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 5 of 13:

National Report on Approaches in German Policy

Authors:

Dr. Annette Scheersoi

Goethe University Frankfurt (GUF) Germany

www.creative-little-scientists.eu

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

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

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

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

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

D3.2 Report on Mapping and Comparing Recorded Practices

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

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

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

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

Table of Contents

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

Executive Summary

This National report examines the way in which teaching, learning and assessment is conceptualized in German policy for early years science and mathematics, and the role for creativity. This report is one of the European national policy reports that contribute to the Creative Little Scientists project deliverable (D3.2 Report on Mapping and Comparing Recorded Practices) mapping and comparing policy approaches across Europe.

In order to map the key messages in German policy, as well as allow comparisons with other nations, this report draws upon a survey instrument used to rate the extent to which certain approaches and the role of creativity are emphasized across relevant policy documents in this area. The survey tool was designed drawing on two key sources. Firstly, approaches were distinguished according to nine curriculum themes: Rationale, Aims, Content, Learning Activities, Teacher Role / Location, Materials and Resources, Groupings, Time, and Assessment. Secondly, specific approaches within these dimensions were identified from prior work in this project (the D2.2 Conceptual Framework and D3.1 List of Mapping and Comparison Factors). The ratings given in the survey were then discussed in sections within this report that drew upon other sources and commentaries to interpret approaches within the particular context of German education and policy.

In Germany, educational legislation and administration of the educational system are primarily the responsibility of the 16 Federal States (= Länder). This particularly applies to school system, higher education and the adult education/continuing education sector. Schools are, as a rule, institutions of the local authorities or the Länder, whilst higher education institutions are institutions of the Länder. In addition, there are church-run or privately run schools and institutions of higher education.

To guarantee by means of coordination the necessary measure of shared characteristics and comparability in the Federal Republic of Germany's education system, the Standing Conferences of Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (*Kultusministerkonferenz = KMK*) was founded in 1948. The KMK brings together the ministers and senators of the Länder responsible for education and training, higher education and research, and also cultural affairs. The resolutions of the KMK have a status of recommendations. They are implemented in the individual Länder in the form of administrative action, ordinances or laws, with the Land parliaments plying a role in the legislative procedure.

For this National Report, common dimensions in policy across the country were identified using mainly documents from the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK). These common dimensions are illustrated by applications of national policy in two federal states: Hesse and the North-Rhine Westphalia.

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

Under the joint framework of the Länder for early education in day-care centers for children (*Gemeinsamer Rahmen der Länder für die frühe Bildung in Kindertageseinrichtungen*), educational objectives focus on communicating basic skills and developing and strengthening personal resources, which motivate children and prepare them take up and cope with future challenges in learning and life, to play a responsible part in society and be open to lifelong learning. Methods of educational work are determined by a holistic approach. The main emphasis is on project work, which shall communicate subject-matter of relevance to the children's environment and interests.

The Primary school's role is to lead pupils from more play-oriented forms of learning at pre-school level to more systematic forms of school learning. Primary schools' curricula or education plans are the responsibility of the Ministries of Education and Cultural Affairs in the Länder. They are binding on teachers. At the same time, curricula are formulated in such a general way as to leave to the teachers' freedom of teaching methods in practice. Particular importance is attached to the general improvement of linguistic competence and to basic understanding of mathematical concepts – science education plays only a minor role. In 2004, educational standards were adopted in the subjects of German and mathematics for the primary sector (grade 4). Since 2009 cross-Länder comparative studies are conducted for grade 3 (VERA) on the basis of these educational standards. These surveys on learning levels are carried out annually in order to provide information on the targeted promotion of pupils. In addition, the 16 Länder agreed that these standards serve to determine the quality of teaching and at the same time to develop teaching.

The role of creativity is not mentioned explicitly in the context of mathematic and science learning in German policy papers reviewed for this report. However, by taking a closer look at these policy papers, there is potential for children to foster creative dispositions identified, such as curiosity and imagination. This report discusses in greater detail the findings from this national policy, and importantly the implications, not only for the fieldwork planned in the next project phases, but also for the development of policy recommendations.

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

1. Introduction

1.1 Aims of national report

This main aim of this national report is to map existing approaches, as recorded in public policy documents and official statements of policy, to the teaching, learning, and assessment of science and mathematics in the early years and to teacher education in early years mathematics and science, in Germany. 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 German 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 German policy.

1.2 Defining terms

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

1.2.1 Policy

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

1.2.2 Curriculum

The term curriculum is often used to refer to different aspects of educational policy. In a narrower sense it refers to the content and activities prescribed. In contrast, the term can be used to capture the wider aspects of educational policy. For example, Alexander (2010) 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

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

learners). In this light, policy texts are an element of the intended or planned curriculum: what is formally written.

1.2.3 Creativity

As reported in the *Conceptual Framework* (D2.2), the Creative Little Scientists project indicates a focus on little c, or personal, or everyday, creativity, i.e. 'purposive imaginative activity generating outcomes that are original and valuable in relation to the learner'. In the Review of Science and Mathematics education in pre-school and early years of primary school (Task 2.2), an appendix to the *Conceptual Framework*, the following definition is used in relation to creativity in Science and Mathematics: 'generate alternative ideas and strategies as an individual or community, and reason critically between these'.

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

2. Overview of National Early Years Education provision and policy

In Germany, children regularly start kindergarten at the age of three (see Figure 1). However, children can also start day care before kindergarten and this provision undergoes expansions at the present. From August 2013 onwards, all children from the age of one have a legal right to a place in day care. Kindergarten is not compulsory in Germany and it is regulated by the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (*Bundesministerium für Familie, Senioren, Frauen und Jugend; BMFSFJ*). In the 16 different federal states (= "Länder") the authorities for kindergarten provision are Ministries of Youth and Social Affairs and, in part, also the Ministries of Education and Cultural Affairs. So, like the in the schools system, the *federal ministry (BMFSFJ)* provides regulative guidelines, which interpretations then lie in the competencies of the federal state ministries. Therefore, kindergarten systems and provisions vary between the different federal states. Subjects and weekly teaching hours are not laid down and there are no curricula such as those in schools. The principles of education policy in the elementary sector are laid down in the Common Framework of the Länder for early education in the early childhood sector (*Gemeinsamer Rahmen der Länder für die frühe Bildung in Kindertageseinrichtungen*) which was resolved by the KMK and the Youth Ministers Conferences in 2004. On the level of the Länder, education plans specify the basic notion of education. Responsibility for actual educational work in the individual Kindergarten lies with the maintaining bodies (e.g. churches, welfare associations, local authorities, parents associations).

