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

D4.3 Country Reports

Report 8 of 9:
Country Report on in-depth field work in Romania

Authors:

Dr. Dan Sporea and Dr. Adelina Sporea
National Institute for Laser, Plasma and Radiation Physics,
Center for Science Education and Training
Romania

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: April 2013
Actual submission date: 07/06/2013
Deliverable title:

D4.3 Country Reports

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

Lead partner for this deliverable
Ellinogermaniki Agogi, Greece:
Dr. Fani Stylianidou, Dimitris Rossis

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

1. Aims of this report 5
2. Methodology 7
2.1 Research Questions 7
2.2 Research Instruments 10
2.3 Data Collection 11
2.3.1 Sampling principles 11
2.3.2 Ethical issues 12
2.4 Data Analysis 13
2.4.1 Process 13
2.4.2 Final sample 14
2.4.3 Limitations 14
3. Case studies 16
3.1 Case 1 – Maria 16
3.1.1 Context 16
3.1.2 Episodes 21
3.1.3 Case summary and conclusions 32
3.2.1 Context 35
3.2.2 Episodes 41
3.2.3 Case summary and conclusions 47
3.3 Case 3 – Anca 50
3.3.1 Context 50
3.3.2 Episodes 54
3.3.3 Case summary and conclusions 60
3.4 Case 4 – Sanda 63
3.4.1 Context 63
3.4.2 Episodes 66
3.4.3 Case summary and conclusions 72
3.5 Case 5 – Cora 74
3.5.1 Context 74
3.5.2 Episodes 78
3.5.3 Case summary and conclusions 85

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

3.6 Case 6 – Delia 88
3.6.1 Context 88
3.6.2 Episodes 92
3.6.3 Case summary and conclusions 98
4. Discussion of Findings 101
4.1 Enabling Factors or Barriers at Contextual Level 101
4.1.1 Differences between preschool and primary school 102
4.1.2 Differences between science and mathematics 103
4.1.3 Opportunities and challenges for creative learning and teaching 104
4.2 Revisiting the CLS Mapping and Comparison Factors: A summary of findings 105
4.2.1 Aims and Objectives: *Toward which goals are children learning?* 105
4.2.2 Learning activities*: How are children learning?* 107
4.2.3 Pedagogy: *How is the teacher facilitating learning?* 110
4.2.4 Assessment: *How is the teacher assessing how far children's learning has progressed, and how does this information inform planning and develop practice?* 113
4.2.5 Materials and Resources: *With what are children learning?* 115
4.2.6 Grouping: *With whom are children learning?* 117
5. Implications 120
5.1 Implications for teacher training 121
5.2 Implications for policy development 122

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

1. Aims of this report

The *Country Report on in-depth field work in Romania* forms part of the *Country Reports* (Deliverable D4.3) of the EU-funded project *Creative Little Scientists* and aims at presenting the qualitative analysis of data gathered through field work in schools in Romania.

The fieldwork was carried out during the months January-April 2013 in each of the nine participating European countries (Belgium, Finland, France, Germany, Greece, Malta, Portugal, Romania and the UK) representing a wide spectrum of educational, economic, social and cultural contexts. The findings of this qualitative study aim to reveal the potential for creativity and the role of inquiry in the classroom realities of pre-primary and first years of primary science and mathematics education, and are grounded on concepts and synergies identified in the *Conceptual Framework* (D2.2) and operationalized in the *List of Mapping and Comparison Factors* (D3.1) developed previously in the project. Moreover, they aim to complement the findings of the *Report on Mapping and Comparing Recorded Practices* (D3.2) and the *Report on First Survey of School Practice* (D3.3), previous project deliverables which addressed the same goals through the analysis of relevant policy records and teacher survey data respectively.

The focus of the fieldwork was on sites where there were indications that we would find 'good practice', and covering all pupil age groups from age 3 up to 8 years and the different provisions of pre-primary and early primary education in the country. The characteristics of 'good practice' emerged from reflection on findings of previous project deliverables: the *Conceptual Framework* (D2.2), the *Report on Mapping and Comparing Recorded Practices* (D3.2) and the *Report on First Survey of School Practice* (D3.3). This has enabled the project to document and analyse practice at the cutting edge of creativity in early science and mathematics, revealing insights into whether/how:

- children's creativity is fostered, and
- the emergence of appropriate learning outcomes is achieved.

As far as the latter is concerned, focus was placed on (but not limited to) issues of central importance in current science and mathematics education discourse, including generating children's interest in science and mathematics, avoiding emergence of misconceptions and stereotypical images, and considering gender, socio-economic and cultural issues.

The in-depth field work followed the research design and methodology specified for the project and set out in detail in the *Methodology for in-depth fieldwork* (D4.1), and involved the use of interviews and observations with teachers and children, using field notes and audio recordings. The present report presents the analysis of data in relation to six cases (each case comprises one teacher and the children they work with), based in four sites of pre-primary and early primary education. Each case contains episodes, documenting examples of science and mathematics through the lens of creativity.

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

Finally, this report is one of the working documents that will provide input to the *Report on Practices and their Implications* (Deliverable D4.4), which is the final outcome of Work Package 4. The latter will give a detailed account of the analysis of the evidence gathered through the field work in all partner countries, as well as identify a set of exemplary Case Studies illustrating the variety of approaches observed and the possibilities identified.

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

2. Methodology

The full range of methodological planning and framing for the fieldwork study presented in this report is set out in the *Methodology for in-depth fieldwork* (D4.1). The following sections serve as a reminder of some of its essential elements, and mainly provide the details of how this methodology was implemented in the fieldwork carried out in Romania and described in this report.

2.1 Research Questions

The research questions for this report originate from the project's overall research questions as they are identified in the *Conceptual Framework* (D2.2). The overall research questions are:

RQ1 How are the teaching, learning and assessment of science and mathematics in early years in the partner countries conceptualised by teachers and what role if any does creativity play in these?

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

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

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

As articulated in the *Conceptual Framework*, the first question is focused on mapping conceptualisations in relation to classroom practices in preschools and early primary education, while the second and the third on probing practice in such settings in science and mathematics education using the lens of creativity. The final question draws on both the mapping and probing questions and seeks to apply what has been learned so as to develop practice (in relation to ITE and CPD).

As mentioned above, this report is dedicated to revealing current practice in the intersection between science, mathematics and creativity in both pre-school and first years of primary education in the partner countries. As such, this report has to focus on research questions RQ2, RQ3 and provide input towards RQ4.

Sub-questions running across all research questions probe:

- **Aims/purpose/priorities**, including teachers' explicit and implicit perspectives and identities as scientists and mathematicians, and in relation for example to: aims and purposes of creativity in science and mathematics education; how science and mathematics are taught and learned in relation to other domains of knowledge; how

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

these shift from pre-school to primary across the consortium; how these relate to inquiry-based science education (IBSE); views of creativity in relation to perceived purpose.

- **Teaching, learning and assessment**, including learning activities, pedagogy and resourcing, and in relation for example to: multimodal expression and experience; learning activity types; resources used; dynamics between adults and children; exploration; questioning and argument; also how teachers assess creativity in early science and mathematics education.
- **Contextual factors**, including ethos, teacher characteristics and teacher general education and knowledge, skills and confidence, curriculum, institutional factors, home-school links and the wider cultural background, location, grouping, time.

Moreover, drawing on the framework of curriculum components 'the vulnerable spider web' (van den Akker, 2007, p.39) [25] these three broad strands have been broken down into ten more narrowly-defined dimensions, which focus on key questions about aspects of learning in schools. Along these dimensions and sub-questions, a number of factors reflecting the study's scope and parameters for mapping of and comparisons between existing approaches to and practices of early years science and mathematics education, i.e. which have a strong potential to foster the development of creative skills in children, have been identified in the *List of Mapping and Comparison Factors* (D3.1), and are explicitly addressed in this report.

Table 1 shows these dimensions, sub-questions and factors, and their codes. Factors highlighted in yellow concern important issues identified in the previous deliverables (*Conceptual Framework* (D2.2), *Report on Mapping and Comparing Recorded Practices* (D3.2) and *Report on First Survey of School Practice* (D3.3)) as needing further investigation. This report focuses on these factors as they enable the mining of key issues identified by previous reports and thus ensure continuity and consistency amongst the various parts of the research study.

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

Table 1: Dimensions, Sub Questions and Factors

	Dimensions	Sub questions	Factors important to nurturing creativity in science and mathematics in the early years	Coding
PEDAGOGI-CAL INTERVENTIONS	Learning Activities ***Interaction***	How are children learning?	*Focus on cognitive dimension incl. nature of science* • Questioning • Designing or planning investigations • Gathering evidence (observing) • Gathering evidence (using equipment) • Making connections *Focus on social dimension;* • Explaining evidence • Communicating explanations	• LA: Ques • LA: Plan • LA: Obs • LA: Equip • LA: Connect • LA: Expl • LA: Comm
	Pedagogy ***Interaction***	How is teacher facilitating learning?	• role of play and exploration; role of play valued • role of motivation and affect ; Efforts made to enhance children's attitudes in science and mathematics • role of dialogue and collaboration; *collab. between children valued* • role of problem solving and agency ; use of IBE/PBL, Children's agency encouraged • fostering questioning and curiosity - Children's questions encouraged • Diverse forms of expression valued • fostering reflection and reasoning; children's metacognition encouraged • teacher scaffolding, involvement, Sensitivity to when to guide/stand back	• P: Play • P:Affect • P:Collab • P:Agency • P:Ques • P: Express • P: R and R • P: Scaff
	Assessment ***Framing and Interaction***	How is teacher assessing how far children's learning has progressed, and how does this information inform planning and develop practice?	*Assessment function/purpose* • formative • summative • recipient of assessment results NO CODE *Assessment way/process* • strategy • forms of evidence ; excellent assessment of process +product, Diverse forms of assessment valued • locus of assessment judgment – involvement of children in peer/self assessment	• A:Form. • A:Summ. • A:Strat. • A:Evid. • A:Peer/self

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 ***Framing and Interaction***	With what are children learning?	• rich physical environment for exploration; Use of physical resources thoughtful; Valuing potential of physical materials; Environment fosters creativity in sci/ma • sufficient space • outdoor resources; recognition of out of school learning • informal learning resources • ICT and digital technologies; confident use of digital technology • variety of resources • sufficient human resources • policy documents; NO reliance on commercial schemes	• M:Explor. • M: Cr • M:Space • M:Outd. • M:Inf. • M:ICT • M:Variet. • M:Human • M: Pol.
	Dimensions	**Sub questions**	**Factors important to nurturing creativity in science and mathematics in the early years**	**Coding**
PEDAGOGICAL FRAMING	Aims and Objectives ***Framing and Interaction***	Toward which goals are the children learning?	• knowledge/understanding of science content • understanding about scientific inquiry • science process skills; IBSE specifically planned • capabilities to carry out scientific inquiry or problem-based activities; use of IBE/PBL • social factors of science learning; collaboration between children valued • affective factors of science learning;efforts to enhance children's attitudes in science and maths • creative dispositions; creativity specifically planned	• AO: Kn.Sc • AO: Und. SI • AO: Sc Proc Skills • AO: IBSE/PBL • AO: Social • AO: Affect • AO: Creative
	Location ***Framing and Interaction***	Where are they learning?	• outdoors/indoors Recognition of out of school learning • formal/informal learning settings/ • small group settings	• L. Out/Indoors • L.Formal/ Informal • L.grp
	Grouping ***Framing and Interaction***	With whom are they learning?	• multigrade teaching • ability grouping • small group settings • number of children in class	• G:MG • G:Abil. • G:SmallG • G:No.

2.2 Research Instruments

The methodology document for the fieldwork (D4.1) set out a series of core and repertoire research instruments. All partners have been expected to use the same core instruments so as to collect similar data to enable comparisons. Additionally, each partner was encouraged to use a repertoire of instruments, depending on preferred approaches and existing expertise. Data was to be collected across four areas spanning site and case (see D4.1, p33):

1. **WIDER SITE CONTEXT**: encompassing data from existing Deliverables D3.2, D3.3, and D3.4.

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

2. **CASE PEDAGOGICAL CONTEXT**: the setting's teaching and learning policies and planning documents as appropriate, assessment records if they exist, overview of resources and a map of the space.
3. **CASE OBSERVATION OF PEDAGOGICAL INTERACTION AND OUTCOMES** (episodes of learning involving children and teachers):

   Core Instruments: Sequential digital images capturing detailed interactions, with fieldnotes supplemented by audio recording (later transcribed) and an overall timeline, enabling narrative construction

   Possible additional repertoire instruments: teacher journals, Fibonacci style tools to support diagnostic observation, Involvement Scale, Reggio style documentation, conceptual drawing, video.

4. **CASE ORAL EVIDENCE (INTERVIEWS)- PERSPECTIVES ON PEDAGOGICAL INTERACTION AND OUTCOMES (children + teachers):**

   Core Instruments: individual interviews (teachers), group interviews (children) using digital images from observations, 'learning walk' led by child, looking at children's work.

   Possible additional repertoire instruments: supplements to interviews such as conceptual drawings or teacher journals. Some oral interviews might be spoken to audio recorder.

For the research field work in Romania all the Core Research Instruments were uses, with two exceptions: group interview with children and learning walks, due to constraints of time and availability of children. In addition, two Additional Research Instruments were used: Fibonacci-IBSE diagnostic tool and video recordings.

2.3 Data Collection

2.3.1 Sampling principles

The methodology document for the fieldwork (D4.1) specified that each partner should visit a minimum of four sites (i.e. schools/preschools), five where possible and gather data from a minimum of six cases (i.e. one teacher and the children they work with) reflecting both settings (pre-school and primary education). In order to reflect the science and mathematics focus of the project, partners were asked to aim to identify three episodes of activity per case (ensuring at least one each of science and mathematics) resulting in a total of 18 episodes being reported per partner. The episodes are meant to provide illustrations of actual practice - chosen because they exemplify one or more of the aspects identified in Table 1.

The sample of cases was thus deemed to be a purposive one, involving a range of contexts, learning opportunities and teacher populations and age ranges of children. Moreover, the following selection criteria were identified to be used as part of the selection of each national sample (see D4.1, p28):

- Includes appropriate diversity (e.g. in respect of culture, circumstance, language).

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

- Covers appropriate age span 3-8.
- Represents span of mainstream (i.e. not special) early years provision.
- Settings primarily focused on education not care.
- There are indications of good practice of early years mathematics, science and creativity.
- Allows us to mine one or more of the important research foci (identified in previous deliverables and shown in Table 1).
- Geographical accessibility for researchers.

2.3.2 Ethical issues

Any fieldwork undertaken with young people can potentially carry ethical implications, both in terms of the conduct of the researcher whilst undertaking fieldwork, and in the collection and application of data following the fieldwork period.

Each partner was required to identify and meet the ethical approval policies for their institution, school system, region and country as appropriate. In addition, the consortium identified the following minimum standards that were applied by all partners in all cases:

- Participation to the research was on an informed voluntary basis. Letters for school staff and parents were developed for this purpose (see D4.1, Appendix 4, p72). Written consent was obtained before the fieldwork was undertaken. The right to withdrawal was clearly communicated.
- Explicit permission was requested to take and use photographs (and videos where appropriate) of the children and staff for the project in project reports and publications.
- Explicit permission was requested to interview children as part of focus groups.
- The sites used, the adults and children who were involved were given pseudonyms to protect their identities.
- Any electronic data collected was stored on password protected encrypted storage systems, where only authorised staff had access. An agreed protocol for storage and labelling of data was agreed (see D4.1, Appendix 7, p85).

In Romania, the project partner 'National Institute for Laser, Plasma and Radiation Physics' through the Center for Science Education and Training has the right to collect, use and store the personal data of the participants to the *Creative Little Scientists* project. (The Institute is registered to the Romanian National Supervisory Authority for Personal Data Processing starting with 22.04.2010 under the number 15407.) All data were used for research purposes and were not made public.

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

2.4 Data Analysis

2.4.1 Process

As already mentioned, the methodology agreed for the fieldwork specified that each partner would produce a minimum of six identified cases, with a minimum of three narrative episodes per case to fully explore the opportunities presented for the fostering of creativity in early years science and mathematics education. A narrative episode in this case was defined as a written narrative account that describes an observed event or series of connected events of science and mathematics teaching/learning with a creativity focus, which forms a coherent story by itself. These were to be drawn from observations selected for their relevance to the pre-identified project factors and supported by information gathered through a minimum of two types of core data. Where possible the views and thoughts of the children in addition to those of the teachers were sought; extracts from relevant transcripts, containing they key areas of interest specific to the focus of the episode are provided.

All data were coded using a set of deductive codes, based on the project factors (see Table 1), and were discussed in terms of Siraj-Blatchford et al.'s (2002) [24] framework to explore pedagogy in terms of pedagogic framing and pedagogic interventions. Their opportunities for science or mathematics creativity were highlighted.

Finally, the episodes were combined in overall cases, which included information about the site, the setting and the teacher. These cases and related episodes are presented in 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.

2.4.2 Final sample

The characteristics of the final sample are given in the table below.

Fieldwork Sites		1	2	3	4	5	6
General Selection Criteria							
Phase	Preschool	X		X	X		
	School		X			X	X
Governance	Non-fee paying			X	X	X	X
	Fee paying	X	X				
Age(s) of children	3			X			
	4			X			
	5	X			X		
	6	X			X		X
	7		X			X	X
	8		X			X	
Mixed age groups							
Special school							
High Diversity	SEN						
	Non-native speakers						
	Socio-economic disadvantage						
Location	Urban	X	X	X	X	X	X
	Suburban						
	Rural						

2.4.3 Limitations

In drawing conclusions from this report one has to consider several major limitations which mark the overall resulting inferences:

1. The field study covers only a limited timescale of the school year, and only the winter time classes. Romanian schools observe their return to the activity following the winter holiday by mid January and they run out of school, non-formal educational activities for one week in April. So, for the planned field visits the research team had little opportunities to attend outdoor classes or participate to non-formal, informal learning practices. Another limited factor concerning the outdoor activities was the winter weather when very few activities took place in open spaces.
2. The small number of sites visited can provide only a truncated picture of the Romanian Early Education landscape. More time has to be allocated to such investigation, involving more and divers actors.
3. A bias is present in this report as the researchers selected teachers with whom they worked previously in order to find good practice examples as requested by the WP4 proposal.

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

4. Because of time and financial constrains some interesting sites were not considered as they are located far from Bucharest, and not so easy to be reached.
5. The fingerprint of the Romanian curriculum restrictions as it concerns creativity development in Early Education and the use of inquiry can be noticed in this report.
6. In some cases, teachers prepared "special" lessons for the research team visits, so, the observations can be altered by these special set-ups, as not being convincing for the everyday practice.
7. The selection of observed teachers based on their response to the survey questionnaire can induce another biasing effect on the overall conclusions, making generalization less acceptable.
8. There is no practice in Romania concerning visits to classes by outside visitors and, for this reason difficulties were encountered in having children interviewed.
9. Another limit to be considered is the lack of experience of the researches involved in the study, as their knowledge in the field is mainly based on the training course delivered in the frame of the "Creative Little Scientists" project.

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

3. Case studies

3.1 Case 1 – Maria

3.1.1 Context

Where?	Country	Romania			
	Setting name	HK-RV			
	Location within setting	Pre-school			
Who? (children)	Year group/age of children	5 - 6 years old			
	Number of children in class	12			
Who? (adults)	Number of adults	1			
	Role of adults	teacher			
	Case teacher role	Co-ordinator			
When?		1	2	3	
	Dates of visits	18/1/13	18/1/13	19/1/13	
	Times of visits	9:30-12:00	14:00-16:30	9:30-12:00	

a) School/setting

The site is primary devoted to nursery and pre-school education and includes also a small primary after-school facility. The unit is located into a provincial town (about 92,500 inhabitants), situated in the central-south area of Romania at the foothills of the Southern Carpathians. Beautiful landscapes can be reached within ½ hour drive. An attractive park and a zoo are available for outdoor activities.

The educational establishment is privately owned. Pre-school pupils are from 2 years to 6 years and 4 months old. The total number for the current school year is 82. At the primary after-school program are enrolled 12 children from 8 to 10 years old. Most of the children attending the classes belong to the middle and upper class. Access to low income families' children is also provided.

The daily program is from 8.00 am to 5.00 pm. The number of educators is 7, all women.

The educational unit is authorized by the Ministry of National Education and meets the national curriculum requirements for the pre-school level. The kindergarten program is completed by specific activities corresponding to its nursery profile. The mission of the unit is to stimulate the desire to learn, creativity and interest to explore of the pupils, managing to achieve educational standards, and to support the social and emotional development of

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

children without special needs. Pupils are also taught English language by educators having faculty degree in foreign languages. Children's communication skills are supported by its intensive English language program in books and interactive media. English is used both in actual activities for learning and as a means of communication in kindergarten. Besides the intensive English teaching program the kindergarten offers extra art education courses and sport related activities with qualified personnel. During both summer and winter time, outdoor activities are organized in the surrounding country side.

The educational unit has two locations: one devoted to nursery (2 to 3 years olds) and one for pre-school and after-school. The main location has an extensive play ground for outdoor activities with spaces designed to run special activities and games (sand corner, swimming pool). During warm seasons (spring, summer, early autumn) children practice gardening in the vegetable garden. The second building is equipped with a terrace at the first level. Each unit has its own cooking and dinning facilities.

Children attending the primary after-school program are assisted in their return home by the kindergarten van. The unit has its own medical doctor and doctor assistant ready to assist children and parents in more delicate healthy related situations.

The kindergarten has a very good reputation at national level, as it organize every two years a national symposium dedicated to science education at pre-school and primary school level (Figs. 1 and 2). The support of parents and local community is also important to its development. At the beginning of each school year parents receive “Parent’s Guide”, a brochure aiming to familiarize the families with the kindergarten objectives, activities, program, and facilities. The educational unit runs partnership projects in the frame of European collaborations.

Figure 1

Figure 2

b) Teacher (national teachers’ survey, Fibonacci evaluation tool)

Maria, in her late 40s, is a graduate of a Faculty and completed a Master degree in education. She is a certified teacher for pre-school level with more than 20 year educational experience.

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

She has experience in working with both pre-school and primary school children. She is accustomed with Science subjects from her Faculty studies. She is confident on subjects on general sciences, mathematics, ICT, pedagogy, methods in developing children's creativity. She attended courses and workshops related to science teaching. Maria learned a lot also from conferences and seminars. She is also active in teachers' networks. As some of her kindergarten colleagues she is very confident in understanding scientific inquiry and science pedagogy and didactics. As she has to refer to the Romanian school curriculum for pre-school she dedicates up to 3 hours per week to mathematics teaching and 4 hours to science education. She teaches mostly science, creativity and aesthetics. She strongly believes that science education during the compulsory education plays a major role in "developing socially and environmentally aware and responsible citizens" and in"preparing more innovative thinkers". For her it is very important to teach children "to be able to ask a question about objects, organisms, and events in the environment", "to be able to communicate investigations and explanations", "to be interested in science". In class, Maria uses often open play, role play, story telling, links between science and everyday life. She is a strong adept of group work, collaboration, and physical exploration of materials as driving forces to develop creativity. She encourages pupils to observe the surrounding world and phenomena, to design simple experiments to test their ideas, to communicate with peers. Maria considers that an open approach is suitable for children questions and gathering evidence. She agrees that children need time to find their own solutions and run some inquiry. She uses formative assessment during class activities, by asking pupils to reflect on their solutions and results. She bases her evaluations also on children's portfolios. Children's assessment is considered also as a mean to improve her personal practice. Generally speaking, Maria is satisfied on the resources available in her educational unit (printed materials, audio and video aids, small equipments, computers and IT facilities).

