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

D3.1 List of Mapping and Comparison Factors

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creative little SCIENTISTS

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D3.1 List of Mapping and Comparison Factors

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0	22.3.2012	UEF	Preliminary list of factors for project meeting
1	30.3.2012	UEF	First draft of Scope of D3.1
2	3.4.2012	AUC, IoE, BG, NILRP, UPJV,UoM,GUF, EA, UEF	Comments / corrections/ development for second draft of D3.1
3	5.4.2012	UEF	Second draft of D3.1
4	12.4.2012	UEF	Third draft of D3.1
5	21.4.2012	UEF	Fourth draft of D3.1to circulate to the partners
6	15.5.2012	UEF	Final draft to circulate to the partners
	23.5.2012	AUC, IoE, BG, NILRP, UPJV, EA	Comments / corrections / and new version for development final version of D3.1
7	27.6.2012	UEF and EA	New advanced draft of deliverable to be sent out for QA
QA	28.6.2012		QA by Prof. Derek Bell
8	02.07.2012	UEF	Final document to submission
9	10.07.2012	EA	Submission to EC

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EXECUTIVE SUMMARY

Scope and aims of the deliverable

The deliverable 'List of Mapping and Comparison Factors' is the outcome of work carried out in Task 3.1 and aims to provide the key factors for the mapping and comparison of existing approaches of policy and practice in pre-school and first years of compulsory school science and mathematics, across the *Creative Little Scientists* partner countries, based on the concepts identified in the project's Conceptual Framework (Deliverable D2.2). These factors encompass the key features and processes of science and mathematics teaching, learning and assessment, highlighting those in the common conceptual ground between creativity and inquiry based science and mathematics education.

The factors have been extracted from the conceptual framework and literature reviews (Deliverable D2.2) produced in the project. The contextual descriptions and theoretical background of factors are therefore explained and justified in detail in that deliverable (D2.2).

In general the 'List of Mapping and Comparison Factors' aims to use the concepts identified in Work Package 2 (WP2):

- to define the key factors that characterise the common ground that early years science and mathematics education can share with creativity;
- to provide the analytical concepts to guide the development of the research tools to be used in the first empirical research phase of the project (i.e. desk research and teacher survey);
- to provide an analysis schema for the data collected in the desk research and teacher survey;
- to provide the scope and parameters for mapping and comparing existing approaches and practices.

This deliverable is tightly linked to the purposes of both the desk research (Task 3.2) and first-level field research (Task 3.3) and was originally intended to precede them and act as their guiding document. However, the work on these tasks started earlier than originally scheduled, and as a consequence the list of factors has been created in parallel with, rather than in precedence to, the development of the research instruments used in the desk research on existing approaches, as these are reflected in policy records (Task 3.2), and in the survey of school practice (Task 3.3).

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Categorisation of factors and their relationship to the project's research questions

The list of factors reflects the concepts and processes identified in the project's conceptual framework as characterising creative practices in early years science and mathematics education. The conceptual framework suggested that the following three broad strands running through all research questions might focus on:

- **Aims/purpose/priorities**, including teachers' and national policies' conceptualisations of the aims and purposes of science and mathematics education and the role of creativity in them;
- **Teaching, learning and assessment**, including use of inquiry activities, dynamics between teachers and children, also how teachers assess creativity in early science and mathematics education;
- **Contextual factors**, including resources used or prescribed, teacher characteristics and competencies, curriculum, institutional factors.

This deliverable (D3.1) has implemented this suggestion, to ensure consistency between the conceptual and operational research frameworks. It has further elaborated these three broad strands into a number of sub-dimensions, which represent both key aspects of learning in schools and key teacher-related factors. The former draw on the framework of curriculum components 'the vulnerable spider web' (van den Akker, 2010), which is also used to guide the development of the 'prototypical' curriculum design principles for teacher education in Task 5.1 of Work Package 5.

To sum up, the mapping and comparison factors in D3.1 are grouped and presented under the following headings, which aim to address the corresponding key general questions:

Aims/purpose/priorities:

- Rationale or vision: Why are children learning?
- Aims and objectives: Toward which goals are children learning?

Teaching, learning and assessment:

- Learning Activities: How are children learning?
- Pedagogy: How is the teacher facilitating learning?
- Assessment: How is the teacher assessing how far children's learning has progressed, and how is s/he using this information to inform planning and develop practice?

