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

D6.6 Recommendations to Policy Makers and Stakeholders on Creativity and Early Years Science and Mathematics

ADDENDUM 7 of 9:
National Report on Recommendations for Policy Makers and Stakeholders in Portugal

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1. Aims of national report

- The main aim of this National Report is to provide concrete recommendations to policy makers and stakeholders in Portugal for further practice grounded on the research outcomes of the Creative Little Scientists project about enabling children’s creativity through science and mathematics in preschool and first years of primary education.

- To provide concrete recommendations to policy makers and stakeholders according to a list of factors developed in prior conceptual work in this project that identified key issues concerning the role of creativity in early science and mathematics education.

- To contribute to the project deliverable D6.6 Recommendations to Policy Makers and Stakeholders on Creativity and Early Years Science and Mathematics that provides recommendations to policy makers and stakeholders across the nine European partner nations.
2. Overview of National Early Years Education provision and policy

The Portuguese education system, according to the basic law, is organized in pre-school education, school education and out-of-school education: a) the pre-school educational is complementary to the family action, b) school education includes Basic Education, secondary and higher education; c) the out-of-school adult education includes literacy activities and Basic Education, cultural and scientific improvement and updating, and initiation, retraining and professional improvement and takes place in an open framework of multiple initiatives, both formal and non-formal (LBSE, artº 4).

Portuguese educational system 2011/2012

The national school network is composed mostly by public schools. In the last years there has been a reorganization and rationalization of the school network, which has been performed based on the closure of schools with few students and the reorganization of schools and groups, promoting the integration of all teaching cycles in the same educational project. These measures intended to promote greater efficiency in the afeccion of system resources, both in the administrative/logistical support, and in terms of human resources¹.

Private schools in Portugal are regulated by a specific law and status subordinated to what is foreseen in the Education Act. In this sense, they are subject to administrative and financial inspections carried out by the competent authorities of the Ministry of Education. Central

Government finances public and supports private schools/institutions which celebrate contracts of association with the Ministry of Education where supposedly there is shortage of places in public school provision. The amount of financial support depends on the number of pupils included in the association contract and it involves teaching staff, non-teaching staff and running costs.

Nevertheless, there are independent private schools which are not financed by the state and which can have or not pedagogical autonomy and parallelism. In the first case, pupils’ assessment is carried out by the school itself, and in the second case pupils must be submitted to final examinations in a public school.

**Table 1 - School population: Pre-school / 1st and 2nd cycles of Basic Education, school year 2008/09.**

<table>
<thead>
<tr>
<th>Education levels</th>
<th>Public schools</th>
<th>Publicly-funded private schools</th>
<th>Independent private schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-School</td>
<td>51.83%</td>
<td>29.84%</td>
<td>18.33%</td>
</tr>
<tr>
<td>1st and 2nd cycles of Basic Education</td>
<td>88.08%</td>
<td>3.19%</td>
<td>8.73%</td>
</tr>
</tbody>
</table>


The Ministry of Education sets the broad education policies. Five regional bodies (on the mainland) implement ministerial policies and provide guidelines, coordination and support to all non-higher education establishments. In the autonomous regions of Madeira and Azores, education administration is responsibility of the respective regional governments, through secretariats of education.

Since 1998, more autonomy has been given to schools or groups of schools management bodies. In 2007, contracts of autonomy and development were negotiated between the Ministry of Education, schools who applied for it and local partners, in order to consolidate the transfer of new responsibilities.

The overall inspection remains a responsibility of the General Inspectorate of Education, which has regional delegations supervising all aspects of non-higher education.

### 2.1. Pre-school education

In Portugal, pre-school education is considered as the first step of the education system and is aimed at children aged 3 to 5 years. In 2009, the law no. 85/2009 of 27 August, established
the universality of pre-school education for children who reach 5 years, nevertheless, attendance is never compulsory.

The pre-school network is provided by the state, private and cooperative bodies, private social solidarity institutions and non-profit institutions. The public network is fully financed by the state which also covers the costs of the educational component provided by the private social and non-profit networks. Fees are paid in independent private nursery schools.

Each class should have a minimum attendance of 20 and a maximum of 25 children per educator. Although in the case of a homogeneous group of children 3 years of age, cannot have more than 15 children assigned to each educator (Order no. 0 5106-A/2012, April 12).

**General Objectives**

The Law on Educational System Bases defines in article five, eight objectives for this level of education, which encompass health, wellness and cognitive development. These objectives are: (1) to stimulate the capabilities of each child, encouraging their training and the balanced development of all their potential, (2) to contribute to emotional stability and safety of the child, (3) to facilitate the observation and understanding of natural and human environment for better integration and participation of the child, (4) to develop the child's moral education and sense of the responsibility associated with freedom, (5) to promote the integration of children in different social groups, complementary of the family, in view of the development of social skills, (6) to develop the child’s capacities of expression and communication, as well as their creative imagination, and encourage playful activity; (7) to promote hygiene habits that defend personal and public health; (8) to screen for inadequacies, disabilities or precocities, and to promote better orientation and guidance of the child.

Consistent with the objectives set forth in the Basic Law, the Framework Law of Pre-school Education establishes the general principle that pre-school education should encourage "the formation and the balanced development of the child, with a view to their full integration into society as an autonomous, free and fair human being". This principle underlies all the articles of the law and it affects the overall objectives set for teaching pre-school education: a) To promote the personal and social development of the child based on life experiences in a perspective of democratic citizenship education; b) to promote the inclusion of children in different social groups, the respect for different cultures, favoring a progressive awareness as a member of the society; c) to contribute to equal opportunities in the access to school and to learning success; d) to encourage the global development of each child in the respect for their individual characteristics, instilling behaviors that promote meaningful and diverse learning’s; e) to develop the expression and communication across multiple languages as media for relation, information, aesthetic awareness and understanding of the world; f) to awaken curiosity and critical thinking; g) to provide opportunities for child welfare and safety, particularly in the context of individual and collective health; h) to identify the inadequacies, deficiencies or precocious behavior and promote a better orientation and guidance of the
child; i) to encourage the participation of families in the educational process and to establish effective collaborative relationships with the community.

Curriculum

Curriculum Guidelines for pre-school education are a set of principles to support the teachers in decisions about their practice, i.e., to conduct the educational process to develop with the children. Curriculum Guidelines provide a common reference for all preschool teachers of the National Preschool Education and are intended for the organization of the educational componente.

It is not a program, since they adopt a perspective that is more focused on indications for the teacher than the prediction of learning to be undertaken by children. They differ from some conceptions of curriculum as they are more general and extensive, that is, they include the possibility to support various educational options and therefore various curricula.

With support on these grounds, curriculum development is the responsibility of the educator and will take into account: (i) the general objectives – set out in Law Table of Preschool Education; (ii) organization of the educational environment – as support for curriculum and its intentionality.

2.2. Compulsory education

Since 2009 (Decree-Law No. 85/2009 of 27 August), education is compulsory from 6 to 18 years of age - has a duration of 12 years. Pupils who have reached the age limit for compulsory education and who have not successfully completed the 12th grade may continue their education in different types of adult education.