Maria's answers to the Fibonacci self-evaluation tool demonstrate her knowledge on inquiry-based science teaching and her commitment to the kindergarten mission to foster children curiosity and creativity.

c) Classroom

Classroom of the unit, decorated with children's participation, create an intimate environment and a fairytale atmosphere (Figs. 3 and 4). On both its locations, the Kindergarten is warm and welcoming, filled with a positive atmosphere that encourages every child's development.

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

Figure 3

Figure 4

Figures 5 - 8 depict scenes from the interior of the building. Corners dedicated to specific activities are distributed over the two stores of each building: science club, building center, games center, reading / writing centers, art center, music center, drama center; sand and water center.

Figure 5

Figure 6

Figure 7

Figure 8

Kindergarten library contains over 1100 books in Romanian and English for both children and teachers (Fig. 9). The seven computers with printers and multifunctional peripherals (Fig. 10),

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

cameras and video camera help the personnel to be effective in meeting the educational objectives.

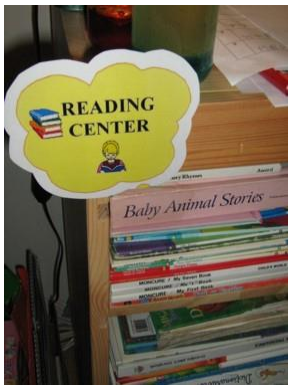

Figure 9

Figure 10

Maria's classroom is a friendly, nice decorated one (4 m x 4 m) with a big window facing the balcony and opposite to the entrance (Fig. 11), equipped with IT equipment (PC and video player), a white board, a science corner with some boxes, one aquarium and three round tables with chairs. The white board and the display are easily accessible by the teacher and visible to all children. Each table, having a semi round shape, can accommodate 4 – 5 children to work in a relaxed manner. The localization of the tables makes possible transfer from one table to the other and permits pupils to reach both the white board and the PC unit. Along the walls selves with educational aids and books are placed.

Along side with her colleagues, Maria benefits of the culture of its organization, open to innovation in education. Inquiry is well understood and applied at least partially into this kindergarten. As an example, Figs. 12 - 15 display clear massages on this subject on the classroom walls.

Children involved into these episodes are 5 to 6 years old. Over all they were 12, six girls and six boys. All of them attend regularly the educational programs and manage to understand and speak English.

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

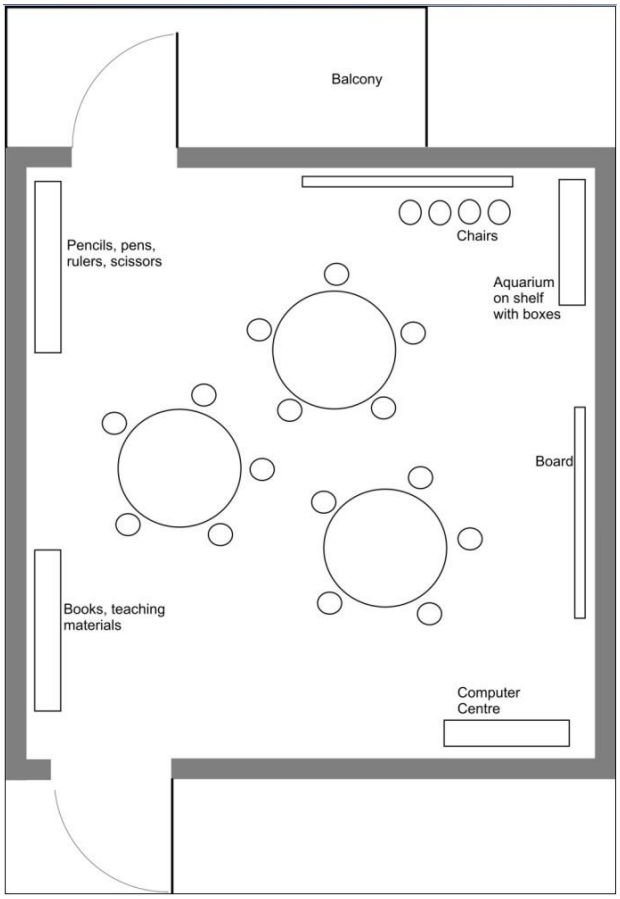

Figure 11

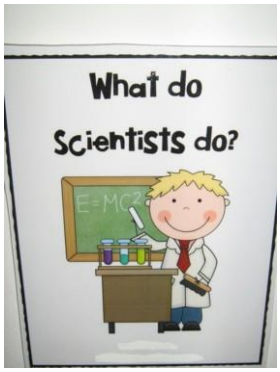

Figure 12

Figure 13

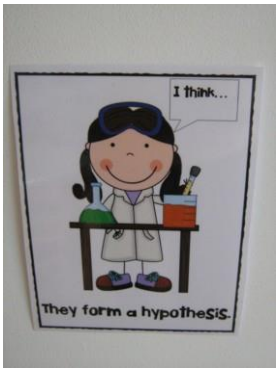

Figure 14

Figure 15

3.1.2 Episodes

After a general visit to the site and discussions with the management and key personnel, the research team attended two lessons delivered to pre-school children, in two subsequent days, during morning activities, at Maria's class. The core instruments used are: map of the classroom, audio recordings, sequential digital photos, timeline, and dialog with the teacher, some artefacts (children's class work and worksheets). In addition Maria's answers to the

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

national survey and video recordings were employed, as well as her answers to "*Fibonacci – IBSE Self-Reflection Tool for Teachers"*. All the available information was used to reconstruct the general atmosphere of the kindergarten, to emphasis teacher's attitudes and practice, to highlight children's engagement and participation, and to reproduce the lessons major lines. Both lessons were well structured with a clear goal in promoting inquiry-based learning. The group of children participating to these lessons is small enough to be handled by only one adult. During the activities pupils are allowed to move around, keeping a "reasonable" quite environment. The teaching process relayed on various educational resources, handled with professionalism by Maria. In order to catch Maria's style the details of the first episode presented in this case study are more abundant, audio recording transcripts being reproduced "in extenso".

a) "Float and sink" episode context and data and analysis

At the beginning of the lesson, Maria verifies that all the children are present and for the start of the lesson she asks them to choose one card from her hand. Each card has a picture and children form groups according to the image they extracted and find their sit at three tables.

Maria starts the lesson with a story about the diligent little ant living in the forest (Annex 1).

She asks children what a forest is, what kind of trees can be found in a forest. There is a permanent dialog with children who respond to teacher's questions. The little ant is looking for food. What seasons are used by the ants to gather food? All the children are engaged in the dialog and are asked if they agree with the answers. The ant arrived near the creek and dropped into water. A dove flying around saw what happened and came to help the ant. When telling the story, Maria shows children some drawings representing the ant and the dove (Fig. 16). She speaks slowly, pronouncing all the words very clearly, both in Romanian and in English. The children are asked to describe the two characters and to compare them. How can the dove help the ant?

Figure 16

Children are required to give solutions. There is an emotional situation created by involving children in the story, so they are determined to help the dove to save the little ant. The

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

children suggest that the dove should pick the ant by its beak, but he could hurt the little ant. They also suggested that the dove could catch the ant by his paws, but the paws are too long and cannot hold the ant.

Class dialog (CD) 1

T: "What do you think the dove had done to save the ant?"

Ch1: "It took her with its beak."

Ch2: "It does not work; dove's beak is too strong."

T: "Then the dove looked around to find something to help the ant out of the water. I wouldn't tell you what it found. I shall leave you to guest what it used. You have to discover what is the object dove used."

Ch3: "Let me tell you. I know what it is about. The dove helped the ant with its feet. With its paws"

T: "Let's pay attention. Where was the ant? Where was located its mound? "

Ch4: "At the edge of the forest."

……

Class dialog (CD) 2

T: "What do you think the dove can find in the forest to help the ant?"

Ch3: "A liana."

T: "That is a stick?"

Ch1: "It was a stick, a small stick. The dove can place it below the ant and lift it up and place it on the stone."

T: "An idea came from D. The dove has to take a small stick with its paws or the beak, and throw it in the water near by the ant.

Ch5: "The dove keeps the stick in its beak and gives it to the ant and draws the ant from the water."

Ch1: "The dove takes a stick with a hole inside and places it in from of the ant, and the ant goes inside and comes out."

……

The general idea was that the dove will put on the water something for the ant to stay on it: a leaf, a wooden stick, a feather, a blade of grass, etc. When children give various choices for the materials to be used, the teacher writes their names on the whiteboard (Fig. 17).

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

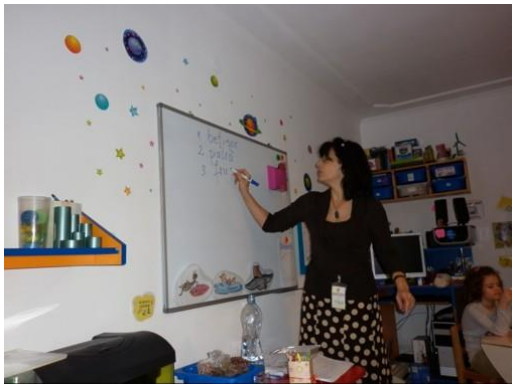

Figure 17

Class dialog (CD) 3

T: "Your ideas were to use sticks and leaves. There is anything else in the forest?"

Ch1: "Stones, and soil."

T (taking a stone form a container): "Let me see. We have here some rocks. But what do you think about this item (showing conifer cone)? Or this one (indicating a acorn)?"

Several Chs: "Wow!!!"

Ch6: "How small it is."

Ch2: "It can float on the acorn and go to the shore."

T: "Would you like to try your idea? She would like to test if the ant could not climb on the acorn and float on the water."

Ch1: "The bird takes a nut form a tree, breaks it and takes out the all the kernels and the ant climb on the sell and goes to the shore."

T: "OK. What else do we have here (showing a piece of bark)? Can we find this in the forest?"

Several Chs: "Yes."

Ch3: "You can float on it to the shore."

T: "OK. Let me see. Or may be you would like to look for something to test."

Maria handles a container with various items to a group of children. They gather together and start to investigate the content.

Ch3: "Miss. What is this?"

Ch7: "It takes a blade of grass and climbs on it."

Ch8: "It has to have something as a stick and use it in this way (she shows a movement as using a paddle)."

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

Ch9: "A nut shell, like a boat."

Ch4: "Miss. I have another idea. To break a small stick and use it as paddle."

Ch2: "Or a flower."

Maria has a list on the white board of possible materials to be used. She suggests to pupils to run an investigation in order to identify what is the best idea to solve the problem. Children are given small containers with water in order to verify what materials existing in the forest can be used as little "boats" for the ant (Fig. 18): nuts, feathers, wooden sticks, leaves, little stones, acorns, pieces of bark, fir cones, etc. Maria asks every group to come to the front table and to take the materials they think to be most suitable for the task to save the ant, items they intend to test. Children have to evaluate a priori what are the objects which float. At this point there is a rumour on possible candidate materials.

Figure 18

Children are engaged into identifying and naming the objects they find in the container. Children discuss in group and test if some of these materials can be considered to build a boat (Fig. 19). They receive also worksheets on which they have to draw or write their results (Figure 20), so they can indicate which materials can float and save the ant. Worksheets are filled individually (Figs. 21 and 22) with drawings or text.

Figure 19

Figure 20

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

Figure 21

Figure 22

Experiments being done, one representative of each group presents and discusses their findings in front of the class (Fig. 23). During this final class discussion, Maria highlights a special part of one experiment.

Figure 23

<u>Class dialog (CD) 4</u>

T: "And here, who will present what you had done?"

Ch1: "Me (very convinced)."

T: "Every one agrees? Is it OK with your team?"

Ch4: "I would like to present."

T: "Then I leave you to discuss and decide who will make the presentation. There are two proposals. Let's decide in a democratic manner."

Pupils debate and vote and take a decision with a majority.

……

The first group presents its conclusions as they are drawn on the worksheet.

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

Class dialog (CD) 5

T: "Silence please. Those who expect to be listened, have to listen to others. Let's listen to P. Please tell me P. what did you verified?"

P.: "We verified a cone, a piece of bark, a nut sell, a feather, and a stone."

T: "According to your opinion, what can be the most useful object? All of them suite?"

P.: "Yes. Excepting the stone."

Maria concludes on the results of the first team, in this way the entire class agrees."

Class dialog (CD) 6

T: "Besides this conclusion I notice D. that you tested a material which was discharged away by the end of the investigation. We had an object which, according to my opinion, can be use to rescue the ant. What was that object?"

D.: "The red feather?"

T: "No, besides the red feather. What it was? A piece of …."

Several Chs.: "Napkin."

T: "What did you notice happened to this piece of napkin?"

D.: "It sank."

T: "Yes. It went to the bottom of the water. It is very interesting what your colleagues are saying. They took a piece of napkin placed it on the water surface, and what he noticed? At the beginning, it floated…"

D. "It went wet and went to the bottom of the container."

T: "Do you think this object can be used to save the ant?"

Several Chs. : "No. No."

……

The worksheet of a pupil belonging to the second group is presented in front of the class.

Class dialog (CD) 7

T: "Let's hear the opinion of the second team. What did you verified?"

S.: "We verified a nut shell, an acorn, a feather."

T: "What is the most suitable material to be used?"

S.: "The acorn."

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

T: "I ma addressing to the second team. Your colleague option was the acorn. Do you agree with her? Any other opinion?"

Ch 8: "The nut shell."

……

The discussion goes on in analyzing one container of the third group.

Class dialog (CD) 8

T: "What is this?"

Ch2: "A leaf."

T: "Do you think it can be used?"

Ch3: "Yes. But we did not test it."

T: "Well done. You found a lot of solutions."

By the end of the lesson, Maria congratulates all of the groups for the very good work they have done.

b) "Weather" episode context and data and analysis

This lesson is part of a multi-subject, cross-disciplinary learning unit spread across the school year and aiming to familiarize pupils with concepts such as: seasons, weather and time (Annex 3). It merges science, mathematics and language teaching. The lesson reflects the Romanian pre-school curriculum as it concerns knowledge of the proximal environment and temporal orientation. It includes both "theoretical" aspects and practical activities. The objectives of the unit are: to learn about weather and its characteristics in relation to natural phenomena; to learn to measure and record temperature using a simple thermometer; to use records in graphical and text format by registration of data into tables; to support the development of observation and comparison skills over a period of time; to learn about week days, months and dates of the month; to improve English language skills.

The observed activity is part of a series of repeated daily sessions when children are asked to observe the weather, to make some simple measurements and to record/ comment data. This "traditional ceremony" was developed after Maria took part along with her pupils, in the last two years, to the Greenwave project (part of the Fibonacci project).

During this session, Maria engages a dialog with children (Annex 3) about weather, seasons, day of the week, date of the month. The aim of this approach is to develop and foster pupils' observation, comparison and communicating skills, both in Romanian and English languages. In the mean time, children become aware of the temporal relation between events and are trained to read an instrument and to use numbers to express data. Activities are carried out

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

individually, each child having his/her own worksheet to record / represent data, and discussions are carried out with the entire class to clarify and fix the newly acquired knowledge.

Maria uses posters (Fig. 26), multimedia means or PowerPoint Presentations to introduce concepts or to catch children attention and to engage them into a dialog.

Figure 26

In the frame of each session, Maria distribute to each child his/ her worksheet (kept in the child portfolio) in order to update the information. Pupils read the scale of the thermometer and enter data into a histogram-like graph (Fig. 27). Each day they record the appropriate information how weather looks like, temperature and wind. The notes are both in text and graphic form (Fig. 28). These data are correlated to the date and the day of the week. On a separate worksheet, children mark daily the calendar (Fig. 29).

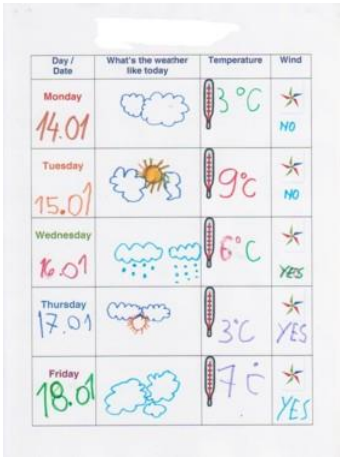

Figure 27

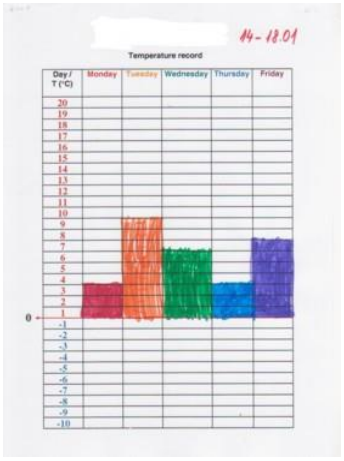

Figure 28

Figure 29

In order to keep pupils focused on the subject (time, weather, days of the week, months and the relationship between these concepts) Maria hanged on the classroom wall a chart to which she refers often (Figure 30).

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

Because she has to fulfil the requirements of the national curriculum on science teaching and in the mean time the kindergarten being an educational unit with English as the second language, Maria keeps at hand a poster in English depicting the four seasons, their distinctive signs (as per children evaluation norms), months on the year, along with a board on which pupils can place the date for each day of the month (Fig. 31).

Figure 30

Figure 31

c) Magic water episode context and data analysis

This activity Maria carries on in relation to the curriculum for pre-school science teaching, which refers to different states water is present in the environment familiar to children (Annex 2). The referred episode constitutes an additional teaching moment linking the water subject to ambient air pressure (notion not accessible at pre-school level). The demonstration is very exciting for young children and they can perform at home with parents and relatives, showing in this way what they learned. It is a sort of magic and it will be remembered for long by participants.

As in a veritable inquiry, Maria started the demo session based on pupils' previous knowledge and experience from every day life. Maria interrogates pupils about its characteristics.

Class dialog (CD) 9

T: "What are the characteristics of water we learned about based on the experiments we done in the last lessons?"

Ch1: "Water is a liquid."

Ch2: "Which flows."

T: "What are the properties of liquids?"

Ch3: "It has no form."

T: "What forms have liquids?"

Ch4: "Have the form of the glass."

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

T: "Any thing else about water?"

Ch2: "Water has no smell."

T: "Clean water has no smell."

Ch5: "Water has no color."

Ch6: "Water does not poison you and has no acid."

T: "Let's repeat. Water is a liquid. Liquids flow. No color, no smell, no taste."

T: "If I put some water in a glass (it is a transparent one in this case) can I see through it?"

T: "How is a material through I can see?"

Several Chs: "Transparent."

T: "OK. It is not enough for a liquid to be without color, in order to be transparent."

She provoked the audience by asking a question about substances used to stick to objects together.

T: "Now, I would like to ask you a tricky question. Can I fix to objects together using water?"

Several Chs: "NO !!!!!"

Ch2: "I think we can."

T: "Can you provide some examples? Let me write on the white board."

Answers for the audience: "Paper, metal, metal on paper, paper on paper."

T: "What is this (showing a sheet of glass)? Can we stick glass with water?"

Maria marks on the white board the answers of pupils.

Ch7: "Water with glue."

T: "It is not clear to me what do you intend to stick."

Ch3: "A string."

T: "Textile material, fabrics."

T: "Enough. Let's try something."

Maria covers with water two sheets of glass and try to fix them one to the other. It works. Children are astonished to see the two sheets of glass bounded.

Class dialog (CD) 10

Ch4: "No they are different. It is a magnet and it sticks to the magnet."

T: "Let's try another experiment. This is plastic. I shall try to fix two such sheets of plastic."

Several Chs: "Wow!, Ohh!"

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

Ch 2: "It is not possible such a thing."

T: "Let's proceed with another experiment. I shall put some water in a glass, and cover it with a sheet of paper. I shall reverse the glass upside down."

From the audience: "No! No! Oh, Miss! Hei!"

Applauses.

Class dialog (CD) 11

Ch1: "I think you put some glue there."

T: "Let's try with another glass. Say "Adacadabra!"

Audience: "Abracadabra!" "Yey! It works!"

Children try by themselves the experiment (Figs. 24 and 25). Everybody follows with great enthusiasm.

Figure 24

Figure 25

Maria declares all the participants to be great magicians.

3.1.3 Case summary and conclusions

Discussion in relation to synergies between science and mathematics and creativity

The present analysis is based on previous deliverables of the project with a focus on specific national aspects reviled:

- Conceptual Framework (D2.2);
- List of Mapping and Comparison Factors (D3.1);
- Report on Mapping and Comparing Recorded Practices (D3.2): Romanian National Report on Approaches in Policy;
- Report of First Survey of School Practice (D3.3): Romanian National Report on First Survey of School Practice,

and is supported by the evidences gather during in-depth fieldwork.

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

According to the adopted methodology for in-depth fieldwork the research is carried out along two guiding lines: a) pedagogical interventions and b) pedagogical framing both associated to the deductive coding for the data collected. These codes are used for the inductive analysis in order to underline the reflection in school practice of the factors identified in the *Conceptual Framework*, factors fostering creativity in the context of inquiry-based science and mathematics teaching and learning. For each episode, factors important to nurturing creativity in science and mathematics in the early years and the associated codes are highlighted.

The kindergarten officially stated mission and goals are supported by its staff efforts to promote "science process skills, as IBSE is specifically planned" (**AO: Sc Porc Skills**) and "to enhance children's attitudes in science and mathematics" (**AO: Social**), and by the fact that creativity development is "specifically planned" (**AO: Creative**), as proved by Maria's answers to teachers survey, dialog with her during filed visits, the filled Fibonacci self-assessment tool form, the posters displayed in the classroom (Figs. 12-15). The unit openness towards inquiry-based education and its dedication to encourage creativity development is demonstrated also by the national symposium it organized to promote children experiments and early age (Fig. 1 and 2).

Generally, the learning process is run in a formal set-up (**L: Formal**). The unit has enough space in its two stores, two buildings facility (**M: Space**) to carry out indoor and outdoor activities (**L: Out/Indoors**). A play ground, a sand corner and a swimming pool facilitate outdoor activities (**M: Outd**). In addition, trips in the surrounding areas and visits to the city zoo, enabling informal science teaching (**L: Informa**), are organized whenever the weather permits (activities promoted on the unit web site). These non-formal teaching activities are complemented by gardening during the Spring-Autumn period.

A great variety of resources are available: science club, building center, games center, reading / writing centers, art center, music center, drama center; sand and water center, a good library with Romanian and English books (**M: Variet**) (Fig. 5-10). The kindergarten accommodates seven PC with appropriate peripherals and has access to the Internet (**M: ICT**).

The number of children per class, about 12, (**G:No**.) makes possible a good interaction with pupils during the lesson, the "human resources being sufficient" (**M: Human**). All three episodes refer to pre-school children, aged 5 to 6 years.

