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

D3.2 Report on Mapping and Comparing Recorded Practices

ADDENDUM 3 of 13: National Report on Approaches in Finnish Policy

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EXECUTIVE SUMMARY

This document is the Finnish national report on Approaches in policy, task 3.2 from the Creative Little Scientist project. The report aims to map recorded approaches to teaching, learning and assessment of science and mathematics education in the early years and to discover how these are linked to creativity. The report has been drawn up through the analysis of core policy documents on Early Childhood Education and Basic Education, with the focus on 4-5 and 7-8 year olds; analysis focused on the issues defined in the project during the earlier phases of work. The policy questionnaire was provided as a tool for analysis and the report aggregates the analysis conducted in accordance with the policy questionnaire.

Approaches to teaching, learning and assessment are considered from the following viewpoints:

- Rationale or Vision
- Aims and objectives
- Content
- Learning Activities
- Teacher role/Location
- Materials and resources
- Groupings
- Time
- Assessment

Each of these sections defines the main trends and tensions according to national policy documents. The role of creativity is discussed in cases in which links are available. In addition, I discuss the main differences between the education of 4-5 and 7-8 year olds as well as the differences in science and mathematics education.

In general, the Finnish national policy is very broad in nature, the specific, detailed aims and approaches being defined in local curricula and strategies. This being so, very specific conclusions and differences between teaching and learning activities cannot be made. In addition, with regard to Early Childhood Education and Care, science and mathematics are not discussed separately in terms of targeted themes with the result that conclusions here have been derived from general descriptions of policy documents.

According to document analysis, Finnish science and mathematics education in the early years, aims to develop children's skills through encouraging them to gather information from their close environment, to use their own senses and promote active exploration. Through science, the rationale for education aims at educating children to become skilful citizens with almost equal emphasis being placed on the cognitive, affective and social dimensions of learning .

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The Learning content focuses on children's immediate environment and every day activities. In Early Childhood Education and Care (ECEC) science and mathematics education has no specific content areas but is defined as content orientations without aims and purposes. In primary school, both these areas have the status of being a school subject with specifically defined content areas, aims and objectives.

When planning learning activities, children's existing ideas are significant; child initiated activities are particularly recommended in ECEC. In general, learning activities are investigative by nature and there is emphasis on children's active exploration and data gathering using their senses and processing skills. Especially in ECEC, the joy of learning is strengthened as well as the cognitive dimensions of Basic education.

Although creativity is not explicitly apparent in policy documents, the creativity dispositions defined in the project can clearly be found from curricula and other documents related to giving guidelines in education. ECEC especially recommends several creativity dispositions which should be taken into account in teaching and learning situations so that at best, science and mathematics education serves to provide diverse opportunities for creative learning activities among children.

In ECEC, education for 4-5 year olds, the learning process and its outcomes are not assessed through summative or formative assessment criteria nor are there any specific assessment criteria for science and mathematics education; evaluation in ECEC is based on the child's individual ECEC plan.The idea of this plan is firstly to map and document the child's individual experiences, strengths and needs which should be taken into account. In primary school, assessment focuses both on the learning processes and conceptual understanding. The core curriculum defines what is considered to be good performance, at the end of the fourth grade. This relates to activities in science and mathematics as well as other content areas.

Initial teacher education and continuous teacher education are discussed at the end of the report. In Finland, both teacher groups (kindergarten and primary school teachers) have university education. Each university has its own local curricula for education but the national frame, set by law, stipulates the qualifications demanded of teachers.

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1. Aims of the national report

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

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

1.1 Defining terms

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

1.1.1 Policy

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

1.1.2 Curriculum

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

1.1.3 Creativity

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

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

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2. Overview of the National Early Years Education provision and policy

This section provides the structure of EY education in Finland and focuses on the context, history and direction of policy changes in the near future. In addition, the different sectors of education are described focusing on the particular area for which each is responsible.

2.1 Structure of education for 4 to 8 year olds

In Finland, early childhood, pre-school, and comprehensive education are unique. When taking into account structural, organizational, implementation and curriculum issues, they differ from many similar systems in Europe. Early on in 2000, an extensive curriculum reform was executed which created conditions for integration and a continuum between different parts of initial education, *early childhood education, pre-school education* and *comprehensive education*. Throughout the country, the rules and principles are consistently applied to the administration and organization of these activities. One central principle of early childhood education, pre-school education and comprehensive school education is to guarantee basic education for all, irrespective of their place of residence, language and economic standing. (Laki perusopetuslain muuttamisesta 1288/1999; National Board of Education 2000).

Finnish Early Childhood Education and Care (ECEC) combines, care, teaching and education. The aim of early childhood education is to meet the needs of children and their families. The target is to foster the healthy growth, development and learning of children between 0-5 years. Early childhood education involves systematic, goal-directed interaction and co-operation in which free play is the key element. Education is rooted in a holistic view of children's growth, development and learning, based on a broad spectrum of multidisciplinary knowledge and research, plus expertise in the methods of early childhood education. The curriculum guidelines concern all forms of publicly operated and supervised ECEC. Municipalities must use them in assessing the extent to which their ECEC services meet the standard and specify the content and modes of action for different activities in their own curricula.

The Finnish ECEC does not have a curriculum in it traditional meaning, but it is more of an action plan. This national document emphasises the holistic nature of ECEC. However, the guiding document is called the National Curriculum Guidelines on Early Childhood Education and Care in Finland and the document compensates the curriculum in general discussion. (Stakes 2004.)The National Curriculum guidance on ECEC provides guidance for implementing the content of early childhood education and care in Finland. The document was established for the first time in 2004 by a team of experts at STAKES (social and health research institute). However, the current ECEC system in Finland is based on the Act, Children's Day Care (1973) which has provided a framework for the implementation of day care and early education services since 1973.

All children have the right to participate in voluntary pre-primary education (called pre-school) during the year preceding compulsory schooling. Nearly all 6-year-olds do so. The

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first national core curriculum for preschool was established in 1996. It developed as the standard for pre-school education provided in primary schools and day care centres (Board of Education 1996). Pre-school education for 6 year old children is provided in accordance with the Basic Education Act.

2.2 Structure of education for 7-8 year olds: Basic education

A Finnish child usually starts schooling at the age of seven. In the first and second grades (8 year olds) the instruction takes into account the abilities provided by early childhood education. Pre-primary education and basic education must make up a consistent, unified whole. The special task of instruction in the lower grades is to develop pupils' capability for subsequent work and learning (the National board of education, 2004).The nine-year basic schooling is free for all pupils. Basic education is publicly funded; funding is shared between the State (57%) and the local authorities (43%). Private schools, which are very limited in number, have state funding and follow the regulations set down by the Ministry of Education.

Comprehensive school is based on a single structure which does not separate the lower or uppers stages. Basic education is divided into grades (classes) and instruction in grades 1-6 is mainly provided by class teachers; subject-specific instruction is mostly given by subject teachers in the upper grades (7–9) as shown in Figure 1.