Table 2 - Compulsory education – Basic Education and secondary education

<table>
<thead>
<tr>
<th>Levels</th>
<th>Grades</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic (primary) Education</td>
<td>First Cycle</td>
<td>1.st - 4.th</td>
</tr>
<tr>
<td>(Ensino Básico)</td>
<td>Second Cycle</td>
<td>5.th - 6.th</td>
</tr>
<tr>
<td></td>
<td>Third Cycle</td>
<td>7.th - 9.th</td>
</tr>
<tr>
<td>Secondary Education</td>
<td></td>
<td>10.º - 12.º</td>
</tr>
</tbody>
</table>

Basic Education – 1st cycle (6-10 years old)

Admission to compulsory school is generally based on catchment areas. However parental choice is possible if there are places available in the school they prefer for their children.

Initial enrolment in the 1st year of Basic Education is compulsory for all children who have completed 6 years of age by 16th of September, or 31st of December at the request of parents and depending on the places available in schools (Order No. 14 026/2007 of 3 July).

In the 1st cycle of Basic Education the working day consists of 5 compulsory teaching hours plus 3 more hours of optional curricular enrichment activities.

The main guidelines for organizing the school year are the following ones:

- The school year is the period between 1st September and 31st August;
- The school year, fixed annually by legislation from the Minister of Education, lasts for 180 effective days of school activities in schools which minister compulsory education;
- Each term lasts for approximately 3 months, followed by a two weeks break of school activities;
- Breaks of school activities occur at Christmas, Carnival and Easter;
- School year begins in the first fortnight of September and ends near the end of June.

For the first cycle of Basic Education one single teacher is assigned to each class, with the recourse to specialist teachers in certain areas, e.g. in Special Education.

Class size/student grouping

In the first cycle, the constitution of classes must meet, according to the Order nº 5106-A/2012, 12 April, the following conditions:

- a class who started school in a given year should be maintained throughout the entire cycle, i.e., during four years;
- a class cannot be constituted only by students that were retained;
- whenever possible, the same teacher should accompany the class over the four years of schooling;
- classes are comprised of 26 students, as long as they include only one year of schooling. If they include students from different school years and only one teacher, they must be composed by 18 students – if with more than one teacher may reach 22 students;
- classes that have students with special educational needs of a prolonged character (cannot include more than 2 students in these conditions), consist of 20 students maximum.
Curricular control and content

The curriculum is determined at national level. The Ministry of Education also defines the teaching methods’ guidelines, which are adapted in each school by the teachers, in close relation with the school education project.

The current curriculum for the first cycle of Basic Education dates from 1998. It was updated in 2004, having then been introduced some changes resulting from the entry into force of some official documents. Until now, it keeps unchanged.

As to what concerns the first cycle of Basic Education, teaching is the responsibility of a generalist teacher who may be assisted by other teachers in specific areas, namely: Music, Foreign Language and Physical Education.

With the implementation of full-time school, by extending the hours of operation for a minimum of eight hours per day, schools promote voluntary activities to enrich the curriculum, which assume a formative, cultural and playful nature and complement the activities of the developed curriculum component in the classroom. These activities focus on learning English or other foreign languages and sports, artistic, scientific, and Information and communications technologies (ICT), to link the school with the environment and citizenship education (Article 7th, Order No. 9265-B/2013). These activities have a working week between five and seven and a half hours (Decree-Law No. 139/2012, of 5 July) and are promoted not only by schools but also by Local Authorities, associations of parents and private institutions of social solidarity.

Beyond curricular enrichment activities there is still a component of family support, which must include a number of activities aimed at monitoring the student’s primary school education, before and after the course or the curriculum enrichment component, as well as, in the interruption periods. This component of family support is provided by local authorities, parents’ associations, private charities or other organizations that promote this type of social response, in agreement with the schools (Order No. 9265-B/2013 of 15 July, 2013).

General Objectives

According to the Basic Law of the educational system, the curriculum of the 1st cycle defines three main objectives for Basic Education:

- Creating the conditions for global development and harmonious development of personality, through the progressive discovery of interests, skills and capabilities that provide a personal training, in its dual individual and social dimension.
- Provide the acquisition and mastery of knowledge, tools, skills, attitudes and values essential to informed choice of future paths or professional school.
- Develop values, attitudes and practices that contribute to the formation of conscious and participatory citizens in a democratic society.
Directions of Policy

At this moment in Portugal, several changes and a reorientation of the educational policy are under way, with particular emphasis on the action and the educative organization of teachers of all grade levels.

An important curriculum document, "National Curriculum for Basic Education - Essential skills" was recently revoked by Order No. 17169/2011 of 23 December. This document contained the guidelines that served as reference for the official documents of the Ministry of Education, especially for programs, learning goals, national tests and examinations of Basic Education. The Ministry of Education, through the Secretary of State for Basic and Secondary Education, is preparing documents clarifying educational goals and priorities of the fundamental contents of the programs.

The “National Curriculum for Basic Education - Essential Skills” defined a set of general competencies to be achieved by students at the end of basic education. It contained also, general and specific instructions for its operation in each curriculum area and the actions and activities to be undertaken by the teacher. In the case of "Environmental Studies" the following learning experiences were suggested: problem solving, collaborative work, individual work, the use of ICT (Information and Communication Technology) resources, investigative activities, a variety of situations for communication and action in the environment, projects, etc.

Competence, in this official document, related to the process of activating 'resources' (knowledge, skills and strategies) in various situations, including problem situations (ME 2001, p. 9).

When the “National Curriculum for Basic Education - Essential Skills” was implemented, some changes were introduced to the Basic Education “Curricula and Programs Organization” (ME, 2004). According to Varela (2012), the most significant changes made by these official documents concern the schools' primary objectives and a renovated didactic approach to the several curricular areas consistent with those designs, including the Natural and Physical Sciences component of the Environmental Studies area:

- Valorization of experimental learning in the different areas and disciplines of Basic Education, particularly and compulsorily in Science teaching;
- Adoption of a school curriculum for the development of student skills. In it, it is explained that reasoning, communication and attitudes are important domains for the development of specific skills to achieve scientific literacy by the end of Basic Education. Skills in these domains are developed simultaneously and transversally with the different forms of knowledge (ME, 2001);
- existence of comments in the curriculum that point to a greater appreciation of the social dimension in the construction of the students' learning:

  “(...) students come to school with their own sets of ideas, preconceptions, representations, emotional and affective dispositions and ways to act. (…)
These structures, when faced with other more objective ones, socially shared and emanating from the teaching process, get ruptured and the simplistic view of reality is undermined, (…), originating an increasingly accurate and scientific knowledge.” “This progression stems from the subjective (that which is experienced) and aims for the objective (that which is socially shared)….“ (ME, 2001, p. 75).

In another part of the text, there is also a suggestion to carry out:

“(…) learning activities that include the use of scientific language, (…) of discussion situations that allow for the development of skills in explanation of ideas, refutation and argument,(…) educational experiences which also contemplate cooperation in the sharing of information, presentation of results…” (ME, 2001, p. 133).