Children in the early childhood education sector are looked after by trained educational staff and by assistant staff. The trained staff include state-recognised *Erzieher* (pedagogic staff) and *Sozialpädagogen* (graduate youth and community workers). The assistant staff mainly consists of nursery assistants (*Kinderpflegerinnen*)

Compulsory education starts with the entry to Primary School at the age of 6 (see Figure 1). Primary school consists of four grades, and it usually takes till the age of 10 to complete primary school (in two federal states the primary school comprises six grades and takes until the age of 12). Also for the primary schools, guidelines are given by the federal ministry (Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung; BMBF*) or the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (*Ständige Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland*; *KMK*). The implementation of these guidelines lies in the hand of the federal states. The federal states are in charge of organising the school structure and determining the content of courses and teaching objectives.

Primary schools are run by a head teacher, who is responsible for the educational and pedagogical work in the school. Together with the teaching staff, the head teacher takes decisions on instruction and education. Pedagogical concepts are laid down in individual

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

school programs. Pedagogical responsibility/freedom includes the rights of teachers to teach lessons on their own authority within the framework of the applicable legal provision.

Class sizes in German Primary schools differ from federal state to federal state. Normally, they are fixed between a minimum of 16 and a maximum of 28 pupils per class (e.g. Baden Württemberg). However, they can also be bigger. In North-Rhine Westphalia, class sizes in elementary school lie between 18 and 30 children per class. Kindergarten groups also range between 20 and 25 children per group (e.g. North-Rhine Westphalia). However, for children under the age of three, group sizes are fixed to six to eight children per childminder.

In Kindergarten, maths and science are taught by the kindergarten teacher who is not a subject specialist teacher. Although, both subjects are specifically mentioned in several curricula for pedagogical training, which kindergarten teachers have to undergo, explicated by the federal states, the kindergarten teachers currently teaching children do not feel they are specialized enough and are often uncertain with regard to their science and maths skills.

Primary school teachers have to take maths as an obligatory subject in their initial teacher training at university. Thus class teachers are normally qualified to teach maths at primary level. There is however no pure science subject in primary school. Natural sciences are taught together with social sciences, like politics or history, and geography. Therefore natural sciences only take a subordinate part in primary teacher education and are often taught as optional subjects.

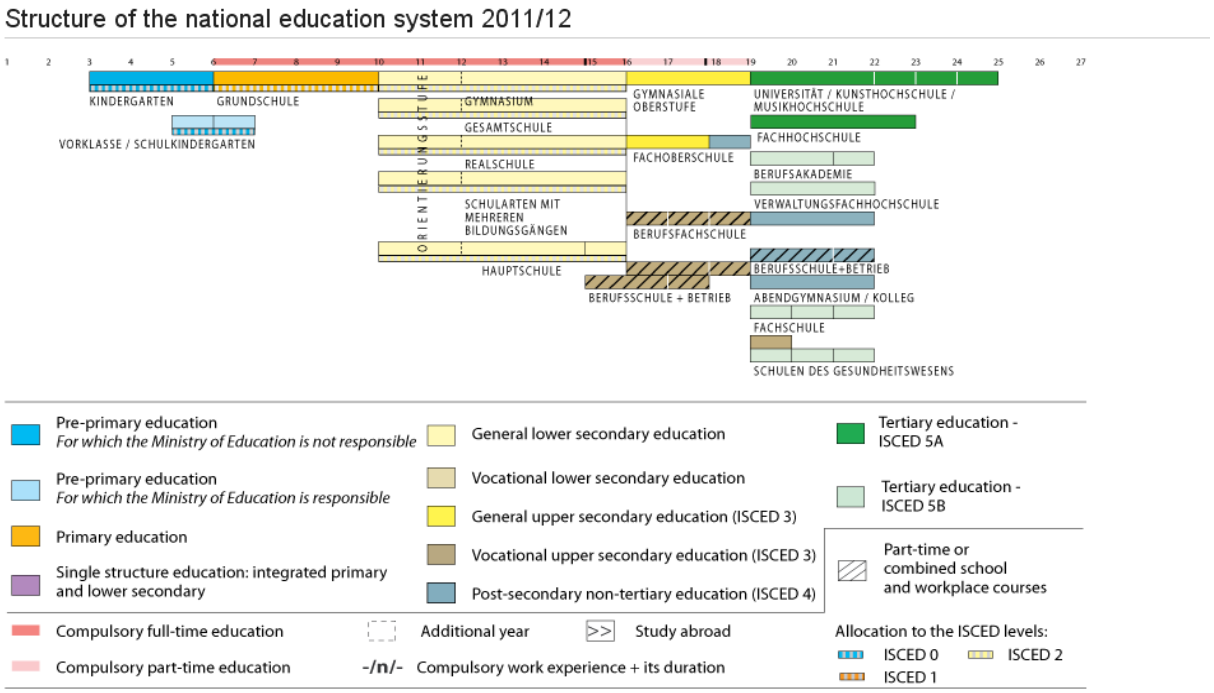

Figure 1: German Educational Phases (Eurydice, https://webgate.ec.europa.eu/)

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

Recently, national educational standards have been introduced in Germany. This concerns primary school education from the first to the fourth grade in maths and German lessons. With these national educational standards, the authorities in place hope to ensure quality and facilitate assessments and evaluations: "Through the implementation of educational standards, for the first time, quality development in the general education schools of all *Länder* shall be measured according to jointly agreed criteria in the form of standards related to school qualifications (task of the Institute for Educational Progress = *Institut zur Qualitätsentwicklung im Bildungswesen* – IQB)".

Furthermore, cross-Länder comparative studies take place for primary and secondary school levels (grade 3 and grade 8). This survey tested students' attainments in maths and German and is conducted on an annual basis.

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

Policy paper	Type of document	Rationale
JMK/KMK. *Gemeinsamer Rahmen der Länder für die frühe Bildung in Kindertageseinrichtungen* (2004)	KMK, Pre-school, guidance	Agreements on educational areas in kindergarten → federal states are responsible for implementing the agreements
KMK. *Bildungsstandards im Fach Mathematik für den Primarbereich* (2004)	KMK, Primary school, standards maths, mandatory	Introduction of new national educational standards, maths, primary school (grade 4)
KMK. *Aktivitäten der Länder zur Weiterentwicklung des mathematisch-naturwissenschaftlichen Unterrichts* (2005)	KMK, report	Report: activities in the different Länder to improve science and maths education
KMK. *Empfehlung der Kultusministerkonferenz zur Stärkung der mathematisch-naturwissenschaftlichen-technischen Bildung* (2009)	KMK, recommendation	Enhancement of science and maths education
KMK. *Empfehlungen zur Arbeit in der Grundschule* (1994)	KMK, Primary school, recommendation	Primary school education in general
KMK. *Vorgaben für die Klassenbildung* (2011)	KMK, guidance	All type of schools, Groupings /Class size
KMK. *Weiterentwicklung der Aus-, Fort- und Weiterbildungen von Erzieherinnen und Erziehern.* (2010)	KMK, Kindergarten teacher education, guidance	Standardized agreements concerning the training of kindergarten teachers (including CPD)
KMK. *Rahmenvereinbarungen über Fachschulen*. (2012)	KMK, Kindergarten teacher education, guidance	Standardized agreements concerning the kindergarten teacher initial training
KMK. *Rahmenvereinbarung für die Ausbildung und Prüfung für ein Lehramt der Grundschule bzw. Primarstufe*. (2009)	KMK, Primary school teacher education, guidance	Standardization of Primary school teacher training

Table 1: KMK-Policy papers reviewed for this report

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

3. Research Questions and Methodology

3.1 Research Question

The main research question for 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 Germany?