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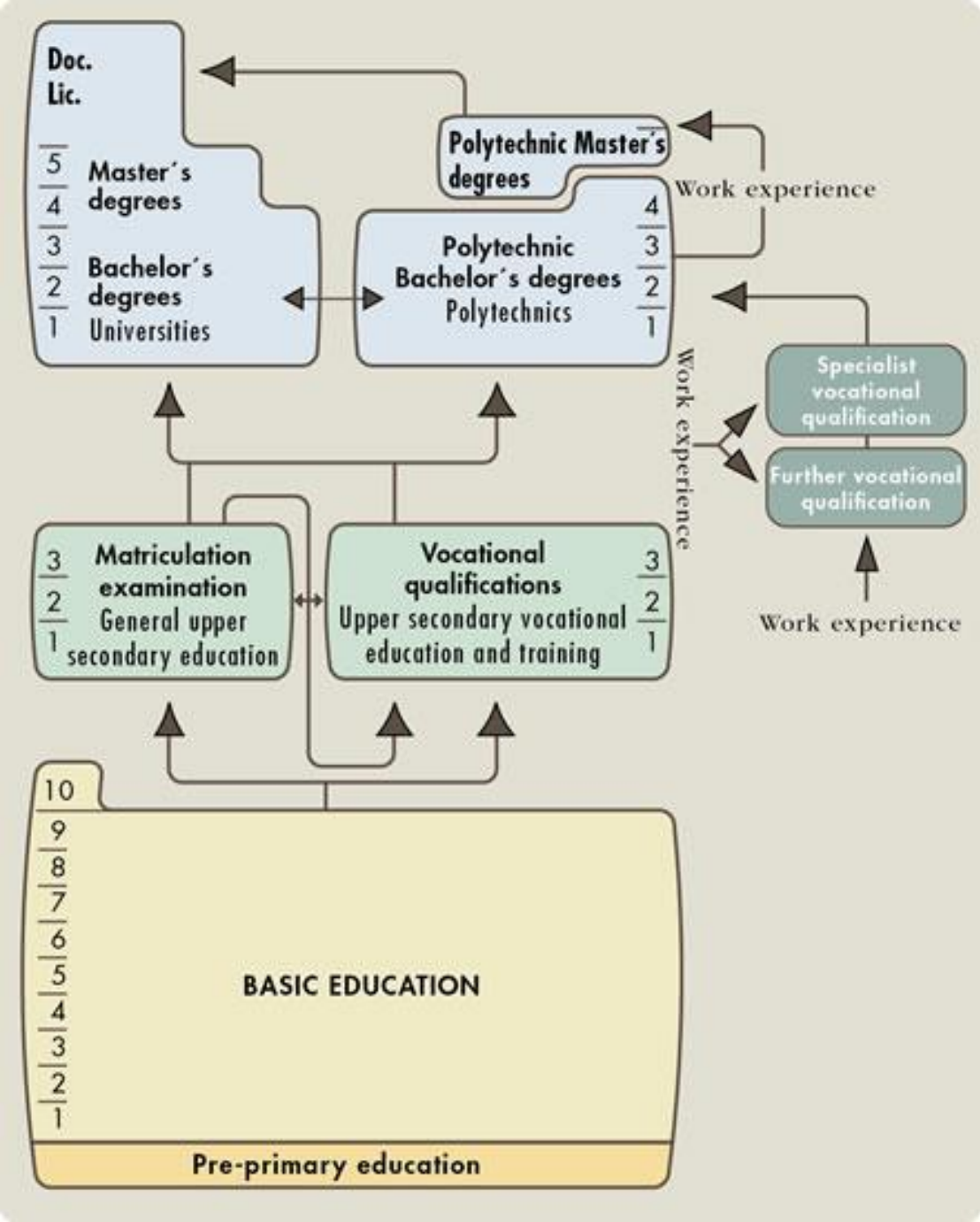

Figure 1. School system in Finland

The Ministry of Education is responsible for basic education. The Finnish National Board of Education works with the Ministry to develop educational aims, content and methods for all educational phases of basic education. Local authorities (Municipalities) have a prominent role as education providers.

The school year comprises of 190 days which starts in mid-August and lasts up to the beginning of the following June. Schools work five days a week and the number of lessons

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per week varies from 19 to 30, depending on the level and optional subjects taken. (Ministry of education, 2006.) Children in primary school (grades 1-6) can study the following subjects:

Finnish language and Literature

Mathematics

Natural and Environmental Sciences (grades 1-4)

Biology/geography (grades 5-6)

Physics/ Chemistry (grades 5-6)

Religion or ethics

History (grades 5-6)

English

Physical education

Music

Visual arts

Craft

The National core curriculum has been drawn up by the Finnish National Board of Education and includes objectives and assessment criteria for each school subject. The Core curriculum works as a framework for local curricula at Municipalities and at school (National board of Education, 2004). The core curriculum determines the conceptions of learning, the learning environment, operational culture and working approaches. However, the curriculum of an individual school may also determine its provision in another way, e.g. there are no provisions governing the size of teaching groups.

Student assessment and the evaluation of education and learning outcomes are encouraging and supportive by nature. The aim is to produce information that supports the development of both schools and students. There is no national testing, school ranking lists or inspection systems.

Learning materials are mostly produced by commercial publishers which publish textbooks, exercise books, teacher guides and additional material such as CDs, maps, web pages etc. The Finnish National Board of Education produces material for special groups which has a small circulation. Schools and their teachers themselves decide on the material and textbooks to be used, taking into consideration the school budget. The same applies to the use of ICT. All school materials such as pencils, rulers, notebooks etc. are free for pupils.

2.3 Responsibilities for providing education

Parliament passes legislation concerning education and research which determines the basic lines of education and science policy. The Government, together with the Ministry of Education and Culture, are responsible for preparing and implementing education and science policy. The Ministry of Education and Culture is responsible for education which is financed from the state budget; every four years the Government adopts a development plan for education and research (Ministry of education and culture, 2012).

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From the perspective of organizing Early Childhood Education, an important change took place in the early 1990s when the system of central government grants was reformed giving municipalities greater freedom and responsibility for developing services. A move has been made towards encouraging cooperation between different administrative bodies by proposing a relation/reform in the regulations governing the administrative arrangements for daycare at the municipal level. (Ministry of social affairs and health, 2003)

Since the day-care law came into force in the early 1970s, the connection between kindergarten and social welfare administration has increasingly strengthened. During the 1990s and 2000s developmental work relating to day- care appears to have focused on welfare services for families, whereas developing early education has been more or less of secondary interest (Onnismaa & Kalliala, 2010).

In December 2006, new regulations were added to the Act of Children's Day Care which allowed municipalities to move child day-care from the welfare to the education sector. Currently, approximately half of the municipalities have made those changes. This significantly proves the need for change in Early Years Education, a factor which now has also been recognised in the Ministry (see Onnismaa & Kalliala, 2010). From the beginning of 2013, all Early Childhood Education in Finland will come under the sector of basic education. As Early Childhood education, pre-school education and basic education in Finland will all be on the national and local level, policy documents concerning education need to be considered and understood at two levels:

1. **National regulations and policy documents:**

   Legislation on child day-care and pre-school education regulates the implementation of early childhood education and care, of which pre-school education is a part. These documents are the Act on Children's' Day Care (1973) and the Education Act (1998) which includes pre-school education for six-year olds.

   National Policy Definition on Early Childhood Education and Care (2002) covers the central principles and development priorities for publicly operated and supervised ECEC.

   The National Curriculum Guideline on Early Childhood Education and Care (2004) provides national guidelines for the content and quality of Early Childhood Education and gives a framework for drawing up local curricula.

   The Core Curriculum for Pre-School Education in Finland (2000) is a national guide for the content and approaches of pre-school education and provides a framework for drawing up a more specific local curriculum.

   The Basic Education Act (628/1998)
   The Basic Education Decree (852/1998)
   Government Decree on the General National Objectives and Distribution of Lesson Hours in Basic Education (1435/2001).

   The Core curriculum for basic education in Finland (2004) includes the objectives and core content of different subjects, as well as the principles of pupil assessment, special-needs education, pupil welfare and educational guidance.

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2. **Local regulations and policy documents**

Local policy definitions and strategies for early childhood and basic education

A Local ECEC curriculum

A local pre-school curriculum

A local curriculum for primary and secondary education

These local documents are provided by each municipality. They define the central principles and priorities in each municipality and describe the educational service system.

Municipalities as local government units, are responsible for the delivery of most education and social services in Finland. The municipality is obligated to provide these services in either the municipal school, kindergarten or in a private child care program (including family home care). Municipality documents are regularly updated, some documents every second or third year (e.g curricula from every third year) and some even more frequently.

At this stage, it is significant to mention that a wide-span, continuous, documentation and monitoring culture, does not exist in Finland. School teachers have a good deal of freedom and responsibility and specific methods or approaches for teaching or learning are not documented at the national level. Although some general pedagogical guidelines are set out to implement the philosophy of early years education in Finland, international, national and even local documents are unrestricting and supportive more than regulatory.