However, more than three decades of experience have shown that the introduction of Science themes and new approaches to knowledge construction in the Basic Education programs has failed to produce any significant effects in the renovation of pedagogical practices and subsequent improvement of the quality of student learning. It has not been enough to include in the curriculum these scientific didactic innovations, whose aim is to break away from the teaching practices that have been engrained in our schools for years (Sá 2002).

It is also important to refer that in the scope of the 'Global Strategy for the National Curriculum Development' the Ministry of Education launched a project called “Metas de Aprendizagem” – Learning Goals (M.E. 2010)2. This project was designed with the aim to establish learning goals for each cycle (including pre-school level), as well as its development and progression by grade, subject and disciplinary area. Although these learning goals are not binding, the Ministry of Education hopes that they will turn into an important tool to support the curriculum management, as a consequence from the recognition of its practical use by teachers, students and families (for more information please consult the following link – http://metasdeaprendizagem.dge.mec.pt/).

However, Learning Goals, defined for all levels of education, excluding higher education, and including pre-school education, would also be repealed in 2011 (Order No. 17169/2011). However, in 2012, after having gone through a period of public discussion, were approved new goals, now designated "Curricular Goals" (Order No. 15971/2012). According to this order, the Curricular Goals "identify the fulfillments that are translated to acquire knowledge and skills that they want to see developed" by the students. They are a "privileged way to support the planning and organization of teaching, including the production of teaching

2 http://metasdeaprendizagem.dge.mec.pt/
materials, and intended to constitute a reference for internal and external evaluation, with particular relevance for final cycle tests, and national exams."

According to the schedule of mandatory application of Curricular Goals can be inferred that is not provided for the setting of targets for Preschool Education or to the subject area of Environmental Studies of the 1st cycle of basic education. For this last cycle of teaching Curricular Goals just were built in the areas of Mathematics and Portuguese, depending on the objectives of the new programs in these areas which entered into force in this academic year (2013/2014), and the national exams to perform at these curricular areas in the end of the 1st cycle (4th grade).

Currently, for the 1st cycle of basic education only the program with the contents of each curriculum area (Curriculum Organization and Programs of the 1st cycle of basic education, 2004) exist at this time. Here too, there have been changes, earlier this school year, with the introduction of the new programs in Mathematics and Portuguese. It is likely that the “Environmental Studies” program will also be subject to change in the coming times.

3. Recorded, Reported and Implemented Approaches to Teaching, Learning and Assessment

3.1 Rationale or Vision

The curriculum for pre-school and 1st cycle of Basic Education in Portugal does not state specific purposes for science education. In these two levels of education, the sciences are grouped into content areas – “Knowledge of the World” in pre-school, and “Environmental Studies” in the 1st cycle. The objectives of these areas are formulated in close relation with the learning that children should acquire in each of those areas of the curriculum. Also the

However, a few ideas emerge from the analysis performed in the areas of "Knowledge of the World" (Pre-school) and “Environmental Studies” (1st cycle) : i) this area is seen as a sensitization for the science and integrates aspects of different fields of human knowledge: history, sociology, geography, physics, chemistry and biology ... that, although elementary and appropriate for children of these ages, should always correspond to a great scientific rigor; ii) it must promote understanding and interaction with the natural and social world that surrounds the child, to make sense of the ideas that he builds; iii) encourage the natural curiosity and desire to know; iv) use and refine different means of expression and communication, to better understand the world and have the means to represent and give meaning; v) solve problems that lead children to reflect on how and why. Thus, for example, the different explanations of reality should be verified by observation and action, looking for
patterns, reasoning about data, solving problems and communicate results. In this sense the area of mathematics is directly related to the area of “Knowledge of the World” (ME-OCEPE, 1997, p. 78).

Creativity is not mentioned as a purpose in the curriculum of "Environmental Studies" of the 1st cycle of Basic Education or in the curriculum guidelines for pre-school education.

In this document, the curriculum guidelines for Pre-school Education, does not appear any reference to the term creativity or any other associated with it (ME-OCEP, 1997), nor in the current document that defines the learning goals that the children will reach at the end of Pre-school. Though, in spite of the Basic Law of the Portuguese Education System, in its Article 5, point 1.f, taking the promotion of creativity in children as one of the objectives for this level of education: “to develop the child’s capacities of expression and communication, as well as their creative imagination ...

3.2 Aims and Objectives

In the current Science Portuguese National Curriculum, since 2004, there are any connections to creativity. Despite the curriculum does not appeal to the creativity, the teachers are aware of its importance. Teacher interviews emphasized the importance of creativity in aims and learning objectives and these were evident in planning.

There is no explicit reference in the curriculum guidelines for environmental studies, given more emphasis to knowledge. However the Law of the Portuguese educational system can read that principles are: "Education promotes the development of democratic and pluralistic spirit, respectful of others and their ideas, open to dialogue and free exchange of views, forming citizens capable to judge critically and creative social environment in which they are involved and to engage in a progressive transformation."

At preschool level should be a priority "Developing the capabilities of expression and communication of the child, as well as creative imagination, and encourage recreational activity".

In pre-school, the area World Knowledge is not intended to promote encyclopaedic knowledge, but to provide relevant learning meaningful for children who may not necessarily be related to immediate experience. Even if the child doesn’t dominate entirely the contents, introduction to different scientific domains creates an awareness that awakens the curiosity and desire to learn. What seems essential in this field, whatever the issues are addressed and their development, are the aspects that relate to the processes of learning: the ability to observe, the desire to experience the wondering, the critical attitude.

The objectives of basic education: "Ensure a general instruction for all Portuguese that guarantees the discovery and development of their interests and skills, reasoning ability,
memory and critical thinking, creativity, aesthetic sensibility and moral sense, promoting the realization individual in harmony with the values of social solidarity;

In some observed episodes creativity was more evident than others through emphasis on motivation and encouragement of problem-solving and children’s agency that result in solutions to problems and expressed scientific ideas that are unexpected and show creativity. Other evidence, such as teacher interviews, as well as observations of practice, indicate creativity through interaction that encourages children to make connections between prior and new conceptual understandings in science, develop new reasoning and creating ideas and artefacts.

3.3 Learning Activities

With the revocation of the 'National Curriculum for Basic Education - Essential Skills - Basic Education' (Order no. 17169/2011), there is little information on the learning activities. However, in the document containing the program (Organization Curriculum and programs of the 1st cycle), you can read in the guiding principles for the management of “Environmental Studies”, that it will be “through different situations of learning that include direct contact with the environment, performing small research and actual experiences in school and community as well as through the use of information from more distant sources that students will be tackling and integrating progressively the meaning of the concepts. [In this process,] students will be helped to learn to organize information and to structure it so that it would constitute knowledge, facilitating then the teacher, its communication and sharing "(p. 102).

