policy questionnaire refer to?

Nation	
Researcher(s)	

B. What age phase does this policy questionnaire refer to?

Please tick the phase to which this questionnaire refers.

Preschool	
Primary School	

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C. What documents did you use for this questionnaire?. Please include the policy documents and any other references you draw upon for your critical comments (e.g. media report / policy evaluation report)

Document name	Type of document/reference e.g. media report, Journal paper	Reference for Evidence

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2. Analysis of Approaches to Teaching and Learning

2.1 Rationale or Vision

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

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

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Aii. What is the emphasis, if any, on the role of Creativity in the purposes of Science Education? *(Adapted from Teacher survey Q23)*

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

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2.2 Aims and Objectives

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

	Not Mentioned	Single Mention	Various Mentions	Emphasised	Evidence
a. To know and understand the important scientific ideas (facts, concepts, laws and theories).					
b. To understand that scientists describe the investigations in ways that enable others to repeat the investigations.					
c. To be able to ask a question about objects, organisms, and events in the environment.					
d. To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.					
e. To know and understand the important scientific processes.					
f. To be able to communicate investigations and explanations.					

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g. To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.					
h. To have positive attitudes to science learning.					
i. To be interested in science.					
j. To be able to plan and conduct a simple investigation.					
k. To have positive attitudes to learning.					
l. To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).					
m. To be able to collaborate with other children					
n. Other					

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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	Evidence
a. To know and understand the important scientific ideas (facts, concepts, laws and theories).					
b. To understand that scientists describe the investigations in ways that enable others to repeat the investigations.					
c. To be able to ask a question about objects, organisms, and events in the environment.					
d. To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.					
e. To know and understand the important scientific processes.					
f. To be able to communicate investigations and explanations.					

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g. To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.					
h. To have positive attitudes to science learning.					
i. To be interested in science.					
j. To be able to plan and conduct a simple investigation.					
k. To have positive attitudes to learning.					
l. To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).					
m. To be able to collaborate with other children					
n. Other					

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2.3 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**	**Evidence**
Science				
Mathematics				

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

	Science	**Mathematics**	**Evidence**
1			
2			
3			
4			
5			
6			
7			

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2.4 Learning Activities

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

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

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

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

B. What significant differences, in any, can be seen between Mathematics and Science in relation to learning activities advocated?

Difference between Mathematics and Science	Evidence

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2.5 Teacher Role / Location

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

	Not Mentioned	Single Mention	Various Mentions	Emphasised	Evidence
a. Open/unstructured play					
b. Role/Pretend play					
c. Drama					
d. Teaching science from stories					
e. Using history to teach science (e.g. transport, the work of scientists)					
f. Working in small groups					
g. Physical exploration of materials					
h. Using outdoor learning activities					
i. Taking children on field trips and/or visits to science museums and industry					
j. Integrating science with other curricular areas					
k. Building on children's prior experiences					
l. Fostering collaboration					
m. Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical					
n. Encouraging problem finding – e.g. children asking questions					

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o. Encouraging problem solving – e.g. children solving practical tasks					
p. Encouraging children to try out their own ideas in investigations					
q. Fostering classroom discussion and evaluation of alternative ideas					
r. Fostering imagination					
s. Relating science to everyday life					
t. Using questioning as a tool in science teaching					
u. Using digital technologies with children for science teaching and learning					
v. Fostering autonomous learning					
w. Other					

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

	Counter Creative Emphasis	**No Creative Emphasis**	**Slight Creative Emphasis**	**Highly Creative Emphasis**	**Evidence**
a. Open/unstructured play					
b. Role/Pretend play					
c. Drama					
d. Teaching science from stories					
e. Using history to teach science (e.g.					