Maria is a veteran in applying IBSE in Early Education. She supports children initiatives in questioning (**LA: Quet**) (CD1, CD8, CD9), observing (**LA: Obs**), gathering evidence, planning investigations (**LA: Plan**), handling equipments (**LA: Equip**), offering explanations (CD6), and communicating explanations (**LA: Comm**) (Fig. 23, CD4, CD7, CD10). She supports pupils in developing their experiments based on their ideas (CD3, CD10) and previous experience (CD1, 2) and knowledge (**P: Agency**), by fostering reflection and reasoning (**P: Express**) (Annexes 1-3, CD10). Her approach is more planned experiment than play (Annex 1, CD11). As children work

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

alone, teacher scaffolding can be noticed (Annexes 1, 2). Storytelling and the use of multimedia play a crucial role in her lessons (Annex 1). She distributes pupils to work in small groups (**L: gr**) (Fig. 11), and encouraged them to work both individually (Figs. 20-22) or to cooperate (**P: Collab**) (Figs. 18, CD5). During the in-depth filed research Maria evaluated children mostly in a formative way (Annex 1). On request she can provide evidence on the summative assessment based on pupils' portfolio. For the "Weather" episode she combined very efficiently science and mathematics teaching (Annex 3), in spite of the fact that mathematics in its written form is less practiced at this age, as for example to use graphs (Fig. 27) or handle numerals (Fig. 29) .

RQ2: ***Probing practice***

What approaches are used in the teaching, learning and assessment of science and mathematics in early years?

In this case study it can be observed that the teacher prefers to use more teachers' lead activities than children initiated ones. In any case, she only guides and supports children work; she does not imply solutions, she just advances a problem to be solved. Teacher's scaffolding is evident. On the other hand, play is less used as the teacher deliberately engages pupils in real investigations, lined to real life problems. Storytelling is the crucial starting point of the lesson. It helps capture children's attention and engagement. The teacher proves a good knowledge of inquiry-based education: problem identification, proposal of some hypothesis, design of an experiment, running some tests, elaborating conclusions and discussing the results in a small group or with the whole class. The assessment is done in a formative way, during the calls work, based on the discussions carried out and the worksheets filled by pupils. Mathematics teaching is done in a more classical manner by addressing concepts related to time and weather and the use of numerals.

What role if any, does creativity play in these?

Firstly, teacher's creative teaching methods have to be underlined. She combines very attractively children stories with real life situations by providing to pupils a set of materials to be used in solving the problem they face. Children creativity is proved by the way they are trying to solve the problem they are facing. They offer their response and, in the mean time, they are connecting their answer with the solutions provided by peers. In several occasions, pupils make very interesting links to previous knowledge. Children's agency is encouraged by the teacher through additional questions or challenges.

RQ3: Probing practice

In what ways do these approaches seek to foster young children's learning, interest and motivation in science and mathematics?

Children interest and motivation are supported by focusing their attention on a specific task, accessible to them and linked to a story, a set-up familiar to them. Direct observation of the

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

surrounding world, being it the beginning of an experiment or natural environment, i.e. weather monitoring) rises pupils curiosity and help their engagement. Encouraging the peer-to-peer dialog, as well as the dialog with the adult, the teacher "forces" children to contribute actively to the lesson development. A "magic" experiment is a good opportunity to start a debate.

How do teachers perceive their role in doing so?

The teacher is aware that her main role is to guide and support children learning. She maintains a proper scientific like environment by using posters, the science corner, video records, by explicitly framing the steps of the inquiry learning process. She plans the lesson adequately, and provides a discrete support. She masters the "game" by mixing explanations with questioning. For her it is very important to teaching children to "to be able to ask a question about objects, organisms, and events in the environment", "to be able to communicate investigations and explanations", "to be interested in science". In class, Maria uses often open play, role play, storytelling, links between science and everyday life.

Supporting documents for this case study are given in Appendixes 1-3

3.2 Case 2 – Stela

3.2.1 Context

Where?	Country	Romania			
	Setting name	HK-RM			
	Location within setting	Primary school			
Who? (children)	Year group/age of children	7 - 8 years old			
	Number of children in class	12			
Who? (adults)	Number of adults	1			
	Role of adults	teacher			
	Case teacher role	Co-ordinator			
When?		1	2	3	
	Dates of visits	18/1/13	18/1/13	19/1/13	
	Times of visits	08:00-12:00	14:00-16:30	08:00-12:00	

a) School/setting

The site is primary devoted to nursery and pre-school education and includes also a small primary after-school facility. The unit is located into a provincial town (about 92,500 inhabitants), situated in the central-south area of Romania at the foothills of the Southern

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

Carpathians. Beautiful landscapes can be reached within ½ hour drive. An attractive park and a zoo are available for outdoor activities.

The educational establishment is privately owned. Pre-school pupils are from 2 years to 6 years and 4 months old. The total number for the current school year is 82. At the primary after-school program are enrolled 12 children from 8 to 10 years old. Most of the children attending the classes belong to the middle and upper class. Access to low income families' children is also provided.

The daily program is from 8.00 am to 5.00 pm. The number of educators is 7, all women.

The educational unit is authorized by the Ministry of National Education, and meets the national curriculum requirements for the pre-school level. The kindergarten program is completed by specific activities corresponding to its nursery profile. The mission of the unit is to stimulate the desire to learn, creativity and interest to explore of the pupils, managing to achieve educational standards, and to support the social and emotional development of children without special needs. Pupils are also taught English language by educators having faculty degree in foreign languages. Children's communication skills are supported by its intensive English language program in books and interactive media. English is used both in actual activities for learning and as a means of communication in kindergarten. Besides the intensive English teaching program the kindergarten offers as extra art education courses and sport related activities with qualified personnel. During both summer and winter time outdoor activities are organized in the surrounding country side.

The educational unit has two locations: one devoted to nursery (2 to 3 years olds) and one for pre-school and after-school. The main location has an extensive play ground for outdoor activities with spaces designed to run special activities and games (sand corner, swimming pool). During warm seasons (spring, summer, early autumn) children practice gardening in the vegetable garden. The second building is equipped with a terrace at the first level. Each unit has its own cooking and dinning facilities.

Children attending the primary after-school program are assisted in their return home by the kindergarten van. The unit has its own medical doctor and doctor assistant ready to assist children and parents in more delicate healthy related situations.

The kindergarten has a very good reputation at national level, as it organize every two years a national symposium dedicated to science education at pre-school and primary school level (Figs. 1 and 2). The support of parents and local community is also important to its development. At the beginning of each school year parents receive "Parent's Guide", a brochure aiming to familiarize the families with kindergarten objectives, activities, program, and facilities. The educational unit runs partnership projects in the frame of European collaborations.

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

Figure 1

Figure 2

b) Teacher (national teachers' survey, Fibonacci evaluation tool)

A graduate of the Faculty of Physics in a major Romanian city, Stela has a strong science background, which makes her easy in dealing with science and mathematics subjects she teach. With an extensive experience in high school teaching, she developed a passion to educate early age children. She started with pre-school ones and now she in engaged in an after-school program her education unit is offering. In spite of the fact she mentors a small number of children (around 20, 7 to 9 years old); the program can be considered a success, being appreciated by parents. Her graduates at the after-school program are among the best in their school class. In a way, she completes the science education children receive in a normal school, with out-of-school activities, for several hours. She worked in the last 6-7 years in collaboration with the Center for Science Education and Training from the National Institute for Laser, Plasma and Radiation Physics in Bucharest, contributed to the development of several learning units for pre-school science teaching, works on a book dealing with the same subject and took part to an exchange visit in Austria, in the frame of the Fibonacci project. Having a degree in sciences, ICT is familiar to Stela, who uses it extensively. She is fluent in English and uses it in alternation with Romanian language during the science classes. Stela is very confident in teaching science and assessing science learning. Her CPD is based on courses and conferences she attended and on the collaboration she had in science education research.

Stela's answers to the "Fibonacci self-reflection tool for teachers" reveals her interest towards:

- developing in a structured manner pupils ideas and questions;
- supporting them in formulating hypothesis, explanations and communicating findings;
- encouraging children to plan experiments, reflect on the results, and work in teams.

She is an adept of dialogue, collaborative achievements, BUT all based on the personal effort of each participant. Group and whole class discussions are encouraged. Debates and arguing before the final report to the entire class is often used. For the age group she is managing Stela

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

asks children to fill in appropriate worksheets their results, while she writes on the white board in front of the class the major inquiry questions to be investigated.

During the class she likes to use various resources available in the kindergarten (video and audio equipment, PC, projector, posters) and even developed her own experimental kit. Outdoor activities are one of her favourite means to teach science.

In running an inquiry, Stela is interested to facilitate child own investigation, by allowing sufficient time and helping him to find his/ her own solutions. In science teaching she support children to observe natural phenomena; to design or plan simple investigations or projects; to employ simple equipment and tools in order to gather data and extend to the senses; to communicate the results of their investigations and explanations. According to her opinion, creativity can be developed by building on children's prior experiences; encouraging children to try out their own ideas in investigations; fostering imagination; Relating science to everyday life; using questioning as a tool in science teaching; fostering autonomous learning.

Her preferred teaching approaches are: working in small groups; physical exploration of materials; using outdoor learning activities; integrating science with other curricular areas; building on children's prior experiences; fostering classroom discussion and evaluation.

Stela's major assessment foci are: to identify ways to improve child science learning; to monitor year-to-year child progress in science; to set targets with children for their own development in science. During the class and the assessment period, she especially praise the following characteristics in her pupils in science learning: sense of initiative; motivation; ability to connect what they have learnt during lessons with topics in other subjects; imagination; ability to work together; thinking skills. The assessment is done mostly during classroom interaction, by evaluating children's pictures, graphs which show their scientific reasoning and by evaluating children's relevant gestures or physical activity, and by asking each child to reflect on their own learning and progress. She thinks that the assessment process has to target as priorities: knowledge and understanding of scientific ideas (facts, concepts, laws and theories); knowledge and understanding of scientific processes; understandings about scientific inquiry (e.g. how science and scientists work); positive attitudes and increase of interest in learning science.

In preparing her science and mathematics lessons, Stela uses very often the officially recommended manual, teacher's textbook guides, on-line resources, national assessment guidelines. Other helping materials often accessed are: school curriculum; national curriculum; national teacher curriculum guide; national education agency website; teacher professional association documentation or website; school assessment guidelines.

As it concerns other resources, the more used ones are: her own didactic materials; resources downloaded from the Internet; equipment and materials for hands-on exploration in the classroom; ICT equipment; the interactive whiteboard. She employs less often relevant library

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 relevant media materials. Stela has poor interaction with colleagues in sharing teaching aids developed by others.

Comparing with other educational establishments in Romania, Stela's kindergarten is quite well equipped with appropriate resources (textbooks, audio-visual resources, story books, equipment and materials for hands-on exploration in the classroom, equipment and materials for hands-on exploration outside the classroom, computers). They have enough funds for consumables and appropriate support personnel.

c) Classroom

Classrooms of the kindergarten are well equipped and furnished (Figs. 3 and 4). On both its locations, the Kindergarten is warm and welcoming, filled with a positive atmosphere that encourages every child's development.

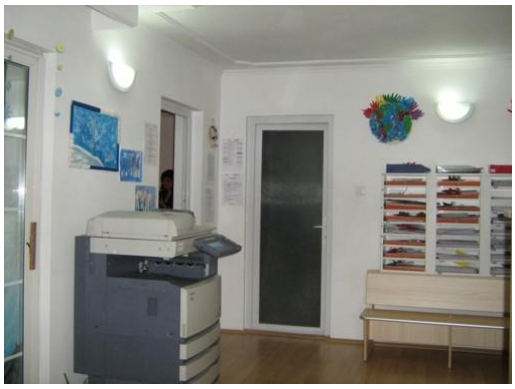

Figure 3

Figure 4

Figures 5 - 8 depict scenes from the interior of the building. Corners dedicated to specific activities are distributed over the two stores of each building: science club, building center, games center, reading / writing centers, art center, music center, drama center; sand and water center.

Figure 5

Figure 6

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

Figure 7

Figure 8

Kindergarten library contains over 1100 books in Romanian and English for both children and teachers (Fig. 9). The seven computers with printers and multifunctional peripherals (Fig. 3), cameras and video camera help the personnel to be effective in meeting the educational objectives.

Figure 9

Figure 10

Stela's classroom is organized more as a classical school classroom. As she deliver science classes both in Romanian and English on the walls hang several panels with English texts (Figs. 11 and 12). One of the walls includes a big window facing the kindergarten playground (Fig. 13). Textbooks and storybooks are accessible from the selves of a small library. It has ICT equipment and projecting facilities.

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

Figure 11

Figure 12

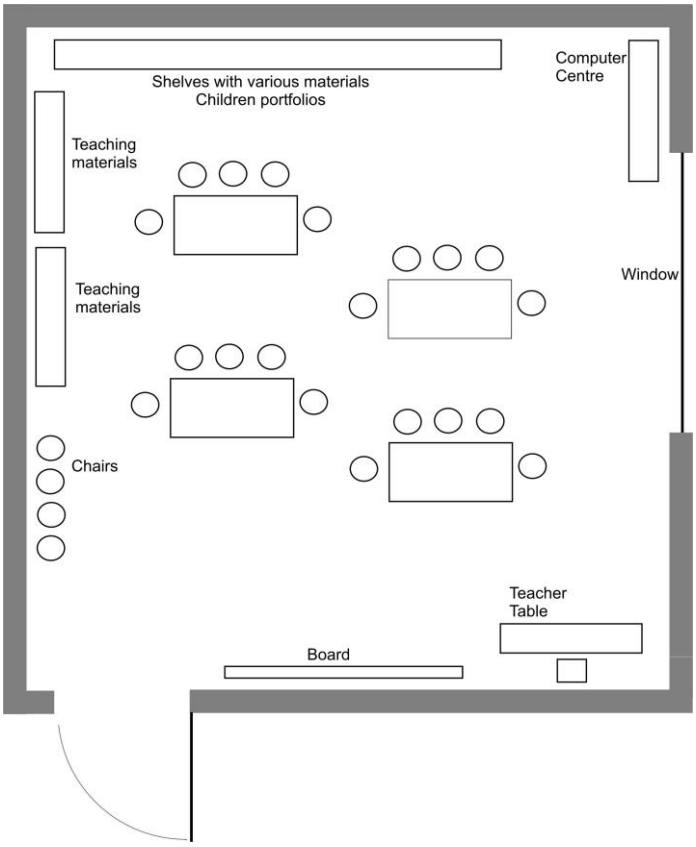

Figure 13

Children involved into these episodes are 7 to 8 years old. Overall they were 12, five girls and seven boys. All of them attend regularly the educational programs and manage to understand and speak English.

3.2.2 Episodes

After a general visit to the site and discussions with the management and key personnel, the research team attended one lessons delivered to primary school children, during morning

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

activities, at Stela's class. The core instruments used are: map of the classroom, audio recordings, sequential digital photos, timeline, and dialog with the teacher, some artefacts (children's class work and worksheets). In addition Stela's answers to the national survey and video recordings were employed, as well as her answers to "*Fibonacci – IBSE Self-Reflection Tool for Teachers"*. All the available information was used to reconstruct the general atmosphere of the kindergarten, to emphasis teacher's attitudes and practice, to highlight children's engagement and participation, and to reproduce the lesson's major lines. The lesson was well structured with a clear goal in promoting inquiry-based learning. The group of children participating is small enough to be handled by only one adult. During the activities pupils are allowed to move around, keeping a "reasonable" quite environment. The teaching process relayed on various educational resources, handled with professionalism by the teacher.

a) "Encrypted message" episode context and data and analysis

After she observes the presence of all children enrolled into the after-school program, Stela asks them to group (**G:Small G**) to the available tables. The session is designed as an informal science learning (**L. Informal**), as experiment done with various materials (**M:Inf.**) is mixed with play (**P: Play**). The lesson stars as children are invited to watch an animated movie (**M:ICT**) about the squirrel Scrat kept prisoner on a sea shore, having its supply of acorns inside ice cubes. In order to survive it has to take out the acorn from the ice. At this point the movie stops and the teacher introduce a challenge (**P:Ques)** in order to catch pupils' attention and induce an emotional state (**P:Affect**). She writes on the white board an encrypted message, in which a string of numbers has to be replaced by letters, according to a provided legend, in order to decrypt the message (**LA: Obs; AO: Creative**). Children received some worksheets to use for this task (Fig. 14) and they are asked to discover the hidden message (**P:Agency**). The message decrypted, reads in English, "HELP SCRAT". In fact it is in brief the topics of the problem to be solved by children (**AO: IBSE/PBL**). This intervention, as an interdisciplinary approach, is a mixture of English language literacy and mathematics. Group work is the key to the element in discovering the answer to the encrypted message. It is expected the investigations will run based on children previous life experience and knowledge (**LA: Connect**).

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

Figure 14

By the end of this episode, Stela asked pupils to formulate clearly the task to be performed (**P:Ques**). Children are invited to work in team (**P:Collab**) and to offer some solution to help the squirrel to reach its food. On each table is distributed a bowl with ice cubes bearing inside each an acorn. Stela explained the tasks both in Romanian and in English. Each group is looking for a solution, by formulating an experiment (**LA: Plan**). On a table in front of the class there are displayed various items (**M:Variet**) which can be used in the experiment (tea spoons, salt, sugar, a small hammer, plastics containers, hot water, worksheets).

b) "Ice and hot water" episode context and data and analysis

The first group (**G:Small G**) suggests using hot water to melt the ice in order to reach the acorn. There is a discussion about ice and water and what children observed during winter time or when ice or snow is placed near a source of heat (**LA: Comm**). "What happens with the ice when it is kept in hand?" (**LA: Connect**). One pupil suggests using hot water with sugar dissolved in it to meld the ice (**AO: Creative**; **M: Cr**, Fig. 15). The ice cube with the embedded acorn is placed on the tray and one of the participants brings a thermos with hot water to be spilled over the ice (**P:Agency; AO: Sc Proc Skills**). Children expose their opinions (**AO: Social**) and debate on the way to proceed (**LA: Plan; P:Collab**). They observe very attentively the process (**LA: Obs**, Fig. 16) and fill as appropriate, with their opinions and conclusions the worksheets (Figs. 17-19). Stela keeps a low profile, monitoring the experiment development and assisting pupils with some hands-on tasks more demanding for them (**P: Scaff**). She uses to observe children during their investigations and evaluate their outcomes based on the filled files (**A:Form**). By the end of the session one pupil from each group presents the results and conclusions to the class (**LA: Comm; A:Summ.**).

Children compare the results with their predictions as in a real investigation; one of the conclusions: "the method works" (**AO: IBSE/PBL).**

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

Figure 15

Figure 16

Figure 17

Figure 18

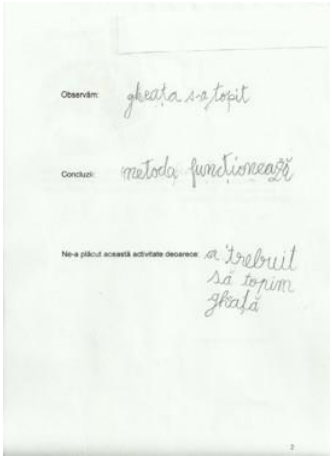

Figure 19

c) "Ice and salt" episode context and data and analysis

For the second group (**G:Small G**) the adopted strategy (**LA: Plan**) to assist the squirrel. They decided to use some salt to melt the ice (**AO: Creative**; **M: Cr**), as they noticed happen during the winter time on the streets (**LA: Connect**). After some debates as a group (**P:Collab; AO:**

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

Social), each participant to the experiment tries (**P:Agency**) the adopted solution and makes observations (**LA: Obs**) on the ice melting (Figs. 20 and 21).

Figure 20

Figure 21

The teacher just supervises them and offers some consultancy when needed (**P: Scaff**). In dealing with the problem they are facing, pupils follow some of the steps of the inquiry-based learning (**AO: IBSE/PBL**) – problem identification, proposal for a solution (**LA: Plan**), set-up of on experiment, selection of materials to be used (**M:Explor.)**, observing a phenomenon, recording the results (Fig. 22).

On the worksheet can be noticed (**AO: IBSE/PBL**): the prediction the child made ("by using salt"), the list of materials needed ("tray, ice cube, tea spoon, salt), and the conclusion ("the ice melted more quickly as we used salt").

Figure 22

Meanwhile, Stela observes (actions, decisions, attitudes, collaborative skills, discipline, vocabulary) the way children progress in their "research" (**A:Form.**). The session ends with a final presentation of the results (**A:Summ.; LA: Comm**), recorded on special worksheets (Figs. 23 and 24).

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

Figure 23

Figure 24

d) "Broken ice" episode context and data and analysis

Another group of pupils (**G:Small G**) by analyzing (**M: Cr**) the materials available on the desk in front of them (**M:Variet.**) decided (**P:Collab; P:Agency; LA: Plan**) to use a hammer (**AO: Creative**; **LA: Equip; AO: Sc Proc Skills**) to break the ice cube in order to reach the acorn (Figs. 25 and 26).

Figure 25

Figure 26

As in other cases, the teacher just observes the process and notices the manner children adopt and apply various strategies to obtain a sound result (**P: Scaff**; **A:Form.**). She is more careful in this case with the pupils not to harm themselves. Pupils observe and look for a solution, and after that record their results and conclusions (Figs. 27 and 28) and as a group present them to the class (**LA: Comm**; **A:Summ.**).

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

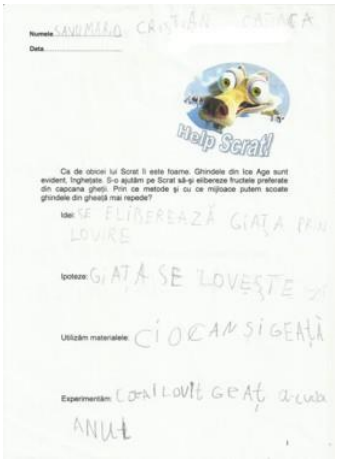

Figure 27

Figure 28

The inquiry-based approach is evident from the worksheet record (**AO: IBSE/PBL**): planning ("we have to free the acorn by the impact of the hammer", "the ice has to be crashed"), list of materials used ("hammer, ice"), action took ("we strike the ice with the hammer"), observation ("the ice is broken"), conclusions ("the ice is took of rapidly").

3.2.3 Case summary and conclusions

Discussion in relation to synergies between science and mathematics and creativity

The present analysis is based on previous deliverables of the project with a focus on specific national aspects reviled:

- Conceptual Framework (D2.2);
- List of Mapping and Comparison Factors (D3.1);
- Report on Mapping and Comparing Recorded Practices (D3.2): Romanian National Report on Approaches in Policy;
- Report of First Survey of School Practice (D3.3): Romanian National Report on First Survey of School Practice,

and is supported by the evidences gather during in-depth fieldwork.

According to the adopted methodology for in-depth fieldwork the research is carried out along two guiding lines: a) pedagogical interventions and b) pedagogical framing both associated to the deductive coding for the data collected. These codes are used for the inductive analysis in order to underline the reflection in school practice of the factors identified in the *Conceptual Framework*, factors fostering creativity in the context of inquiry-based science and mathematics teaching and learning. For each episode, factors important to nurturing creativity in science and mathematics in the early years and the associated codes are highlighted.

The kindergarten officially stated mission and goals are supported by its staff efforts to promote "science process skills, as IBSE is specifically planned" (**AO: Sc Porc Skills**) and "to

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

enhance children's attitudes in science and mathematics" (**AO: Social**), and by the fact that creativity development is "specifically planned" (**AO: Creative**), as proved by the field visit, Stela's answers to teachers survey, dialog with her, the filled Fibonacci self-assessment tool form. The unit openness towards inquiry-based education and its dedication to encourage creativity development is demonstrated also by the national symposium it organized to promote children experiments and early age (Fig. 1 and 2).