In block 3 and 5, of the Organization Curriculum and programs of the 1st cycle, more specifically oriented to science teaching (“Discovering the natural environment” and “The discovery of materials and objects”, respectively) - are proposed activities to develop in students an experimental attitude (observation, introduction of changes, assessing the effects and results, conclusions) that encourage students to raise questions and seek answers to them through experiments and simple searches. The activities will be based on direct observation, using all the senses, the collection of samples, without harming the environment, as well as experimentation. Activities involving the manipulation of objects and instruments, the care in their use and conservation, and the valorisation of handwork, are declared important. The exploration of materials in current use is mainly based on observation of their properties and on elementary experiences that highlight them. The recording of experimental data should be age-appropriate for the students, limited and oriented to the communication of their discoveries.

The work to be undertaken by students in all blocks, but mainly in blocks 3 and 5, must include mandatory, experimental activities and inquiry activities, involving: a) asking
questions, b) the child’s curiosity, c) use of instruments of observation and measurement, d) analysis and participation in the discussion of problems of general interest.

In pre-school education, the content areas assume activities which have as a principle the idea that children learn from exploring the world around them.

The area of “Knowledge of the World” includes the widening of basic knowledge necessary for social life.

But this area also involves the approach of the scientific aspects which go beyond the direct experience of the child and his immediate experiences. There is, for example, content related to biology, knowledge of body organs, of animals, their habitats and habits, of plants, etc., and also experiences of physics and chemistry (light, air, water, etc...) that can be performed by children of pre-school age. Playing with water, to fill and to empty containers may be, for example, one way to understand that the air takes up space, to experience the principle of communicating vessels, to question why do some objects float while others sink. There are also ways to explore the effects of light and shadow, either using natural resources (sunlight) or technical ones (lamps, overhead projector, slide projector, etc.), that allow, for example, to explore the tilt and size of shadows at various times of the day, projecting the shadow of one’s body and hands, and to play with shapes, colours, materials and textures.

These are aspects of the “Knowledge of the World” which also contribute to developing aesthetic sensibility, imagination and language. If the observation of the weather is part of many contexts of pre-school education, the knowledge of meteorology (wind, rain, etc) relates to issues of concern to children that may be treated in more depth. This is also the case of geography that may extend beyond the immediate environment, or deepen and diversify from it (rivers, seas, orography, etc...) and geology (comparing rocks, collection of stones, observation of their properties). There has been little impact on the questioning by students in mathematics and science, which mean that there aren’t significant differences between the school and preschool.

Encourage children to ask questions, to explain and communicate the evidences found, stimulate the social dimension of learning through communication. The type of activity may be more open, always keeping in mind the willingness of the teacher to facilitate the expression of curiosity and doubt thus fostering student’s creativity.

### 3.4 Teacher Role / Pedagogy

The guiding principles of the curriculum confer to the teacher the power to direct the whole process of teaching and learning in which students must become active observers with the ability to discover, investigate, experiment and learn (ME-OCP, 2004, p. 112). However, in the curriculum guidelines for pre-school and curriculum (program) of the 1st cycle of Basic Education there are few concrete indications on how the educator (pre-school) and teacher
(1st cycle) should conduct science activities with children. There are only a few references to: (i) the promotion of group work, (ii) physical exploration of materials, (iii) using outdoor Learning Activities, (iv) Integrating Science with Other curricular areas, (v) Building on children’s prior Experiences (vi) Encouraging different ways of recording and expressing, (vii) Encouraging problem finding.

The teacher interviews indicate many opportunities, outside of the observations, for creativity. In these learning activities creativity was seen through learning activities that encourage the children to make connections between previous ideas and activities, question assumptions and cross-curricular concepts and ideas.

The emphasis, in the observed activities, of the teaching of mathematics and science shows that there is purpose in valuing attitudes and increase motivation for these areas. It is imperative to foster and develop the students thinking and reasoning. This may involve the teacher in standing back and allowing free exploration, or by teacher questioning that allows and values free expression of ideas.

3.5 Assessment

Assessment in the Basic Education (all cycles) covers the following forms:

- Diagnostic evaluation – leading to the adoption of pedagogic differentiation strategies, to overcome any difficulties encountered by students, facilitating their integration into school and supporting career guidance and counselling. It can occur at any time during the school year when combined with formative assessment.

- Formative assessment – is the primary mode of evaluation of basic education, assumes a continuous and systematic nature and aims to regulate the teaching and learning, using a variety of tools to collect information, according to the nature of learning and to the contexts in which they occur.

- Summative assessment is carried out at the end of each term of each school year, and at the end of each cycle. It is reflected in the formulation of a judgment on the globalizing learning achieved by students. In the 1st cycle, the information resulting from the summative evaluation is descriptive in all curricular areas.

At the end of each cycle of Basic Education (4th, 6th and 9th year of schooling), students are also subjected to an external evaluation process.

Creativity in assessment is evident in the schools that use a variety of evidence and peer/self-assessment. There is some evidence that in some schools the absence of national tests in science has resulted in a greater focus on maths.

Summative assessment is more evident in Mathematics. The summative assessment results from the National testing in Portuguese primary schools. In the discipline Estudo do Meio
(environmental sciences - including science) there is no national exam. This has led to science having a lower status than when the national curriculum was introduced in 2004, and since 2013 even more, due to the requirement of the national examination in Mathematics and Portuguese Language.

3.6 Materials and Resources

The guiding principles of the program of the 1st cycle of Basic Education suggest to the teacher the use of various materials and resources, aiming at a diversity of learning, without specifying them.

The more specific references to instructional materials come only in "Block 5 - The Discovery of materials and objects". Here are listed various materials, tools and equipment for hands-on exploration in the classroom or for hands-on exploration outside the classroom (e.g. salt, sugar, milk, wood, clay, cork, sand, paper, wax, scissors, hammer, saw, hoe, typewriter, camera, recorder, magnifying glass, stapler, paper punch, balloons, syringes, lenses, prisms, mirrors, magnets, nails, pins, lamps, wires, batteries, levers, pulleys, pipettes, dropper, microscope, overhead projector, slide projector, thermometer, compass, magnifying glass, binoculars ...)

In the Curriculum Guidelines for Pre-school two types of materials are referred: some are reference materials such as books, newspapers, videos, slides, computer; others are materials for conducting experiments. Among these are very simple materials from everyday life or the natural environment that can be used, and there are also specific materials such as magnets, magnifying glasses, binoculars, microscopes...It would be good if Portuguese schools had a physical environment richer for exploration and use of physical resources that foster thinking, especially where children can explore the use of resources in creative and imaginative ways. Further teacher training is fundamental and this is stressed by the teachers themselves.
3.7 Content

The curriculum organization of the 1st cycle of Basic Education has the following structure:

<table>
<thead>
<tr>
<th>Curriculum areas of the 1st cycle of Basic Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory disciplinary areas of (a):</td>
</tr>
<tr>
<td>Portuguese;</td>
</tr>
<tr>
<td>Mathematics; Environmental Studies;</td>
</tr>
<tr>
<td>Expressions: Artistic, Physical and motor.</td>
</tr>
<tr>
<td>Areas not disciplinary (b):</td>
</tr>
<tr>
<td>Project area;</td>
</tr>
<tr>
<td>Supported Study Education for citizenship</td>
</tr>
<tr>
<td><strong>Total: 25 hours (a)</strong></td>
</tr>
<tr>
<td>Discipline of optional frequency (c)</td>
</tr>
<tr>
<td>Moral and Religious Education</td>
</tr>
<tr>
<td><strong>Total: 1 hours</strong></td>
</tr>
<tr>
<td><strong>Total: 26 hours</strong></td>
</tr>
<tr>
<td>Curricular enrichment activities (d)</td>
</tr>
</tbody>
</table>

Each subject area of the curriculum includes the following components: a) the Guiding Principles b) General Objectives c) Learning Blocks. These latter correspond to sets of learning activities designated by a concept, an articulating theme or designation by a stage of development of curricular activity. Each block, while section or segment of a subject area, consists of four stages of activities corresponding to each of the four years of the 1st Cycle.