In ECEC, the curriculum does not set any learning aims or subject areas. The core content areas of ECEC are built on six orientations; the intention is not to study the content of different subjects but to start to acquire tools and capabilities for examining, understanding and experiencing a wide range of phenomena in the world around them. However, there are specific orientations towards mathematics and natural sciences, the learning content and themes of which will shortly be described.

The role of creativity or creativity in education is not strictly determined or defined. Creativity is seen as a significant part of the learning process, but it does not have a clearly determined role in either ECEC nor in the basic education curricula.

2.4 Future plans in national education

Reform of the curriculum for pre-school and comprehensive education is under work and the new curricula is to be published in 2016. Based on the PISA results, Finnish basic education has been under active consideration with widespread discussion and debate. This has also aroused self-assessment in Finnish education and the director of the National Board of Education (Lankinen 2010) has provided an agenda for changes. According to this presentation, reform will focus on the following issues:

Increase in the Arts

More diversified language programme

Highlighting the 21st Century Skills- Citizen skills

Multidisciplinary subject-groups

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Increase in the minimum instruction time

More individual freedom to choose between subjects and multidisciplinary subject- groups

(Lankinen, 2010).

All these visions for the future support increasing creativity in education aimed at enhancing art, diversity and freedom and a multidisciplinary approach to schooling. In addition,the objective seems to be to encourage students to make their own choices and become effective and competent citizens.

These reforms aim to clarify and enhance the mission with integrity, ensure high level knowledge and skills, strengthen individual support and guidance and clarify the principles of providing basic education. The national process of renewing basic education has already started with the governmental work on the curricula. On 27.6.2012, the Finnish government voted on the new subjects and working hours; there will be more lessons in history and societal studies to increase pupils' societal capabilities and less teaching of religion. In addition, more emphasis is going to be put on foreign language learning. The national process for renewal of the Core Curriculum will continue to progress during the years 2011-2013 and the curriculum should be taken into use locally by 2016.(Lankinen, 2010; Newspaper Karjalainen, 2012)

2.5 Science and mathematics attainment

In 1996, the Finnish government established a developmental project which focused on the encouragement of science and mathematics education at several educational levels of Finnish Society. The main aim was to raise the Finnish people's abilities in science and mathematics to the international level. The challenges met in Finnish Science and mathematics education prior to 1996 were defined as follows:

- There is not a sufficient amount of students studying mathematics, physics and chemistry at the upper secondary level to fulfil the needs of universities and polytechnics.
- Learning outcomes are not satisfactory to meet the necessary skills needed to explore and apply the content of Physics, Chemistry and Biology.
- The amount of professional subject teachers in mathematics and science education is limited.
- Girls are not interested in studying issues related to physics and technology.
- School studies in mathematics do not progress at an international level.

Although the project between the years 1996-2002 mainly focused on secondary, upper secondary, university and teacher education, it was also a large step towards supporting science and mathematics in early years education. Science education had not been previously included in ECEC or pre-school education and its role in basic education became clearer and more multidimensional than earlier. In the following years science education (called environmental and natural sciences) has been defined as one of the core academic subject areas in early years education, alongside the Finnish language and mathematics. In

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addition, several in-service courses for teachers have been provided by the National board of education to help teachers deal more easily with scientific issues.

Finnish success in International PISA studies has particularly increased international discussion concerning science education. During the last five years there have been several pieces of research and educational policy analyses (Pehkonen et al., 2007) considering Finnish science and mathematics education and its implications. These studies mainly focus on older students' achievements and progress; studies in the field of early years science education (from 0-10 year olds) are rare. The CLS project is therefore extremely significant for Finnish ECEC and primary education and aims to enhance the role of science and mathematics education at school, taking a new view of its learning through creativity.

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3. Research Questions and Methodology

3.1 Research Questions

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

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

The sub questions identified within this overarching research question were:

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

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

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

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

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

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3.2 Method

The aim of this report is to identify approaches advocated to teaching, learning, assessment and teacher training in science and mathematics education in the Early Years, as well as to record any links with IBSE and creativity. Analysis has been standardised and systemised through use of a questionnaire (see section 3.3 below). The questionnaire has been developed according to the project aims and key factors identified from the conceptual framework. The questionnaire has also been explicitly linked to the Teacher survey in order to provide comparisons between the approaches advocated in policy; these have been interpreted in practice. Using this approach, comparison with other partner countries will be possible.

The analysis of science and mathematics education in Finland differs with two age groups under foci in terms of its content and aims of learning, thus it has been conducted separately. The analysis focuses on Science and then reflects on any identifiable differences in approaches to Mathematics.

3.2.1 Selection of Documents

The aim of this report is to describe and map how teaching, learning and assessment issues of science and mathematics education are presented in Finnish policy documents, focusing on two parts of Early Years Education. Finnish Education is based on laws and acts concerning child daycare and basic education. However, the core references of this report are the national curriculum guidelines given as objectives for both age groups. These documents provide an exact description of the aims, approaches and priorities of science and mathematics education in accord with the laws and acts; the curricula are only documents which focus on practice. Some advisory texts have also been included for analysis, because they are written to support the teachers' work on curricula and other policy documents. Some supportive, current or critical views have been derived from presentations or research that is available and the references given here have been listed in both policy questionnaires.

3.2.2 Questionnaire and analysis method of the document

As a basic tool for policy document analysis, the policy questionnaire aims to address the main project research questions adapted for focus on approaches in recorded documents. The framework of the questionnaire is established in the CLS-project and is meant to be used as such in all national reports. As the various concepts or philosophy of national education provided may differ in the original references, the author's interpretation is needed to fulfil the aims of the analysis. In order to secure the transparency of analysis, evidence has been provided.

Analysis focuses on responding to a) which particular factors (determined in the project) are discussed in policy and b) which of these are presented using language relating to creativity. Creative dispositions are analysed according to the factors determined and the conceptual framework of the project.

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The analysis of documents follows the qualitative content analysis approach in which the content of phrases has been the principle of analysis. The analysis units (statements from the questionnaire) have been derived from the questionnaire and using the phenomena found from the documents under analysis, the aim is to describe how these fit the questionnaire. As a rule, the number of words has not been counted because the expressions used in different countries can vary depending on their translations and the content of particular terms.

The documents analyzed belonging to ECEC are widespan in nature and cover all activities; all aims, approaches and contents are not always explicitly focused on science or mathematics. Thus, the issues discussed are those relevant to the factors of policy analysis.

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4. Approaches to Teaching, Learning and Assessment

This section summarizes and reflects upon the findings of approaches to teaching, learning and assessment from the policy questionnaires, discussing separately education for 4-5 and 7-8 year olds. In the case of 4-5 year olds, the aims, curriculum, pedagogy and assessment dimensions are not directly focused on science and mathematics education. This is due to the fact that the rationale of ECEC education is to emphasize the integration of care, education and teaching and the content areas are seen as orientation areas for more integrative learning and developmental activities.

4.1 Rationale or Vision

The rationale in education for 4-5 year olds, sees science and mathematics as a context for the development of general skills and dispositions for learning. Science and mathematics education are not separated from other disciplines in terms of educational goals. Early childhood education and care is educational interaction which takes place in young children's different living environments and builds on a holistic view of children's growth, development and learning. In ECEC, education highlights personal experiences. The vision of learning rests on personal exploration, through which children become familiar with their immediate environment and nature around them.

The rationale of science education, through science, strengthens the pupils' development as citizens but emphasis on technology is also imperative. Science teaching and learning in basic education is based on investigative and exploratory work which aims to develop the pupils' scientific thinking and problem solving skills. The main task is to support pupils' understanding of the nature of science and to capture new scientific concepts, laws and models. In addition, providing opportunities for collaborative working and active participation during inquiry based learning is seen to be significant (see Anttalainen & Tulivuori, 2011.)

4.2 Aims and Objectives

In this section, I present the aims of science and maths from recorded documents. In addition, focusing on both science and mathematics education, there is analysis of the main differences between various phases of early years education.