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	transport, the work of scientists)				
f.	Working in small groups				
g.	Physical exploration of materials				
h.	Using outdoor learning activities				
i.	Taking children on field trips and/or visits to science museums and industry				
j.	Integrating science with other curricular areas				
k.	Building on children's prior experiences				
l.	Fostering collaboration				
m.	Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical				
n.	Encouraging problem finding – e.g. children asking questions				
o.	Encouraging problem solving – e.g. children solving practical tasks				
p.	Encouraging children to try out their own ideas in investigations				
q.	Fostering classroom discussion and evaluation of alternative ideas				
r.	Fostering imagination				
s.	Relating science to everyday life				
t.	Using questioning as a tool in science teaching				
u.	Using digital technologies with children for science teaching and learning				

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v. Fostering autonomous learning					
w. Other					

B. What significant differences, if any, can be seen between Mathematics and Science in relation to learning/teaching contexts and approaches?

Difference between Mathematics and Science	Evidence

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

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

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2.6 Materials and Resources

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

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

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B. What significant differences, if any, can be seen between Mathematics and Science in relation to materials suggested?

Difference between Mathematics and Science	Evidence

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2.7 Groupings

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

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

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2.8 Time

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

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

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2.9 Assessment

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

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

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

To assess the development of children's:

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

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

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

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D. What Creative attributes are addressed in assessment?

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

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3. Analysis of Approaches – Teacher Professional Development

3.1 Initial teacher education

A. What are the Entry requirements?

Entry Requirement	Evidence

B. What are the main Standards/competencies to be achieved?

Standards/Competencies	Evidence

C. What Curriculum content, if any, is required? This could include subjects to be studied, length of school experience.

Curriculum content	Evidence

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D. What is the Level of training e.g. Diploma, Bachelor, Masters?

Level of Training	Evidence

E. What is the Length of training?

Length of Training	Evidence

F. What kinds of institutions are authorised to provide training?

Institutions	Evidence

G. What qualifications and/or experience are required to be a teacher educator?

Qualifications/Experiences required (Teacher Educator)	Evidence

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H. What qualifications and/or experience are required to be a school mentor?

Qualifications/experience required (School Mentor)	Evidence

I. Model(s) of training - concurrent/consecutive?

Models of training	Evidence

J. Evidence (model of assessment) required/advocated (n.b. in Policy)? E.g. observation of teaching, written assignments, classroom research projects, presentations, reflective journals, examinations, audit of subject knowledge

Modes of assessment	Evidence

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3.2 Continuing professional development

A List any National initiatives for Teacher professional development in Science and Maths

National initiatives for teacher professional development in science and mathematics	Focus of CPD	Evidence

B What standards/competencies are set out for practising teachers (for example early career teachers, specialist teachers, advanced skills teachers as appropriate)?

Level/role	Standards/competencies	Evidence

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4. Any other thoughts / reflections on Policy not captured previously

Issue	Evidence

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Appendix A.1: Synergies between Inquiry-Based and Creative Approaches (from D2.2 Conceptual Framework)

- play and exploration
- motivation and affect
- dialogue and collaboration
- questioning and curiosity
- problem solving and agency
- reflection and reasoning
- teacher scaffolding and involvement
- assessment for learning.

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Appendix B: Mapping Strands from the *Conceptual Framework* (D2.2), curriculum components, questionnaire items and *List of Mapping and Comparison Factors* (D3.1)

Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Policy Research - Questionnaire	Factors
CURRICULUM	Aims / purpose / priorities	Rationale or vision	Why are they learning?	2.1 Ai What are the purposes of Science Education?	• science economic imperative • creativity economic imperative • scientific literacy and numeracy for society and individual • technological imperative • science and mathematics education as context for development of general skills and dispositions for learning
				2.1 Aii What is the emphasis, if any, on the role of Creativity in the purposes of Science Education?	
		Aims and Objectives	Toward which goals are they learning?	2.2 Ai What views are indicated about the importance of the following Science learning outcomes?	• knowledge/understanding of science content • understanding about scientific inquiry • science process skills • capabilities to carry out scientific inquiry or problem-based activities • social factors of science learning • affective factors of science learning • creative dispositions
				2.2 Aii What is the emphasis, if any, on the role of Creativity in the following Science learning outcomes?	
	Teaching, learning and assessment	Learning Activities	How are children learning?	2.4 Ai What activities are encouraged?	• focus on cognitive dimension • focus on social dimension
				2.4 Aii What is the emphasis, if any, on the role of Creativity in the following activities?	
				2.4 B What significant differences, in any, can be seen between Mathematics and Science in relation to learning activities advocated?	