The Natural Sciences were included in the primary school program in 1975 (with the establishment of democracy in Portugal), through the creation of the “Physical and Social Environmental Studies”. Some changes introduced by the curricular reform carried out in 1990 in Portugal are still in effect today: i) the change of the curricular area name from “Physical and Social Environmental Studies” to “Environmental Studies”; and ii) the extension and intensification of the Science component, with the inclusion of Physical Sciences into a block called “Discovering Materials and Objects”. Since its creation until today, the curricular area of Environmental Studies takes on a globalising nature, as it integrates contributions from several other scientific disciplines, such as History, Geography and Ethnography, among others (Varela, 2012).

The Environmental Studies program, which includes the component of the sciences (physical and natural), is organized in the following content blocks:
The mathematics program of the 1st cycle of Basic Education, recently readjusted (2012) consists of two main components: mathematical themes and transversal capabilities common to all the learning of mathematics.

The program is structured around four main themes of mathematics, by cycles of learning and not by years of schooling: Numbers and operations, Algebra, Geometry, and Data organization and treatment. However, in the 1st cycle of Basic Education does not appear the subject of Algebra - although there are objectives in other subjects of this cycle that have an algebraic character – and, in this cycle, Geometry is associated with Measurement. But transversal capabilities are offered for problem solving, mathematical reasoning and

### Blocks and Content

<table>
<thead>
<tr>
<th>Blocks</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block - Self-discovery:</td>
<td>1. Your identification;</td>
</tr>
<tr>
<td></td>
<td>2. Your tastes and preferences;</td>
</tr>
<tr>
<td></td>
<td>3. Your body;</td>
</tr>
<tr>
<td></td>
<td>4. The health of your body;</td>
</tr>
<tr>
<td></td>
<td>5. The safety of your body.</td>
</tr>
<tr>
<td>Block - The discovery of your natural environment:</td>
<td>1. The living beings in your environment;</td>
</tr>
<tr>
<td></td>
<td>2. The physical aspects of the local environment;</td>
</tr>
<tr>
<td></td>
<td>3. Identify colours, sounds and smells of nature;</td>
</tr>
<tr>
<td></td>
<td>4. Astronomical bodies.</td>
</tr>
<tr>
<td>Block - The discovery of materials and objects:</td>
<td>1. Conducting experiments with some materials and objects of everyday Use;</td>
</tr>
<tr>
<td></td>
<td>2. Conducting experiments with water;</td>
</tr>
<tr>
<td></td>
<td>3. Conducting experiments with sound;</td>
</tr>
<tr>
<td></td>
<td>4. Handling objects in concrete situations;</td>
</tr>
<tr>
<td></td>
<td>5. Conducting experiments with air;</td>
</tr>
<tr>
<td></td>
<td>6. Conducting experiments with light;</td>
</tr>
<tr>
<td></td>
<td>7. Conducting experiments with magnets;</td>
</tr>
<tr>
<td></td>
<td>8. Conducting experiments in mechanics;</td>
</tr>
<tr>
<td></td>
<td>9. Conducting experiments with electricity.</td>
</tr>
</tbody>
</table>

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3 Available at: [http://area.dgidc.min-edu.pt/materiais_NPMEB/home.htm](http://area.dgidc.min-edu.pt/materiais_NPMEB/home.htm)
mathematical communication. These capabilities should receive continued attention in all cycles of Basic Education.

In Pre-school Education there is no formal curriculum but a set of guidelines that help the educators to structure their educational activity (ME- OCEPE, 1997 - Curriculum Guidelines for Preschool Education). The document is structured into two main parts: General Principles and Educational Intervention. In the first part are emphasized the scope of application and the specific objectives of this level of education. In the second part, the educational intervention incorporates three dimensions: organization of the educational environment, the content areas and educational continuity.

In relation to the content areas, these are defined as "areas of knowledge, with their own structure and socio-cultural relevance, which include different types of learning, not only knowledge but also attitudes and know-how" (ME- OCEPE, 1997 p. 47).

The area of the “Knowledge of the World” in Pre-school education is rooted in the child’s natural curiosity and his desire to know and to understand why. Curiosity is encouraged and extended in pre-school through opportunities for contact with new situations that are both instances of discovery and exploration of the world.

The organization of the content areas covers domains and sub-domains that have a correspondence with the program areas of the 1st cycle of Basic Education.

<table>
<thead>
<tr>
<th>Content areas in the curriculum guidelines of the pre-school</th>
<th>Compulsory curriculum areas of the 1st cycle of Basic Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Personal and Social Formation</td>
<td>Education for citizenship</td>
</tr>
<tr>
<td>Area of Expression and Communication:</td>
<td></td>
</tr>
<tr>
<td>- Domain motor expressions, dramatic, artistic and musical;</td>
<td>Expressions: Artistic, Physical and motor</td>
</tr>
<tr>
<td>- Field of Oral Language and Approach to Writing;</td>
<td>Portuguese Language (Oral and written communication)</td>
</tr>
<tr>
<td>- Domain of mathematics.</td>
<td>Mathematics</td>
</tr>
<tr>
<td>Knowledge of the World Area</td>
<td>Environmental Studies</td>
</tr>
</tbody>
</table>

The area of the “Knowledge of the World” includes the widening of basic knowledge necessary for social life, for example: learn to name and use different equipment and utensils, to use objects to build new shapes, to recognize and name different colours, sensations and feelings, to know his full name, address and location, to know how to say his age and to realize that he is growing; to know some aspects of the natural and social
environment. But this area also involves the discussion of scientific information on biology, knowledge of body organs, of animals, their habitats and habits, of plants, etc... And also experiments of physics and chemistry (light, air, water, etc.) that can be performed by children of pre-school age. Playing with water, to fill and to empty containers may be, for example, one way to understand that the air takes up space, to experience the principle of communicating vessels, to question why do some objects float while others sink. There are also ways to explore the effects of light and shadow, either using natural resources (sunlight) or technical ones (lamps, overhead projector, slide projector, etc.), that allow, for example, to explore the tilt and size of shadows at various times of the day, projecting the shadow of one's body and hands, and to play with shapes, colours, materials and textures. The observation of the weather and some knowledge about meteorology (wind, rain, etc.) are also referred.