<u>4-5 year olds' education</u>

According to the national curriculum guidelines on early childhood education and care (2004) orientation areas such as mathematics and natural science do exist. According to ECEC the child does not study the content of different orientations or different subjects and there are no requirements from learning outcomes. (National curriculum guidelines on early childhood education and care, 2004 p. 25.)

The aims of education for 4-5 year olds is to provide a general education of which science and maths orientation is a part.

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Educational goals are:

1. Promotion of personal well-being
2. Reinforcement of considerate behaviour and action towards others
3. Gradual build-up of independence

Its purpose is also to promote the child's positive self-image, his/her expressive and interactive skills as well as developing the process? of thinking (National curriculum guidelines on early childhood education and care, 2004: 15).

In addition to these educational goals, two rationales for ECEC education can be defined. **The Joy of learning** is an element in which all of the children's developmental areas (cognitive, social, emotional, kinetic and ethical) are included. The process of learning is based on the use of senses and continuous interaction with all participants of the learning process. Learning is effective when it is active and interesting and children have a feeling of success. The **role of language** is also emphasized. Language plays a vital role in the learning process from the viewpoint of knowledge construction and societal and cultural development. Language learning is seen as a creative and personal process.

Through description of the content and learning environment, it can be noticed that the aims of science education for 4-5 year olds highlight aspects which focus on **environmental awareness and responsibility, understanding and interaction with natural and science issues, as well as generally important attitudes and personal experiences**. ECEC encourages children to act independently and learn to think about other people, culture and environments. In addition, ECEC contributes to providing conditions favourable for the creation of a good society and our common world. The purpose of the role of creativity in science education becomes explicit in the areas which are highlighted. The creative approach can be shown through highlighting communication and language when developing environmental awareness and fostering personal experiences. Language learning is linked to the main learning situation and is always seen as a creative and personal process (National curriculum guidelines on early childhood education and care, 2004 p. 18). In general, children's self-expression and the way they act, play, move and explore are all crucial and foster their creativity. Through play and exploration, children create new things.

It is challenging to analyse aims and objectives in terms of 4-5 year olds' learning outcomes, because specific aims or learning outcomes have not been stated. However, through mirroring approaches, the environment, as well as the content of ECEC, some main paths can be shown. In the national curriculum guidelines, conceptual (understanding scientific ideas, knowing and understanding scientific processes) and social (communication about the scientific themes) factors are mentioned a number of times. Several of the procedural aims stated in the policy questionnaire were mentioned only once, although actions and participation are highlighted several times in the curriculum. Specific aims for asking questions or using simple equipment and tools were mentioned only once. Interest and motivation towards science was briefly considered but the aim was to foster children's individual curiosity and experience. Children's positive attitude towards learning and

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exploration are systematically motivated through the role of the teacher, artistic experiences, self-expression and exploration (National curriculum guidelines on early childhood education and care, 2004 p. 21-23).

7-8 year olds' education

Science as a subject in basic education, is carried out under the name of *Environmental and natural studies.* It is an integrated subject group (interdisciplinary) comprising of the fields of biology, geography, physics, chemistry and health education. The main aim of instruction for pupils to get to know and understand nature and the constructed environment, themselves and other people, human diversity, as well as health and disease. There are also other aims which support pupils'cultural awareness. According to the National core curriculum, the objectives of Environmental and natural studies are as follows:

Pupils will

- learn to behave safely so as to protect themselves in their immediate environment, in traffic and to follow instructions to ensure this aim;
- **get to know the natural** and constructed environments in their neighbourhood, **to observe changes** happening there and to perceive their home region as a part of Finland and the Nordic countries;
- learn **to obtain information** about nature and the environment by observing, investigating and using a variety of source material;
- learn **to make observations** using different senses and simple research tools and **to describe, compare and classify** their observations;
- learn to perform **simple scientific experiments**;
- learn to read and draft simple maps and use an atlas;
- learn **to represent information** about the environment and to describe and explain the phenomena and concepts embraced by those subjects;
- learn to protect nature and preserve natural resources;
- learn to develop their psychological and physical self-knowledge, respect for themselves as individuals, respect for others and social skills;
- learn concepts, vocabulary, and procedures relevant to health, disease, the promotion of health and to make choices to achieve this aim.

In primary education, learning outcomes focus strongly on using process skills to gather information from pupils' immediate surroundings. In addition, there seems to be emphasis on investigations, scientific experiments and learning to explain scientific concepts.

What are the main differences between preschool and school?

The main difference between ECEC and primary school education is that there are no goals for mathematics and science education in 4-5 year olds' education. In basic education, the aims and learning outcomes are presented but are not only focused on the age group of this project (7-10 year olds). The specific parameters between the different age groups in primary education are often set in school curricula and thus are not available in this analysis.

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The purposes and aims in terms of general education, seem to be very much the same: it aims to support children's abilities and skills in process skills (observing, describing) and inquiry (gathering data). In basic education, the aims and purposes are broader (including several content areas) and global (sustainability).

Differences between science and mathematics education

There are no significant differences in the aims and purposes of mathematics and science education in ECEC. The general aims of ECEC regulate both orientations of education.

In primary education, the aims and purposes of science and mathematics education differ and specific aims and content are defined for both learning areas. The aims of mathematics learning focus on the different ways of presenting mathematical concepts and formation processes. In addition, during grades 1-2, the main focus is on understanding the concept of the natural number and learning the basic computational skills appropriate to it. The core processes integral to the learning/teaching of mathematics are listening, communicating and developing the pupils' thinking. In science education, the aims focus on acquiring scientific knowledge through investigative and experiential approaches (learning skills, table 1). Both areas of science and mathematics aim to promote problem centred approaches and the use of one's own senses and individual needs when gathering data.

Table 1. Similarities and differences in the objectives of Environmental and natural studies and Mathematics

Types of objectives	Objectives of Environmental and natural studies	Objectives of Mathematics
Content specific	learn concepts, vocabulary, and procedures relevant to health, disease, the promotion of health and choices to achieve this aim	gain diverse experiences with different ways of presenting mathematical concepts; in the concept formation process, the focus will be on the spoken and written language , tools and symbols
	get to know the natural and constructed environments in their neighbourhood, to observe the changes happening there and to perceive their home region as a part of Finland and the Nordic countries.	understand that concepts form structures
	learn to protect nature and to preserve natural resources	understand the concept of the natural number and learn the basic computational skills appropriate to it.
		become practiced in making observations about mathematical problems

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Learning skills (process skills and inquiry skills)	learn to read and draft simple maps and use an atlas	learn to concentrate, listen, communicate and develop their thinking so as to derive satisfaction and pleasure from understanding and solving problems
	learn to make observations using different senses and simple research tools; to describe, compare and classify their observations	learn to justify their solutions and conclusions by means of pictures, concrete models and tools, either writing or orally; to find similarities, differences, regularities, cause –and-effect relationships
	learn to present information on the environment and to describe and explain those phenomena and concepts embraced by these subjects.	
	learn to perform simple scientific experiments	
	learn to make observations using different senses and simple research tools; to describe, compare and classify their observations.	
	learn to obtain information about nature and the environment by observing, investigating, and using a variety of source material.	

4.3 Content

Content is analysed according to curricula. In terms of the policy questionnaire, the main issues are considered by focusing on the inquiry approaches of learning. The National curriculum guidelines (2004) for ECEC (4-5 year olds' education) describe orientation in the following way:

Natural sciences' orientation

"The phenomena of the natural world are examined by observing, studying and experimenting. In the same way as above, the content areas of this orientation with their various phenomena, such as ***animals and plants found during the different seasons****, can be located in children's immediate environment indoors and outdoors. A typical feature of natural science orientation is the use of experimentation. Causal relationships become familiar in controlled conditions which help children gradually gain insight into natural phenomena and the factors influencing it."*

Mathematical orientation

"Mathematical orientation is based on ***making comparisons, conclusions and calculations in a closed conceptual system.*** *In ECEC, this takes place in a playful manner*

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in daily situations by using concrete material, objects and equipment that children know and find interesting."