Contextual factors:

Curriculum-related

- Content: What are children learning?
- Location: Where are children learning?

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- Materials and Resources: With what are children learning?
- Grouping: With whom are children learning?
- Time: When are children learning?

Teacher-related

- Personal Characteristics
- General Education and Training
- Work Experience
- Science and Mathematics Knowledge, Skills and Confidence
- Initial Teacher Education
- Continuing Professional Development

The selection of this categorisation for the presentation and discussion of the mapping and comparison factors does not only reflect the strong relationship between this deliverable and the state-of-the-art theoretical knowledge produced in WP2, but also the consistency in approach between the comparative research, which concludes in Deliverable D3.4, and the production of the prototypical design principles and guidelines for teacher education in WP5.

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TABLE OF CONTENTS

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

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I. INTRODUCTION

A. Aims of the document

This document is the deliverable of Task 3.1.This aims to present the factors to be used for mapping and comparing existing approaches and practices in science and mathematics teaching, learning and assessment, and their relationship with the development of creativity in pre-school and the first years of primary school, in the context of inquiry-based education. The following list of factors sets out the framework and specific parameters for the first empirical research phase of the project, that is the desk research in Task 3.2 and the teacher survey in Task 3.3, and subsequently for the comparative report (Task 3.4). In Tasks 3.2 and 3.3, the factors are used to develop the research instruments for data collection. The factors also provide a tool for data analysis, defining the units of analysis and structuring the presentation of the findings. Finally, the factors will play an essential role in the synthesis and comparison of the findings from the desk research and teacher survey in the resulting comparative report (Deliverable D3.4).

The Deliverable D3.1 presents the factors as a list, shortly describing the nature of the factors in each category. The factors listed in this deliverable are developed, based on the conceptual framework of the project and the literature reviews accompanying the conceptual framework (Deliverable D2.2). The list of factors follows overall the concepts and terms identified in this conceptual framework, elaborating in some cases with more detailed and concrete terminology. Significant additions of concepts have been avoided. Therefore, a full account of how these factors are derived from the literature, as well as of their significance and meaning for the project is already given in the conceptual framework and is not repeated here.

The list of factors can be seen as providing a “bridge” between the theoretical understanding (developed in Work Package 2) of the issues that lie in the common ground shared by early years science and mathematics education and creativity, and the need to capture the practical and empirical contexts of the relevant practices in the studies conducted in Work Package 3 (WP3). The factors assist the researchers to focus on theoretically significant concepts, processes or characteristics in the empirical research phase in Tasks 3.2 and 3.3. In addition, the list of factors supports the project in its aim to achieve equal and valid comparisons between the approaches and practices of the partner countries in Task 3.4.

As previously mentioned, this deliverable is tightly linked to the purposes of both the desk research (Task 3.2) and first-level field research (Task 3.3) and was originally intended to precede them and act as their guiding document. However, due to practical considerations linked with time available within the school year in each partner country to carry out the teacher survey, the work on these tasks started earlier than originally scheduled, and as a consequence the list of factors has been created in parallel with, rather than in precedence

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to, the development of the research instruments used in the desk research on existing approaches, as these are reflected in policy records (Task 3.2), and in the survey of school practice (Task 3.3). This parallel development of all three tasks has strengthened the validity of the identified factors, since their understanding and usefulness in describing practice focusing on the issues of importance to the project in all partner countries has to a large extent already been confirmed; both in the first stages of the desk research where partners had to use these factors to interrogate their policy documents, but most importantly in the pilot phase of the teacher survey, where teachers had to make sense of them to answer the relevant survey questions. Feedback from the pilot phase was also used to finalise the factors and establish a shared understanding of their meaning in the different languages of the consortium in which these have been translated.

The factors are given varying emphasis in the different tasks of WP3, as these shed a different light on the research questions of the project. Moreover, the relevance of these factors varies across the different levels of approaches and practices addressed by the WP3 tasks. These levels can be distinguished as:

- **supra** level: international/comparative level, addressed in Task 3.4;
- **macro** level: system/society/nation/state level, addressed in Task 3.2;
- **meso** level: school/institution level, addressed in Tasks 3.2 and 3.3;
- **micro** level: classroom level, addressed in Task 3.3;
- **nano** level: individual/personal level, addressed in Task 3.3.