Creativity is not referred in the content for science. In the curriculum of pre-school it is only referred that some aspects of the area “Knowledge of the World” can “help to develop aesthetic sensitivity, imagination and language” in children.

The contents of science in pre-school education are treated in a more rudimental way, but as can be seen in the table above there is a tendency for continuity and deepening of the same themes in the 1st cycle.

Unlike the sciences which constitute a component of Pre-school and 1st cycle of Basic Education integrated in a curriculum area, “Knowledge of the World”, and “Environmental Studies”, respectively, mathematics is treated as a cross-curriculum domain as well as a separate curriculum area.

### 3.8 Groupings

In Pre-school Education there is a greater emphasis on group work. This emphasis is immediately expressed in the principles that underlie “Curricular Organizations: “the requirement to respond to all children-which presupposes a differentiated pedagogy, based on cooperation, in which each child benefits from the educational process developed with the group” (ME- OCEPE, 1997, p.14). There is a greater tendency to enhance the social dimension of learning. Work in pairs, in small groups and, fundamentally, in a large group, are mentioned several times...

“The planning of the educational environment allows children to explore and to use space, materials and tools available to them, providing them diverse interactions with the whole group, in small groups and with a peer, and also the possibility to interact with other adults”(ME- OCEPE, 1997, p 26).

According to the latest publications of the organization of the school year the minimum number of students per class is 24 and the maximum 28 in the first cycle, in this sense, it
becomes very difficult for a single teacher to organize the class into groups and give them the support and monitoring required for fostering creativity in students.

More than an environment rich in materials and suitable space, the number of students per class seems to be the major constrain for the teacher.

3.9 Time

The curriculum guidelines for pre-school and 1st cycle of Basic Education do not mention the time that teachers should dedicate to approach the various curricular topics. The educational time dedicated to each of the areas of the curriculum is the responsibility of the educator or teacher, who may manage the curriculum flexibly, according to the educational needs of children. However, the daily or weekly educative routine is intentionally organized and planned.

Thus, the sequence of each day has a certain pattern in terms of approach of each curriculum area. Children know this routine that provides for succession and they know what they can do at various times, having the freedom to propose modifications. Not all days are equal, the proposals of the educator/teacher or children can modify the usual rhythm of work devoted to each area of the curriculum. The preschool curriculum explicitly states that it is for the teacher to organize the time devoted to each content area, although this organization matches "moments that are repeated at regular intervals" (ME-OCEPE, 1997, p. 40). The curricular structure of the 1st cycle of Basic Education refers only to the weekly time that should be devoted to the teaching of Compulsory disciplinary and not disciplinary areas (25 hours) and to the frequency of optional disciplines (one hour).

4. Approaches to Teacher Education

4.1 Initial teacher education

As previously mentioned, in Portugal the pre-school education is provided pursuant to point 2 of Article 30 of the Law of the Education for early childhood educators, while in the 1st cycle of basic education, as its character of globalization (integration) is in accordance with Article 8. of the referred Act, the responsibility of a single teacher, which can be assisted in specialized areas. The training of these professionals is carried out in Universities and Higher Schools of Education of the public and private sector.
In Portugal, is since 2007 (Decree-Law No. 369/2007 of 5 November), there is the Agency for Assessment and Accreditation of Higher Education (A3ES). This agency’s mission is to ensure the quality of higher education in Portugal, through evaluation and accreditation of higher education institutions and their courses.

A. Entry requirements

In order to apply for access to higher education via the national system, students must fulfill the following requirements: they must have passed an upper-secondary education course or legally equivalent qualification; they must have taken the necessary entrance exams for the course that wish to attend with a minimum mark of 95 points in 200 points; they must have satisfied the necessary pre-requisites (if applicable) of the course they are applying to. Entrance to each higher education institution is subjected to *numerus clausus*.

B. The main Standards/competencies to be achieved

In Portugal, the specific profiles of competence of Educators and teachers of first cycle of Basic Education are defined by Decree-Law No. 241/2001 of 30 August. The profile of competences of these professionals is organized into two main areas: a) skills development and curriculum development - the educator and teacher of the 1st cycle design and develop the curriculum, through the planning, organization and evaluation of the educational environment and learning performed by students; b) skills curriculum integration - the educator and teacher of the 1st cycle mobilizes the knowledge and skills needed to develop an integrated curriculum within curriculum areas.

C. Curriculum content

The initial training of Educator and Teacher Primary School comprises two separate training courses (two cycles of studies) that usually have the following structure:

- A first cycle of studies - Degree - which focuses on the scientific area or areas specific to each domain of competence for teaching in order to ensure mastery of the scientific content, humanistic and technological disciplines to teach. In the case of Early Childhood Educators and teachers of the 1st cycle of Primary School corresponds to the degree in Elementary Education;
- A second cycle of studies - Master - which gives professional qualification for teaching and is organized in accordance with Decree-Law no. 43/2007 of February 22 - new Legal Professional Qualification for Teaching, the following training components:
  o General education - Covers the knowledge, attitudes and skills in education relevant to the performance of all teachers in the classroom, kindergarten
or school, in community relations and participation in analysis and policy development education and teaching methodologies;

- Specific Didactics - covers the knowledge, attitudes and skills related to teaching in curriculum areas or subjects and cycles or levels of education of their area of qualification for teaching;
- Introduction to professional practice;
- Training cultural, social and ethical;
- Training in educational research methodologies;
- Training in the area of teaching.

Professional qualification conferred by a higher school of education or a university - In Portugal the ownership of the professional qualification for teaching general, in pre-school and on the 1st and 2nd cycles of Basic Education is given to those who have a degree in Elementary Education and a Masters in Education.

D. Level of training

The professional qualification for teaching is the Master’s degree. This is the minimum academic qualification for the teaching profession, according to the changes introduced within the Bologna Process.

To enter the profession it is necessary to possess a professional qualification conferred by a higher school of education or a university for the cycle or recruitment group one is applying to, and pass the knowledge and competencies test (designed to evaluate scientific readiness) as well as obtain, at least, the mark of Good in the performance assessment of the probationary period (to assess pedagogic and didactic competencies).

Access to the teaching employment in the public sector is done via national application, based on academic qualification and professional experience. Teachers working in the public sector are public officials..

E. Length of training

The length of training is 5 years - 3 years (degree) + 2 years (Master).

F. Institutions authorized to provide training

Initial teacher education is carried out in higher education institutions – polytechnic and universities – with the Master’s degree being the minimum academic qualification for the teaching profession, according to the changes introduced by the Bologna Process.
4.2 Admission to the profession since 2013

As this report is being produced, teachers who want to enter the boards of the Portuguese educational system, regardless of their years of teaching experience, must undertake an exam, divided into two parts: one is general for all applicants to be held in December 2013, and another one is expected to be more specific for each area of teaching, to be held in a close future.