In ECEC, specific content areas include issues which are not recommended for actual study but put more emphasis on varied experiences and environments which are used for supporting the children's growth and development in general. Only animals and plants are specified in content descriptions. Furthermore, in education, contexts of orientation are involved through communication between adults and children, using appropriate language and concepts to understand and learn new phenomena and concepts.

In basic education (7-8 year olds) the content of environmental and natural science is defined into six categories:

1. Organisms and living environments
2. One's immediate environment and home region and the world as a living environment for humans
3. Natural phenomena
4. Substances around us
5. Health and the Individual
6. Safety

The content used in environmental and natural studies is selected on the basis of the pupils' prerequisites and developmental level and organised as modules in which the pupils' own immediate living and learning environments are examined; the content is derived from children's own lives and experiences which follow the seasonal rhythm.

4.4 Learning activities

Learning activities are closely related and even interlinked with content and pedagogical approaches. As such, although the learning activities are difficult to separate from the content, the approaches are described. ECEC encourages exploration and different experiments to be carried out both indoors and outdoors. In addition, activities are recommended which focus on determining the causal relationships between concepts.

In primary education, the main themes of natural science orientation focus on encouraging children's processing skills, especially observing and experimenting. Because language learning is significant, description also plays an important role. Experimental activities and children's own activity are emphasized in many ways and becoming familiar with their own environment is integral to learning. Exploration mainly focuses on the natural sciences and the differences between the seasons. Although comparison is not clearly in focus, it seems that only seasonal differences are compared. In addition, process skills are needed when focusing on explaining causal relationships in controlled situations. According to the aims of learning, children's immediate environment should be under consideration in a multidimensional way. The main aim is to encourage and support pupils to understand their immediate environment and the human being's interaction with it (National board of education, 2004 p. 170).

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Instruction in environmental and natural studies relies on an investigative, problem centred approach; previous experiences, current skills and knowledge level form the basis for this. The learning process is linked to the affective dimension, pupils' current interests and their previous experiences. Environmental and natural studies aim to teach pupils to use process skills and conduct experiments. Reading and writing skills are also supported when documenting observations.

In what ways are Inquiry based approaches emphasized?

ECEC recommends several activities which emphasize Inquiry based learning, one of which is exploration (p. 23). According to curriculum guidelines, children's initial way of learning is linked?? to the sense of exploration and wonder. Children are curious by nature and they are easily inspired to spontaneous exploration through interaction with adults and peers. However, these explorations are not seen as a systematic problem solving process but more as experiences of trial and error. Thus, there seems to be room for fostering the elements which more profoundly support Inquiry based approaches.

In primary education (7-8 year olds) instruction is seen as investigative in nature and the problem centred approach is defined as a core method. Instruction should include experiences which develop a positive attitude towards science. Inquiry based approaches focus on observing and conducting investigations, but the role of designing and planning them is not highlighted in the core curriculum (see page 170). Similarly, questioning is not supported although planning, as a part of process skills, is emphasized in didactic material (see Aho et al. 2004).

Communication and collaboration are seen as being significant in general educational goals and working approaches (National board of education 2004, p. 12; 17), but is not specified in any subject area. Instruction in basic education supports learning that occurs through interaction among the pupils.

Role of creativity in the content and activities of science and mathematics education

ECEC emphasises several areas of creativity in science and mathematics education synergised in the project's conceptual framework; play and exploration are seen as a core approach for learning and activity. The joy derived from these activities is emphasized alongside the significant role of dialogue and collaboration. Affective dimensions such as motivation, have been mentioned in documents in several different instances but are not specifically focused on science or mathematics education. There are also some signs of problem solving approaches (probing questions, explorations, justifying) but these are not clearly stated nor are they profoundly connected to each other.

In primary education creativity is emphasized to a lesser extent. General working approaches in core curriculum stipulate that approaches used in instruction must also provide opportunities for creative activity. However, according to the creativity dispositions, problem solving and thinking skills are seen as a central role of working approaches. Other dimensions have rarely been mentioned in the core curriculum, but have been taken into

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account in teacher education material (Aho et al.2004). However, in Finnish science education, it does seem that creativity is not explicitly fostered in teaching and learning.

The main differences between ECEC and primary school in terms of the content and activities of science and mathematics education

The main difference between ECEC and primary school is the definition of content areas. In ECEC the content areas which refer to science and mathematics education are broadly considered and conceptually presented in different ways. In the basic education curriculum, the content areas are clearly stated and grouped into different categories; the aims of each content area have been defined and the expected learning outcomes have been stated. In EHEC, the orientation of the curriculum describes the recommended processes more than the content, whereas in basic education, content areas also have a strong role.

The activities in EHEC are more explorative and creativity becomes more crucial to learning. In primary education the content areas and knowledge of environmental and natural phenomena have a deeper role.

Differences between science and mathematics

The description of the content of science and mathematics in ECEC differs in two ways. Firstly, mathematics is set in the orientation area but science education is described as natural environmental sciences, which is more limited than the way in which science education is generally defined in Finland (Pehkonen et al. 2007; Aho et al. 2004). The orientation of Natural sciences particularly seems to leave out the content upon which the understanding of physics and chemistry is based. Secondly, mathematics education focuses on mathematical and general procedural skills but the content or mathematical concepts are not provided as a content of mathematical orientation. Natural science orientation provides both procedural and conceptual content areas, albeit in a superficial way.

4.5 Teacher Role/Pedagogy

In this chapter, the pedagogical approaches of early years education and the role of creativity in them are referred to in terms of policy documents. Inquiry approaches and differences are gathered from the view point of ECEC and primary education and the differences between science and mathematics are discussed. Pedagogical approaches are presented from the teacher viewpoint; what the teacher does to facilitate children's learning.

Pedagogical approaches

<u>4-5 year olds' education</u>

ECEC education strengthens the approaches which promote children's balanced growth, development and learning. The National curriculum guidelines for early childhood education (2004) especially focus on pedagogical approaches which are the basis for all education in ECEC. These approaches are applied to science and mathematics education and generally support the framework used in pre-school and basic education.

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Play, physical activities, artistic experiences, self-expression and exploration, are the approaches which are suggested to be taken into account in planning and implementing activities and to be used as a guiding principle in educators' work. Orientation areas such as mathematics and natural environmental science are embodied in these pedagogical approaches.

Play is seen more as an attitude than a practical activity. Playing is seen to be a significant part of the learning process during which children imitate and create new things; it can be defined through exploring, imaginary play and games with rules. In addition, there should be room for guided and unguided play, individual and group activities as well as spontaneous and planned play situations. The environment recommended for play takes into account children's current interests, available equipment and the indoor and outdoor space.

Physical activities as a pedagogical approach promotes children's well being, thinking skills and learning, experiencing joy and movement, expressing their feelings and being aware of themselves. The learning environment and activities should include daily physical activities for which there is enough space to move around and explore.

Artistic experiences and self-expression is seen to promote children's activation and to grip their attention. The aesthetic dimensions of life and learning are generally seen as significant in ECEC but especially in the process of developing as individuals and group members. Pedagogically, this means that teachers are able to give space and opportunity for such experiences and expressions in which children's own imagination and creativity is involved. Teachers need support in organizing environments and presenting the results of such experiences.

Exploration is seen as an approach in which children are able to use their curiosity and inspiration; its collaborative and communal nature is emphasized but individual experimenting is also taken into account. Exploration focuses on the living and natural environments which provide support for children's explorative activities.

Pedagogical approaches *in primary education* very much follow the learning approaches mentioned in the core curriculum. To fulfil the regulations set out for learning, the pedagogy relies on problem solving approaches in which new knowledge is built upon children's prior knowledge and experiences. In addition, the teaching and learning content must be related to children's everyday life and support their areas of interest. The subject of environmental and natural studies is integrative in its nature and the concepts being learned must be organized as modules; in these, the surrounding world, the pupils and their actions as members of a community are examined.