Therefore, the key factors are defined and separately analysed in each WP3 task, and their role and limitations are explicitly discussed in the corresponding deliverables (D3.2, D3.3 and D3.4).

To summarise the discussion above, the list of mapping and comparison factors aims:

- to define the key factors that characterise the common ground that science and mathematics education in pre-school and early primary school can share with creativity, as this is described in the project's conceptual framework;
- to provide the analytical concepts to guide the development of the research instruments used in the first empirical research phase of the project (i.e. desk research and teacher survey);
- to provide an analysis schema for the data collected in the desk research and teacher survey;
- to provide the scope and parameters for mapping and comparing existing approaches and practices.

B. Construction and structure of the list of factors

In the initial phase, the factors were constructed from the conceptual framework which focuses on the core issues of science and mathematics education and creativity education

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derived from the research literature. A number of factors were also drawn from the outcomes and implications section in the conceptual framework, which reflects on the aims of the research and states the project's research questions. In the second phase, following the presentations of the related literature reviews, held at the Paris project meeting (2nd project meeting on March 22-24, 2012), the initial factors were revised and improved. In the third phase, as a result of e-mail comments and discussions, the list of factors was reconstructed in collaboration with all project partners and task leaders of WP3. The final categorisation of the list of factors was provided by the project coordinator and is based on the one hand on the three broad strands suggested in the conceptual framework as running alongside all research questions and on the other hand on the framework of curriculum components 'the vulnerable spider web' (van den Akker, 2010) used to guide the development of the 'prototypical' curriculum design principles for teacher education in Task 5.1 of Work Package 5.

In particular, the conceptual framework suggested that the following three broad strands running through all research questions might be a focus on:

- Aims/purpose/priorities, including teachers' and national policies' conceptualisations of the aims and purposes of science and mathematics education and the role of creativity in them;
- Teaching, learning and assessment, including use of inquiry activities, dynamics between teachers and children, also how teachers assess creativity in early science and mathematics education;
- Contextual factors, including resources used or prescribed, teacher characteristics and competencies, curriculum, institutional factors.

D3.1 adopted this suggestion to ensure consistency between the conceptual and operational research frameworks. Moreover, we went further to elaborate these three broad strands into a number of sub-dimensions, which represent both key aspects of learning in schools and key teacher-related factors. The former draw on the framework of curriculum components 'the vulnerable spider web' (van den Akker, 2010). The latter aim to include factors of interest to the work carried out in WP5 on developing directions for teacher training.

To sum up, the mapping and comparison factors in D3.1 are grouped and presented under the following headings, which aim to address the corresponding key general questions:

Aims/purpose/priorities:

- Rationale or vision: Why are children learning?
- Aims and objectives: Toward which goals are children learning?

Teaching, learning and assessment:

- Learning Activities: How are children learning?

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- Pedagogy: How is the teacher facilitating learning?
- Assessment: How is the teacher assessing how far children's learning has progressed, and how is s/he using this information to inform planning and develop practice?

Contextual factors:

Curriculum-related

- Content: What are children learning?
- Location: Where are children learning?
- Materials and Resources: With what are children learning?
- Grouping: With whom are children learning?
- Time: When are children learning?

Teacher-related

- Personal Characteristics
- General Education and Training
- Work Experience
- Science and Mathematics Knowledge, Skills and Confidence
- Initial Teacher Education
- Continuing Professional Development

The selection of this categorisation for the presentation and discussion of the mapping and comparison factors does not only reflect the strong relationship between this deliverable and the state-of-the-art theoretical knowledge produced in WP2, but also the consistency in approach between the comparative research and the production of the prototypical design principles and guidelines for teacher education in WP5.

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II. LIST OF FACTORS

The factors presented below focus both on learning and teaching aspects, characterising the teaching and learning approaches and educational contexts involved in the teaching learning and assessing of science and mathematics as these are realised in the school context but also conceptualised by teachers and in the relevant policy documents.

It is important to note that the factors proposed are thought of as 'creativity enabling' indicators, that is they are not meant to map all the current approaches to and practices of early years science and mathematics education, but to identify those approaches and practices which have a strong potential to foster the development of creative skills in children.

Creative Little Scientists is an international project. Research work must take into account several aspects of national differences between the partner countries and address the challenges involved in comparative studies (see Deliverable D2.2). Thus the factors include a number of contextual factors, which although not explicitly described in the conceptual framework, are essential for comparing intelligently the mapped approaches and practices.