The observed teacher proves her experience in inquiry-based teaching as she bases her class activities on major key concepts of IBSE (Annexes 2 – 4): questioning children on the investigated phenomena (**LA: Ques**) and on the materials (**M:Explor.**; **M:Variet.**)/ equipment (**LA: Equip**) to be used; offering them the opportunity to observe (**LA: Obs**), make predictions, test hypothesis (**AO: IBSE/PBL**); establish connections between the problem they face and real life situations (**LA: Connect**); supporting them in their work without too much guiding (**P: Scaff**). She encourages pupils' initiative and questions (**P:Agency**; **P:Ques**); asks them to work in team (**G:Small G**) and to have a permanent dialog (**AO: Social**). Stela relays on different didactic means to teach science (whiteboard, video recording, worksheets, experimental kits, various materials from children's familiar environment) (**M:Variet.**). She counts on the role of motivation and affect (**P:Affect**) in focusing children interest into science and mathematics, by combining planned exploration (**LA: Plan**) with play (**P: Play**) and story telling. Her creative teaching is demonstrated by the introduction to the problem to be solved by offering to children a video familiar to them (**M:ICT)**. Children are trained to cooperate (**P:Collab**), to formulate questions (**P:Ques**) and to provide solutions, with a focus on the development of competences (**AO: Sc Proc Skills**). The results and conclusions are both individual and a group work. Data are recorded on worksheets and reports are delivered both in written and oral form (**LA: Comm**). Inter individual and whole class communication is a common approach for the participants. Pupils' creativity was mobilized during both the decrypting of the coded message and the ice cube problem solving (**M: Cr**; **AO: Creative**). In the decoding process children had to combine English language knowledge with skills in mathematics. Stela encourages reflection on the process and results, supporting children metacognition development (**P: R and R**).

The class is conducted into a formal set-up (**L.Formal**) with some elements of informal learning (video introduction, decoding of an encrypted message). The lesson is designed to complement the school curriculum, addressing through experiment concepts related to water and its forms in the environment. For the group age engaged into the learning process the space (**M:Space**) and resources (**M:Variet.**) are adequate. Stela manages to control the process alone (**M:Human**). Language skills development is combined with science and mathematics teaching. She applies both formative and summative assessment (**A:Form.**; **A:Summ.**) in the class.

RQ2: Probing practice

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

What approaches are used in the teaching, learning and assessment of science and mathematics in early years?

The originality of Stela's teaching method resides in combining play with planned experiment. She starts the class by playing a video on a known children story, captures pupils' attention and mobilizes their affection by asking them to find a hidden message, uses this opportunity to plunge them into a real life situation to be solved in order to help the movie character. Once engaged into this rescue adventure, children conceptualize the problem; start to think to a possible solution, based on various materials offered to them. Their response has to be connected to their previous knowledge and to the means they have at hand. Guided by the teacher and supported by the distributed worksheets, pupils follow step-by-step the frame of an inquiry procedure (formulating the problem, make some predictions based on previous experience; select materials to be used; plan and run an experiment; report results). Teacher's involvement is quite reduced, her role being more of a mentor, guide and consultant than a coordinator. Assessment is done on the way, using as evidence children activities, attitudes, and notes. Science teaching is combined with English language development and mathematics education. Both individual and team work are appreciated. The teacher guides pupils activities by the appropriate design of the worksheets which require from children to observe a strict logical development of the experiment phases (planning, use of resources, recording and reporting).

What role if any does creativity play in these?

Stela creates different opportunities for children to contribute in a creative manner to the learning process. First, she addresses their imagination by playing the beginning of the movie and stopping so that the audience misses the development of the story plot and has to continue with their experiment as part of the narrative. In this way, pupils have to recreate the atmosphere and have to invent continuation of the action to be taken. Children's engagement is further increased as they have to guess what problem has to be solved, as the message is encrypted. At this point, they have to combine English language knowledge with mathematics to reach their goal. Once the question to answer is clarified, pupils are asked to imagine a mean to answer it, based on previous experience from everyday life and by selecting the materials and tools to be used from a heterogeneous collection of materials and objects. They have to run a test which was planned after group discussions.

RQ3: Probing practice

In what ways do these approaches seek to foster young children's learning, interest and motivation in science and mathematics?

Children' interest in learning science and mathematics is fostered by the approaches used as far as these methods motivate the participants to solve a puzzle, to locate a problem, and to look for a solution. On the other side, pupils are involved emotionally as they are mentally coupled to the story, being ready to help.

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

How do teachers perceive their role in doing so?

Stela is an experienced educator with a strong background in using inquiry-based teaching and learning in early years (pre-school and primary school). She avoids applying "traditional" methods as they are used to be in Romania. She focuses on promoting an open style teaching, leaving enough space and time to children in implementing their own ideas and solutions, supporting them to structure an investigation plan, assisting them in gathering data, counselling them on group work and reporting. By her training she is very well acquitted with science concepts and handle easily various equipments and IT stuff. Children direct interaction and experimentation with materials and objects are her major concern in science teaching. Stela herself is an innovator on educational subjects; she developed training aids, learning units, science teaching resources. One of her main goal is to teach pupils from early age to become autonomous learners. She can be, without any doubt, to be considered a model and a "pioneer" on educational matters in Romania.

Supporting documents for this case study are given in Appendixes 4-7

3.3 Case 3 – Anca

3.3.1 Context

Where?	Country	Romania			
	Setting name	GC			
	Location within setting	Pre-school			
Who? (children)	Year group/age of children	3-4 years old			
	Number of children in class	15			
Who? (adults)	Number of adults	2			
	Role of adults	Teacher and assistant			
	Case teacher role	Co-ordinator			
When?		1	2	3	
	Dates of visits	28/1/13	05/2/13	21/2/13	
	Times of visits	8:30-12:00	08:00-10:30	12:00-13:00	

a) School/setting

The site is represented by a public kindergarten under the jurisdiction of the Ministry of National Education. It was founded in 1964 and operated along these years as a regular (8 hours per day), extended program and weekly educational unit. Today it is run as an extended program kindergarten (from 7.00 am to 6.00 p.m.). It is located into a medium and working class area of Bucharest, in a ward of apartment buildings. The kindergarten mission is to offer

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

equal educational and personal development opportunities. Children from 3 to 7 years old are accepted. Four age groups are in operation: the youngest group (3-4 years old); the medium age group (4-5 years old); the oldest group (5-6 years old) and the pre-school group (6-7 years old). The total number of classes is 23. The maximum number of children in a class is 20. Over 400 children are enrolled for this school year.

The kindergarten has its own kitchen and medical unit, open all day long. Apart form the mandatory curriculum the unit offers optional courses and activities: English language, dance, musical education, propriety, math activities, environmental knowledge, civic education society, practical activities and housework, art education, physical education. It has an extensive yard and playground for outdoor activities. Periodically, the staff organizes for children extracurricular activities as visits to museums, zoo, field trips, etc.

The daily program is the following:

8.00 arrival of children;

8.30-9.00 breakfast;

9.00-10.00-frontal activities (personal development activities + activities in various fields);

10 .00 – fruit breakfast;

10.30-11.00 - frontal activities and optional activities according to the group age;

11.00-12.00 - free choice activities;

12.00-lunch;

13.00-15.30- sleep hour;

15.30-16.00-serving a snack;

16.00-18.00- various activities.

The unit is involved into various educational projects such as "Read for the third millennium", "Junior Achievement", "ENO-Environment" "Spring Day", "Leaf-Learn about forest", "Pay attention to the road traffic", "Education for health","Education for values".

The kindergarten staff numbers 27 qualified personnel, educators, assistants, medical assistant.

b) Teacher (national teachers' survey)

Anca is a young lady in her 30s. She is a certified teacher, first degree. She graduated the Faculty of Economics and Management, with additional training in pedagogy on pre-school and primary school education. She inherited her passion for teaching from her mother, also an educator. Her professional experience covers more than 15 years. In the last years she was engaged in the education of 4-6 years olds. She uses to teach up to 25 children. She is

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

comfortable with sciences and mathematics which she studied during the years she was trained at the Faculty. She has an introductory education in environmental sciences and ICT, child psychology, development of creativity. She attended few seminars and course with medium impact on her carrier. Anca has no involvement in teachers' networks, working groups or research teams.

She is very confident in the "knowledge and understanding of important scientific ideas", the "knowledge and understanding of important scientific processes", "general pedagogic knowledge", the "knowledge of science pedagogy/didactics", "science and mathematics teaching", "assessing children in science". She is less confident in relation to the use of inquiry teaching and ICT.

She is teaching 2-3 hours of science and mathematics per week. Other subjects she teaches are: communication and language, esthetics and creativity, man and society. She thinks that compulsory science teaching has to "develop socially and environmentally aware and responsible citizens", to "enrich the understanding and interaction with phenomena in nature and technology", to "develop more innovative thinkers", to "develop important attitudes and dispositions as a foundation for future learning".

Her activity in the classroom is focused on the development of the following learning skills of children:

- To be able to ask a question about objects, organisms, and events in the environment.
- To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.
- To know and understand the important scientific processes.
- To be able to communicate investigations and explanations.
- To have positive attitudes to learning.

In science teaching, Anca often uses: storytelling; "working in small groups"; "physical exploration of materials"; "integrating science with other curricular areas"; "building on children's prior experiences"; "fostering collaboration"; "encouraging different ways of recording and expressing ideas – oral, visual, digital, practical"; "encouraging children to try out their own ideas in investigations"; "fostering classroom discussion and evaluation"; "fostering imagination"; "relating science to everyday life"; "using questioning as a tool in science teaching"; "fostering autonomous learning".

She considers being very important in the development of children's creativity to acquire observation skills, to conduct simple experiments and to employ simple equipments and tools

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

to manipulate materials and objects. She thinks that for a successful science education the teacher has to "facilitate children's own inquiry" and to "allow children to find solutions to problems on their own".

In assessing children science learning the teacher has to focus on the "knowledge and understanding of scientific ideas (facts, concepts, laws and theories)" and to encourage "positive attitudes and increase of interest in learning science". Generally, Anca performs the assessment of pupils learning process "during classroom interaction" by "evaluating children's relevant gestures or physical activity", "using authentic problem-based tasks" and "portfolios".

She highly appreciates the sense of initiative, ability to come with something new, imagination, curiosity, thinking skills. By assessing children results and development Anca is looking "To identify aspects of the science curriculum that could be improved", "to identify ways to improve child science learning", and "to set targets with children for their own development in science".

c) Classroom

The kindergarten includes a new building with spacious classrooms (24 to 32 s.m.) and ICT equipment (Figs. 1 and 2).

Figure 1

Figure 2

Anca's classroom is one of these, with big windows and a generous space to work and play (Fig. 3).

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

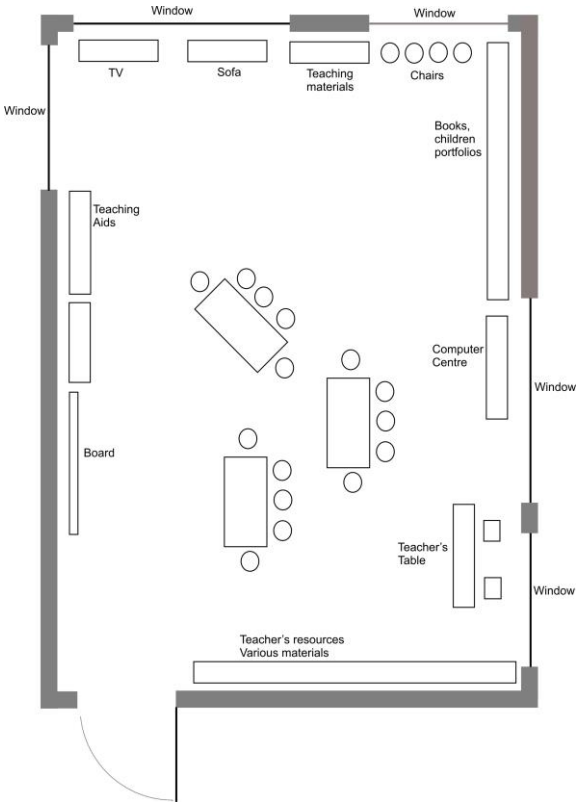

Figure 3

Children involved into these episodes are all 3-4 years old. Over all they were 15, seven girls and eight boys.

3.3.2 Episodes

The activities described in the next three episodes belong to the subject "Learning about the environment", field "Sciences". Its type is according to the Romanian curriculum transfer and assimilation of knowledge and it is implemented through "scientific type investigation". The main goals of this lesson are (as per Anca's lesson plan):

- to train learners to understand and acquire knowledge on the proximal environment and to stimulate curiosity to children;
- to train learners in using algorithms in analysing a subject;
- to stimulate thinking processes (analysing, comparing, generalizing, synthesis);
- to encourage children to study natural sciences.

The operational objectives of the lesson are:

- to recognize different colours found in their environment, based on previous experience;
- to analyze the results obtained successively when a prescribed algorithm is applied;

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

- to identify possible changes of the results by using various research means;
- to highlight possible similarities and differences between two results obtained by different methods;
- to use appropriately the scientific terminology.

During the class, the teacher uses various methods and procedures: experiment, observation, play, dialog, explanation, problems identification. He/ she will work frontally and individually with children.

Materials to be used: colored images covering the visible spectrum; magnetic colored tokens (red, blue, yellow, orange, green and violet); smiling/ sad faces; worksheets; napkins; watercolours; plastic transparent bowls; disposable syringes; flash lamp, transparent color filters.

The planned time scale is about 3 x 20 min.

In her lesson plan Anca refers to the national curriculum for kindergarten and pre-school education, and to a brochure explaining the curriculum.

During the class, Anca is assisted by one of her colleagues (**M:Human**). Children are allowed enough time to explore and conclude on the experiments. The tables where children are sited are large enough to permit easy handling of the materials and equipments used. The classroom is very spacious (**M:Space**). The lesson has a formal set-up (**L.Formal**) and is run indoor (**L. Indoors**). Considering the age of the participants (3 years old) most of the class is based on questioning (**LA: Ques**) and the dialog between the teacher and the pupils. All activities are teacher led. There is no collaboration between children during the class. Pupils are grouped (**G:Small G**) and share the resources in some cases.

a) "Coloured fingers stamps" episode context and data and analysis

This episode starts with some questions (**LA: Ques**) addressed by Anca to all participants. Children have to recognize (**LA: Obs**) and name, based on previous knowledge (**LA: Connect**) the colors of several pencils Anca shows to them (Fig. 4). Generally, they answer in group. At this stage no dialog is established. After each correct answer, Anca praises the children (**P:Affect**) for their results.

After this introduction designed to capture pupils' interest, the teacher distributes to each one a set of watercolours (**M:Variet.**) and some worksheets with three circles on it, aligned on the same line (Fig. 5). At the beginning, Anca asks children to dip the index finger of each hand into the same watercolour and stick one to the other to see what color will result. Pupils conclude that the color does not change, it remains the same.

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

Figure 4

Figure 5

In the next step they have to put two different colors, as indicated on their worksheets, on the two clean index fingers and "stamp" them on the middle circle and have to observe (**LA: Obs**) what color results (**P: Play**). In this way, children conclude how primary color mixture (Fig. 6) produces a new, secondary color (**M:Explor**). They are free to test on their own color mixing (**P:Agency**; **M: Cr, AO: Creative**). The teacher and her assistant are guiding them (**P: Scaff**) without imposing any restrictions on the way they are playing with colors (Fig. 7).

Figure 6

Figure 7

Each child is asked to name the color he/ she obtained (**A:Form.**). In order to fix the concept of color mixing, Anca calls several pupils, one-by-one, to come to the white board (Fig. 8) and to explain what color is obtained after mixing two primary colors (**P: R and R**; **LA: Comm**; **A:Summ**). For this discussion, magnetic colored tokens are used. The interviewed child has to select the token corresponding to the result. At his stage, children are required to select the right color circle from an assortment of colored circles and squares. Anca combines science teaching with mathematics starting at very early age. Each type he/ she gives a correct answer he/ she is awarded with a "smiling face" (**AO: Affect**).

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

Figure 8

b) "Mixing coloured water" episode context and data and analysis

During this lesson, children have to understand the production of new colors through color mixing, based on the mixing of two differently colored water samples. Anca and her assistant distribute (Figs. 9 and 10) to each participant a transparent plastic bowl, a disposable syringe and two additional transparent plastic containers each filled with water colored by a two different colors (**LA: Equip; M: Cr**).

Figure 9

Figure 10

Anca asks pupils to comment on the color and clearness of the water in the bowls they received (**LA: Ques; LA: Connect**), with the intention to link the subject of the lesson with children previous knowledge. After this dialog, the teacher instrtructs children on the way to use syringes and the colored liquids in order to combine them in the empty container. A new color is generated from primary colors. Pupils are very happy to be engaged into this activity (**P: Play**; **P:Agency**; **P:Affect; AO: Creative**) (Figs. 11 and 12).

They are asked one after the other to identify (**LA: Obs**) the newly formed colors (Figs. 13, 14 and 15) and to name them (**LA: Comm; A:Form.**). During this discussion, pupils have to reflect on the way new colors can be obtained by mixing two liquids having different colors (**P: R and**

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

R). They are free to explore the new situation, as Anca and her assistant supervise them not to split the liquids or to smear all around (**P: Scaff**).

Figure 11

Figure 12

Figure 13

Figure 14

Figure 15

As in the case of the previously analyzed activity, by the end of the lesson, children are required (**A:Summ.**; **LA: Comm**) to come to the white board and to identify the resulted color from the mixture of two primary colors by selecting the appropriate square shape colored token (Fig. 16). In this situation one again science is combined with mathematics, as elementary geometrics shapes have to be compared. A correct answer is rewarded (**AO: Affect**) (Fig. 17).

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

Figure 16

Figure 17

c) "Coloured lights" episode context and data and analysis

The third activity is more a demo session led by the teacher than on in which children are involved. This is because of the age of the pupils and the difficulty in handling the equipment (a torch) (LA: Equip). Anca shows to the audience different transparent colored glass filters (Fig. 18) and a torch (**M:Explor.**; **M: Cr**). She asks children (**LA: Ques**) to observe the colored light spots projected on the ceiling when the light of the torch passes through various filters and is directed upward (**LA: Obs**). Depending on the situation, pupils indicate (**LA: Comm**) both primary and derived colors projected on the ceilings (Figs. 19 and 20). By varying the optical set-up, the teacher keeps the attention of the children and provokes them to reflect on the coulors which can be obtained through color lights mixture (**P: R and R**), trying in the mean time to evaluate their understanding (**A:Summ**). They have to guess which color has to be generated by different primary light colors (**LA: Connect**; **AO: Creative**), based on their previous experiments.

Figure 18

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

Figure 19

Figure 20

3.3.3 Case summary and conclusions

Discussion in relation to synergies between science and mathematics and creativity

The present analysis is based on previous deliverables of the project with a focus on specific national aspects reviled:

- Conceptual Framework (D2.2);
- List of Mapping and Comparison Factors (D3.1);
- Report on Mapping and Comparing Recorded Practices (D3.2): Romanian National Report on Approaches in Policy;
- Report of First Survey of School Practice (D3.3): Romanian National Report on First Survey of School Practice, and is supported by the evidences gather during in-depth fieldwork.

According to the adopted methodology for in-depth fieldwork the research is carried out along two guiding lines: a) pedagogical interventions and b) pedagogical framing both associated to the deductive coding for the data collected. These codes are used for the inductive analysis in order to underline the reflection in school practice of the factors identified in the *Conceptual Framework*, factors fostering creativity in the context of inquiry-based science and mathematics teaching and learning. For each episode, factors important to nurturing creativity in science and mathematics in the early years and the associated codes are highlighted.

The kindergarten which is the subject of the present field research covers almost the entire age span of interest for the project. Its stated mission includes education according to the national curriculum as well as extra-curricular activities such as foreign language teaching, civic education, arts and dance education, practical activities and housework. In such an environment there is plenty room to run inquiry-based teaching lessons and to encourage the development of children's curiosity and imagination (**AO: Creative**). The establishment has enough space (**M:Space;** Fig. 3) to carry out both indoors and outdoors activities (**L.**

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

Out/Indoors.). There is enough personnel to run daily tasks (**M:Human**). The education is done mostly in a formal approach (**L.Formal**), at least for the lessons the research team took part. Participation to some projects and networks offers the opportunity to deal with non-formal teaching environments (**L. Informal**). A multitude of didactic aids as well as IT equipments are available (**M:Variet**.; **M:ICT;** Fig. 3).

The teacher shows a remarkable understanding on the role of science teaching in school as a vehicle to promote the scientific understanding of the surrounding world, and a mean to develop thinking skills (**AO: Kn.Sc**; **AO: Und. SI**; **AO: Sc Proc Skills,**) and civic responsibility (**AO: Social**) to children from early age. She is also concerned on the role of the school in training youngsters on "learning to learn". Developing pupils creativity in relation to the understanding of basic concepts is her major target (**AO: Creative;** Anca's profile from the survey, interview and Fibonacci tool feedback). She has less knowledge on inquiry-based teaching methods and the age of the children she is working with does not allow her to practice the above mentioned believes. The didactic interest is focused on "positive attitudes and increase of interest in learning science", based on an increased interest from their part (**AO: Affect**), and considers as being very important pupils assessment during the class work (**A:Form**).

Anca's lesson plan reflects her basic strategies in teaching science at 3 years old:

- to work in group (**G:Small G**);
- to introduce the topics using the play (**P: Play**);
- to explain the activity algorithm (**AO: Sc Proc Skills**);
- to record pupils individual results (**A:Form.**);
- to supervise the run of the experiment (**P: Scaff**);
- to use various materials and techniques (**M:Variet.**);
- to offer small appreciation awards by the end of the activity (**P:Affect;** Figs. 8, 17);
- to ask children to perform on their own some activities after similar activities were demonstrated previously (LA: Connect);
- to express general assessment judgments individually and with the whole class (A:Summ).

During the class, Anca assist children with appropriate questions (**LA: Ques**) and, in the mean time, encourage their initiative (**P:Agency**) to work with different materials (**M:Explor., M:Variet.;** Figs. 5, 12, 18, 19), to observe (**LA: Obs**; Figs. 11-14) and to reflect on their results (**P: R and R**). Whenever possible she introduces mathematics elements in designing the lesson.

RQ2: Probing practice

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

What approaches are used in the teaching, learning and assessment of science and mathematics in early years?

Teaching very young children (3 years old), Anca bases her lessons on questioning, play, exploration of different materials, guided experiments, affective engagement. The observation of objects and phenomena are key issues of her activities. Assessment is done during the activities and concluding remakes are used to fix the newly acquired knowledge. The concepts are introduced gradually, from simple evidence (mixing by hand watercolours) to more abstract one (mixing color light). All the way, questions referred either to previous knowledge (what color are the pencils) or address new information (producing secondary colors by mixing primary ones).

What role if any does creativity play in these?

Anca by her education is a fervent supporter of children creative development. She succeeded to design and implement very interesting and "user-friendly" lessons from which even very young participants can understand the message and benefit. Children were guided to run their own experiments without too many constrains. They were able to do these activities and to "draw" conclusions. They started to be quite skilful in handling different materials and even small equipment (i.e. disposable syringes). On the other side, Anca's method has to be appreciated as she introduced mathematics concepts (i.e. geometric forms) as part of the final assessment of the science unit.

RQ3: Probing practice
In what ways do these approaches seek to foster young children's learning, interest and motivation in science and mathematics?

Children interest and motivation were stimulated as the whole activity was planned as part of a play, mixing watercolours with fingers without usual restrictions regarding cleanliness precautions. The awarded system with an emotional touch is another strength point of this approach.