The pedagogy of Finnish primary science education rests on collaborative approaches in which language has a significant role in promoting children's critical thinking. Teachers are encouraged to establish a learning environment in which children have opportunities to explore and learn to use their process skills. These skills are put to use in authentic immediate environments, therefore outdoor activities play an essential role.

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When investigation and exploration are in question, in addition to the senses, simple research tools are used. Generally, 7-8 year old children gather their data through using their senses, but different science material can be used to promote this. Digital technologies are part of the learning process and these are currently being developed.

Ways in which the Inquiry based approaches are emphasized

Although Inquiry based approaches (questioning, gathering evidence, interpreting evidence and communication) are included in the pedagogical approaches of ECEC, these are not clearly stated; the role of questioning and interpretation remain at a very limited level. More emphasis has been given to communicating and the gathering of data using different approaches. In addition, inquiry based learning is linked with approaches such as observing, studying and experimenting.

The pedagogy of primary education supports the inquiry approach (guided inquiry) in general and is specifically in accord with the pedagogy of science education. Inquiry based approaches (questioning, gathering evidence, interpreting evidence and communicating) are included in the core curriculum (National board of education 2004) and also in teacher education material (Aho et al., 2004; Havu-Nuutinen & Ahtee, 2007). Science learning is based on investigative learning processes in which questions and problem probing are seen as starting points for learning. Through investigations, experiments and explorations, the pupil gathers data for interpretations. The learning process is seen as collaborative (teacher-child and peer communication) in nature (Aho et.al. 2004) but reflection and reasoning are not emphasized.

The role of creativity in science pedagogy

ECEC education focuses on several creative dispositions; children's sense of initiative and imagination are seen as pedagogical approaches which foster personal experiences and self-expression and such approaches are highlighted which give room to children's own imagination and creativity. It is also significant to take children's own natural curiosity into account in teaching and learning activities. In the national guidelines for ECEC, although other dispositions of creativity are involved in pedagogy such as innovative thinking, connection making, thinking skills and problem solving, they are not emphasized. It is valuable to encourage children's thinking skills and connection making through scientific approaches used in learning.

The main differences between pre school and school

No significant differences are apparent in the nature of ECEC and primary school education. Both emphasize the problem based and explorative pedagogy in which children's active role is essential. Basic education more clearly follows content based pedagogy while as far as kindergarten is concerned, the pedagogy is seen to be more integrative across orientation areas and emphasizes more creative dispositions. In comparison to studies at primary school, ECEC education is more indefinite in terms of the content and approaches of science

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education and widens the justification for ECEC pedagogy. The pre-school curriculum with its place between these two forms of education, makes learning more continuous.

Differences in pedagogy between science and mathematics education

Mathematics instruction must progress systematically and create a lasting foundation for the assimilation of mathematical concepts and structures, therefore the nature of pedagogy in science education seems to be explorative and in mathematics assimilative. Mathematics pedagogy aims to make a bridge between experiences and the abstract system of mathematics. Although concepts and conceptual understanding are also seen to be important in science education, it more explicitly relies on practical experiences and everyday life investigations, without highlighting scientific theories and laws.

4.6 Materials and Resources

ECEC education is based on the holistic view of learning in which materials and resources are also widely used. The starting point for learning is the use of the senses. Children initially acquire information through using their senses and afterwards use other means to achieve this aim. Policy documents do not mention any specific equipment for science, whereas concrete materials, objects and equipment are suggested for use in mathematics.

ECEC education recommends the use of stories and other play material and although it is thought that children should become aware of technological tools, the use of computers is not mentioned in documents.

Early childhood education focuses on multiprofessional cooperation in daily activities. Collaboration between professionals and parents is seen as an essential resource in education, although the role of people working together is not clearly defined and has sometimes caused problems (see Onnismaa & Kalliala, 2010).

The National board of education has published a separate handbook about science in primary education, its learning environment, safety and material. This particular handbook gives specific descriptions about the outdoor learning environment, the technological tools and suggested activities as well as the basic material for investigations and other science activities. The learning environment, including work in the laboratory, is also defined. At the end of the document there is list of learning materials and tools.

Differences between science and mathematics

The materials and equipment are well defined and guided in science education, but similar guidance is not provided in mathematics. In ECEC education, materials and equipment are mentioned in the curriculum and highlighted more than in science education; in basic education the situation is vice versa.

4.7 Groupings

According to policy documents, learning occurs in small peer groups or in whole classroom discussions. There are no specific guidelines for individual work or group work, but

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interaction between the children and their educators is mentioned several times in the ECEC curriculum.

ECEC emphasizes the individual learning process; therefore the child should be able to study in such a group which is best for his/her learning. Thus multimodal ways of grouping are common.

Primary education aims at collaboration and the sharing of ideas; pupils frequently work in pairs or in small groups (see Aho et al. 2004).

No differences exist between mathematics and science education.

4.8 Time

ECEC education integrates work with science and mathematics issues into other activities so there are no specific guidelines for the timing of these. According to the curriculum, teachers can choose how much time they allocate to science and mathematics, although different content areas must be kept in balance with other activities.

Primary education has national time frames for the number of working hours per week, per subject area; mathematics has more lessons per week than science. Science education has 1-2 hours per week and mathematics, 3-4 hours.

4.9 Assessment

This section is considered in terms of the aims, purposes and ways of assessment.

In ECEC (4-5 year olds' education), the learning process and its outcomes are not assessed through summative or formative assessment criteria and there are no specific assessment criteria for science and mathematics education. ECEC bases evaluation on the child's individual ECEC plan drawn up jointly by the staff and the child's parents. The idea of this plan is firstly to map and document the child's individual experiences, strengths and needs which should be taken account in ECEC education. The plan takes into consideration the dimensions through which the child's development can be supported in the future and it is monitored and regularly assessed by teachers and parents.

The assessment of skills and knowledge is conducted to the very minimum. As a part of ECEC support, there is mention of the cognitive environment and the need for practising basic skills but no clear purpose of assessing inquiry skills or the knowledge of science or maths exists. Similarly, the skills and dispositions associated with creativity are not discussed in terms of assessment.

Observation and reflective multiprofessional discussions are used as a method of assessment. The child's individual needs are assessed based on the everyday experiences perceived in interaction with the child. There are no other specific methods mentioned for evaluation, but interactive methods are recommended for use.

In primary school, assessment focuses both on the learning processes and conceptual understanding. The core curriculum provides descriptions of good performance for use at

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the end of the fourth grade in science activities and other different content areas. These descriptions guide teachers when creating criteria for assessment. The grounds for assessments must be provided by the teacher in advance, but different kinds of approaches are recommended such as numerical assessments, verbal summaries, a combinations of these two, intermediate reports, as well as different types of notices and assessment discussions (National board of education, 2004 p. 260-261.)

Assessment must be based on a diversity of evidence and must focus on pupils' learning and progress in different areas. The learning process has a central role, thus ongoing feedback is also part of assessment.

Through assessment, pupils become aware of their thinking and action and this in turn helps them to understand what and why they are learning.

At primary school, both a formative and summative assessment should be made to inform pupils of their progress and development.

The main differences between pre school and school

The School core curriculum describes criteria for good performance in science and mathematics education which enables assessment to be guided and systematic throughout the whole country. Assessment In ECEC describes the individual's progress but no general criteria are stated. At school there are learning outcomes, but these are not provided in ECEC.

The differences between science and mathematics

General approaches and requirements are similar in both subject areas (assessment progress, skills and knowledge). At the national level there are no clear differences.

The role of creativity in assessment

The national documents on guidance do not strictly define the ways of assessment and evaluation, so although it is not explicitly mentioned, this allows creativity in assessment. Reflective and constructive ways of assessment provide a creative base for monitoring progress, despite the fact that the documents do not clearly state from where to start.