A. Aims/Purpose/Priorities of Early Years Science and Mathematics Education

A1. Rationale or vision: Why are children learning?

The 'rationale' refers to the overall principles or central mission of science and mathematics education in the partner countries. This dimension serves as a major orientation point, and the nine other dimensions are ideally linked to that rationale and preferably also consistent with each other. The corresponding factors, reflecting also the drivers behind this project and the wider educational context in which it is being undertaken, are:

- science economic imperative;
- creativity economic imperative;
- scientific literacy and numeracy for society and individual (including the development of the child as a citizen through science);
- technological imperative;
- science and mathematics education as a context for the development of general skills and dispositions for learning.

A2. Aims and Objectives: Toward which goals are children learning?

Policy documents at the macro-level will usually focus on this dimension of factors. Teachers' conceptualisations of these aims and objectives are also important to map in relation to classroom practices. The question investigated here is whether policy and teachers see science education in the early years as offering opportunities to foster and draw together processes and concepts and attitudes in building on children's curiosity and

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concern to investigate and explain the world around them from their earliest years. The corresponding factors are:

- knowledge/understanding of science content (ideas/concepts and processes)
- understanding about scientific inquiry (how scientists develop knowledge and understanding of the surrounding world)
- science process skills, such as:
  - predicting
  - observing
  - measuring
  - describing
  - classifying
- capabilities to carry out scientific inquiry or problem-based activities, such as:
  - questioning
  - gathering evidence
  - interpreting evidence
  - communicating findings
- social factors of science learning, such as:
  - collaborative and communal engagement
  - communication
- affective factors of science learning, such as:
  - attitudes to science
  - attitudes to science learning
  - attitudes to learning
- creative dispositions, such as:
  - sense of initiative
  - motivation
  - innovative thinking
  - connections making
  - imagination
  - curiosity
  - creative thinking skills
  - problem solving skills
  - reasoning skills

B. Teaching, Learning and Assessment in Early Years Science and Mathematics Education

The factors grouped under the teaching, learning and assessment strand focus on the dimensions which refer to the learning activities, pedagogy, and assessment dimensions of early years science and mathematics education. These dimensions and corresponding factors are at the core of the micro-curriculum in the classroom. The dimension of

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assessment deserves separate attention at all levels and representations since careful alignment between assessment and the rest of the curriculum appears to be critical for successful curriculum implementation.

B1. Learning Activities: How are children learning?

The emphasis of the factors under this dimension is on whether learning activities in early years science focus equally on the cognitive development of children, often called a 'readiness for school' approach, and on their social development, following a 'foundation for lifelong learning' approach (with a social pedagogy approach).

- focus on cognitive dimension, such as on:
  - questioning
  - designing or planning investigations
  - gathering evidence, e.g. observing, running experiments (using equipment, manipulating materials, collecting data)
  - making connections
- focus on social dimension, such as on:
  - explaining evidence
  - communicating explanations

B2. Pedagogy: How is the teacher facilitating learning?

The factors under pedagogy refer to the pedagogical commonalities (or synergies) between inquiry-based science education (IBSE) approaches and creative approaches (CA), identified in the conceptual framework.

- role of play and exploration
  - open/unstructured play
  - role/pretend play
  - physical exploration
  - outdoor activities
  - use of digital technologies
- role of motivation and affect
  - use of drama
  - use of narrative (stories)
  - use of history
  - informal learning settings
  - cross-disciplinary context
  - incorporating children's prior experiences
  - relating science to everyday life
- role of dialogue and collaboration
  - small group settings
  - collaborative approaches

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    - classroom discussion
- role of problem solving and agency
    - guided inquiry
    - open inquiry
    - structured inquiry
    - autonomous learning
- fostering questioning and curiosity
    - questioning
    - imagination
    - multimodal expression
- fostering reflection and reasoning
    - evaluation of alternative ideas
- teacher scaffolding and involvement
    - explicit instruction
    - delayed instruction
    - teacher as facilitator
    - teacher as allower

B3. Assessment: How is the teacher assessing how far children's learning has progressed, and how is s/he using this information to inform planning and develop practice?