How do teachers perceive their role in doing so?

Coming from a family with a strong background in teaching early age children, Anca has a special understanding of the issues involved and knows to tailor the lessons in an original manner, observing in the mean time the curriculum. She manages to pass the knowledge in a very attractive and easy to understand way. She is aware of the opportunities offered by science teaching in Early Education. In spite of the fact that she has no special training on inquiry-based education Anca has some inside on using IBSE methods. Leading the way activities are run, she offers to children a lot of opportunities to manifest themselves.

Supporting documents for this case study are given in Appendixes 8-10

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

3.4 Case 4 – Sanda

3.4.1 Context

Where?	Country	Romania			
	Setting name	GC			
	Location within setting	Pre-school			
Who? (children)	Year group/age of children	5 - 6 years old			
	Number of children in class	15			
Who? (adults)	Number of adults	1			
	Role of adults	teacher			
	Case teacher role	Co-ordinator			
When?		1	2	3	4
	Dates of visits	28/1/13	05/2/13	21/2/13	21/2/13
	Times of visits	10:00-12:00	08:00-10:30	9:00-11:00	12:00-14:30

a) School/setting

The site is represented by a public kindergarten under the jurisdiction of the Ministry of Education, Research, Youth and Sport. It was founded in 1964 and operated along these years as a regular (8 hours per day), extended program and weekly educational unit. Today it is run as an extended program kindergarten (from 7.00 am to 6.00 p.m.). It is located into a medium and working class area of Bucharest, in a ward of apartment buildings. The kindergarten mission is to offer equal educational and personal development opportunities. Children from 3 to 7 years old are accepted. Four age groups are in operation: the youngest group (3-4 years old); the medium age group (4-5 years old); the oldest group (5-6 years old) and the pre-school group (6-7 years old). The total number of classes is 23. The maximum number of children in a class is 20. Over 400 children are enrolled for this school year.

The kindergarten has its own kitchen and medical unit, open all day long. Apart form the mandatory curriculum the unit offers optional courses and activities: English language, dance, musical education, propriety, math activities, environmental knowledge, civic education society, practical activities and housework, art education, physical education. It has an extensive yard and playground for outdoor activities. Periodically, the staff organizes for children extracurricular activities as visits to museums, zoo, field trips, etc.

The daily program is:

8.00 arrival of children;

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

8.30-9.00 breakfast;

9.00-10.00- frontal activities (personal development activities + activities in various fields);

10 .00 – fruit breakfast;

10.30-11.00-frontal activities and optional activities according to the group age;

11.00-12.00- free choice activities;

12.00-lunch;

13.00-15.30- sleep hour;

15.30-16.00-serving a snack;

16.00-18.00-various activities.

The unit is involved into various educational projects such as "Read for the third millennium", "Junior Achievement", "ENO-Environment" "Spring Day", "Leaf-Learn about forest", "Pay attention to the road traffic", "Education for health "," Education for values ".

The kindergarten staff numbers 27 qualified personnel, educators, assistants, medical assistant.

b) Teacher (national teachers' survey)

Sanda (aged between 40 and 49 years) is an experienced teacher (over 20 years in child education and care) involved for many years in early education. She is well acquainted with modern methods in teaching science at pre-university level. Her expertise is in working with children 3 – 6 years old. The highest level of formal education that she completed is post-secondary non-tertiary education (vocational), being a graduate of the College for Pedagogy Studies. In addition she took several courses and now she is a certified teacher. Sanda has a background in science and mathematics at post-secondary non-tertiary education. Her training basic includes: mathematics; science; environmental or earth sciences; pedagogy; developmental psychology; children's development of creativity. In addition she completed her professional development through reading science and mathematics professional literature, engaging in informal dialogue with her colleagues.

Her strongest teaching skills relate to: general pedagogic knowledge; knowledge of science pedagogy/didactics; science teaching; assessing children in science and mathematics.

As a general rule her class accounts about 21 to 25 pupils. Weekly, Sanda delivers about 2 hours of science and mathematics. The major subjects she teach are: language and communication; science; psihomotric classes; aesthetic and creativity; man and society.

In Sanda's opinion science lessons have as main objectives:

- to develop socially and environmentally aware and responsible citizens;

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

- to enrich the understanding and interaction with phenomena in nature and technology;
- to develop more innovative thinkers;
- to develop positive attitudes to science.

In relation to children learning she thinks to be very important: to be able to ask a question about objects, organisms, and events in the environment; to be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses; to know and understand the important scientific processes; to have positive attitudes to learning; to understand that scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge); to be able to collaborate with other children.

The most used teaching methods she applies in science education are: open/unstructured play; role/pretend play; teaching science from stories; working in small groups; physical exploration of materials; building on children's prior experiences; fostering collaboration.

Her lesson delivered for the field visit proves her philosophy according to which questioning plays a key role in education at this age. She encourages children to formulate hypothesis and to ask questions to adults. Sanda believes that:

- teachers should give children ample time to work out their own solutions to problems before showing them how they are solved;
- teachers should facilitate children's own inquiry;
- teachers should allow children to find solutions to problems on their own.

The assessment is done in Sanda's class during classroom interaction, based on children's pictures, graphs etc which show their scientific reasoning or evaluating children's relevant gestures or physical activity.

The assessment role as perceived by the teacher is to monitor regularly individual children's or cohorts of children's progress towards a set of desirable science learning outcomes and to inform parents of their child's progress in science.

Sanda mostly appreciates to children sense of initiative; imagination; curiosity; ability to work together; thinking skills; motivation; innovative attitude.

c) Classroom (age children)

The kindergarten includes a new building with spacious classrooms (24 to 32 s.m.) and appropriate furniture and didactic materials (Figs. 1 and 2).

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

Figure 1

Figure 2

The floor plan of Sanda's classroom is is detailed in Fig. 3.

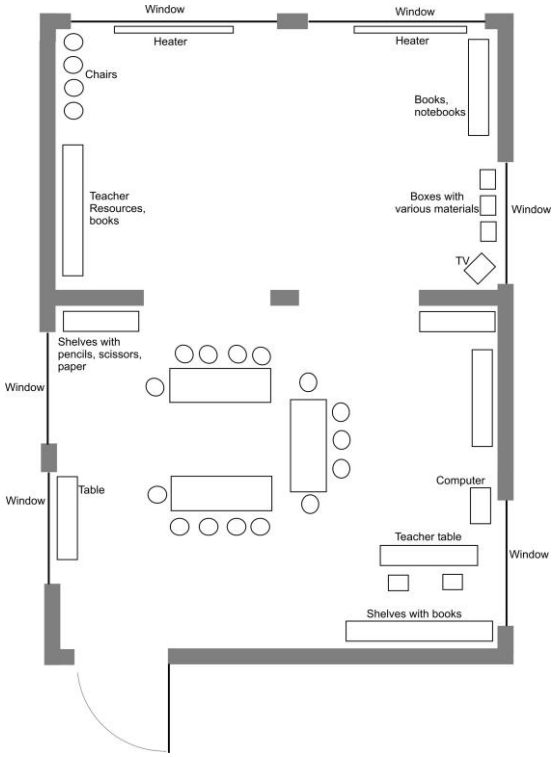

Figure 3

Children involved into these episodes are all 5-6 years old. Over all they were 15, nine girls and six boys.

3.4.2 Episodes

The topic of the lesson, "Comparing the volume of several pots though measurements", fits into the annual theme "How was and it will be life on Earth", in the frame of the project "The animal kingdom", subproject "Water world". It belongs to the curriculum branch "Sciences".

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

The goal of this lesson is the acquisition of new knowledge through an educational and practical exercise (from Sanda's lesson's plan).

The **major objectives** of the class are:

- to familiarizing children with the task of liquids volume measurement using non-standard units (cup, tea cup, water bottles of various shapes and sizes, jars of different capacities, a bucket, a cooking pot, various containers) and standard unit - liter (l);
- to make acquainted children by first hand experience with the concept of liquids volume invariance.

As **operational objectives**, by the end of the activity, children will be able to:

- measure and compare the capacity of several vessels using non-standard units;
- to name vessels having one liter capacity;
- to realize the invariance of liquids volume independently on the form of the vessel they fill;
- to divide a whole into halves and quarters;
- to compare the parts with the whole and to communicate results.

Teaching methods and procedures to be used: conversation, observation, explanation, practice, experiment, independent work, problem-solving, learning by discovery.

Teaching equipment and materials: various containers, cup, tea cup, water bottles of various shapes and sizes, jars of different capacities, a bucket, a cooking pot.

Type of interaction: frontal and individual.

Duration: 30-35 min.

As references Sanda used the national curriculum for 6-7 years old children, and two didactic books, one of them referring to mathematics in the garden.

The assessment is of formative type, by observing pupils work and interactions.

During the class, Sanda is assisted by one of her colleagues (**M:Human**). Children are allowed enough time to explore and conclude on the experiments. The tables where children are sited are large enough to permit easy handling of the materials and equipments used. The classroom is very spacious (**M:Space**). The lesson has a formal set-up (**L.Formal**) and is run indoor (**L. Indoors**). All activities are teacher initiated, but children run the experiments by themselves (**P: Scaff**). There is a strong collaboration between children during the class, as different tasks are assigned to different group members. Pupils are grouped (**G:Small G**) and share the resources.

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

a) "Measuring volumes: non standardized units" episode context and data and analysis

The lesson starts with a discussion (**LA: Ques**) on liquids and the way their volume can be measured. Various non-standard units (**LA: Equip**; **M:Explor**.) associated to different vessels (tea cups, small glasses, cylinders) are used to measure the volume of water samples. Children are sited around tables and work in small groups (**G:Small G**). One after the other each pupil tries the experiment and draws some conclusion (**P:Collab**) (Figs. 4 - 9). They measure and conclude that the volume of a small cylinder is smaller that the volume of a tube. During this process, children are asked to evaluate the outcomes of their work (**P: R and R**) and can be evaluated individually (**A:Form.**). They have to run the experiment by their own (**P:Agency**). The experiment is designed to offer them the opportunity both to take develop equipment handling skills and to take decisions (**AO: Sc Proc Skills; AO: Creative**).

Figure 4

Figure 5

Figure 6

Figure 7

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

Figure 8

Figure 9

Various situations emerged from measuring the same amount of water with different vessels. Children have the opportunity to evaluate (**LA: Obs**) in a very tangible manner the different in volumes. The « units » used are distributed to all teams, so, the children can compare the « value » of different « units » employed (**M:Variet**.). The concepts introduced in this lesson are:

- measuring means comparing the quantity to be measured with a small quantity considered as “unit”;
- the number of units associated to a quantity to be measured depend on the ratio between the quantity to be measured and the unit value;
- in various measuring situations appropriate units have to be used.

By the end of the exercise, pupils conclude (**LA: Comm**) that not all units have the same volume.

b) “Different shape same volume” episode context and data and analysis

The next challenge in volumes measurements refers to the relation existing between the volume and the same of the vessel used. Each group receive three vessels of different shapes (**LA: Equip; M:Variet.**) (cylinder, plastic bottle, jag) having all the same volume. Children are asked (**LA: Ques**) to rank the vessels by their estimated volume. In order to decide on the answer, the teams (**G:Small G; AO: Social**) have to formulate a hypothesis (**AO: IBSE**) and plan (**LA: Plan**) the experiment involving the comparison of volumes. After that they make several tests (**P:Agency**; **AO: Sc Proc Skills**) to rank the vessels by combining them in various set-ups (Figs. 10 – 13).

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

Figure 10

Figure 11

Figure 12

Figure 13

During the experiments pupils are observed (**A:Form.**) by the teacher who guides them (**P: Scaff**) and keeps a dialog with them (**P: R and R**).

Lesson learned from these experiments: as liquids take the shape of the vessel they fill the volume not the shape counts.

c) "Measuring volumes: standardized units" episode context and data and analysis

The next step in learning volume measurements is to compare measurements done with non-standard and standard units. Each group (**G:Small G**; **P:Affect**) receives similar buckets and has to fill tem with water by different means (**AO: Sc Proc Skills**). The results of the experiments are recorded on special worksheets.

First, one group has to use (Figs. 14 – 17) tea caps, the second a small cylinder and the third a plastic bottle (**LA: Equip**; **M:Explor.**; **P:Affect**). They have to count the number of "units" used to fill their bucket and to mark on the worksheet (**LA: Ques**; **LA: Plan**; **LA: Equip**; **LA: Obs**; **LA: Comm**). Some of the children are doing the measurements (**P:Agency**), one of them counts the number of elementary units used and another one reports the results (**P: R and R**; **P:Collab**).

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

The conclusion of the first set of measurements is that different groups spent different efforts to complete the task. Some of them used less measuring steps than the others. Those with smaller "units" had to repeat the operation more time than those with larger vessels.

Figure 14

Figure 15

Figure 16

Figure 17

In the second set of investigations all groups receive similar buckets and similar measuring units with a volume of one liter (Fig. 18 and 19). After they run the measurements children concluded that using the same unit all of them made the same number of operations. So, they realized the value of a standard unit of volume measurement (**LA: Connect**).

During the investigations pupils were observed, guided (**P: Scaff**) and assessed (**A:Form.**) by the teacher. Sanda congratulate children for their achievement (**P:Affect**).

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

Figure 18

Figure 19

3.4.3 Case summary and conclusions

Discussion in relation to synergies between science and mathematics and creativity

The present analysis is based on previous deliverables of the project with a focus on specific national aspects reviled:

- Conceptual Framework (D2.2);
- List of Mapping and Comparison Factors (D3.1);
- Report on Mapping and Comparing Recorded Practices (D3.2): Romanian National Report on Approaches in Policy;
- Report of First Survey of School Practice (D3.3): Romanian National Report on First Survey of School Practice, and is supported by the evidences gather during in-depth fieldwork.

According to the adopted methodology for in-depth fieldwork the research is carried out along two guiding lines: a) pedagogical interventions and b) pedagogical framing both associated to the deductive coding for the data collected. These codes are used for the inductive analysis in order to underline the reflection in school practice of the factors identified in the *Conceptual Framework*, factors fostering creativity in the context of inquiry-based science and mathematics teaching and learning. For each episode, factors important to nurturing creativity in science and mathematics in the early years and the associated codes are highlighted.

The kindergarten which is the subject of the present field research covers almost the entire age span of interest for the project. Its stated mission includes education according to the national curriculum as well as extra-curricular activities such as foreign language teaching, civic education, arts and dance education, practical activities and housework. In such an environment there is plenty room to run inquiry-based teaching lessons and to encourage the development of children's curiosity and imagination (**AO: Creative**). The establishment has enough space (**M:Space**) to carry out both indoors and outdoors activities (**L. Out/Indoors.**). There is enough personnel to run daily tasks (**M:Human**). The education is done mostly in a

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

formal approach (**L.Formal**), at least for the lessons the research team took part. Participation to some projects and networks offers the opportunity to deal with non-formal teaching environments (**L. Informal**). A multitude of didactic aids as well as IT equipments are available (**M:Variet**).

Sanda had documented very well her lesson as far as she does not follow the "classical" approach recommended by the national curriculum, generally based on demo sessions run by the teacher, when children are simple witness, bystander. She has a deep intuition in running classes based on inquiry, working mostly on concepts understanding. She developed the pupils' knowledge gradually, using an experimental approach. Children have a multitude of vessels of different shapes and capacities to carry out the investigation (**LA: Equip.**).

Sanda makes clear from the beginning of the class the missions which have to be completed and explain in few words the equipment usage (**P: Scaff**). After that introduction, children are left alone to perform the job (**P:Agency**), following their own ideas and solutions.

The development of investigative skills is supported as the teacher trains pupils to formulate hypothesis and plan experiments (**LA: Ques**; **LA: Obs**; **AO: Sc Proc Skills**; **AO: IBSE**).

She combines very effectively science teaching with mathematics asking children to count, to compare results, to write down numerals (**AO: Creative**). Group work is strongly encouraged (**G:Small G**; **P:Collab**).

She focuses on formative assessment (**A:Form.**) by using direct observation of children activities and attitudes as well as by evaluating their reports. Dialog and questioning – answering sessions are present (**LA: Comm)**. Rationing and verbalizing conclusions are parts of the creative thinking maturity process (**P: R and R**).

By varying the experimental conditions children are captivated by the tasks to be done and participate affectively to the problem solving (**P:Affect**).

RQ2: Probing practice
What approaches are used in the teaching, learning and assessment of science and mathematics in early years?

Sanda has a good knowledge of modern approaches in science teaching. She succeeds to combine efficiently science education with mathematics teaching. She is close to an inquiry-based education method as far as her main concern is to teach children basing concepts on volume measurements. She uses a variety of vessels in order to convince pupils, through their own investigations, about basic principles involved in vessels capacity evaluation. She tries to explain in advance what the tasks to be completed are, and leaves children alone to experiment. Skills related to manipulation of equipments and planning/ reporting of investigations are encouraged. She runs only formative assessment considering children actions, attitudes and written results.

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

What role if any does creativity play in these?

Without any doubts, considering the Romanian standards for science teaching, Sanda is a pioneer and trendsetter. Her science teaching procedure is very creative and open to innovation. She makes efforts in designing a set of lessons of gradual complexity in order to pass to children basic notions.

RQ3: Probing practice
In what ways do these approaches seek to foster young children's learning, interest and motivation in science and mathematics?

Her approach increases children interest and enthusiasm. Children perceive the tasks as a sort of serious game, waiting for a clear answer. They work very attentively, consult each other, take notes on the results and report in a responsible manner. The way the class is conducted offer to them the opportunity to find answers based on experiments, and forces them to reflect on the results. She opinion on these issues are illustrated in her interview "Major approaches are through play and exploration; engaging emotions, stimulating questioning. "

How do teachers perceive their role in doing so?

Sanda is, by her nature, more a mentor and a guide than a teacher in "stricto senso". She understood the importance of social constructivism. A citation form her interview proves this "From the listed methods you mentioned (NB cognitive dimension, through hands-on activities; social dimension; children cooperation), I use mostly group work when children can cooperate freely. This makes possible the development of social and communication skills, competences I think to be very important to be encouraged at this age."

Supporting documents for this case study are given in Appendixes 11-13

3.5 Case 5 – Cora

3.5.1 Context

Where?	Country	Romania			
	Setting name	CB School			
	Location within setting	Primary school			
Who? (children)	Year group/age of children	7 - 8 years old			
	Number of children in class	23			
Who? (adults)	Number of adults	1			
	Role of adults	teacher			
	Case teacher role	Co-ordinator			
When?		1	2	3	

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

	Dates of visits	8/2/13	13/2/13	15/2/13	
	Times of visits	8:00-10:30	8:00-11:00	12:00-13:30	

a) School/setting

The site is a public school covering education from pre-school to lower secondary school (6 to 13 years old children). The school motto is "It is easy to learn waking, but it is important the direction you follow". It was established in 1962 as a general school in a working to middle class neighborhood, with 16 classrooms, two labs and two educational workshops. In 1972 a new building was finished extending the facilities of the school. After 1989, two modern labs of informatics were arranged. In the last years the school modernization program continued with the setup of a phonic laboratory, educational software AeL laboratory, medical and dental facilities, and laboratories of physics, chemistry, biology, a library and a small gym. Starting from 2007, the construction of a multipurpose hall begun; it is designated for various meetings, conferences, local community activities, artistic events, etc. to be organized. A greenhouse is in operation in school for biology teaching purposes.

One of the school declared objectives is "to continue teachers' training so that they are able to use in class modern techniques and the existing teaching materials to make lessons more attractive to students".

The school participated to several projects: Comenius, GAP (for learning English by authorized persons from England, Australia, and United States), bridges between village and city projects for environmental education, health education, education for democracy and others.

From 2012-2013 school year, the Center for Excellence in Mathematics is in operation organized by Archimedes association in collaboration with the Association of Parents. The courses target students in grades II-VII. The parents association supports the organization of extra curricular courses and activities on: English language, computer science, ballroom dance, karate, aerobics, volleyball, basketball.

Among the school employees are 23 primary school teachers.

From the 2009-2010 inspection report: "by the end of the school year statistics show:

- school dropout rate - 0%;
- graduation rate - 100%;
- admission to high school - 100%;
- percentage of pupils with good and very good results - 85%;
- frequency deviations by low marks - 4.5%;

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

- assessment test results at national graduation tests: Romanian language: 93.75%; mathematics: 96.88%."

Number of enrolled pupils: over 750.

b) Teacher (national teachers' survey, Fibonacci self-assessment tool, teacher's interview)

Cora is an experienced primary school teacher (30 to 39 years old) and she graduated the Faculty of Romanian language. She is a certified teacher who attended also ECDL courses on the use of ICT. She is teaching at primary school level for more than 14 years. Over the last few school years, her pupils' age is from 7 to 9 years. The class is attended by 21 to 25 children. She is confident in teaching sciences and mathematics as per her educational background studies, which include also: pedagogy, developmental psychology, children's development of creativity, creative teaching approaches.

Cora's professional development was supported also through participation to courses, conferences, workshops, teachers' networks activities, collaborative projects.

She is very confident in relation to "the uunderstanding about scientific inquiry", "general pedagogic knowledge", "knowledge of science and mathematics pedagogy/didactics", "science/ mathematics teaching" and ICT knowledge.

Cora devotes more than 4 hours per week to science and mathematics teaching. Her topics of interest being:

- life and the environment;
- transformations in the natural world;
- measuring units and measurement processes;
- intuitive geometry.

Teaching science is very important to Cora because this "provides a foundational education for future scientists and engineers", "enriches the understanding and interaction with phenomena in nature and technology", "develops more innovative thinkers" and "develops important attitudes and dispositions as a foundation for future learning." For her science education has to support children "to be able to ask a question about objects, organisms, and events in the environment", "to be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses", "to be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses", "to be able to plan and conduct a simple investigation."

Cora's favorite methods of science teaching are outdoors activities, field trips and visits to museums, and often she uses open/unstructured play, role/pretend play, working in small

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

groups, integrating science with other curricular areas, building on children's prior experiences, fostering collaboration, encouraging different ways of recording and expressing ideas – oral, visual, digital, practical, encouraging children to try out their own ideas in investigations, fostering imagination, using questioning as a tool in science teaching.

She sees as vectors for creativity development the observation of natural phenomena, planning and designing of simple experiments, conducting simple experiments and looking for explanations. From her point of view, the teacher has to offer enough time to children to work on their own ideas and solutions.

According to Cora, the major goals of evolution have to be children' "knowledge and understanding of scientific ideas", their "competencies necessary to carry out scientific inquiry" and the development of "positive attitudes and increase of interest in learning science". She bases her evaluation on: observations made during classroom activities, children's worksheets, report, graphs, relevant gestures and attitudes.

Cora mostly values pupils initiative, motivation, curiosity, thinking skills. She also thinks that group work has to play an important role in developing children's competences in science.

c) Classroom (age children)

The school classrooms are regular ones (6 m x 8 m), equipped with IT devices, may be a little too crowded, as the number of children per class is quite high.

Figure 1

Figure 2

The floor plan of Cora's classroom is detailed in Fig. 3.