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 Germany?*
- *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 Germany?*
- *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 Germany?*

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

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

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?

3.2 Method

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

3.2.1 Data selection

Policy documents were chosen that captured the different aspects of curriculum according to the nine dimensions identified by van den Akker (listed in the previous section) in relation to early science and mathematics. As there are hardly any specific early years science and mathematics documents in Germany, this meant drawing upon documents that related more generally to the early years, as well as more generally to science and mathematics.

We mainly evaluated documents from the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK), giving guidelines and recommendations to the ministries of the 16 federal states for implementing curricula or teacher training. Moreover, we focussed on mandatory agreements between the KMK and the ministries of education concerning the new national educational standards.

With regard to the specific standards and curricula, we consulted the Hessian and the North-Rhine Westphalian policy papers. We also based our statements on initial teacher trainings on these two federal states. As school policies with regard to school system, curricula and teacher education lies in the authority of the different federal states, we hope that through these examples we can give an impression on the German policies. However, the data should be considered as an indication only without reaching to generalized conclusions.

Additional materials reviewed include Eurydice reports and a number of research articles.

3.2.2 Survey tool

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

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

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

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

The sections were comprised of a series of questions about approaches advocated in national policy. In each section researchers in partner countries were asked to provide background information or evaluate the extent to which particular approaches were, or were, not emphasised across policy documents, and also the extent to which the role of creativity is emphasised in these approaches. These approaches listed were carefully drawn from prior work in the Creative Little Scientists project, namely the D2.2 the *Conceptual Framework* and the D3.1 *List of Mapping and Comparison factors*, which drew attention to significant approaches characteristic of creativity in early years science and mathematics.

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

4. Approaches to Teaching, Learning and Assessment

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

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

4.1 Rationale or Vision

4.1.1 What are the key summary points?

As one main purpose of science and maths teaching in primary school and pre-school education, the policy papers highlight that education should encourage the development of socially and environmentally responsible children. Most of the papers also expand this thought to autonomous thinking students, appreciating and valuing the environment and taking an active part in society. Furthermore, in both pre-school and elementary school policy papers, the importance of developing attitudes and dispositions for future learning and a positive attitude towards learning is stressed. In pre-school education laying the foundation for an understanding of natural phenomena and interactions with nature and technology is also emphasised. This point does not receive as much attention in primary school policy papers, where it is only mentioned in a single paper.

All of the policy papers reviewed do not focus on the development of innovative thinkers or to lay the groundwork for future engineers and scientists. Both only receive one single mentioning in the KMK's recommendation on how to foster maths and science education (*Empfehlung der Kultusministerkonferenz zur Stärkung der mathematisch-naturwissenschaftlichen-technischen Bildung* (2009)).

4.1.2 What issues/ tensions/ policy criticisms exist?

Innovation and creative thinking is not emphasised throughout most of the papers. Although they all state the importance of autonomous, experimental and child-centred learning processes, they lack explicit remarks on creativity, thus failing to acknowledge its importance in science and maths learning.

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

The fact that most of the policy papers discuss both, pre-school and primary school education, makes it difficult to distinguish between the two sectors.

4.1.3 In what ways is the role of creativity emphasised?

There is no focus on creativity. In the policy papers concerning primary school education only one remark could be interpreted as slightly emphasising creativity, which is made in the context of the development of positive attitudes for future learning.

In pre-school papers the role of creativity is mentioned with regard to the development of positive attitudes towards learning and the discovering and understanding of natural phenomena and technology. However, both remarks are only slightly mentioning creative processes.

All in all, the policy papers do not focus on creativity in maths and science learning.

4.1.4 What are the main differences between preschool and school?

As most of the papers reviewed discuss both primary school and pre-school, no important differences in the rationale were found. In pre-school education, the focus lays more on interacting with nature and the environment than in primary school. Play and exploration is more often mentioned in pre-school contexts.

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

In this section, no great differences between maths and science learning can be detected. The only discrepancy is that in science teaching the development of responsible behaviour in children receives more attention than in maths learning. However, also the papers on maths education stress the importance of shaping autonomous and self-thinking, self-reliable students. Scientific thinking receives little more attention in Maths than in Science learning which might be due to the fact that natural sciences are hardly mentioned on their own but generally together with other subjects (social sciences, politics, history...) where scientific thinking does not play an important role.

4.2 Aims and Objectives

4.2.1 What are the key summary points?

One of the main objectives in science and maths education is to raise the children's interest. Concerning inquiry skills, it is emphasized that children should be able to ask relevant, scientific questions and then to investigate them, using tools if necessary. Another focus lies on communicating their ideas and to collaborate with other children. Several papers also stress the importance of teaching children how scientific investigations and explanations work and how scientists reach their conclusions by using observation techniques and their scientific knowledge.

Less attention is paid to the development of positive attitude specifically towards science learning. As positive learning attitudes as teaching goal are explicitly mentioned in general subject areas, they are not remarked upon again with special focus on maths/sciences.

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

4.2.2 What issues/ tensions/ policy criticisms exist?

-

4.2.3 In what ways is the role of creativity emphasised?

Creativity is more emphasised in maths education, at least for primary schools. Here its role is acknowledged in the formulating of questions and the conducting and planning of investigations, which both are held accountable for the development of free and independent way of thinking and an active engagement with the problems at hand. Policy reports also refer to creativity in relation to the communication of data and the gathering of data, using tools.

In pre-school policy reports, creativity is also mentioned several times. In kindergarten, the focus rests more on the interest in science and communicative aspects. Nonetheless, also the experimental tasks are considered to have an influence on the development of creativity in children.

4.2.4 What are the main differences between preschool and school?

The objectives in primary school display a greater focus on the knowledge of scientific facts and ideas and the designing and conducting of scientific investigations. Although pre-school objectives also state explorative and investigative attitudes of children it does not claim such an emphasis as in primary school education (however, it is also mentioned several times that children on a pre-school level should be able to undertake simple experiments). Pre-school aims also do not emphasis actual science learning as much as primary school policies.