The following factors express the intention of the project, as this is formulated in its conceptual framework, to examine:

- the ways in which formative and summative assessment are used in science and mathematics teaching in early years;
- the involvement of children in assessment processes;
- the use of multimodal approaches to assessment;
- the role of context and authenticity of assessment tasks;
- the person/people considered to be responsible for making judgments in assessing science and mathematics.

The factors referring to the focus of assessment overlap with those mentioned under the dimension 'Aims and Objectives' and are not repeated here below.

Assessment function/purpose

- formative (assessment for learning)
    - improvement of learning
    - improvement of teaching
    - improvement of curriculum
- summative
    - evaluation of performance

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    - comparative purpose
- recipient of assessment results
    - parents
    - children
    - authorities (central/ local)

Assessment way/process

Strategy

- formative
    - self-assessment
    - peer assessment
    - ongoing
- summative
- focus on product vs. process

Forms of evidence

- multimodal
- context-based
- authentic problem-based
- portfolios
- tests
- checklists
- homework

Locus of assessment judgment

- teacher
- child

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C. Contextual Factors

Contextual factors are divided into curriculum related and teacher related factors, since *Creative Little Scientists* need to document the role of context at all levels in the mapped approaches and practices of science and mathematics education, in order to make useful and valid comparisons of them.

CURRICULUM RELATED

C1. Content: What are children learning?

These factors refer to how science and mathematics are represented mostly in policy documents and national curricula.

- science and mathematics as separate areas of knowledge or within a broader grouping
- level of detail of curriculum content
- links with other subject areas / cross-curriculum approach
- subject-specific requirements vs. broad core curriculum
- content across key areas of knowledge

C2. Location: Where are children learning?

The factors of this dimension can be seen as referring to the macro (i.e. education system), meso (i.e. the school) and micro (i.e. classroom) levels.

Education system level

- centralized/decentralized

School level

- state/public, private etc.
- fee paying / non-fee paying
- size of school
- urban/rural location
- student intake

Classroom level

- outdoors/indoors
- formal/informal learning settings
- small group settings

C3. Materials and Resources: With what are children learning?

According to *Creative Little Scientists* conceptual framework a wide range of materials in the classroom, including digital technologies, can be motivating and offer different ways for

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young children to represent ideas and express their thinking. Research in science, mathematics and creativity also highlights the importance of a rich physical environment and the use of the outdoor environment in promoting opportunities for exploration in the early years.

The following factors are therefore closely linked with the ones of the 'Learning Activities' and 'Pedagogy' dimensions and could be easily seen as belonging to the 'Teaching, Learning and Assessment' strand, as well as to the 'Contextual Factors' strand. In this document we decided to include 'Materials and Resources' in the latter strand, as WP3 mapping and comparison tasks focus more on their availability at the meso (school) level and less on their use in the micro (classroom) level, which is investigated more thoroughly in the in-depth field study in WP4.

- rich physical environment for exploration
- sufficient space
- outdoor resources
- informal learning resources
- ICT and digital technologies
- variety of resources
- sufficient human resources
- policy documents

C4. Time: When are children learning?

This dimension deals with the time available for science and mathematics teaching and learning in early years education.

- sufficient time for learning science and mathematics

C5. Grouping: With whom are children learning?

The focus of these factors is on whether children are learning individually, in small groups, or whole-class, and whether and how are they allocated to age or ability groups for learning.

- multigrade teaching
- ability grouping
- small group settings
- number of children in class

TEACHER RELATED

The following dimensions of factors include focus on issues of interest related to work carried out in WP5 on developing directions for teacher education. These come mainly

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under the dimensions of 'Initial Teacher Education' and 'Continuing Professional Development.

C6. Teacher Personal Characteristics

- Gender
- Age

C7. Teacher General Education and Training

The importance of appropriately educated pre-school teachers in providing high quality pre-school education is emphasised, although a sole focus on these factors is considered unsatisfactory and potentially misleading.