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

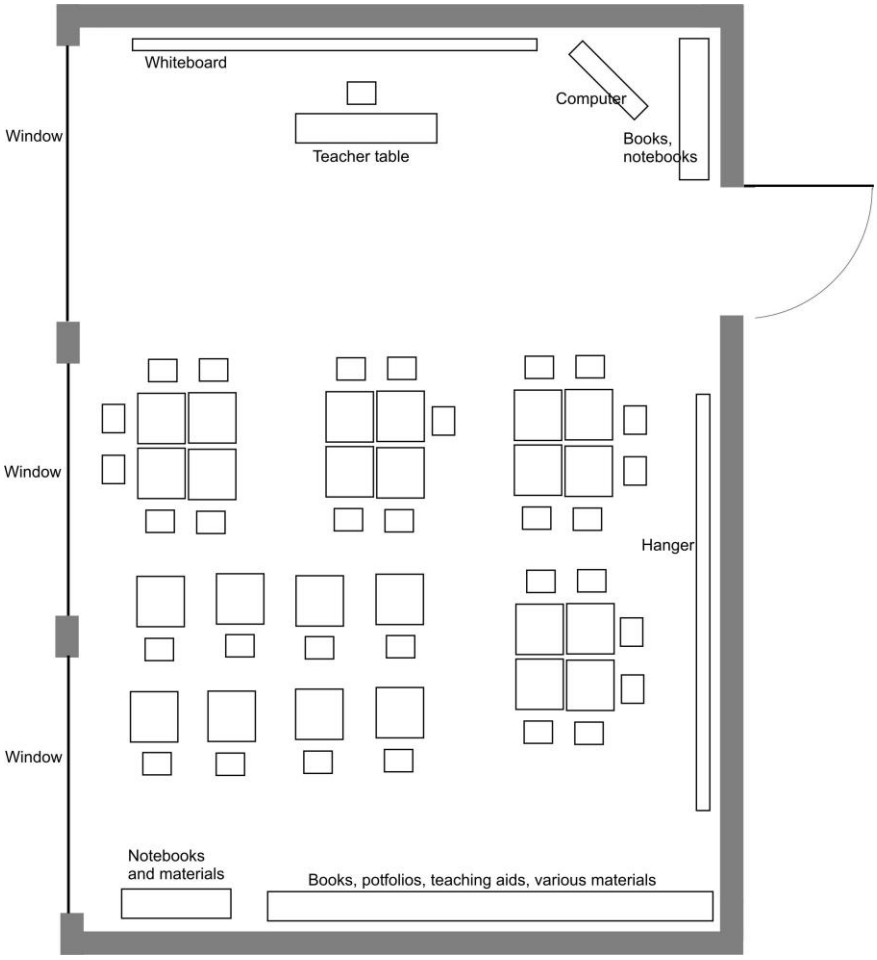

Figure 3

Children involved into these episodes are all 7 years old. Over all they were 23, nine girls and fourteen boys.

3.5.2 Episodes

The three episodes covered by this case study refer to two sessions of science teaching, one about seasons and one on natural phenomena, and one mathematics session. For the first science session, children worked in small groups (**G:Small G**) as they have to design a collective poster. For the other two activities they worked individually, each on his/ her table. The teaching runs in the classroom (**L. Indoors**) in a formal setting (**L.Formal**), under the supervision of one adult (**M:Human**).

The classes are conducted according to the national curriculum for grade I (**M: Pol.**). The lesson plan for the science lesson places the activities carried out in the filed "knowledge of the environment", learning unit natural phenomena, subject "seasons and animals".

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

The **operational objectives** focus on: to recognize the seasons under discussion, to list each season characteristics, to comment on influence seasons have on plants and animals.

Among the referred materials are: the national curriculum for grades I and II, a school book on the knowledge of the environment and its notebook.

The didactic methodology employed includes:

- mixed didactic strategies;
- dialog;
- observation;
- explanation;
- didactic play;
- team work.

The lesson is supported by IT, movies, music, flipchart, posters.

a) "Seasons" episode context and data and analysis

The lesson has two major lines of development:

A. a permanent dialog (**LA: Ques**) between the teacher and pupils;

B. free style activities, totally initiated and lead by children.

The dialog part refers to (**LA: Obs**; **LA: Connect; P: Scaff**):

- naming the seasons;
- identifying seasons characteristics;
- identifying seasons festivals and celebrations;
- discussions on the current season and the outside weather;
- effects of seasons rotation on nature and wide life.

During the discussions, in the background Vivaldi "Seasons" are played (**M:ICT**) and Cora displays some images specific to the seasons under discussion (Fig. 4).

For the children lead activities they are divided in four small groups (**G:Small G**), each group dealing with one season. The children conducted and run activities are implemented based on a previous requirement of teacher who asked children to bring from home various materials (**AO: Creative**) (images, graphics, photos, small decorative objects, etc.) (**M:Explor.**; **M:Variet**) related to a specific season (Figs 5 – 7).

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

The teacher explains that each group (**P:Collab**) has to design (**LA: Plan**; **P:Agency; P:Agency**) a poster on which the artefacts brought to school are glutted (**P: Play**) in order to express some ideas related to a specific season. Children have full liberty to choose the artefacts, to arrange the artefacts on the poster (**AO: Sc Proc Skills**) and to prepare the over all design of the poster.

Figure 4

Figure 5

Figure 6

Figure 7

At the end of the class, the teacher asks the group to come one-by-one in front of their colleagues to present (**A:Summ**) and to comment (**LA: Comm**) their poster (Figs. 8 – 11). For each season presentation, children sing a song specific to that situation.

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

Figure 8

Figure 9

Figure 10

Figure 11

b) "Natural phenomena" episode context and data and analysis

This lesson aims to teach children about natural phenomena, their relation to seasons and the assessment of daily weather (**LA: Obs**; **LA: Connect**; **P:Agency**).

The class starts with a discussion (**LA: Ques**) about what natural phenomena children know about and what their signs are.

Pupils comment on thunderstorms, rain, snow, wind, rainbow, cloudy /sunny days (**LA: Comm**).

In order to support the creativity of children, their initiative and observation skills, Cora asked them to look at home for different artefacts (**M:Variet**; **M: Cr**; **AO: Creative**) associated with seasons and natural phenomena (illustration, photographs, drawings, etc.) and bring such items in class.

During the class, pupils have to associate these artefacts with different seasons and to speak about these relations in front of the class (**A:Form.**) (Fig. 12 – 14).

Figure 12

Figure 13

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

Figure 14

Following the discussion, children receive some worksheets illustrating four trees (**P:Agency**; **LA: Connect**; **M: Cr**). They have to spend some time in coloring and decorate these trees according to the season it is supposed they belong to (Figs. 15 and 16). This activity is part of the written assessment (**A:Summ**) which complements the assessment done during the discussions.

Figure 15

Figure 16

These activities are individual actions, mostly teacher lead, but the class dialog offers an overview on whole class assessment: peer assessment (**A:Peer/self**), as children interfere during their colleagues answering sessions.

At another moment, the teacher distributes to pupils worksheets where they have to indicate (**LA: Connect**; **P:Agency**; **P: Scaff**; **A:Form.;** M: Cr) by drawing some symbols, the weather of the day (Figs. 17 - 18).

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

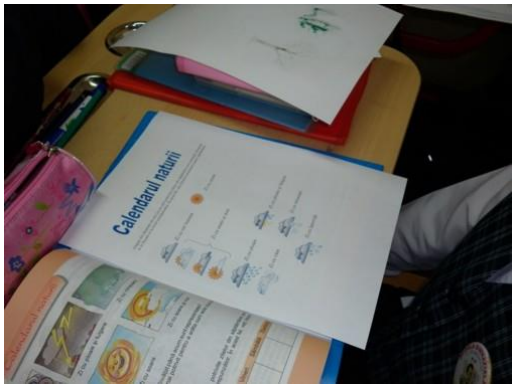

Figure 17

Figure 18

By the end of the session additional drawings illustrate what children learned (**A:Summ.**) about natural phenomena (Figs. 19 and 20).

Figure 19

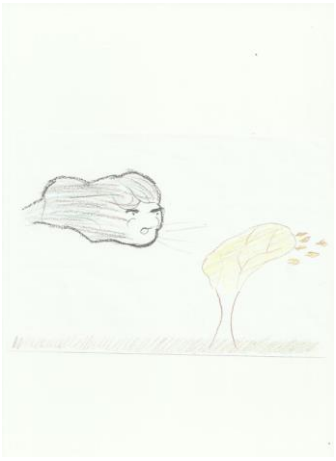

Figure 20

c) "Adding and subtracting" episode context and data and analysis

The Romanian curriculum, as well as the tradition in teaching mathematics does not offer many opportunities for creative teaching and innovation in spite of good examples provided by European projects. Romanian teachers have no exercise in mathematical education in other way than the "classical" one (Figs. 21 and 22). For this reason, little can be reported on the creative side of this subject.

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

Figure 21

Figure 22

The lesson evolves in a classical manner: children are asked (**LA: Ques**) about the homework and to perform some calculus on numbers proposed by the teacher. They have to fill some worksheets for class evaluation (Fig. 23). Each child works individually and answers (**LA: Comm**) when asked. No collaboration exists. There is no room for innovative learning. The only observation (**LA: Obs**), they have to do, refers in being attentive to perform the right exercise, in time.

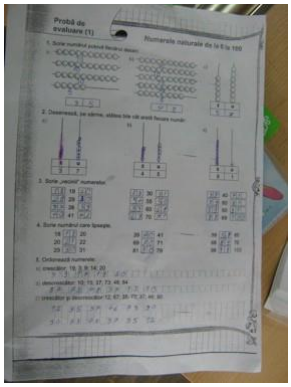

Figure 23

At the end of the class pupils have to make some calculus by their own using the worksheets (Figs. 24 – 27) (**A:Summ.**).

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

Figure 24

Figure 25

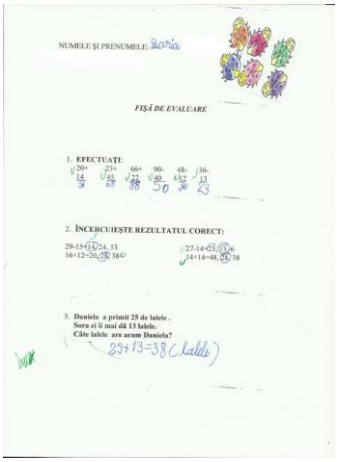

Figure 26

Figure 27

3.5.3 Case summary and conclusions

Discussion in relation to synergies between science and mathematics and creativity

The present analysis is based on previous deliverables of the project with a focus on specific national aspects reviled:

- Conceptual Framework (D2.2);
- List of Mapping and Comparison Factors (D3.1);
- Report on Mapping and Comparing Recorded Practices (D3.2): Romanian National Report on Approaches in Policy;
- Report of First Survey of School Practice (D3.3): Romanian National Report on First Survey of School Practice, and is supported by the evidences gather during in-depth fieldwork.

According to the adopted methodology for in-depth fieldwork the research is carried out along two guiding lines: a) pedagogical interventions and b) pedagogical framing both associated to

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

the deductive coding for the data collected. These codes are used for the inductive analysis in order to underline the reflection in school practice of the factors identified in the *Conceptual Framework*, factors fostering creativity in the context of inquiry-based science and mathematics teaching and learning. For each episode, factors important to nurturing creativity in science and mathematics in the early years and the associated codes are highlighted.

The school where Cora teaches first grade pupils is typical for big cities working to middle class neighborhood. The buildings are quite recently renovated or extended, so, the space (**M:Space**) is convenient for education with additional facilities such as multi-purpose hall, sport hall, labs for informatics and sciences, greenhouse (**M:Variet.**). The school staff is well qualified and covers the educational needs (**M:Human**). Extracurricular activities are available, supported by parents' organization. The overall school results are good and very good with a low drop out rate.

The teaching process takes place mostly in a "classical", formal environment (**L.Formal**), but informal educational approach is present, too, through gardening activities or field visits (**L.Informal**). In any case, creativity in primary school teaching of science and especially mathematics is limited by the curriculum (**M: Pol.**), by the limited time available, and by the "tradition" of the Romanian educational system. Teachers have to follow specific teaching patterns and are evaluated according to very strict standards.

Cora is making her best to "escape" to these limiting factors, especially in science classes. Mathematics is taught in a quite arid manner, assessment being of summative type (**A:Summ**) in this case.

Coming to science lessons, the teacher's efforts to bring a change or some innovations are evident. Cora combined science teaching with music and Romanian language (use of poetry) classes (**AO: Affect**). Children are working both individually and in small groups (**G:Small G**), according to the subject studied. The social dimension of team work is appreciated by the teacher (**AO: Social**) as pupils are asked to collaborate (**P:Collab**) in developing seasons' specific posters (**LA: Plan**; **LA: Connect**; **M: Cr**; **AO: Creative**) using materials and artifacts (**M:Explor.**) they brought from home (**P:Agency**). The process of producing the posters provides a lot of opportunities for children to manifest their personality, creativity, imagination. They have to plan (**LA: Plan**), gather materials, design (**LA: Connect**), improvise (**AO: Creative**) negotiate a solution (**P:Collab**), implement this solution (**AO: Sc Proc Skills**), present the results (**LA: Comm**), all done according to their own vision (**LA: Obs**; **P:Agency**), taste, skills. When presenting their results, children sing some songs related to the seasons their posters illustrate (**AO: Affect**; **LA: Connect**).

Cora uses a mixture of pedagogical methods to reach her teaching goals as she puts in the interview "We considered very seriously the way to attract pupils' interest towards the learning process. Within this aim we used different methods and means, such as: mixed

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

teaching strategies; various methods and procedures, as for example: conversation, observation, explanation, problems identification, educational games, group work; forms of pedagogic organization of the lesson: frontal, individual and group; didactic means: portfolio, computer aided learning, scorecards, PowerPoint Presentations, the black board, music, poetry" (**M:Explor.**; **M: Cr**). Within this process, Cora is a guide and observer (**P: Scaff**; **A:Summ**).

RQ2: Probing practice
What approaches are used in the teaching, learning and assessment of science and mathematics in early years?

Cora applies some methods based on IBSE in teaching sciences. It seems to be difficult for her to use more open, innovative methods in mathematics education as far as the methodology is quite rigid. She combines playing with a structured design of a product (in this case a thematic poster). Children have full control on the selection of materials employed, the poster plan, the way they implement their ideas. Cora embedded into the science lesson some elements of musical education and literature. The assessment is done individually during the poster production and by the entire class as the results are on display. The worksheets for the assessment are elaborated in a format which forces pupils to make connections with previous knowledge.

What role if any does creativity play in these?

By far, the most creative part of the lesson is represented by the creation of the poster. In this context, children are trained to be innovative, to plan the activities, to implement some strategy, to negotiate and promote the results.

RQ3: Probing practice
In what ways do these approaches seek to foster young children's learning, interest and motivation in science and mathematics?

Through the approaches she used, Cora succeeded to motivate children, to increase their interest in learning more on seasons, their relation to environment and the links existing between seasons and festivities associated to them. Affectively, pupils are more attached to the learning process as they correlate it with poetry, songs and design.

How do teachers perceive their role in doing so?

Cora perception on her teaching objectives can be summarized "Currently, we are using all three methods (hands-on activities, development of social skills, support for collaborative work) in class to teach children science or mathematics." She employs different methods to mobilize children interest towards learning sciences:

- She mixes discussions on seasons and their importance for environment and wide life with instrumental musical works, poetry and song played by pupils groups.

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

- She links affectively the debate on seasons with children memories of different festivities.
- She encourages children to bring their own artefacts as testimonies for seasons' symbols.
- She congratulates them for their initiative, innovative approach and collaboration in planning, designing and producing the posters.

Supporting documents for this case study are given in Appendixes 14-16

3.6 Case 6 – Delia

3.6.1 Context

Where?	Country	Romania			
	Setting name	EL School			
	Location within setting	Primary school			
Who? (children)	Year group/age of children	6-7 years old			
	Number of children in class	21			
Who? (adults)	Number of adults	1			
	Role of adults	teacher			
	Case teacher role	Co-ordinator			
When?		1	2	3	
	Dates of visits	15/2/13	18/2/13	05/3/13	
	Times of visits	8:30-10:00	08:00-10:00	10:30-12:40	

a) School/setting

The site is a public theoretical school which covers the entire pre-university educational spectrum: pre-school, primary school, lower secondary school and higher secondary school. At the beginning it was a school devoted to compulsory education (grades I to VIII). Starting from 2000 it was extended to include also higher school education.

It is located in two, three stories buildings, and was refurbished in the last decade. The school has 55 classrooms, one sports hall and a 400 sm playing ground for sport activities. The facility includes also: laboratories for physics, chemistry, biology, computer cabinets, modern languages (English, French, Portuguese), a pedagogical assistance office, a medical dental office and two libraries: one for middle school, and the other for high school. Over 1100 children are studying in the school in two shifts.

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

The school staff is formed by certified 90 teachers, 60 % of them having the first or the second grade. The pre-school and primary school education is delivered by 16 educators or primary school teachers. There are 2 classes for the pre school and 12 classes for the primary school (three per each grade).

Apart from the standard national curriculum, the school offers, for the primary school, additional optional courses such as: Pockets ideas; Curiosity in the world of nature; Health Education; Travelers in Space and Time; Let's play in English; Easy English; Welcome to Storyland; Famous characters from stories; Reading and writing targets; My friend the computer. The school has its own drama group.

In the last six years, the school runs several educational projects in partnership with schools from Finland, Germany, France, Greece, Latvia, Iceland, Poland, Portugal, and Spain. In Romania the school is involved in environmental related projects both at primary school and secondary school level. School students are involved also in two clubs, one working on literature subjects and one investigating history subjects. On the other hand, in the Romanian language and natural sciences fields the school issues two publications. The school has strategic partnerships with CISCO and ORACLE.

b) Teacher (national teachers' survey, Fibonacci self-assessment tool, teacher's interview)

Delia is working in a school where children from 6 to 19 years old are taught. A graduated of a Faculty with a Bachelor degree in Romanian and French language and literature, a Master degree in communication sciences, she is under 25 years old. Her competences cover: Romanian and French languages teaching, and religion. She is a certified schoolteacher. She has less than 5 years of teaching practice. She works with children from 3 to 6 years old. Her knowledge of sciences and mathematics is at vocational school level. She is very confident on environment and ecology, ICT, pedagogy, development psychology, creativity development and creative teaching methods. Apart form her educational background, Delia professional development includes: participation to open lessons on science and mathematics, membership to teachers' networks, individual or group research on educational subjects, mentoring activities. She counts on a strong background on general pedagogy and pedagogy of science and mathematics teaching.

Weekly she delivers 1-2 hours of science and 1-2 of mathematics. Delia's current teaching program addresses:

- personal development;
- Romanian language communication;
- mathematics and environment exploration;
- visual arts and handcraft;

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

- music and physical activities;
- civic education.

She strongly believes that among major science teaching goals are:

- to educate good citizens,
- to develop children understanding of the world and man made objects and devices;
- to form creative thinking habits;
- to develop competences towards independent learning.

The main focus of science education has to be children teaching to ask questions, to adopt a positive attitude on science and general learning.

For the group age she is teaching, Delia consider the most important methods to be: free play, teaching with stories, integration of science teaching with other disciplines, stimulating imagination, establish links with every day life situations.

In supporting creativity development, Delia confesses her interest towards: observation, materials manipulation, collaborative work, asking questions, teaching based on children's ideas and experience, whole class discussions, problem-based learning. She appreciates that for children at this age it is important to learn to analysis of results, make connections, reflection on results and communication. Within this context, the teacher has to demonstrate first the procedures and after that he/ she has to allow pupils to find their own solutions to the problems under discussion.

Delia assesses her pupils results based on checking lists and during class activities. She is interested to support children initiative, motivation, imagination, curiosity, cooperation capabilities.

She runs assessments in order to identify new means to improve her work and set up with children future teaching activities.

Delia appreciate that her school has some educational means such as: printed materials, audio and video resources, computers. She complains on the lack of educational kits, digital means, and consumables. She works a lot with teaching aids she developed herself and with resources from the Internet.

c) Classroom

Delia's class room is spacious one (Fig. 1). It is equipped with a laptop, a video projector and a whiteboard (Fig. 2), and has various teaching aids (Figs. 3 and 4).

23 children are enrolled (10 girls and 13 boys). They are 6 years old.

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

Figure 1

Figure 2

Figure 3

Figure 4

The floor plan of Delia's classroom is detailed in Fig. 5.

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

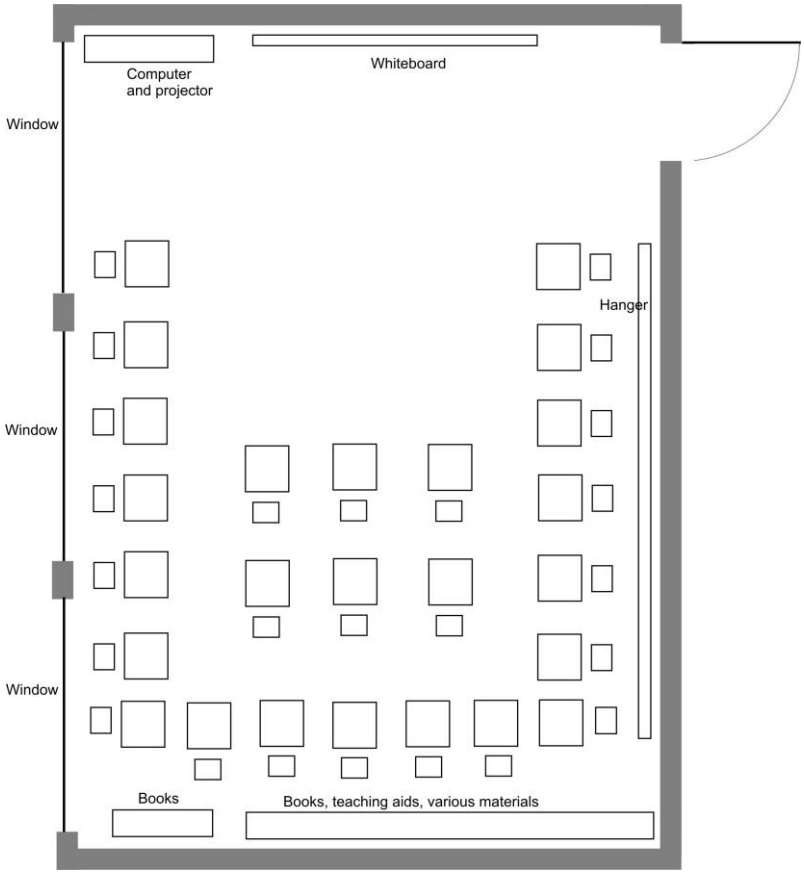

Figure 5

3.6.2 Episodes

The three episodes covered by this case study refer to two sessions of science teaching about the parts of a plant and one session on mathematics. For the first science session, children worked individually as they have to assemble a puzzle depicting the main parts of a plant. For the second science activity they worked in small groups (**G:Small G**), on a common table where an assortment of materials are available to chose from. In the mathematics session, each child sits on his/ her desk with all the materials needed available in front of him/ her. The teaching runs in the classroom (**L. Indoors**) in a formal setting (**L.Formal**), under the supervision of one adult. For the amount of activities carried out in these sessions it seems that the space is quite restrictive and only one teacher has difficulties in running the lesson in a relaxed manner, as the time to interact with all children is missing.

a) "Parts of a plant" episode context and data and analysis

The lesson major theme is the component parts of a plant. In order to introduce the subject, Delia uses a animated video (**M:ICT**) (Figure 6) about an elf observing the development of a plant from seed to fruits. Children are asked to observe (**LA: Obs**) step-by-step the plant's development phases and a permanent dialog is established. Pupils are asked questions (**LA:**

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

Ques) and in the mean time the teacher listens to their remarks and comments (**LA: Comm**) on a comparison between plants and trees (**LA: Connect**). They are very excited about the newly acquired information (**P:Affect**) and bring their personal vision on the subject.