Both policies pay great attention to the communicative and collaborative aspects of teaching science and maths, especially calling upon children asking their own questions about organisms or events they observed.

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

Both subject areas stress the importance of teaching children explorative and investigative skills. Also the communication of findings and the formulation of questions are of great importance in both subjects.

4.3 Content

4.3.1 What are the key summary points?

Maths and Science teaching are encompassed in a more general learning in pre-school. Often learning here arises out of specific, unscheduled contexts, for example a certain natural phenomenon that occurs and the kindergarten teacher using it to call the children's attention to the process behind it, or to foster the children's curiosity. Science and maths education are often modelled around the children's interests.

In primary school, maths education is a separate learning area with designated hours and a stronger subject-focus and structure. In contrast, science teaching is taught together with

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

social sciences and geography (=> subject called “Sachunterricht”) and receives comparably less attention.

In pre-school and primary school the focus of maths teaching lies on the children’s numeracy skills, geometric forms and ability to organize objects. In primary school, children start to learn to cope with arithmetic operations and written math problems. Furthermore, they learn how to measure quantities, areas and volumes and conduct some basic statistics.

Natural phenomena, health and the body, ecology and humans influence on eco-systems and the environment as well as life cycles are the major study fields in pre-school and elementary school science. In primary school, children also start to compare and classify plants and animals. It is stressed that it is less important to acquire specific subject knowledge but more to be able to ask and inquire own questions.

4.3.2 What issues/ tensions/ policy criticisms exist?

Science is not taught as a subject on its own right but encompassed with social sciences and geography instead, leaving less time for the children to develop an understanding of natural sciences.

Curricula and national educational standards mention competencies children should have acquired at the end of fourth grade, however they do not include any detailed contents, methodology or syllabus.

4.3.3 In what ways is the role of creativity emphasised?

Especially in pre-school, the themes arise out of the children’s natural curiosity. So, the children’s questions and their ability to critically receive the world around them are fostered throughout kindergarten.

4.3.4 What are the main differences between preschool and school?

In pre-school neither maths nor sciences are learning areas which stand alone. Instead they are employed to enrich the children’s general understanding of the world.

In primary school the subjects are taught much more focussed and structured than in pre-school, especially maths. Here, the teacher normally sets the topics which have to be covered. This focus arises also from curricula and national educational standards, which are implemented in primary schools (but not in pre-schools) and should be reached by the end of the fourth grade. Moreover, comparative studies assess the children’s abilities and thus the teachers, enhancing pressure.

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

In kindergarten, the subjects are treated quite similar. In primary school, Maths education is presented in lessons solely focussing on this domain. Natural sciences however, are taught together with other study areas thus leaving less time for children to develop scientific understanding.

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

4.4 Learning Activities

4.4.1 What are the key summary points?

Scientific skills (hypothesise, conduct investigations and then communicate results) are seen as vital for both science and maths education in pre-school and primary school. Furthermore, the observation of natural phenomena and the planning or designing of experiments are also highlighted as advisable activities. There is a very strong focus on out-of-school learning/experiences, especially in pre-school.

In primary school, children should also gather data using tools or equipment and then formulate explanations involving their data. These activities are less promoted in kindergarten policy papers.

4.4.2 What issues/ tensions/ policy criticisms exist?

To be able to help children to conduct investigations, teachers themselves have to know how scientists work. However, most of them do not have any scientific knowledge/background (see 5).

4.4.3 In what ways is the role of creativity emphasised?

Creativity is emphasised a lot with regard to activities. The formulating of hypotheses and conduction of investigations – especially in form of longer lasting projects – are seen as highly creative and also the communicative aspects of maths and science learning are stressed. The creative impact of using tools to gather data is also duly noted in the policy papers for primary school and kindergarten. However, the observation of natural phenomena is only seen as slightly creative, and also formulating explanations from data is not emphasised concerning creativity.

4.4.4 What are the main differences between preschool and school?

Pre-school activities focus more on the observation of nature, whereas primary school documents highlight the designing of investigations and the finding of explanations. Science and maths activities are more target-oriented and less open in primary school.

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

Mathematics and Sciences should be introduced in concrete situations and hands-on approaches to foster an experience involving all of the children's senses. Furthermore the training of communication skills to talk and discuss experiments, possible hypotheses or questions and outcomes is also highly advocated. However, in Science, there is a bigger focus on experimenting and hands-on approaches. Furthermore, the policy papers also point towards observational activities, which are less mentioned in papers on maths education (nonetheless, some remarks on observing patterns and organizing structures are made here as well). In primary school, there seems to be a bigger focus on creativity in maths than in science which could be due to the fact that science is not taught on its own (see above).

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

4.5 Teacher Role / Location

4.5.1 What are the key summary points?

Teachers should foster hands-on approaches, letting the children formulate hypothesis and then conduct investigations. It is also seen as important to let children design their own investigations and bring in their own ideas for finding solutions or explanations. Outdoor projects and excursions should be conducted (strong focus especially in pre-school), giving children the opportunity to experience nature first hand or to see how people work in mathematical or scientific domains. Maths and Science learning should be related to the children's everyday life and prior experiences to enable them to see the practical relevance of these subject areas and to create a productive and reassuring classroom atmosphere. Encouraging children to learn autonomously and collaborate with others is also seen as one of the teachers' tasks. In pre-school this should be achieved through open and unstructured play, a social form which does not find as much support in primary school documents. Teachers should also enable children to use digital technology and use a holistic approach in their teaching, relating sciences and maths to other curricula areas.

None of the policy papers mentions that the teacher should foster imagination in maths or science teaching (but as lessons should centre on hands-on approaches and children should plan investigations, based on their own hypotheses, imagination seems to be implied) or use history to teach science.

Co-construction is explicitly mentioned, at least in the Hessian policy paper for pre-school and primary school.

In pre-school, none of the inquiry approaches are mentioned explicitly. Nevertheless, generally guided learning seems opportune. Primary school policy papers include different approaches to the children asking their own questions and formulating hypotheses. In this context, open, guided and structured approaches are mentioned. Explaining and communicating the results should be structured by the teacher.

4.5.2 What issues/ tensions/ policy criticisms exist?

Presently, the teacher's role is changing in Germany. Many policy papers now advocate the role of the teacher as guide and supporter or co-constructor, dismissing her/ his former role as leader. Teacher should help the children to discover natural phenomena and to find new possibilities to approach problems, but refrain from imposing ideas or structure, in order to help children to learn autonomously.