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5. Approaches to Teacher Education

5.1 Initial teacher education

The requirements of Teacher Training

Finns hold the teaching profession in high esteem and only a small proportion of those applying for teacher education are admitted. Finnish universities provide teacher education for the following sectors:

- Kindergarten teachers
- Class teachers
- Subject teachers
  Teachers for special education
- Counsellors

The Finnish government regulates the norms and qualifications necessary for students to participate in teacher education, but a national teacher training curricula does not exist in Finland and the content of teacher education is determined by each university.

In 4-5 year olds' education, within the domain of ECEC, adults work in multiprofessional teams which are built up of persons with several educational backgrounds. Professionals in Finnish day care centres consist of kindergarten teachers who have either completed a Bachelor's degree (university education) or have a Social pedagogue's (polytechnic) training with a minimum of 60 credits in early childhood education. In addition, there are nursery nurses, who have vocational training (secondary level) in practical nursing. Kindergarten teachers are responsible for the children and the teaching. The national requirements for kindergarten teacher education are stipulated in the law on university degrees.

Primary school teachers are trained in class teacher education and become qualified to teach grades 1-6. Class teacher qualifications are achieved by taking a Master of Education degree and by completing teacher's pedagogical studies and multidisciplinary studies in the subjects taught in basic education. A subject teacher who has completed the multidisciplinary studies will also be granted a class teacher qualification.

The Ministry of Education defines the number of studying places for each university and the universities select the applicants through a two-phase entrance exam(see Figure 2.). Firstly students participate in the national written exams, after which some of the students are selected for the second phase; this comprises of an interview and group discussions.

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Figure 2. Initial Teacher Education provided by Universities in Finland (see https://sool-fi.directo.fi/okopa/)

Pedagogical approaches advocated in Teacher Training regulations

The pedagogical approaches used in teacher training are not determined in national regulations; each university has its own curriculum and a number of different approaches are in use in teacher education. The major subject in teacher education is pedagogy/educational sciences (in Helsinki university also educational psychology).

In class teacher education, the teacher's pedagogical studies are didactically emphasized and include mentored teacher internship/teaching practice.

In both kindergarten and class teacher education, teaching practice is set down by law and belongs to the student's pedagogical studies:

- Orientation practice
- Basic practice
- Applied practice
- Final or advanced practice

Teaching practice in Kindergarten teacher education is conducted in different kindergartens and supervised by an experienced kindergarten teacher. According to the practice in question (phase of studies), each practice has its own aims which are determined in the curricula.

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The qualities emphasized in teacher assessment

At the national level, there are no assessment criteria for teacher education. Teacher education must provide studies which give competence to work as a teacher and take responsibility for all duties determined by the school and in the curriculum. The Ministry of Education regularly monitors teacher education through systematic evaluations carried out by committees designated to this task.

The role of creativity in Teacher Training

The content and approaches are not determined in national documents. Thus the role of creativity varies in different teacher education programmes and there are no national recommendations which relate to this.

The main differences between training for pre school and school

Kindergarten teachers have a three- year Bachelor education programme (main subject education); class teachers' Master's education (main subject education) lasts five years. Kindergarten teachers focus on themes of educational caring and nurturing while class teachers focus on the pedagogies of school subject areas, educational science and educational research.

5.2 Continuous teacher education

Teachers already active in working life can update their professional competence on an ongoing basis. The purpose of continuing professional education is to maintain and update teachers' pedagogical skills. It has been found that continuing education also promotes teachers' satisfaction at work. Continuous training is voluntary for teachers but the majority of them participate every year. It is provided free of charge for teachers and full pay is granted to them during the days of training

Responsibility for teachers' in-service training mainly rests with their employers who are usually the local authorities. They have an obligation to provide teachers with a minimum of three days of training every year. In addition to this, the central government also arranges continuing training which is mostly related to the use of ICT in education. Other topical themes are counselling and guidance; the development of special-needs education, curricular development, virtual pedagogy and media education, mathematics and natural sciences, languages and the development of vocational education and training.

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6. Summary

According to current legislation, Finnish school policy guidance is mainly based on the regulations provided by the law for basic education and its implicational document, the National Core Curriculum for Basic Education. Because basic education and early childhood education currently belongs to different areas of administration, the Core curriculum for Early Childhood Education and Care (ECEC) is established by the Centre for Welfare and Health. As a result, gaps exist between ECEC and basic education due to the different action cultures (different guiding legislations and regulations) and teachers' pedagogical thinking (different kinds of teacher education) (see Haring *et al*., 2008). Pre-school, in its position between these two sectors of education, has been established to support the child's transition from ECEC to school.

From the viewpoint of science education, the biggest change in the 1990s was the launching of the new school subject "Environmental and Natural Studies". This integrative subject is based on the combination of several disciplines belonging to natural and social sciences. The main aim of the subject is to support and guide pupils' growth into becoming investigative, active citizens who are interested in nature, the study of nature and nature conservation. Environmental and Natural studies include several social and cultural approaches and their objectives have also been established. As such, through science, Finnish education clearly focuses on the child's development as a citizen (scientific literacy). According to Tani (2004) scientific approaches strengthen process skills (observing, comparing, interpreting and assessing) while the methods which support culture and societal orientation are missing (see Tani, 2004). Thus, although the Environmental and Natural studies are presented as an interdisciplinary subject, there is a strong focus on scientific knowledge and processes.

The early years' Science and mathematics education in Finland seems to encompass the requirements of inquiry which focuses on investigative approaches in instruction.However, investigative means more exploration and the use of process skills for data gathering, rather than planning and conducting investigations and projects. Project work is taken into account by emphasizing the interdisciplinary nature of the subject, but the approach is not mentioned concretely.

In terms of inquiry approaches, questioning as a teaching and learning approach remains only at the minimum level in policy guiding documents. In addition, problem probing and problem solving approaches in mathematics education are not systematically reflected in the same way as in science education; the main method used in mathematics seems to be the use of assimilation with numbers and the counting system.

According to policy documents, creativity dispositions are involved in science and mathematics education even though they are not explicitly mentioned. Finnish education in general, aims to increase pupils' motivation and interest to learn, to learn science and mathematics and to find new information through problem solving and investigative approaches. Science and mathematics education puts emphasis on thinking and process

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skills, in order to achieve these more demanding targets. In addition, the sense of initiative is included in several sections of policy texts.

Teaching staff take a positive view of in-service training and there has been an increase in participation particularly in the areas stressed in the development programme. However, ensuring equal access to continuing education in different regions and for different teacher groups (Ministry of Education, 2006) has proved to be problematic and has not been realized in various working communities. In-service training does not cater adequately for the different needs which arise at different stages of a teaching career. Thus, for example, the possibility of strengthening abilities in science and mathematics education is not always dependent on the interest of pupils or teachers.

6.1 Limitations

Analysis of the national policy of science and mathematics education in Finland, is based on documents which are steering documents or which are the national guidelines for conducting education with children. As mentioned in the first chapter of this document, in accord with these national documents, the final decisions and approaches are made at the local level. Local documents provide the guidelines for practices in each municipality and at each school. In addition, the curricula, the approaches used and the material, are all determined by the teachers themselves. Because this results in variations and differences between schools and municipalities, this analysis cannot reveal the reality in terms of activities, aims, pedagogy and assessment, but can only provide a scope for the aims, strategies and values of educational policy throughout the whole country.

This analysis has focused on science and mathematics education and the role of creativity in these areas. In Finnish Early Childhood Education, science and mathematics are not systematically studied nor are there specific aims for learning. As such, in this analysis there is a strong interrelationship between the aims, approaches and pedagogy, because policy documents do not provide any specific statements for each of the areas separately analyzed in this document. In basic education, the aims, approaches (methods) and the teachers' role are specified more systematically, albeit on a very broad level. Exact interpretations cannot be made.

6.2 Implications

According to national policy guidance, there is need not only for further research on aims and purposes, but also on the pedagogy and learning activities which focus on creativity. The National core curriculum focuses on the several creativity dispositions defined in the CLS project, but do not refer to those aiming to develop creativity. It seems that creativity, as it is defined in the project, is not similarly forming a basis in Finnish education. The national guidance takes creativity into account, but leaves it without any definition or framework. It is therefore interesting to explore how Finnish teachers define the concept of creativity and its role in their pedagogical thinking and experiences of teaching. In addition, a field study could provide information on the importance children place on creativity dispositions and their views on learning.