Figure 6.

As the lesson develops, Delia returns on the new notions and tries to fix the fresh knowledge (**LA: Ques**). She praises them for their attention and understanding (**AO: Affect**). After clarifying all the terms and their role various parts in the plant life, the teacher proposes a practical exercise in order to assess children perception on the new subject. They have to solve a puzzle by glutting on a sheet of paper pieces of a plant drawing cut in various forms (**P:Agency**, **P:Agency**, **AO: Creative**). By assembling this puzzle pupils have the opportunity to reflect on what they learned and to establish links between plant parts (**P: R and R**). During this process, Delia has little interventions (**P: Scaff**) and keeps track of children approach in solving the task (**A:Form.**). Children have to take the decisions on the materials to be used (**M:Explor**.) and the way the drawing is reassembled (**M: Cr**) (Figures 7 – 10).

Figure 7

Figure 8

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

Figure 9

Figure 10

By the end of the activity pupils have to show to the entire class the outcome of their work (Figures 11 – 13), an occasion for additional reflection and communication (**A:Summ**).

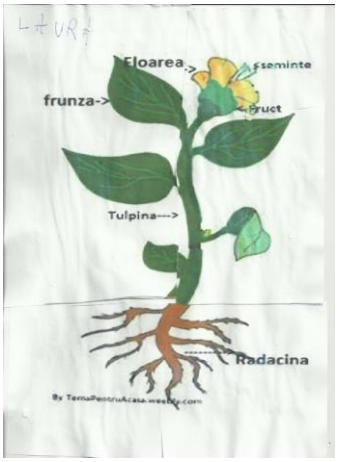

Figure 11

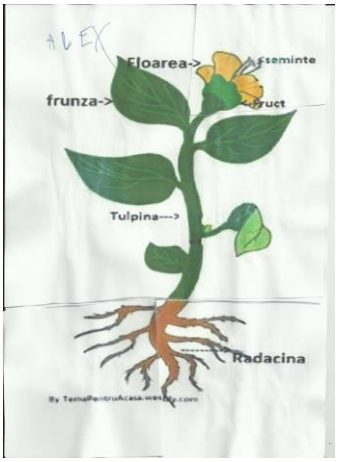

Figure 12

The assessment based on children worksheets proved to be very effective as can be seen. It was not obvious for all pupils the structure of a plant. In the mean time, as the major parts of the plant are indicated on the drawing, they have a new opportunity to fix their knowledge, by associating the graphical description with a text (**AO: Creative**, **LA: Plan**).

In any case, they had the chance to use different tools and materials to fulfill the job (**M:Explor**).

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

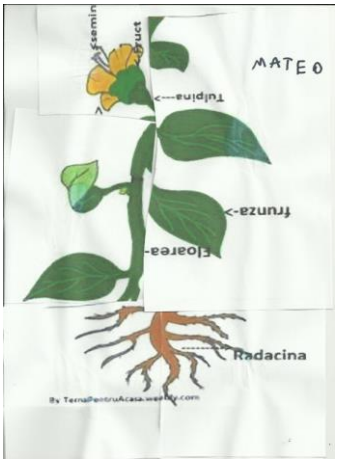

Figure 13

b) "Sowing seeds" episode context and data and analysis

The second episode on science is closely linked to the previous one as they have the same roots: learning by doing about plants and their development. Starting from the movie (**M:ICT**) on plants and the previous introduced discussions (**LA: Ques**) by comparing plants and trees (**LA: Obs**, **LA: Connect**) another group of children (**G:Small G**) was given small plastic cups, plastic tea spoons, soil and seeds (**M:Variet**, **LA: Equip, M: Cr**) and they were asked to sow the seeds according to a previous explained procedure (**LA: Plan, AO: Sc Proc Skills, M:Explor**) (Figures 14 – 17) and in connection to what they learn (**P:Agency**) from the movie about plants grow (**LA: Connect**, **AO: Creative**).

Figure 14

Figure 15

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

Figure 16

Figure 17

They act most of the time individually, but they interact as they have to share the resources, which is a good opportunity to exchange impressions and knowledge (**P:Collab**, **AO: Social**). Delia had almost no intervention in their work or planning, but considered very carefully their interactions and attitude on the activities run (**P: Scaff**, **A:Form**) (Figure 18).

Figure 18

At the end of the lesson, all children from this group displayed their results to their colleagues explaining what they done and answering some questions (**LA: Comm**, **A:Summ, P:Affect**) on the procedure followed and the reasons of their approaches (**P: R and R**).

c) "Adding and subtracting" episode context and data and analysis

The third episode addresses mathematics teaching in Romanian schools at pre-school level. The subject of the lesson was counting and simple arithmetic operations.

For the counting activity, the teacher engaged pupils by asking them to remember a well-known children song (**P: Play, P:Affect**) according to which ten elephants hang one-by-one on a spider web. The web is strong enough to resist their weight. During the singing children have to increase by one the number of elephants. This activity is a whole class one.

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

Delia used special worksheets with drawings of objects and animals for counting (Figures 19 and 20), the whiteboard (**M:ICT**) where these sheets are projected and sets of sticks of two colours (Figure 21) (**M:Variet**). As children were asked to fill the worksheets (**M: Cr**) she also writes on the whiteboard the results after consulting with the class.

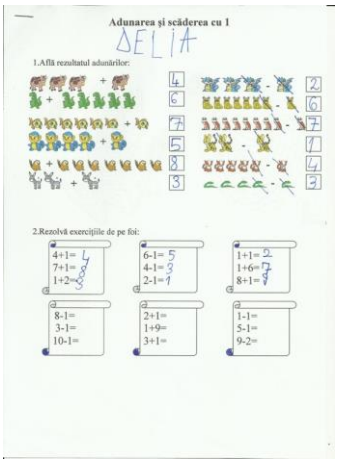

Figure 19

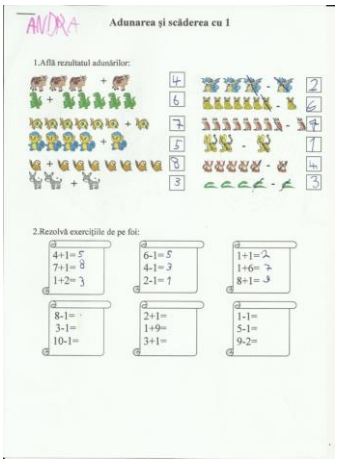

Figure 20

Figure 21

Pupils are asked individually (**LA: Ques, LA: Obs**) to add or subtract one unit to different numbers with the help of worksheets and sticks (Figures 22 – 25). Formative assessment is carried out during the class based on children answers or the results filled on the worksheets (**A:Form.**).

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

Figure 22

Figure 23

Figure 24

Figure 25

3.6.3 Case summary and conclusions

Discussion in relation to synergies between science and mathematics and creativity

The present analysis is based on previous deliverables of the project with a focus on specific national aspects reviled:

- Conceptual Framework (D2.2);
- List of Mapping and Comparison Factors (D3.1);
- Report on Mapping and Comparing Recorded Practices (D3.2): Romanian National Report on Approaches in Policy;
- Report of First Survey of School Practice (D3.3): Romanian National Report on First Survey of School Practice, and is supported by the evidences gather during in-depth fieldwork.

According to the adopted methodology for in-depth fieldwork the research is carried out along two guiding lines: a) pedagogical interventions and b) pedagogical framing both associated to the deductive coding for the data collected. These codes are used for the inductive analysis in order to underline the reflection in school practice of the factors identified in the *Conceptual*

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

Framework, factors fostering creativity in the context of inquiry-based science and mathematics teaching and learning. For each episode, factors important to nurturing creativity in science and mathematics in the early years and the associated codes are highlighted.

Delia's school is a big one in a working class – middle class environment. The class set up was recently modernized with the assistance of the parents committee. Delia has access to various pedagogical aids. It seems that the space is not enough for the number of children taught and the teacher needs some sort of additional help to handle the great number of children attending the class.

RQ2: Probing practice
What approaches are used in the teaching, learning and assessment of science and mathematics in early years?

She uses playing based on children suggestions in order to capture their interest and attention. As for this group age it is difficult to organize work in pairs, she mixes this approach with frontal work. When she is running a lesson Delia offers enough time to children to reflect on the problem in discussion and ask questions, even if these questions are not related directly to the subject. She noticed that "When I leave them to investigate by their own or express their opinions on a particular issue, children look very happy."

She combines practical exercises with drawing or singing, in order to make more attractive the class.

What role if any does creativity play in these?

The creative teaching can be observed when Delia brings together, in dealing with a science subject, story telling, an animated move and the dialog with the class, as for example in identifying the part of a plant. She exploits children natural interest towards the movie and its characters with the identification and naming of plant's constituents.

During the mathematics lesson, children are asked to do additions and subtractions using both drawings of objects and handling sticks.

RQ3: Probing practice
In what ways do these approaches seek to foster young children's learning, interest and motivation in science and mathematics?

In order to foster children interest towards science in particular and towards learning in general, Delia rewards, congratulates or praises them and shows interest into their work. As she confesses in the Fibonacci questionnaire "Praise seems to be the most productive mean to motivate little ones."

How do teachers perceive their role in doing so?

Delia promotes her vision on science teaching through:

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

- the use of IT and multimedia means;
- hands-on activities;
- dialog with children on time and weather.

Supporting documents for this case study are given in Appendixes 17-19

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

4. Discussion of Findings

4.1 Enabling Factors or Barriers at Contextual Level

Enabling factors for the creativity development in relation to science and mathematics teaching at early age are discussed in the context of national policies, as depicted in deliverable 3.2 "Report on Mapping and Comparing Recorded Practices. National Report on Approaches in Romanian Policy". Barriers are identified mainly in the discussions with participating teachers or in the national survey carried out in the task 3.3.

In Romania, a major enabling factor for the change in developing creativity and in promoting innovative science/ mathematics teaching methods ***could be*** the official policy, as far as according to the Romanian official documents, a mixture of goals is stated in relation to science teaching and learning, as the educational process is affected by the social and economic changes the society is facing [1]. Within this context several layers of understanding the role of science teaching emerge. These issues are more or less reflected in interviewed teachers' perception on science and mathematics teaching.

- Children are educated towards "scientific literacy", to become a responsible citizen able to use the scientific approach to understand the world, to be an active participant to the social life [2], [3], [4], and to be a person able to provide an objective point of view to the surrounding environment challenges [5]. Maria strongly believes that science education during the compulsory education plays a major role in "developing socially and environmentally aware and responsible citizens" and in "preparing more innovative thinkers" (Case 1 - Maria).
- Science education assists children: to observe and interpret natural processes; to investigate connections inside and between physical, chemical and biological systems [6]; to learn to discover patterns [7], [8]; to develop the capability to formulate simple opinions on the objects/ facts/ phenomena in the surrounding world [7] in association with the development of critical thinking by investigation, exploration and solving problems [9]; to be aware of the meta-scientific dimension of the scientific knowledge as well as of its limits [4] . For Maria it is very important to teach children "to be able to ask a question about objects, organisms, and events in the environment", "to be able to communicate investigations and explanations", "to be interested in science" (Case 1 - Maria). Stela is working hard on developing in a structured manner pupils ideas and questions; supporting them in formulating hypothesis, explanations and communicating findings (Case 2 - Stela).
- Science education plays an important role in changing the paradigm of education: to transform the learner from a spectator into an actor participant to scientific activities [3], [4]; to teach children on "learning to learn", "learning to know to do", "permanent learning" [10]; to assist children in developing favorable attitudes towards science and more generally towards knowledge. Anca thinks that compulsory science teaching has to

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

"develop important attitudes and dispositions as a foundation for future learning" (Case 3-Anca)).

- The study of natural sciences in primary education does not target the transfer of knowledge and scientific information (even if they are confirmed or infirmed by test and experiments) but it is concerned to "confront the child to his/ her environment" [6].

Another enabling fact is the inclusion, according to the newly adopted "Law of National Education" (2011), of the preparatory class in the primary school, which makes possible a more structured science and mathematics teaching and learning at early age.

As it concerns teachers' education, at this moment Romania is in a transition period, the new law of education implementation is under way. Pre-school teachers ("educatoare") and primary school teachers ("invatatori", "institutori") are required now to have a higher education degree, and more opportunities for high quality professional development are available to them through Master degrees and PhD studies. As for example, Maria is ~~a~~ graduate of a Faculty and completed a Master degree in education (Case 1 - Maria). Stela is ~~a~~ graduate of the Faculty of Physics of a major Romanian city (Case 2 - Stela). Anca is a certified teacher, first degree, and a graduate of a Faculty of Economics and Management, with additional training in pedagogy on pre-school and primary school education (Case 3 - Anca).

Unfortunately, there is more to be done for the implementation of these reforms and school curriculum still expects changes. A too overloaded curriculum puts pressure on teachers as they have not enough time to test new pedagogical approaches and develop their own teaching creativity. The lack of resources, too many children in the classroom, obsolete textbooks are other barriers to be overcome. Not on the last place has to be mentioned the lack of motivation, as the low level of salaries affects the recruitment of highly qualified personnel in the educational system. As Sanda points out "My opinion is that such methods as experimental activities have to be generalized, but unfortunately human and financial resources are scared and do not allow us using such an approach for every project or investigated subject."

4.1.1 Differences between preschool and primary school

Starting from pre-school level, science education is viewed as a guide and an opportunity for the child to head towards a future profession, to rise his/ her interest for future studies in specific fields [6], [11], to become able to answer to socio-economic and personal development needs [2], and to assist his/ her integration in social and professional life [12]. Within this line, Delia's opinions resonate with the official goals. Her main focus on science education is "to assist children in asking questions, in adopting a positive attitude on science and general learning".

Even at very early age, emphasis is placed on the exploration of the surrounding world, on the understanding of the cause-effect connection between natural and man produced phenomena

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

[13]. Official documents indicate an interest towards the development of children's positive skills and attitudes towards ecology associated problems and the environment protection [5], [14], and to the care he/ she has to pay to Nature [7], [11], [13], [15]. As an example on the way teachers perceive these guidelines, it is of interest to cite Anca whose efforts are directed towards the development of the following learning skills to children:

- To be able to ask a question about objects, organisms, and events in the environment.
- To be able to employ simple equipment and tools, such as magnifiers, thermometers, and rulers, to gather data and extend to the senses.
- To know and understand the important scientific processes.
- To be able to communicate investigations and explanations.
- To have positive attitudes to learning.

Teaching science is very important to Cora because this "provides a foundational education for future scientists and engineers", "enriches the understanding and interaction with phenomena in nature and technology", "develops more innovative thinkers" and "develops important attitudes and dispositions as a foundation for future learning."

According to official documents, it is of interest to underline one objective of the pre-school curriculum, which can be linked in a way or another to creativity: "the development of the capacity to learn about and to understand the world surrounding the child, and more important, the stimulation of his/ her curiosity to investigate this world and to try to offer some explanations" [13].

For the case of the first year at primary school – grade zero ("clasa pregătitoare/ clasa zero") a limitation resides in the fact that this approach is at its beginning and not all conditions are fulfilled (lack of textbooks and resources, poor training of teachers to face this challenge, some confusion in the public perception of this grade role and expected impact).

4.1.2 Differences between science and mathematics

Most of the official policy documents referred in this report [3, 4, 5, 6, 10, 12, 14] address science teaching issues, underlining the goals of science education. Few of them [1, 15] are devoted to the ICT and its place in school curriculum.

The main objectives/ goals of mathematics education at early age are: a) "the development of pre-mathematics intellectual operation; b) the development of the capability to understand and use measuring units, numbers, and to employ an appropriate vocabulary; c) the development of the capability to recognize, name, build and use geometric forms; d) the development of the capability to solve problem like situations, by acquiring appropriate strategies; e) the development of the capability to observe and to establish causal, spatial and temporal connections" [13].

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

4.1.3 Opportunities and challenges for creative learning and teaching

Looking for links between creativity and science/ mathematics education at early ages, as reflected by official Romanian documents on education policy, the following picture can be derived:

- The education system in Romania aims to the "development of critical thinking and creativity" to children [16], who have to demonstrate creative thinking capabilities [8].
- "The main goals of early childhood education for 3 to 6/7-year-olds are: …. support of their (N.B. children) autonomous and creative training" [17].
- The aim of the education at early age is to help children: to express their curiosity towards elements/ phenomena/ patterns observed in the surrounding world [7], [8]; to show curiosity towards a) changes and transformations; b) active learning methods as projects proposed by the teacher [8].
- The curriculum for "the knowledge of the environment" (grades I and II) was designed to "stimulate the scientific curiosity of children to understand facts and phenomena of the surrounding world" [18], and to "initiate and develop creative investigations, starting from a proposed subject" [4].

"The introduction of new methods and forms of evaluation and for the development of creativity, adaptability and transferability of knowledge for its use in other circumstance" [10], "the increase of innovation and creativity at all educational levels" [19]. The proposed curriculum "has to develop to the young student attitudes and capacities of creative, reflexive, cognitive type.." [20],[21].

During the filed work, the research team noticed several facts demonstrating the efforts made by schools and teachers to implement those official statements in practice, besides their teaching duties:

- Maria's kindergarten organizes every two years a national symposium for pre-school and primary school children, offering them the opportunity to develop and to present hands-on oriented projects.
- Most of the educational institutions involved into this research study were participants, in the past, to several national and international projects lead by the Center for Science Education and Training, projects focused on IBSE ("Discover!"; "Fibonacci"; "i-BEST Inquiry-Based Education in Science and Technology").
- Some of the participating teachers (Maria, Stela, Cora, Delia) attended IBSE courses and demo sessions or are involved into European school projects which assisted them in refining their teaching methods in relation to inquiry and creativity.

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

- Stela, for example, took part to an exchange visit to an Austrian educational center working on IBSE.

4.2 Revisiting the CLS Mapping and Comparison Factors: A summary of findings

Based on deliverable D4.1 "Methodology for in-depth fieldwork" and the research done on site, the summary of the finding are presented in the following sections of this report, referring to the established "spider categories".

4.2.1 Aims and Objectives: *Toward which goals are children learning?*

As indicated by teachers' survey and interviews, as well as by the practice observed, for Romanian teachers the major goals for science teaching are:

- knowledge/understanding of science content (**AO: Kn.Sc**):

For Maria, children have to learn to formulate questions on the surrounding world, to understand concepts, to observe the environment (see for example, Case 1 – Maria, "Float and sink" episode).

Even for early age pupils Anca thinks concepts understanding to be of interest, as in the case of obtaining secondary colors by mixing primary colors (Case 3 - Anca "Coloured fingers stamps" and "Mixing coloured water" episodes).

- development of science process skills; specifically planning IBSE type activities (**AO: Sc Proc Skills**):

Stela supports children to observe natural phenomena; to design or plan simple investigations or projects; to employ simple equipment and tools in order to gather data and extend to the senses, as it is the case of Case 2 - Stela, "Ice and hot water" and "Ice and salt" episodes.

Maria encourages her pupils to plan and design some tests to check what materials are more suitable to assist the ant to escape from drowning.

- encourage collaboration between children, as an application of social constructivism (**AO: Social**):

Both Maria and Stela asked groups of children to find solutions to the problems they are facing as they perceived themselves (children) as part of the stories they were told (the ant and the dove, and Scrat's frozen acorns).

Cora's seasons' posters session was specifically designed as a group activity combining brainstorming, negotiation, collective work.

- use of affective factors to enhance children's attitudes on science and mathematics and interest learning (**AO: Affect**):

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

Story telling and emotional involvement of children in providing help to their beloved characters are presented in Maria's set-up on the little ant trouble or in Stela's lesson referring to the adventurous squirrel.

Cora associates seasons with related events important to children (Christmas, Ester) or to traditional songs.

- designing lessons to support creative learning (**AO: Creative**):

Good examples are Maria and Stela lessons as children are asked to offer some solutions to a new problem they are facing, solutions based on their previous knowledge (i.e. melting ice with heat or salt, or finding objects able to float and which can be reasonable found in the forest). A good example is the "Magic water" episode of Case 1 – Maria during which, children were asked indirectly about water properties.

In spite of the fact that several teachers declared during the discussion that they are accustomed with scientific inquiry (**AO: Und. SI**) and problem-based (**AO: IBSE/PBL**) teaching it seems that they miss the practice. This is probably because the Romanian educational system does not include a well defined training program for teachers on these issues.

Differences between preschool and primary school

Knowledge and understanding of science content and concepts constitute a major theme for both primary and upper pre-school segment (age 5 to 6 years old) (Case 1 - Maria "Float and sink" episode, Case 4 – Sanda "Measuring volumes" episodes, Case 6 - Delia "Parts of a plant" episode). At kindergarten level the focus is mainly on observation, materials and objects manipulation, classification, ranking (Case 3 – Anca episodes on color mixing).

Inquiry based teaching was observed at primary school level in few situations, when problem identification, hypothesis formulation and design of a test were carried out (i.e. Case 2 - Stela).

Development of social attitudes and inter-personal relations is more frequent in pre-school, because, as a teacher said, at this age children are more selfish and collaborative attitudes have to be developed and encouraged. Within this context, may be a more flexible curriculum enables more intensive group work.

Affective factors are present in both pre-school and primary school pedagogy.

Differences between science and mathematics

Based on the national curriculum provisions, science teaching has a more practical approach trying to focus on the interaction with the surrounding world and everyday problems (seasons, nature, plants and animals, materials transformations and use). It encourages in most situations a cross-disciplinary (Case 4 - Sanda "Measuring volumes: standardized units" episode and Case 5 - Cora "Natural phenomena" episode) approach and investigation (Case 1 – Maria "Weather" episode, Case 5 - Cora "Seasons" episode). By its nature, science teaching

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

and learning can be quite easily directed towards children-guided or initiated activities (Case 3 - Anca colours mixing episodes; Case 6 - Delia's seed sowing episode).

On the other side, mathematics education according to the Romanian system is almost arid as it request pupils to perform abstract calculus without too much practical meaning to them (Case 5 - Cora and Case 6 - Delia "Adding and subtracting" episodes. Practically, as the situation is prefigured nowadays by the curriculum, there are no concepts in mathematics to be passed to children for future use. Skills in manipulating measuring instruments are considered. It seems that there are too many curriculum constrains and limitations in teaching mathematics.

Opportunities and challenges for creative learning and teaching

Inter-disciplinary approaches in science teaching can be an efficient vehicle to drive creative teaching, as both teacher and pupils have to assemble different type of knowledge, various experiences to come to an end. In the studied cases, a fruitful implementation is the merge of science and mathematics. Stela engaged children into an investigation by asking them to reveal an encrypted message, based on numbers and letters, in relation to the animated movie they just witnessed. Working with very young children (3 years old), Anca assisted them to make connections between the way colors were presented to them during the lesson (circular watercolors sets, cylindrical transparent jars) and geometric shapes (colored circles and rectangles). Sanda asked children to count and mark the number of measuring units used to fill a bucket.

Materials handling and manipulation constitute another opportunity for creative learning, as in the example cited by Sanda "I can cite as an example, another science related activity when kids were ask to prepare their own pancakes. It is an interesting and very educational event for children as their work was guided towards the development of senses: touch, smell, sight, taste. Besides being very practical, as children faced the challenge to make their own cake, in the shape they wanted, it was a complex task, engaging pupils' abilities in various ways."

By planning such type of activities, teachers are approaching their objectives in relation to inquiry focused, creative based science teaching and learning.