However, it is difficult to accomplish this new ideal of a teacher role, as class sizes are to big and external assessments create pressure. Moreover, many teachers feel uncomfortable and restrained in their new roles (Mienert & Vorholz, 207).

Physical explorations receive more attention in the Primary school papers than in pre-school and so does teaching science from stories. However, these approaches are very

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

common in German pre-school education, so they might be considered as a matter of course and not be explicitly mentioned in the policy papers.

4.5.3 In what ways is the role of creativity emphasised?

Especially open hands-on approaches can fostering creativity, but also enabling children to hypothesise or design investigations. Creativity is also enhanced through open play and outdoor activities or excursions, as they broaden the children's horizons. Regarding this, integrating sciences into other curricula areas could also be beneficial for the development of creativity. In pre-school and primary school, fostering autonomous learning could advance creativity as well.

4.5.4 What are the main differences between preschool and school?

Pre-school education focuses more on unstructured play than primary school, whereas in primary school the discussion of alternative ideas and solutions to a task and different ways of expressing ideas should be advanced.

In pre-school reports, hardly any approach towards inquiries is specified, leaving kindergarten teachers more freedom in their teaching methods. Primary school documents state different approaches, ranging from open to structured with regard to different areas of inquiry. In general however an open approach towards teaching is advocated in primary school, whereas the teacher in kindergarten should guide the children through the stages of inquiry.

There is a bigger focus on co-construction (teacher-children) in pre-school education than in primary school education.

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

Outdoor activities are more often mentioned in the context of science learning.

Also the observation of phenomena are rarely described in the educational standards for maths teaching.

Otherwise, both maths and science teaching recognize the importance of experimenting, letting the children pose their own questions and investigate them and usage of open, unstructured play which gives children the opportunity to develop autonomous learning skills. Both learning areas point towards the use of digital technology and new media for learning purposes.

4.6 Materials and Resources

4.6.1 What are the key summary points?

The main focus lies on equipment for hands-on approaches and outdoor learning activities or experiments, which should be included in both kindergarten and primary school teaching. Here, everyday objects or even toys come in handy to teach children about and how to approach inanimate nature.

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

Computer equipment and appliances should be provided to the children as well. Children should learn how to use computers and other technical equipment appropriately. However, this is mentioned according to a separate technical education or ICT lessons, not specifically integrated into science or maths education.

Other materials, such as text- and storybooks or audio-visual resources are also mentioned but do not receive comparable attention. None of the policy papers remark upon budget for supplies, but this could be due to the fact that these factors are included in school curricula, which the schools have to write themselves and thus vary from school to school. At least in schools, there is no supporting personnel.

4.6.2 What issues/ tensions/ policy criticisms exist?

Materials which could be used for teaching maths and science are not discussed in a satisfactory manner, leaving a lot of room for interpretations (e.g. using only paper/pencil for science learning).

4.6.3 In what ways is the role of creativity emphasised?

Varying materials, giving children the opportunity to get in touch with different tools or approaches, and providing different types of materials for children to choose from could be seen as beneficial for the development of creativity.

4.6.4 What are the main differences between preschool and school?

Computers, ICT-resources and digital equipment is more emphasised in the pre-school documents than in the primary school ones. This however, could be due to the few remarks on materials in primary school science and maths teaching in general. Furthermore, outdoor equipment receives more attention in pre-school policies. Here, the importance of everyday objects like toys is remarked upon.

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

In Pre-school, no real differences between the material suggested for science and maths learning can be detected except of the stronger focus on the outdoors and thus outdoor equipment in science. In Primary school, there is a stronger focus on original and real life experience in science than in maths.

4.7 Groupings

4.7.1 What are the key summary points?

In both pre-school and primary school small group work are suggested various times in the policy papers as being a preferable mode for teaching maths and science. Thereby, the children's collaborative and interactive skills should be fostered. In addition, the teacher has more opportunities to evaluate and guide the children in their tasks and abilities. The possibility to divide the children into groups according to their attainments is also discussed.

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

Another form of grouping mentioned is individual work. The documents reviewed admit to the fact that children also need to work individually from time to time, to learn how to work autonomously and self-reliantly. However, this form of grouping is not strongly emphasised.

Neither pair work nor whole class activities are discussed, although some of the activities imply a working as a whole class, for example excursions or outdoor activities.

4.7.2 What issues/ tensions/ policy criticisms exist?

-

4.7.3 In what ways is the role of creativity emphasised?

Individual learning process, which should foster autonomy and self-reliance are advocated. Furthermore, group work should enable children to collaborate and communicate efficiently. This could also seen as beneficial to the children's creative skills.

4.7.4 What are the main differences between preschool and school?

In pre-school group work receives less attention than in primary school policy papers. Otherwise no differences could be detected.

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

No differences concerning the social forms are mentioned in the policy papers reviewed.

4.8 Time

4.8.1 What are the key summary points?

As kindergarten does not appropriate different units or lessons to maths or science teaching but instead follows a holistic approach to learning/teaching, one cannot determine how much time is scheduled for math and science teaching.

In primary school however, time slots for science and maths teaching are scheduled. The timetables vary between the federal states, thus making it impossible to pin down the number of hours planned overall. In NRW, "Sachunterricht" (which encompasses different subject areas like social sciences, geography and natural sciences) is mentioned together with other subjects, i.e. German language, Maths and remedial lessons. Altogether 12 hours per week in the first two school years are planned, which leaves about 1-2 hours for "Sachunterricht". In Hesse, for "Sachunterricht" 4 hours per week should be planned and for Maths 10 hours.

4.8.2 What issues/ tensions/ policy criticisms exist?

As natural science teaching is encompassed with other curricula areas this leaves less time for science learning. Also the fact that timetables vary between the federal states could be seen as problematic as this lessens comparability across the country. Teachers decide themselves how many time they want to spend for science teaching (and if they are not trained in science subjects, they sometimes even do not teach sciences at all).

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

4.8.3 In what ways is the role of creativity emphasised?

The role of creativity is not explicitly mentioned in this section.

4.8.4 What are the main differences between preschool and school?

In pre-school no fixed time slots for maths and science teaching are mentioned, whereas in pre-school maths and science teaching is fixed in timetables (see above). As science teaching only receives comparatively little attention and time in primary school, the more open timetable in Kindergarten leaves more opportunities for science learning.

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

In Primary school, there is much more time scheduled for maths lessons than for science lessons.

4.9 Assessment

4.9.1 What are the key summary points?

To find ways of improving science and maths teaching or the curriculum is seen as one of the most pressing issues for assessment. Also informing parents of their children's progress is emphasised. In primary school children should be given information on their own progress to be able to set their own learning targets.

In pre-school the children's performance is not assessed. Teachers document children's development in general and inform parents of their child's progress and individual educational needs. No priorities for assessment in maths or science education are given.