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Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Policy Research - Questionnaire	Factors
CURRICULUM	Teaching, learning and assessment	Pedagogy	How is the teacher facilitating learning?	2.5 Ai What learning/teaching contexts and approaches are mentioned?	• role of play and exploration • role of motivation and affect • role of dialogue and collaboration • role of problem solving and agency • fostering questioning and curiosity • fostering reflection and reasoning • teacher scaffolding and involvement
				2.5 Aii What is the emphasis, if any, on the role of Creativity in the following learning/teaching contexts and approaches?	
				2.5 B What significant differences, in any, can be seen between Mathematics and Science in relation to learning/teaching contexts and approaches?	
				2.5 C What, if any, Inquiry Approaches are discussed?	
		Assessment	How is the teacher assessing how far children's learning has progressed, and how is s/he using this information to inform planning and develop practice?	2.9 A What purposes of assessment are included?	*Assessment function/purpose* • formative • summative • recipient of assessment results *Assessment way/process* • strategy • forms of evidence • locus of assessment judgment
				2.9 B What importance is given to the following priorities for children's assessment in Science?	
				2.9 C What ways of assessing are advocated?	
				2.9 D What Creative attributes are addressed in assessment?	
	Contextual factors	Content	What are children learning?	2.3 A How are Science and Mathematics presented as learning domains?	• science and mathematics as separate areas of knowledge or within a broader grouping • level of detail of curriculum content • links with other subject areas / cross-curriculum approach • subject-specific requirements vs. broad core curriculum • content across key areas of knowledge
				2.3 B What are the key Science and Mathematics topics/strands/themes?	

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Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Policy Research - Questionnaire	Factors
CURRICULUM	Contextual factors	Location	Where are children learning?	Provide a summary of what provision is given for each phase (pre-school/school) and who is responsible (in each partner country)	*Education system level* • centralized/decentralized *School level* • state/public, private etc. • fee paying / non-fee paying • size of school • urban/rural location • student intake *Classroom level* • outdoors/indoors • formal/informal learning settings • small group settings
				Country	
				Characteristics of system of education - system and level of regulation - not sure this really fits into spider but certainly context!	
		Materials and Resources	With what are children learning?	2.6 A What materials are suggested?	• rich physical environment for exploration • sufficient space • outdoor resources • informal learning resources • ICT and digital technologies • variety of resources • sufficient human resources • policy documents
				2.6 B What significant differences, in any, can be seen between Mathematics and Science in relation to materials suggested?	
		Time	When are children learning?	2.8 A How much time should be planned for teaching Science and Mathematics per week?	• sufficient time for learning science and mathematics
		Grouping	With whom are children learning?	2.7 A What groupings, if any, are suggested for teaching Mathematics and Science?	• multigrade teaching • ability grouping • small group settings • number of children in class

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Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Policy Research - Questionnaire	Factors
TEACHER	Contextual factors	Initial Teacher Training	Who is the teacher children are learning with?	3.1 A What are the entry requirements?	• entry qualifications/requirements for prospective teachers • ITE standards/competencies • ITE curriculum • level of education • length of ITE • location of ITE • ITE providers • profile/role of teacher educator • profile/role of school mentor • models of training • assessment approaches used in teacher education
				3.1 B What are the main standards/competencies to be achieved?	
				3.1 C What curriculum content, it any is required? This could include subjects to be studied, length of school experience.	
				3.1 D What is the level of training e.g Diploma, Bachelor, Masters?	
				3.1 E What is the length of training?	
				3.1 F What institutions are authorised to provide training?	
				3.1 G What qualifications and or experience are required to be a teacher educator?	
				3.1 H What qualifications and or experience are required to be a school mentor?	
				3.1 I Models of training - concurrent/consecutive?	
				3.1 I Evidence (model of assessment) required/advocated?	
		Continuing Professional Development		3.2 A National initiatives for teacher professional development in science and mathematics	• standards / competencies • national priorities • impact of CPD • nature of CPD • CPD providers
				3.2 B What standards/competencies are set out for practising teachers?	

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