Qualifications

- level
- focus / content
- professional

C8. Teacher Science and Mathematics Knowledge, Skills and Confidence

The level of teachers' science and mathematics knowledge, their pedagogical knowledge and experience, as well as their beliefs and attitudes towards science and mathematics are key to the way in which they are likely to teach the disciplines and provide appropriate science and mathematics experiences for young children. Moreover, knowledge about creativity, creative approaches and what these mean in the context of early years science and mathematics are also vital. The following factors attempt to address these issues:

pedagogical competence

- professional autonomy
- pedagogical content knowledge
- teachers' understanding of and skills related to inquiry based education
- teachers' understanding and skills of creative approaches

scientific competence

- level of scientific understanding
- prior knowledge and skills of science and mathematics

confidence, such as in

- science teaching
- mathematics teaching
- science assessment
- mathematics assessment

ICT skills

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C9. Initial Teacher Education (ITE)

The following factors will be addressed mostly at the macro (national) level, as part of the desk research of policy documents in Task 3.2. However, relevant data will also be derived from the teacher survey in Task 3.3. The information collected is expected to feed into relevant work in WP5.

- entry qualifications/requirements for prospective teachers
- ITE standards/competencies
- ITE curriculum
- level of education
- length of ITE
- location of ITE
- ITE providers
- profile/role of teacher educator
- profile/role of school mentor
- models of training
- assessment approaches used in teacher education

C10. Continuing Professional Development (CPD)

The level of CPD on offer, the range of strategies used for delivering it, and its focus and responsiveness to the specific needs of the participants are investigated using the factors below:

- standards / competencies
- national priorities
- impact of CPD
- nature of CPD
- CPD providers

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III. RELATIONSHIP OF FACTORS TO RESEARCH QUESTIONS

The factors listed in this deliverable are seen as essential elements for mapping and comparing approaches to and practices of creative science and mathematics in early years education. They are given a different emphasis in the desk research and teacher survey according to the specificities of each research methodology and purpose, but on the whole they provide a valuable tool which supports the researchers to address the research questions established in the project. These were identified in the conceptual framework and structured into four groups:

RQ1*: Mapping conceptualisations:* How are the teaching, learning and assessment of science and mathematics in early years in the partner countries conceptualised by teachers and reflected in official policy documents? What role if any does creativity play in these?

RQ2: *Probing practice:* What approaches are used in the teaching, learning and assessment of science and mathematics in early years in the partner countries? What role if any does creativity play in these?

RQ3: *Probing practice:* In what ways do these approaches seek to foster young children's learning, interest and motivation in science and mathematics? How do teachers perceive their role in doing so?

RQ4: *Drawing on mapping and probing questions:* How can findings emerging from analysis in relation to questions 1-3 inform the development of practice in the classroom and in teacher education (ITE and CPD)?

In particularly, the first group of questions (RQ1) is focused on mapping conceptualisations in relation to classroom practices in preschool and early primary education and includes how teachers conceptualise objectives and outcomes as well as how policy frames these. The second and third group of questions (RQ2 and RQ3) are focused on probing practice in science and mathematics education within settings, and includes the exploration of opportunities and challenges for development of skills and attitudes associated with creativity. The final group of questions draws on both the mapping and probing questions seeking to apply what has been learned so as to support further development of practice particularly in relation to ITE and CPD.

Research questions in groups 1 and 2 are the main focus of the first phase of the empirical research, that is of the work carried out in WP3; research questions in group 3 are the main focus of the second phase of the empirical research carried out in WP4; research questions in group 4 are tackled in both phases of the research, but are the main focus of work carried out in WP5.

As mentioned above the foci of the factors run across all research questions. Table 1 shows how factors are connected to the research questions and whether they are addressed by the desk research and/or teacher survey.

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Table 1: Factors, research questions and WP3 research

Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Desk Research	Teacher Survey	Factors
CURRICULUM	Aims / purpose / priorities	Rationale or vision	Why are they learning?	RQ1	RQ1	• science economic imperative • creativity economic imperative • scientific literacy and numeracy for society and individual • technological imperative • science and mathematics education as context for development of general skills and dispositions for learning
		Aims and Objectives	Toward which goals are they learning?	RQ1	RQ1	• knowledge/understanding of science content • understanding about scientific inquiry • science process skills • capabilities to carry out scientific inquiry or problem-based activities • social factors of science learning • affective factors of science learning • creative dispositions
	Teaching, learning and assessment	Learning Activities	How are children learning?	RQ1	RQ2	• focus on cognitive dimension • focus on social dimension