In primary school, knowledge and understanding of scientific ideas, inquiry skills, mathematical knowledge and the attitude towards science should be assessed. Also the creative attributes of collaboration and coming up with new ideas are mentioned.

Especially checklists and portfolios are seen as sound ways of assessment. With regard to portfolios children are also asked to reflect on their own work and scientific progress. In addition, evaluating children during classroom interactions is encouraged (observation). In grades one and two the focus is on direct observation of the pupils, in grades three and four, written class test are common in most subjects including science and maths.

Cross-*Länder* comparative tests in third grade only take place in maths and not in science.

4.9.2 What issues/ tensions/ policy criticisms exist?

There are general discussions about what to assess (e.g. content knowledge/facts and/or skills).

4.9.3 In what ways is the role of creativity emphasised?

Thinking skills, the ability to come up with something new and knowledge transfer are mentioned in this context.

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

4.9.4 What are the main differences between preschool and school?

Only in Primary school documents precise qualities are given, which should be assessed and then also marked (in pre-school children's performance is not assessed). Children are given more feedback on their own work through written development reports and report cards than in pre-school.

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

In primary school, mathematical knowledge and understanding, understanding of inquiries and the competency to carry them out and a positive attitude towards science teaching are given priority in assessment. In Maths education the focus lays more on the knowledge and understanding of facts, than in science education. The cross-*Länder* comparative tests in third grade only take place in maths and not in science.

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

5. Approaches to Teacher Education

5.1 Initial teacher education

5.1.1 Entry requirements:

- Pre-school: lower secondary school level 1 certificate („Mittlere Reife“, ISCED 2) or lower secondary school level 2 certificate (CSE, „Hauptschulabschluss“) plus vocational training (vocational upper secondary level, ISCED 3). „Abitur“ (General upper secondary education level certificate, ISCED 3) for university studies
- Primary school: „Abitur“ (General upper secondary education level certificate, ISCED 3) plus sometimes internship (e.g. in Hesse and NRW).

Pedagogic staff in German early childhood sector do not have the training and status of teachers. To become a *Erzieher* (state recognised youth or childcare worker), one has to pass either a Secondary School Level I Certificate (*Mittlere Reife*) or a CSE (*Hauptschulabschluss*) plus vocational training to be admitted to the training. The training then takes about three to five years until one receives either a bachelor in Childhood education or is accredited as certified educator. This training can take place at university or (much more often) vocational schools and usually includes two years of internship at a kindergarten. Presently, more university courses for pre-school teacher educations are installed to further an academic initial teacher training for pedagogic staff. Nonetheless, only 3 % of the kindergarten teachers currently employed have received academic training!

Primary school teacher training always takes place at universities and thus also always requires an *Abitur* (= Allgemeine Hochschulreife, final secondary school examinations). At present, in the majority of Länder the Abitur can be obtained after the successful completion of 13 consecutive school years (nine years at the Gymnasium). Yet in almost all Länder the gradual conversion to eight years at the Gymnasium is currently under way, where the Allgemeine Hochschulreife can be obtained after a 12-year course of education. In some federal states (e.g. Hesse and NRW), an internship is required before being admitted to university courses.

As a teacher in training, one has to pass two state examinations (one after university and the second after a practical training at school and in teacher training colleges) before one is accredited as primary school teacher. The practical training, which takes approximately 12 to 18 months, varying from federal state to federal state, then takes place simultaneously at teacher training colleges and schools. The initial teacher education lies within the authorities of the federal states and may thus vary across Germany. This is also the reason why sometimes primary school teachers now do not undergo state examinations but instead receive bachelor and master degrees, e.g. North-Rhine Westphalia. Preparatory service at school still takes place in all the federal states.

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

5.1.2 Main competencies

Pre-school educators should develop several competencies ranging from an understanding of developmental psychology and pedagogy and the political, social, jurisdictional and institutional framework in which education takes place to a basic knowledge in the areas of education. In their initial teacher training they should develop diagnostic and reflective skills, a way of communicating and interacting appropriately on different age levels and the abilities to promote children's competencies, design positive environment (inside and outside) and bridge the gap between pre-school and primary school. In addition, Pre-school teachers should acquire methods of inclusion and early preventive strategies and conflict management. They should learn how to foster networking, be it with parents, learning sides or their colleagues, and teamwork skills within their groups. These competencies should be reached through a strong practical relevance of the initial education.

Primary school initial teacher training should convey evaluation, educational and diagnostic skills. Teachers in training learn how to guide children's learning process and how to counsel them in their learning targets, the promotion of their competencies and problems at home or with their school mates. This should enable primary school teachers to provide individual advancements to each student. Cooperative skills also receive a lot attention in the initial teacher training as they should ensure that teachers can deal with heterogeneity, manage larger groups of children and foster a close connection to the children's parents.

5.1.3 Training content and time

Level and length of training:

- Pre-school:
  a) Certified educator („Staatlich anerkannte/r Erzieher/Erzieherin"), duration 4-5 years => 2 years internship + 2-3 years vocational school
  b) and recently Bachelor („Childhood Education" / „Bildung und Erziehung in der Kindheit"), duration 3 years.
- Primary school:

  <u>1st phase</u> at university: Bachelor, 1st State exam or Master (depending on the Land, duration minimum 3,5 years),

  <u>2nd phase</u> at teacher training colleges and schools: 2nd State exam (in all of the Länder, duration 1-2 years).

To become a certified pre-school educator, one has to pass through several study fields: interdisciplinary studies (minimum of 360 hours), field related studies (min. 1800 hours) and practical training courses (min. 1200 hours). The whole of this training thus takes up to a minimum of two years (maximum study time is three years at vocational schools). Furthermore a two year internship before the vocational school training has to be completed.

The bachelor in childhood education, which also qualifies for kindergarten teaching, encompasses six semesters, ergo a three year study period as well.

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

The length of primary school education varies between the federal states. In Hesse, teachers in training have to complete 3,5 years of studying at university and then 18 months of practical training at teacher training colleges and schools (simultaneously). In North-Rhine Westphalia, the first phase of teacher training takes 5 years, including five months of practical training. The second phase is shorter than in Hesse, encompassing only 12 months of preparatory service.

The curricula contents for a certified educator in kindergarten and a primary school teacher are listed in table 2.