As this exam has never been done before, nor the results and consequences are yet known, nothing further can be said but that the general part model yielded by the Ministry of Education does not evaluate knowledge, skills or competences related to teaching; in fact, the sort of questions in that exam should be easily answered by any person, of any age, with mid intellectual competences and low level of education.

4.3 Continuing professional development

The training of educators and teachers is recognized as a right that is enshrined in the Basic Law of the Portuguese Educational System. In this Law, it is stated that the training "is provided predominantly by the respective training institutions, in cooperation with the institutions where educators and teachers work" (Art. 38, 3). The Legal System of Training Educators and Teachers of Primary and Secondary Education reinforced the idea of lifelong learning and stated it as a duty and a right inseparable from the initial training (Decree-Law 207/96 of 2 November). Also the publication of the Teaching Career Statute expresses this understanding of training, considering it as a prerequisite for career development (Art. 43.) With this encouragement to continuing education has been recognized that the initial training alone is not sufficient for the teaching career, this was pointed out in the Basic Law when it stated that continuous training "complements and updates the initial training in a perspective of lifelong learning" (Article 33, 1.b).

As a consequence of some of the earlier legislative measures, was found in the period 1993 to 2005, a massified and mandatory training, given the demands of teachers' careers. During this period, there were thousands of training actions on several topics. Since 2005 there was a set of policy guidelines that led the training to be more scarce and controlled.

In the period 2005 to 2011 there were privileged actions on didactic training on the specific relevance to the application in the classroom, which should represent at least 50% of the actions to be attended by teachers (Order No. 794/2005 of August 3). Later, it was established that at least two thirds (66%) would be in the scientific-teaching area of the teacher (Decree-Law No. 15/2007 of 19 January). Thus, since 2005, the training of teachers
came to be targeted to priority areas defined by the Ministry of Education, from a diversity and freedom of subject (1993-2005) to the opposite situation (2005-2011) (Silva, 2011).

To ensure the training of teachers were created Centres of Associations of Schools (CFAEs), entities currently responsible for the largest percentage of the number of training courses.

For the accreditation of these centres, the training and trainers to ensure that, was created the Coordinating Council for Further Education of Teachers, which existed until 1994, when it was replaced by the Scientific Council for Further Education Teaching (CCPFC), organ of ministerial appointment. The financing of continuing training was provided from January 1994 to December 1999 by FOCUS (under the Community Support Framework II, the PRODEP II, Measure 2/Action 2.1) and since then by PRODEP III, Measure 5 / Action 5.1.

In addition to the training centres for associations of schools, the training of teachers is also offered by institutions of higher education universities and colleges responsible for initial teacher training.

There is, in Portugal, a Scientific and Pedagogical Council for Continuous Training, who is responsible for the accreditation of training providers and continuing training of teachers, monitor the system evaluation process of training, as well as the accreditation of specialized training courses (Decree-Law 155/99 of May 10).

In relation to continuing training of teachers in mathematics and science, the Ministry of Education, in collaboration with institutions of higher education responsible for teacher training and schools or groups of schools, has developed two major national projects of continuing training of teachers in mathematics and science. These projects, oriented at teachers of the 1st and 2nd cycle of Basic Education, had as main objectives to improve levels of student success in mathematics and science and the enhancement of skills of teachers in these curricular areas:

- The national program of teacher training in mathematics was developed successively between the years 2005 and 2010 (Joint Order no. 812/2005 and Order no. 8783/2010). This program aimed at improving the students’ learning of mathematics in the 1st and 2nd cycles of Basic Education and also at developing a positive attitude towards this curricular area. To this end, it intended: a) to enhance the mathematical knowledge, teaching and curriculum of the teachers involved; b) to implement experiences in mathematics curriculum development; c) to develop positive attitudes of teachers in relation to Mathematics; d) to create dynamic collaborative work between teachers; e) to promote networking between schools and groups.

The program has been addressed to the teachers of the 1st and 2nd cycles that are to teach Mathematics and lasted for one academic year. During training, teachers had joint training sessions and follow-up sessions in the classroom.
The Training Program in Experimental Science Teaching for Teachers of the 1st cycle of Basic Education has developed over four academic years between 2006 and 2010 (Order no. 2143/2007 of 9 February and Decree-Law no. 701/2009 of 9 January), with the central purpose of increasing the level of scientific literacy of Portuguese students through the development of professional skills of teachers of the 1st cycle of Basic Education, in this curricular area.

Additionally, in recent years the Portuguese government has not been valuating the masters and PhD degrees teachers have achieved, discouraging the whole class to pursue.

Indeed, not long ago, a teacher with a bachelor degree would progress a few years in his career after a masters or a PhD. Nowadays, any academic degree acquired by a working teacher is irrelevant for any promotion.

5. Recommendations to Policy Makers and Stakeholders

Upon our observations and the case studies presented in the Portuguese D4.3 Country Reports – Report 7 of 9: Country Report on in-depth field work in Portugal accessible in the CLS website, we would like to address some key points that may summarize our findings and shed some light on teacher training issues, based on a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. Bullet point recommendations are drawn at the end of this chapter.

STRENGTHS

- We have found teachers who were highly motivated to participate in this research by providing us the observation of teaching moments without any prior input from us.
- They did not fear to be under observation.
- They dare to face new challenges outside their comfort zone.
- The children were easily engaged in the activities, encouraged to share their thoughts and suggestions, showing confidence, creativity and participated with enthusiasm, feeling at home. This denotes a good relationship between teacher and students, which is fundamental for these actions to have success.

WEAKNESSES

- The sample reported in this document although significant is not representative of the average of our country. The cases were chosen after our previous knowledge that school teachers and students they would be interested in cooperating with this research.
• Generally speaking during their graduation the teacher’s training in sciences and mathematics is weak and superficial. Creativity is not, or at most it is only marginally, explored or even mentioned.
• The teachers feel the need to have training in sciences and mathematics in the framework of their mandatory continuous professional training, and yet the offering of those kind of trainings is scarce.
• There is a lack of interaction among teachers to share expertise and to reflect on their practices.

OPPORTUNITIES
• The results presented show that teachers and children are easily engaged in sciences and mathematics activities beyond the curriculum, giving them the chance to discover new subjects of interest and through which imagination and creativity are put to work.
• This research endeavored the cases under study the opportunity to get away from their usual territories with pleasant results.
• There is an urgent need to create and to offer training workshops for the early years of education, not only for updating scientific knowledge, but also for different and effective teaching techniques and strategies.
• In one of our cases, it can be seen that starting with a simple string it is possible to draw an extraordinary session of science learning with imagination and creativity of the children guiding the process. It is not a matter of money, but will and creativity of both teachers and institutions.