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Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Desk Research	Teacher Survey	Factors
CURRICULUM	Teaching, learning and assessment	Pedagogy	How is the teacher facilitating learning?	RQ1	RQ2	• role of play and exploration • role of motivation and affect • role of dialogue and collaboration • role of problem solving and agency • fostering questioning and curiosity • fostering reflection and reasoning • teacher scaffolding and involvement
		Assessment	How is the teacher assessing how far children's learning has progressed, and how is s/he using this information to inform planning and develop practice?	RQ1	RQ1 & RQ2	*Assessment function/purpose* • formative • summative • recipient of assessment results *Assessment way/process* • strategy • forms of evidence • locus of assessment judgment
	Contextual factors	Content	What are children learning?	RQ1	RQ2	• science and mathematics as separate areas of knowledge or within a broader grouping • level of detail of curriculum content • links with other subject areas / cross-curriculum approach • subject-specific requirements vs. broad core curriculum • content across key areas of knowledge

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Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Desk Research	Teacher Survey	Factors
CURRICULUM	Contextual factors	Location	Where are children learning?	RQ1	RQ2	*Education system level* • centralized/decentralized *School level* • state/public, private etc. • fee paying / non-fee paying • size of school • urban/rural location • student intake *Classroom level* • outdoors/indoors • formal/informal learning settings • small group settings
		Materials and Resources	With what are children learning?	RQ1	RQ2	• rich physical environment for exploration • sufficient space • outdoor resources • informal learning resources • ICT and digital technologies • variety of resources • sufficient human resources • policy documents
		Time	When are children learning?	RQ1	RQ2	• sufficient time for learning science and mathematics
		Grouping	With whom are children learning?	RQ1	RQ2	• multigrade teaching • ability grouping • small group settings • number of children in class

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Broad Categories	Conceptual Framework Strands	Dimensions	Key Questions	Desk Research	Teacher Survey	Factors
TEACHER	Contextual factors	Teacher Personal Characteristics	Who is the teacher children are learning with?		RQ2	• Gender • Age
		Teacher General Education and Training			RQ2 & RQ4	Qualifications • level • focus / content • professional
		Teacher Science and Mathematics Knowledge, Skills and Confidence			RQ2 & RQ4	• pedagogical competence • scientific competence • confidence • ICT skills
		Initial Teacher Training		RQ1 & RQ4		• entry qualifications/requirements for prospective teachers • ITE standards/competencies • ITE curriculum • level of education • length of ITE • location of ITE • ITE providers • profile/role of teacher educator • profile/role of school mentor • models of training • assessment approaches used in teacher education
		Continuing Professional Development		RQ1 & RQ4	RQ2 & RQ4	• standards / competencies • national priorities • impact of CPD • nature of CPD • CPD providers

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IV. CONCLUSIONS

This list aims to frame the key factors which are essential when researching science and mathematics education in the early years with the emphasis on the role of creativity. The factors are derived from the conceptual framework of the *Creative Little Scientists* project and thus the factors are grounded and justified there more deeply. This document aims 1) to summarize the key factors which are significant in a creatively conducted science and mathematics education in the early years phase; 2) to support the researchers of the project to develop the necessary research instruments with the right focus on these key elements; 3) to build bridges and consistency amongst the research tasks of Work Package 3 in order to facilitate the synthesis of their findings into the Comparative Report

The factors are grouped into three main strands according to the suggestions of the conceptual framework. The factors focusing on the aims and purposes of creative science and mathematics education in early years investigate the rationale and objectives of instruction, as these are conceptualized by teachers and framed by policy. The factors of teaching, learning and assessment focus on the learning activities, on pedagogical and assessment approaches which teachers use and policy documents structure.

Contextually determined factors are divided into curriculum related and teacher related factors. Curriculum factors refer to the national variations of curriculum and its regulations. Teacher related factors refer to teacher competencies and teacher education.

This list of factors aims to work as a tool to facilitate data collection in each partner country focusing on the dimensions defined in the project. Although the list of factors in this document is mainly focused on the purposes of WP3, the list of factors provides an essential tool to build bridges between the different work packages and to show how these are interlinked.

The *Creative Little Scientists* project is a comparative project which aims to map and compare existing approaches of teaching and learning in science and mathematics education in the early years. This will be synthesized in Task 3.4, in which the comparison is presented, discussed and justified in terms of the factors provided in this document. The contextual factors provide a framework for comparison, to understand and explain similarities and differences and to establish the implications from the empirical findings.

Initial teacher education (ITE) and continuous professional development (CPD) are taken into account in the list of contextual teacher-related factors. They are focus areas of research question 4 and of work carried out in WP5.

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V. REFERENCES

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