Certified educator (kindergarten)	Primary school teacher
1. communication and society	1. educational and social sciences
2. pedagogical theories and practices	2. elementary school education
3. artistic and creative design	3. Maths
4. ecology and health	4. German
5. pre-school organization, law and administration	5. artistic and aesthetic education as well as physical education
6. religion and/or ethics (differs between the federal states)	6. at least one of the following subjects: English, religion, French, arts, music, "Sachunterricht" (including natural sciences) or PE

Table 2: Curriculum content for kindergarten and primary school teacher training

Maths teaching is not mentioned at all in the curriculum of kindergarten teachers, but science is mentioned, if only in the restricted field of ecology and health. In contrast, in primary school teacher education, maths teaching plays a prominent role, as every teacher in training has to study maths as an obligatory subject. Science education however plays only a minor role. It is only represented as an optional subject primary school teachers can choose to study, and in this subject – "Sachunterricht" – it is also encompassed with other areas of study, namely history, politics, social studies and geography. This leaves only little time and space for a natural science education in primary school initial teacher training.

For teachers at pre-school and primary level the teaching programmes are very general. Accordingly, teachers at this level are trained to teach all, or almost all, subjects or subject areas in the curriculum (programmes for specialist teachers only exist at secondary level).

5.1.4 Training providers

Pre-school training can be provided from different institutions. Vocational colleges, universities or vocational schools for social pedagogy train future kindergarten teachers. Although, at the moment vocational schools and colleges are still the most frequented institutions for pre-school teacher training (97% of the kindergarten teachers received their initial training there), more and more university courses are installed to promote an academic pre-school education.

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

Primary school teachers can only receive their initial trainings in university, conservatoires or art academy. After they have passed their first state examination (or Bachelor/Master in some Länder), the second phase of primary school teacher education – the preparatory service – then takes place in schools and teacher training colleges (schools in the morning, teacher training colleges in the afternoons).

5.1.5 Teaching educators and mentors

There are no strict regulations about the qualifications of educators or mentors. Educators/mentors are most of the time general or specialist teachers or sometimes scientists (e.g. biologists at university).

5.2 Continuing professional development

Most of the CPD-courses are organized by private providers or institutions but not by the state. Furthermore, it is organized individually and voluntarily, not mandatory. In schools and in kindergartens headmasters decide themselves whether CPD-courses take place or if teachers may take part. There are no fixed regulations on which basis CPD-courses have to be conducted or taken. Very often, teachers are only allowed to take part if these courses take place on weekend or during school holidays.

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

6. Summary

The role of creativity is not mentioned explicitly in the context of maths and science learning. However, by taking a closer look at the policy papers reviewed for this report, there is potential for children to foster creative dispositions identified, such as curiosity and imagination.

All of the policy papers stress the importance of child-centred teaching approaches, which give children the opportunity to formulate questions and carry out their own investigations. In this context, hands-on approaches and interactions with nature are seen as the most beneficial ways of teaching science and maths. Here, the policy papers also maintain the importance of fostering creativity in a comfortable and engaging environment, in which children can experience science and maths using all of their senses, experimenting, using tools if necessary and exploring the outside.

In both maths and science education, autonomous children which can take an active and responsible part in society should be raised. This is supposed to take place with the aid of various materials, a close connection between sciences, maths and the every-day life or prior experiences of children, and the involvement of the children's parents.

Primary schools and kindergartens should also reach out to other learning facilities or opportunities, using the outside or field trips to offer children the opportunities to engage with nature and observe phenomena. This should also enhance the children's innovative skills and curiosity as it broadens their horizon and shows how natural sciences and maths influence different situations and occurrences. With regard to this, sciences - and in kindergarten also maths - are always taught in a holistic approach, i.e. encompassed with other study domains to advance a more general understanding of the world and to enable children to form networks in their minds connecting information and knowledge.

Through group work, collaborative skills should be fostered and children are encouraged to find means of communicating or explaining their results and ideas.

Although science teaching seems to have a stronger focus on outdoor learning opportunities and experimental approaches, maths teaching also maintains a strong investigative nature encouraging children to hypothesise and find results on their own, which could explain the observed phenomena. Also in both maths and science teaching, engaging in different activities, letting the children try out their own inquiries, using different materials and tools, and fostering a positive attitude towards science and maths is highlighted, especially in kindergarten.

Whereas pre-schools focus more on unstructured and open play, teaching science and maths encompassed in a more general understanding, primary school education is quite focussed on getting across content and fostering an understanding of scientific and mathematic processes, ideas and approaches to inquiries. It is thus more structured than pre-school education. Furthermore, more assessment strategies are introduced, still leaving kids to reflect on their own work, but also marking their attainments and handing out

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

evaluation sheets and report cards. This also displays how in primary school children are already prepared for their later educational careers.

Primary school curricula dedicate more time towards maths learning, sometimes scheduling up to ten hours of maths per week. Natural sciences only receive a subdominant role in this context. As they are not a separate thematic area and taught together with social sciences and geography less time is dedicated to understand scientific phenomena and to foster in-depth inquiries.

Momentarily, the German educational system undergoes many changes. Especially the introduction of national education standards for maths in primary schools are seen as very controversial. They should foster comparability and facilitate quality assessment, however as they leave a lot of room for interpretations and due not discuss how children should reach the standards, many schools and teachers feel overburdened. Furthermore, it is discussed whether the measuring of education or knowledge is in fact as reliable as proclaimed by the standards.

These standards are also introduced in the initial teacher education for primary school teachers. They should serve as a basis for the accreditation and regular evaluation of courses of study leading to a teaching position and are seen as essential elements of the efforts for quality assurance and quality development in school education. They are implemented by the different federal states and here, again the variation between the states and their interpretations of the guidelines becomes clear. Therefore, it could be argued that instead of achieving comparability between the different study courses they lead to problems and a higher level of bureaucracy.

Another very problematic issue in the German teacher training is the lack of proper science education. In primary school teacher education and pre-school teacher education it is only introduced in a minor role, meaning as an optional subject including not only natural sciences but also other study domains («Sachunterricht») or as a restricted learning area focussing only on ecology and health. Primary school teachers often teach the subject «Sachunterricht» without ever having attended a course in natural sciences during their training. As a consequence, they feel unsure with their own exertise on the subject matter and pupils spend their time on worksheet paper and pencil tasks. Also pre-school teachers often feel overburdened by teaching sciences. CPD programmes on science education should be fostered to enable these teachers to use inquiry- and creativity-based approaches to science learning.

6.1 Limitations

The German education system is complex and constantly changing. In the Federal Republic of Germany responsibility for the education system is determined by the federal structure of the state. Our findings are limited by the fact that in Germany each federal state (altogether there are 16 federal states) has its own policies on early childhood maths and science education and teacher training. Therefore, no general findings could be presented

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

but just exemplary works. Still, we believe that through this report an overview on the educational climate in kindergarten and primary school can be conveyed as we focus on the common features of the education system and include descriptions of features that are unique to individual states.

Another issue is that policies from federal ministries and the KMK are generally only guidelines. Although there are some agreements between all of the federal states presented in this paper which can be counted as mandatory, and the implementation of the national educational standards is certainly also obligatory, usually they rather serve a guiding function, leaving a lot of space open for interpretations.