THREATS
• The political, economic and social context of Portugal is a major constraint for the implementation and development of new ways to promote science and mathematics in early years of school.
• The teachers are under an extreme stress and menace, as their binding to the educational system was drastically weakened, which compromises their best wishes to participate in improving the system.
• Increasing academic qualifications is no more rewarding for teachers: they may spend a lot of money and time to make a masters or a PhD, but in the end they are not promoted and their improved knowledge and skills are not an asset to the system, so they feel.
• The fear to interact, to share knowledge and skills, to assess and to be assessed by peers is not a habit in the Portuguese culture.
Upon our observations and the case studies presented in the Portuguese D4.3 Country Reports – Report 7 of 9: Country Report on in-depth field work in Portugal accessible in the CLS website, a final meeting with stakeholders, and from the arguments presented in chapters 3 to 4 in this report, we would like to enhance some key points and to point some recommendations.

In preschool, teachers have more freedom to work with diverse topics and interesting students, depending on their interests. There are many subjects in primary education, because the curriculum is very wide-ranging, and teacher doesn’t have the need to comply it. Moreover, it is necessary to prepare students for the final exams at the end of primary education. Teachers in pre-school education are therefore always more open to new experiences and new approaches to exploit with their students.

Greater emphasis on math for results at the national level, and mathematical challenges help students to achieve patience, to reflect, to not give up, helps concentration, and any other areas do this often, almost like a moral lesson that take into your life, so there are no relevant differences observed between science and mathematics.

As stated in part 3.1 – Rationale or Vision – of this report, creativity is not mentioned as a purpose in the curriculum of "Environmental Studies" of the 1st cycle of Basic Education or in the curriculum guidelines for pre-school education, although the Basic Law of the Portuguese Education System, in its Article 5, point 1.f, aims at "to develop the child's capacities of expression and communication, as well as their creative imagination [...]".

The theme of creativity is a "relatively recent trend" and very often teachers do not have the necessary tools and training to foster creativity. It is required more and better preparation by teachers as they have to be prepared for students’ questions and comments and guide them to reach the intended goals without defraud their expectations.

Initial teacher education

Initial teacher education is carried out in higher education institutions with the Master’s degree being the minimum academic qualification for the teaching profession, according to the changes introduced by the Bologna Process.

The teacher training during their graduation should include more and deeper learning in sciences and mathematics. The teachers themselves recognise their poor proficiency in these matters and are willing to access opportunities to improve their scientific knowledge and related didactical and pedagogical skills. The peer interaction and the sharing of knowledge and skills, assess and be assessed by peers is not a habit in Portuguese culture, neither the teacher training suppresses this gap.
Continuous Professional Development (CPD)

Increasing academic qualifications is no more rewarding for teachers: they may spend a lot of money and time to make a masters or a PhD, but in the end they are not promoted and their improved knowledge and skills are not an asset to the system.

There is an urgent need to create and to offer training workshops for the early years of education, not only for updating scientific knowledge, but also for different and effective teaching techniques and strategies. It is recognized by the teachers their lack of initial and further training on sciences and mathematics but not of motivation to undergo CPD on these areas. CPD of teachers should be reinforced in the areas of science and mathematics in early years of education, which lack diversity and extensive territorial range. Namely, at pre-school level, the opportunities for this kind of CPD is scarce and in many regions is absent.

In the Portuguese educational system CPD is mandatory, and yet it is possible a teacher to complete a full teaching career without making any CPD in sciences and mathematics. Therefore, it would be very much welcome the obligation for every teacher to make a CPD in these areas from time to time.

Main recommendations:

- Educational policies should be set to last at least for one generation (ideally for several generations on its main guidelines) with only minor adjustments to be made according to the evolution of the societies.
- Educational policies should be sound carefully designed and validated as extensively as possible taking into account the most update well established knowledge in science and math education in particular, in this context, at pre-primary and primary school level. Policy makers should refrain to impose their own personal, not widely validated by teachers and researchers in the field, believes seeking the advice of the widest range of recognised specialists, the schools teachers and parents and civil society bodies.
- Initial teacher training at higher education institutions should be reformulated with major efforts being made on the implementation of active hands-on learning teaching/learning student (future teacher and educator) centred.
- Increased attention should, on the initial teacher training, be paid and a clear focus be given to the training on scientific and technical knowledge and competencies on science and maths subject in order to guarantee to future teachers and educators a strong scientific literacy in all fields of science that will allow them to address these issues at different levels of complexity at the different pre-school and primary school level.
- Increased attention should, on the initial teacher training, be paid to the training on creativity and practical learning on strategies of promotion of creativity and on the benefits of its use in the development of the young students. As well IBSE and new trends on early year and primary school educational strategies should be widely and carefully addressed.
- The three last recommendations should apply also to in-service teacher training. That should be generalised increasing the training offer as well and the training opportunities giving teachers and educator practical condition to pursue this training in an effective (and not just apparent as currently most frequently it happens).
- Continuous in-service teacher training should be performed or validated by the active intervention of higher education specialists in the field. The contribution as advisors and or trainers of school teachers and educator should be considered of utmost importance.
- The recognition of the social importance of the teacher and educators should be clearly and effectively made by policy makers and stakeholders.
- Peer support is fundamental to the success of the teaching/learning process and pre-primary and primary education.
- Each teacher/educator should have in her/his classroom the support of a specialist or preferentially another teacher on the first year of her/his professional life.
- The number of students per classroom and teacher should be limited in order to allow teachers and educators to give the proper individual and special support to each student in the different stages of their intellectual development.
- The curricula goals and main implementation strategies should be clearly stated but its design and implementation should be flexible and responsibility of the teacher and school.

**Concluding remarks**

At the present time, the political, economic and social context of Portugal is a major constraint for the implementation and development of new ways to promote science and mathematics in early years of school. The teachers are under an extreme stress and menace, as their binding to the educational system was drastically weakened. The constrictions hitting the teachers such as income reduction, increasing the number of students per class, increase of bureaucratic work, no career progression, constant changes in curricular design (contents, goals, etc.), and others, compromise their best wishes to participate in improving the system.

However, children are easily engaged in activities of science and mathematics. They respond positively to creative approaches and exhibit their own imagination and creativity. They share their thoughts and suggestions, showing confidence, participating with enthusiasm, and feeling at home if there is a good relationship between teacher and students.

To promote creativity and imagination in early years of school, preserving the freshness and intellectual curiosity of children and fostering higher levels of performance in later years is not only a matter of money, but will and creativity of both teachers and institutions, as long as educational political makers fully accomplish their mission.
6. Limitations

Science and mathematics teaching would benefit from having explicitly their own space in curriculum and time in teaching activities. At present time, these subjects are included in a wider area which comprises other subjects (e.g. History, Geography, Chemistry, Physics), making them a minor contributor for children, in preschool and primary school.

In our observations it was clear that children are easily engaged and show high levels of motivation for science and mathematics activities, are creative, make connections and are inquisitive: they are eager to discover new things every day.

For early years of education there is an evident need to create opportunities to train teachers in sciences and mathematics. That means there should be training courses for trainers too. The majority of teacher trainers (other teachers and professors from universities) are tailored to address to 2nd, 3rd cycle and secondary teachers. The specific targets of pre-school and primary school teachers need different and specific training.

This training should provide a framework for developing teaching activities and skills taking into account the younger ages of the students, their level and rate of emotional development, fostering creativity and strengthening the consistency of logical and scientific thinking.
7. References