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There has been a study in Finland on the continuum from pre-school to the first grade in primary school. This project does not give opportunity for reflection because of the gap in one age group. However, it is interesting to compare the educational ethos of these two different systems of education, especially focusing on creativity, science and mathematics education. Only a few studies exist concerning this field in early years education in Finland.

In terms of teacher education, it would be significant to explore teachers' views and attitudes on early years science and mathematics education and how teacher education, both initial and continuous, supports their professional development in this area. It might be relevant to focus on teachers' pedagogical thinking and attempt to model how teachers in early years education see science and the role of creativity in it.

In the end, it might be relevant to mention that even though Finnish teacher education has achieved a high level and status in the educational field, there is still a continual lack of science and mathematics teachers (Ministry of Education, 2006). Thus new teacher programmes have been established in order to strengthen science and mathematics education at school and in teacher education. These make it obligatory for advanced studies of science and mathematics education to be included in primary teacher training. These programmes demand relevant material for the improvement of early years science education in Finland.

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Appendix A: Linking Policy Questions to Main Research Questions

CLS Research Questions	Policy Focus RQs	More focused policy questions	Linked questions in TEACHER SURVEY
1. How is teaching, learning and assessment of S/M conceptualised? What role does creativity play in these? (teachers and policy) ? also IBSE? (both policy and teachers)			**Aims**
	What are the **aims** of Science and Mathematics in policy? And the role of **Creativity?**	What importance is given to particular approaches to S & M?	21 Please indicate your views on the importance of the following purposes of school science in compulsory education (5 to 16-year-olds)
		What importance is given to particular outcomes in S&M?	22 Now focusing on the age group you teach, please indicate your views about the importance of the following science learning outcomes.
		What importance is given to particular assessment purposes in S&M?	23 Please indicate your views on the importance of the following purposes of assessment in pre-school or first years of compulsory education. (Select what applies in your case)
			24 Now focusing on the age group you teach, please indicate your views about the importance of the following aims of children's assessment in science education.
	What are the **aims** of Science and Mathematics teacher training in policy? And the role of **Creativity?**	What knowledge, skills and qualities are emphasised in teacher training?	
		Why do we train teachers?	

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			Teaching and Learning Approaches
	What content and activities are advocated through the **curriculum?** And the role of **Creativity?**	What are the prescribed learning domains / areas?	26 List five (5) science topics/areas that you addressed in your teaching this school year
		What, if any, is the prescribed time for teaching Science?	25 About how much time do you have planned for teaching SCIENCE and MATHEMATICS per week? (Please estimate).
		What, if any, are the promoted learning activities?	31 & 32 How often do you encourage children to undertake the following activities in SCIENCE?
2. What approaches are used in the teaching, learning and assessment of S/M? What role does creativity play in these? What are the opportunities and challenges for skills/attitudes associated with creativity?		What, if any, are the promoted learning outcomes?	33 How often as part of your SCIENCE teaching do you foster the development of the following learning outcomes?
		What kinds of materials are emphasised for supporting S&M learning and teaching?	41 How often do you use the following resources in your SCIENCE and MATHEMATICS teaching?
	What **Pedagogical** approaches are advocated? And the role of **Creativity?**	What teaching Contexts are recommended?	27 & 28 & 29 How often do you use the following learning/teaching contexts and approaches in your SCIENCE teaching?
		What Teaching approaches are promoted?	Mixed with above
		How far is children's agency emphasised?	34 For each of the INQUIRY features please indicate the variation (A, B or C) from the table above that MOSTLY characterizes your approach in the SCIENCE classroom.
			35 How strongly do you agree or disagree with each of the following statements about the role of teacher in fostering INQUIRY skills?

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			Assessment Approaches
	What is **assessed** and how is it assessed? And the role of **Creativity?**	What are teachers expected to assess?	38 How often do you use ASSESSMENTS of children in SCIENCE for the following purposes?
		What constitutes assessment evidence?	36 How often do you assess your pupils in science in the following ways?
		How is assessment information meant to be used?	37 How often do you reward the following characteristics in your pupils in science?
			(Not in Teacher Survey)
	What **pedagogical** approaches are advocated in Teacher Training Regulations? And the role of **Creativity?**	What approaches are encouraged for setting up the context for learning?	Linked to 26,27 and 28 above
		What approaches are encouraged for interaction with children?	

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

Key

E: Early (ages 4-5)

F: First (ages 7-8)

Rationale or Vision

Ai. What are the purposes of science Education?

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

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

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

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Aims and Objectives

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

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

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

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
To know and understand the important scientific ideas (facts, concepts, laws and theories).		F		E
To understand that scientists describe the investigations in ways that enable others to repeat the investigations.		E/F		
To be able to ask a question about objects, organisms, and events in the environment.		F	E	
To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.		E	F	

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To know and understand the important scientific processes.		F	E	
To be able to communicate investigations and explanations.			F	E
To understand that scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.		F	E	
To have positive attitudes to science learning.		E	F	
To be interested in science.			F	E
To be able to plan and conduct a simple investigation.			E/F	
To have positive attitudes to learning.		F	E	
To understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).		E/F		
To be able to collaborate with other children		F	E/F	
.n. Other				

Content

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

	As its own learning area	Encompassed within other social sciences (e.g. geography)	Encompassed within more general understanding
science		F	E
mathematics	E/F		E

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

	science	mathematics
1	E: Process skills F: To learn several content areas/ To learn conceptual knowledge	E: Process skills F: To learn numbers and operations
2	E: Explorations F: To learn procedural knowledge	E: Counting, calculation F: To learn to use symbols and tools
3	E: Animal and plants F: To learn process skills	E: Playfullness F: To learn problem soving skills
4	E: Seasons F: To learn problem solving skills	E: Using concrete materials and tools
5	E: Scientific experiments	

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Learning Activities

Ai. What activities are encouraged?

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

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

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

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Teacher Role / Location

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

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

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

	Counter Creative Emphasis	No Creative Emphasis	Slight Creative Emphasis	Highly Creative Emphasis
Open/unstructured play				E
Role/Pretend play				E
Drama				
Teaching science from stories		E		
Using history to teach science (e.g. transport, the work of scientists)		E		
Working in small groups		F	E	
Physical exploration of materials		E/F		
Using outdoor learning activities			E/F	

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Taking children on field trips and/or visits to science museums and industry		F	E	
Integrating science with other curricular areas			E/F	
Building on children's prior experiences		E	F	
Fostering collaboration			F	E
Encouraging different ways of recording and expressing ideas – oral, visual, digital, practical		F	E	
Encouraging problem finding – e.g. children asking questions		F		E
Encouraging problem solving – e.g. children solving practical tasks		F		
Encouraging children to try out their own ideas in investigations		F		E
Fostering classroom discussion and evaluation of alternative ideas		F	E	
Fostering imagination		F		E
Relating science to everyday life		E	F	
Using questioning as a tool in science teaching		F	E	
Using digital technologies with children for science teaching and learning		E/F	F	
Fostering autonomous learning		F	E	

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

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

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Materials and Resources

A. What materials are suggested?

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

Groupings

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

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

Time

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

	science	mathematics
Less than an hour		
1-2 h	F	
3-4 h		F
More than 4 h		
N/A (Please explain)	E	E

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Assessment

A: What purposes of assessment are included?

	Not Mentioned	Single Mention	Various Mentions	Emphasised
To identify areas for improvement in your science teaching	E			
To identify aspects of the science curriculum that could be improved		E		
To identify ways to improve child science learning	E			
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				E
To help group children for science instruction purposes	E			
To monitor year-to-year child progress in science		E		
To provide feedback to children about their progress in science	E			
To set targets with children for their own development in science		E		
Other				

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

To assess the development of children's:

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

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C. What ways of assessing are advocated?

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

D. What Creative attributes are addressed in assessment?

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

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