6.2 Implications

This report gives an overview on the current issues and changes in German childhood education concerning maths and science learning. It could serve as a starting point for a more focused and in-depth analysis of the German kindergarten and primary school maths and science teaching, e.g. refering to differences in the 16 Länder. Studies approaching the discrepancies between the theoretical guidelines of the policy papers and the actual school and kindergarten practices might be interesting.

As the German educational system undergoes some grave changes at the moment, it would be advisable to repeat a more in-depth study after some accommodation time for the schools and federal states to implement and carry out the new curricula and educational standards.

Science learning and inquiry are mentioned as important subjects in all the pre-school and school policy papers that have been considered for this report. However these subjects/fields are more or less ignored during initial teacher training. As a consequence, teachers are not able to teach science and inquiry or at least feel very unconfident. Continuing professional development will have to fill this gap and offer specific training courses for pre-school and primary school teachers.

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

7. References

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

ErzieherIn Online: Die Fachhomepage für ErzieherInnen. Online: <http://www.erzieherin-online.de/beruf/ausbildung/zugang.php > (accessed 01.09.2012)

Eurydice. Germany: Overview. https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Germany:Overview (accessed 01.09.2012).

Hessisches Sozialministerium & Hessisches Kultusministerium (2011). Bildung von Anfang an: Bildung und Erziehungsplan für Kinder von 0 bis 10 Jahren in Hessen. http://www.bep.hessen.de/irj/BEP_Internet

Hessisches Kultusministerium (2004). Lehrplan für die Fachschule für Sozialpädagogik (Lerngebiet: Ökologie/ Umwelt- und Gesundheitspädagogik). http://berufliche.bildung.hessen.de/

Hessisches Kultusministerium (2011). Bildungsstandards und Inhaltsfelder. Das neue Kerncurriculum für Hessen Primarstufe (SACHUNTERRICHT). http://www.iq.hessen.de

Hessisches Kultusministerium (2011). Hessisches Lehrerbildungsgesetz (HLbG). http://www.kultusministerium.hessen.de/

Janssen, R. & Zech, D. (2011). Bundesweite Perspektiven der Fachschulen für Sozialpädagogik - Der besondere Blick auf NRW. Landesarbeitsgemeinschaft ErzieherInnenausbildung NRW. Document available at http://cms.lag-ea-nrw.de/?p=343 (01.09.2012)

KMK (1994). Empfehlungen zur Arbeit in der Grundschule. http://www.kmk.org

KMK (2004). Bildungsstandards im Fach Mathematik für den Primarbereich. http://www.kmk.org

KMK/JMK (2004). Gemeinsamer Rahmen der Länder für die frühe Bildung in Kindertageseinrichtungen. http://www.kmk.org

KMK (2005). Aktivitäten der Länder zur Weiterentwicklung des mathematisch-naturwissenschaftlichen Unterrichts. http://www.kmk.org

KMK (2009). Rahmenvereinbarung für die Ausbildung und Prüfung für ein Lehramt der Grundschule bzw. Primarstufe. http://www.kmk.org

KMK (2009). Empfehlung der Kultusministerkonferenz zur Stärkung der mathematisch-naturwissenschaftlichen-technischen Bildung. http://www.kmk.org

KMK (2010). Weiterentwicklung der Aus-, Fort- und Weiterbildungen von Erzieherinnen und Erziehern. Gemeinsamer Orientierungsrahmen „Bildung in der Kindheit“. http://www.kmk.org

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

KMK (2011). Vorgaben für die Klassenbildung. http://www.kmk.org

KMK (2012). Rahmenvereinbarungen über Fachschulen. http://www.kmk.org

Mienert, M & Vorholz, H. (2007). Umsetzung der neuen Bildungsstandards in Kindertagesstätten. Chancen und Schwierigkeiten für Erzieherinnen. Bildungsforschung, vol. 4, no. 1, pp. 1–12. Available from http://bildungsforschung.org.

MFKJKS/MSW NRW (2011). Mehr Chancen durch Bildung von Anfang an. Grundsätze zur Bildungsförderung für Kinder von 0 bis 10 Jahren. http://www.schulministerium.nrw.de

Ministerium für Schule und Weiterbildung NRW (2009). Gesetz über die Ausbildung für Lehrämter an öffentlichen Schulen (Lehrerausbildungsgesetz, LABG). http://www.schulministerium.nrw.de

Ministerium für Schule und Weiterbildung NRW (2012). Richtlinien und Lehrpläne für die Grundschule in NRW (Mathematik, Sachunterricht). http://www.schulministerium.nrw.de

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

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

Viernickel, S. (2009). Qualitätsanforderungen an Leitungskräfte in Kindertageseinrichtungen. Available from http: www.erzieherin.de

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

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

Key
E: Early (Preschool); P: Primary

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

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

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

Aims and Objectives

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

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

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

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

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

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

Content

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

	As its own learning area	**Encompassed within other social sciences (e.g. geography)**	**Encompassed within more general understanding**
Science		P	E
Mathematics	P		E

B. What are the key Science and Mathematics topics/strands/themes?

	Science	**Mathematics**
1	Body (E/P)	Numbers and Counting
2	Health (E/P)	Geometric Forms (E/P)
3	The Environment: Ecology and human influence (E/P), Life cycles (E/P)	Sets and quantities, measuring
4	Handling of natural resources (E)	Relative Position of Objects in Spaces
5	Scientific methodology (E/P)	Detection of regularities
6	Animals/Plants (P)	Symmetries and classification systems (E), Volumes, areas (P)
7	Natural phenomena (e.g. thunderstorms, seasons …) (E/P)	Statistics (P)
8	Energy (P)	

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

Learning Activities

Ai. What activities are encouraged?

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

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

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

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

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

Teacher Role / Location

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

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

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

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

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

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

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

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

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

Materials and Resources

A. What materials are suggested?

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

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

Groupings

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

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

Time

A. How much time should be planned for teaching Science and Mathematics per week?

	Science	Mathematics	Evidence or comments
a. Less than an hour			
b. 1-2 h	P		NRW ("Sachunterricht", subject/thematic focus depending on the teacher)
c. 3-4 h	P		Hesse ("Sachunterricht", see above)
d. More than 4 h		P	Hesse, NRW
e. N/A (Please explain)	E	E	As kindergarten follows a holistic approach to learning/teaching, one cannot determine how much time is scheduled for maths and science education.

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

Assessment

A. What purposes of assessment are included?

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

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

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

To assess the development of children's:

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

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

C. What ways of assessing are advocated?

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

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

D. What Creative attributes are addressed in assessment?

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

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