4.2.2 Learning activities*: How are children learning?*

Romanian teachers involved in this study base their teaching activities on:

- questioning (**LA: Ques**):

A permanent dialog is established between Maria and her audience (5 to 6 years old children) on what means a forest, what objects can be found there for helping the ant to float; what solutions they are thinking about to find objects which float; what they need to prove their assumptions. They are encouraged in the mean time to ask their own questions and to answer to their peers (Case 1 - Maria).

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

A question is also the puzzle Stela' pupils have to solve in order to get the answer to the encrypted message (Case 2 - Stela).

On questioning and answering session is based also Delia's lesson on the parts of a plant. Questions are interrupting the animated movie sequences in order to fix both the concepts and the terminology to be used (Case 6 - Delia).

During the final presentation of their projects, Cora's pupils have to answer some questions in order to explain the meaning of some artifacts included in the posters about seasons (Case 5 - Cora).

3 years old hypotheses on the secondary colors obtained by mixing specific primary color are the results of a dialog (ɛase 3 - Anca).

- designing and planning investigations (**LA: Plan**);

Such approaches are evident in Maria's and Stela's lessons when children have to understand the problem, think to some solution and plan some tests to be carried our, either to find objects able to float or to invent solutions to pick up the acorns out of the ice cube (Case 1 – Maria and Case 2 - Stela).

Based on their previous knowledge on seasons and their attributes Cora's children have to design, without previous consensus, some posters carrying the essential messages on each season. (Case 5 - Cora)

When they are sowing seeds, Delia's kids have to follow some specific instructions derived from what they learned from the animated movie (Case 6 - Delia).

- general observation (not only in order to gather evidence) (**LA: Obs**):

In manipulating materials and objects (artifacts, colors, liquids, sticks, worksheets) children are asked to look very carefully, to pick up commonalities, to notice unexpected behavior, to record facts as appropriate to the studied situation. A good example of such a combination of skills to be developed is the Case 1 - Maria "Weather" episode.

- making connections (**LA: Connect**):

Viable solutions are looked for based on dialog, hypotheses formulation, observations, and MOST important by establishing connections between previous knowledge and the current problem, between individual opinions and collective contributions, between particular case and more general situations (see for example, Case 2 - Stela "Ice and salt", "Ice and hot water", and "Magic water" episodes, and Case 6 - Delia "Parts of a plant" episodes).

- using equipment (**LA: Equip**):

Children from 3 to 8 years old are trained by specific means to handle instruments and devices in order to run an experiment or test an assumption. The very little ones operate with

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

watercolors or colored water, while the older ones can manipulate measuring units (i.e. for containers volume measurements) or various tools (hammer, jars with hot water, balloons, scissors, glue, paper and sticks, thermometers, windmills models, etc.).

- communicating explanations (**LA: Comm**):

Communication is focused more on comments of results than on offering explanations. Results communication is linked in most cases with defining the problem in written form and data recording in worksheets, two basic attributes of scientific inquiry. Results are communicated and commented generally with the whole class, by the end of the lesson. In some situations, projects results are present in children portfolios, are posted in the classroom or are presented to some special events.

A major drawback of the Romania education system as referred to the IBSE concepts is the fact that pupils are not trained to look for evidence and to offer their own explanations in relation to a studied subject.

Differences between preschool and primary school

In kindergarten teaching, most of the activities are centered on observation, materials manipulation, language and attitudes development. Meaningful for this approach is Anca answer to the interview “For young children (3 years) learning is inductive rather than creative. As they grow older and personal experience increases their understanding becomes more profound and shift towards creative learning.”

At this age, an important role in acquisition of new knowledge plays the permanent dialog with the teacher and peers “Always I am trying to create the appropriate atmosphere for the exchange of information between children. I think that's one of the most effective methods to learn new things and a starting point to be investigated in the frame of new researches. There are situations in which "truncated" information that a child receives from a peer during a free discussion can be a good motivation for him to initiate an investigation, based on his interest to discover the entire truth.”

“Verbalization is one of the basic principles that we use in conducting research with small children. Children involved in the research are required to describe the operations they perform, along with the expectations they have as it concerns the results.” (excerpts from Anca’s answers to the Fibonacci self evaluation questionnaire).

Planning tests, selecting the adequate resources, instruments and tools manipulation, data recording and establishing connections between facts, pieces of information, cause and effect can be used in primary school science education.

Nevertheless, worksheets for data recording either in graphical or text form are common to both pre-school and primary school science teaching.

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

Differences between science and mathematics

Most of the conclusions from 4.2.2 are valid for science teaching and leaning. Mathematics teaching lack this flexibility and quite everything happens in a strict question-and-answer format, the teacher waiting for the right results of an arithmetic operation he/ she proposes.

Opportunities and challenges for creative learning and teaching

By questioning children about what they observe, what they fill about a fact/ object/situation/ person, about the way they intend to act, the teacher offers a lot of opportunities to engage them into a focused activity. The dialog can assist children in establishing connections and refer to previous knowledge.

When children face a challenge and have to respond individually and as a group, their imagination is nurtured and they participate actively and affectively to the task. By offering to the pupils the chance to select from various solutions, means and materials Maria and Stela succeeded to trigger genuine investigations.

A multi-disciplinary approach as in Cora's episode on seasons, when language, music, slides projection, and poster design are combined is a good example of creative teaching. The same conclusion is emphasized by Delia in her answers to the Fibonacci self-evaluation questionnaire "We combine the lesson topic with visual arts and handcrafts (based on puzzles and toys available from the playing corner in our classroom) and with communication in Romanian language (based on a booklet with graphic signs which can be found in our small library)."

4.2.3 Pedagogy: *How is the teacher facilitating learning?*

An efficient pedagogical interaction teacher – pupils and pupils-pupils represents a balance between:

- role of play and exploration (**P: Play**):

A mixture of story telling, playing and problem solving through hands-on activities represent the strong point of the educational activities carried out by Maria, based on the "culture" of the kindergarten they work. The investigations start from the magic and the fascination of known stories, and transpose the audience into the quest for solutions to real life problems.

In another cognitive plane, Anca allows the practice in class of some otherwise "forbidden" activities such as immersing fingers into watercolors and playing with them, in order to challenge very young children to think about the way secondary colors are produced, and to live an unforgettable experience. Impressed by the liberty offered to him in this activity, a 3 years old boy confessed to the research team that parents do not permit such an experiment at home.

- role of motivation and affect (**P:Affect**):

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

Referring to the examples cited above, the affective engagement of pupils is crucial in the pedagogical demarche of this exploratory type.

Teachers praised pupils' achievements either by asking for applauses from the class or offering "smiling faces".

The mixture of science related activities with audio or video support provides additional emotional adherence to the activities under way.

- role of dialogue and collaboration (**P:Collab**):

All interviewed teachers consider as decisive for the socio-cognitive development of children at this age collaboration and group work. Cora used cooperative design of a poster as a mean to strengthen the cohesion of the group and to encourage mutual support to individual creativity. Sanda organized the learning on the use of unit of volume measurement as a group activities with predefined roles and responsibilities assigned to participants. During the practice on the plants parts study children work individually to a puzzle or to sow seeds but they have to share tools and resources.

- role of guided problem solving and children agency (**P:Agency**):

Generally, all observed activities started as a teacher guided one, as the problem to be solved was identified at class level. In the second stage, children initiative took the stage (see Maria's, Delia's, Sanda's episodes), they bearing the whole accountability for their decisions and acts.

- fostering questioning and curiosity (**P:Ques**):

On this issue, Anca puts it very clearly "Usually we offer a variety of materials to children, in the context of tasks that stimulate imagination and curiosity alike. I believe that it is easier for a child to explore a topic which he/ she thinks was started by his/ her initiative (the child initiates unintentionally the activity, in fact the topic to be investigated was chosen by the teacher)."

"At the age of 6-7 years old children express their great interest to investigate by themselves problems which are new for them" considers Delia.

- diverse forms of expression (**P: Express**):

Teachers value the way children communicate their findings, conclusions, fillings. During the filed visits the team noticed various forms of communication used: dialog, poetry, drawings, posters, music, gestures. Drama corners are organized in some kindergartens but no performance was witnessed.

- fostering reflection and reasoning; encouraging children's metacognition (**P: R and R**):

Some of the teachers are expecting from their pupils not only simple answers but some explanations and arguments (see for example, Case 1 - Maria "Float and sink" episode).

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

Reflection and critical thinking are in some cases considered to be crucial to skills development and content understanding. Delia explains "Even when I read a story to pupils, I bring into discussion some related problems that require them thinking."

- teacher scaffolding and direct support (**P: Scaff**):

As the lesson develops, teacher switches from activities coordinator to a more discrete position of guide, mentor, consultant, mediator. She becomes more discrete and less intruding; children have to mage on their own (see Sanda's sessions or Delia's attitude during seeds sowing). Maria just brings the magic of water-based glutting and leaves children to play and to comment.

Differences between preschool and primary school

By far, playing is more common to kindergarten than to primary school. Children agency is encouraged in all instances, and affection is a major coagulating factor. All forms of expressions are supported.

Teacher's interventions are more acute at primary school level (for example, Case 5 - Cora mathematics episode "Adding and subtracting"). Collaboration among children is more evident in pre-school than in primary school when inter-personal relations are more strictly observed (i.e. science and mathematics lessons of Case 6 - Delia).

Differences between science and mathematics

During mathematics classes, children have very few opportunities to express themselves creatively, as strict rules are applied in the knowledge transfer; teacher asks questions and pupils, nominated by the teacher, have to provide answers.

A more creative approach was noticed in relation to science teaching. Pupils are permitted to bring into discussion their solutions, ideas or hypothesis. More time is dedicated to open debates and analyses.

Opportunities and challenges for creative learning and teaching

Key pedagogical agents in promoting creativity are:

- all opportunities when children can express themselves freely by various means as stated by Sanda in her interview "I can cite as an example, another activity related science teaching when kids were ask to prepare their own pancakes. It is an interesting and very educational event for children as their work was guided towards the development of all senses: touch, smell, sight, taste. Besides that, it was very practical, as children faced the challenge to make their own cake in the shape they wanted; it was a complex task, engaging pupils' abilities in various ways."

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

- teacher's own creative approach, according to Delia "..in Early Education the emphasis is on teaching as a story telling, and within this method teacher's creativity can be found in handling the course and managing the class."

4.2.4 Assessment: *How is the teacher assessing how far children's learning has progressed, and how does this information inform planning and develop practice?*

For primary education the assessment goals are: to diagnose the educational system; to orient and optimize the learning process; to make possible the design of an individual educational path to every child and to plan his/ her "school career"; to identify missing parts and difficulties in learning each student faces; to provide a feedback to the educator and parents, results of the evaluation being communicated to all interested parties; to assess individual competences developed by the child; to develop an individual progress plan which includes diagnostic information and prognoses for future work; to monitor schools and the educational system.

According to "classical" Romanian official doctrine accent is placed on summative assessment. Children have to pass tests periodically and in the last years, evaluation tests are planned also for the primary school level. Such tests are organized in a national frame.

The aim of the national evaluation is to: a) "evaluate knowledge; b) diagnose students' performances; c) compare these performances with classroom results; d) offer a feedback to the educational system; e) inform in a transparent manner social partners; f) develop a national database" [22]. Results are compared to national standards. Part of the educational reform under way, the assessment process has to "change the educational culture". A bank of assessment items was designed and relevant software tools were distributed to schools, hence a diagnostic assessment can be run by the teacher at the beginning of the school year for diagnostic purposes [23].

Formative assessment started to be considered more seriously, and is run mostly at pre-school level. A new paradigm of teaching and learning in early years is promoted, shifting from knowledge transfers and reproduction towards understanding of the surrounding world, development of key competences, active participation of the learner, individual learning planning, inter-disciplinary approach, applied mathematics, formative assessment. All these new concepts are more or less present in official documents and mark the transformation process underway.

Interviewed teachers referred to various assessment strategies: individual observation files, testing and control grids, evaluation files/ reports; observations during different activities; dialog session occurring in connection with a real or imaginary situation; evaluation interviews organized without disturbing current activities; practical abilities and capabilities assessment

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

during applied tests. The research team had access to some of the artifacts derived from these processes (portfolios of Maria's pupils and Cora's children).

No peer supported assessment was observed excepting one situation when 3 years old were asked by the end of the class to award "smiling faces" to their colleagues if they judge their performance meets their expectations (Case 3 - Anca' color mixing episodes).

Differences between preschool and primary school

In the primary education context the focus of the evaluation process is represented by : the understanding of scientific concepts (i.e. the relation cause-effect); the way investigations are carried out, based on the available means; the fact that qualitative terms have to prevail in the evaluation process - both the acquired knowledge and its attributes (profoundness, functionality, durability, stability, diversity, mobility, applicability) are evaluated; the education purposes (i.e. to encourage initiative, creativity, perseverance, development of intellectual abilities).

At pre-school level there is "no official assessment system", excepting the "step-by-step" approach. The process is organized at class level, the teacher having the responsibility to design and run the assessment process.

For environmental education in pre-school, it is recommended to perform the evaluation in conditions close to the real life situations.

Differences between science and mathematics

In mathematics teaching the studied cases revealed that almost all the assessment is of summative type, based on the evaluation of homework or tests run in class. More flexible is the assessment in science where adopted solutions are judged, cooperation and communication skills are assessed, attitudes are considered.

Opportunities and challenges for creative learning and teaching

In the evaluation context, the teacher has to use appropriate assessment methods to encourage creativity, active participation, and group work of children. Such methods and evaluation techniques have to support children capacity to respond to real life challenges.

Below are reproduced some comments from the participating teachers concerning the role and means of children progress evaluation.

Quotation from Anca's interview: "I am applying predictive assessments, formative and summative assessments through the notes, continue observation, portfolios. So, predictive assessment results are used in designing future phase of learning, formative assessment results allow me to apply the required adjustments to the teaching process in order to achieve the intended purpose, and after summative assessment I evaluate the effectiveness and

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

efficiency of my pupils learning outcomes". Here are her opinions on the same subject as expressed in the Fibonacci self-evaluation form: "By the way a child gives an answer, the teacher can identify the knowledge that the child holds (in the investigation or in general). Once identified the level of knowledge, the strategy to be adopted can be developed."

On the same issue, Delia confesses: "In our approach the evaluation is both formative and summative. During the formative stage the phases of the learning process is monitored. It helps to diminish the discrepancies between children, and in the mean time it contributes in gathering information on the acquired knowledge. The summative part of the assessment looks on the cumulative effects of the learning process, provides a snapshot on the teaching achievements, constitute a motivation for children. During the assessment we use various strategies and we evaluate both the process and the results. In some cases, we involve children in evaluating their colleagues and also in self evaluation. Evaluation was performed by systematic observation of pupils behavior during the class, and finally, I run global and individual assessments."

4.2.5 Materials and Resources: *With what are children learning?*

The visits to the educational institutions involved into this study reveal that, generally speaking, they benefit of quite generous spaces (**M:Space**) to run teaching activities (i.e. in Case 3 - Anca up to 40 s.m for 15 children). There are also some exceptions, such as the premises of Delia pre-school, where the same classical classroom seems to be small for the 23-25 enrolled children. Most of the kindergartens have extensive playgrounds (Case 3 - Anca) and corners dedicated to specific activities: science club, building center, games center, reading / writing centers, art center, music center, drama center; sand and water center (a good example being the private kindergarten where Maria work).

Most of the schools in cities have modern labs such as: informatics, phonic lab, medical and dental facilities, and laboratories of physics, chemistry, biology, a library, a small gym (Case 5 - Cora). In some situations, multipurpose halls for various meeting, conferences, local community activities, artistic events, etc. are available. In one school, even a greenhouse is in operation, used for teaching biology (Case 5 - Cora). In a private kindergarten a location for gardening activities is accessible (Case 1 - Maria).

In the majority of classrooms, both in kindergartens and schools, the research team found ICT equipment (**M:ICT**) such as computers, projectors, whiteboards, and Internet connection (Case 2 - Stela Ice and hot water & Ice and salt episodes, Case 5 - Cora "Seasons" episodes, Case 6 - Delia "Parts of a plant & Adding and subtracting" episodes).

A variety of teaching aids and educational sets (**M:Explor**; **M:Variet**) are available to exemplify science related subjects (Case 1 - Maria "Weather" and "Float and sink" episodes, Case 3 - Anca "Coloured fingers stamps" and "Mixing coloured water" episodes and Case 4 - Sanda

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

"Measuring volumes: non standardized units" and "Different shape same volume" episodes), supporting exploration, creativity thinking, hands-on activities.

Most of the schools have their own libraries. In one kindergarten over 100 volumes in Romanian and English are accessible (Maria and Stela case).

Generally, there is only one teacher per class (**M:Human**), for 15 to 24 pupils. In some situations this can be a serious imitation in developing creative teaching and to implement good assessment strategies (Case 5 - Cora and Case 6 - Delia). During the field research sessions, the main teacher benefited by the aid of a teacher assistant, but this approach is not a common one.

Almost all the interviewed teachers referred to the national curriculum (**M: Pol.**) as the staring point of their lesson plans (Sanda lesson plans and Delia lessons plans). It is significant a teacher's opinion on this issue "In selecting the lesson theme I guided myself based on the "Curriculum for early childhood education for 6/7 years old children". Within this respect, the objectives of this lesson are aligned to the national educational requirements." (Sanda's interview).

Differences between preschool and primary school

Pre-school settings use more extensively outdoors activities (**M:Outd.**) than primary school classes. For this reason, they are more at ease with non-formal science teaching (**M:Inf.**) run in the premises playgrounds.

Primary schools teachers referred to outdoors activities mainly in relation to excursions, field visits, visits to botanical gardens or zoo.

ITC equipment (computers, projectors, Internet) is used mainly at school level (Case 6 - Delia, Case 5 - Cora, Case 2 - Stela), while the whiteboard is accessed by both pre-school and primary school teachers as a teaching aid (Case 1 - Maria, Case 3 - Anca).

Printed materials in Romanian related to sciences are generally of a limited diversity. More printed materials are available for general use as story books and illustrated books. An exception is offered by a set related to environment issues teaching which includes a textbook for teachers and a notebook for students. They are not too much inquiry oriented.

Primary school teachers complain about the lack of science teaching kits or experimental sets. Some of the interviewed teachers confessed that they are using in the classroom resources they developed inspired by the information available on the Internet (Case 1 - Maria and Case 6 - Delia).

Differences between 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.

It seems that more resources are available for science teaching than for mathematics, as teachers use everyday materials or sets they developed to organize demo sessions. An assortment of toys, posters and playing cards like teaching aids are used at kindergarten, while school science is based on textbooks and notebooks. Worksheets are available in both instances.

Usually, measuring instruments, in small quantities, are employed during mathematics lessons. For learning simple mathematics operations such as addition or subtraction, colored sticks are used.

Depending on teachers' skills, ICT technology is present in science as well as in mathematics classes.

Opportunities and challenges for creative learning and teaching

The research team noticed several opportunities of creative teaching sciences.

Cora, for example (Case 5 – Cora), mixed music, slides projection and a permanent dialog with children to work on contents knowledge in relation to seasons and their characteristics. She played Vivaldi's "Seasons", but in the mean time asked pupils during the final part of the lesson to sing themselves children songs generally associated to specific seasons' events. Her pupils prepared posters with seasons subjects using materials they brought from home (drawings pictures, small objects etc.).

In her lesson on "float and sink" Maria (Case 1 – Maria) offered to her class boxes with various natural materials (nuts, acorns, wooden sticks, bark, leaves, feathers etc.) to choose as objects for their experiments.

Delia's session on parts of a plant (Case 6 – Delia) was a combination of animated movie, a graphic puzzle problem-solving and some hands-on exercise to sow seeds. All together they created a high excitement and interest among pupils.

Another interesting example on creativity development, based on affective engagement, is present in Sanda's episode related to the use of non-standard volume (Case 4 – Sanda) measuring units when the amount of work to be done to fill a bucket depends on the volume of the unit used.

4.2.6 Grouping: *With whom are children learning?*

In most cases, the teacher works with the whole class (**G: No.**), one teacher being assigned to 15 to 28 children. Within this frame, children work individually, trying to answer to specific tasks or questions. Occasionally, as it was the case of the filed visits, a second teacher assists the main teacher during hands-on activities. Generally, the pupils are of the same age, no multi-grade teaching (**G:MG**) was noticed. When grouped, children are distributed randomly,

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

without any predefined criteria (**G:Abil.**). Small group (**G:Small G**) means 4-5 pupils on the same table, facing the same subject/ problem, and sharing resources.

Differences between preschool and primary school

In both pre-school and primary school settings the first part of the lesson is addressed to the entire class, when the introduction to the subject to be taught takes place.

The activities to follow are either whole class work or small groups' activities. In the majority of cases, the small group approach is adopted by pre-school teachers, as children mix colors (Case 3 – Anca "Coloured fingers stamps" episode, Case 1 – Maria "Float and sink" experiments). On special occasions, primary school teachers implement also the small group format for learning sciences (i.e. the preparation of posters by Cora' class (Case 5 – Cora, sowing seeds in Delia's class (Case 6 – Delia).

Differences between science and mathematics

Definitively, small group activities are used in science teaching. Practically, in all cases, mathematics teaching is centered on the individual work of pupils.

Opportunities and challenges for creative learning and teaching

Group work proved to be very effective in developing creativity when children were asked to solve a problem emerging from a story they know, but with answers took from real life situations (i.e. Maria's and Stela's approaches to combine a story with previous knowledge of pupils either to save the ant or to help Scrat, the squirrel).

Cora succeeded to capture children interest and to push their creativity at work by asking them to bring some materials for posters from home and to work together without a pre-established plan.

4.2.7 Location: *Where are children learning?*

In all the visited settings, either state owned or private sites, the activities were run indoors (**L. Indoors.**). Proves exists (i.e. pupils portfolio, drawings, photos, etc.) that in some situations related to special subjects teachers use also outdoors teaching (**L. Out**), either in a garden, playground or greenhouse.

Differences between preschool and primary school

During spring, summer and autumn time, a lot of activities are done in the kindergarten playground or garden, as confessed by some pre-school teachers during the discussions with the research team. The learning environment can be much diversified such as: plants grow and observation; sand and water play; shadow measurements.

At primary school level there are few opportunities offered by the curriculum to perform outdoors activities. In most cases, such activities are associated with excursions, visits to

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

museums or the botanical garden. Often these actions took place by the beginning of April, when out of school activities are planed for a week long

Differences between science and mathematics

Most of the outdoors activities are carried out in sciences. Only some activities related to measurements, belonging to the mathematics curriculum, are done as outdoor activities.

Opportunities and challenges for creative learning and teaching

As all the studied activities were organized inside, the only opportunities for creativity development are linked to the appropriate use of space. Most of the kindergartens have special corners dedicated to science, reading, art or music centers. In special cases, small pet (aquarium) or even drama corners are available (i.e. Case 1 – Maria).

Most of the primary school children are offered access to sport halls, physics and chemistry labs, or IT facilities (see Cora's school: Case 5 – Cora). As an exception a small greenhouse was found in a general school.

Classrooms are more open spaces in kindergarten were various learning and playing facilities are spread around the room. A more strict arrangement of tables occurs in primary schools, where teacher spend some time in redistributing tables for group activities (see Case 5 – Cora "Seasons" episode or Case 6 – Delia "Parts of a plant" episode especially the sowing seeds one).

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

5. Implications

The national report has two dimensions in order to be effective, dimensions which, in some instances, can to be associated to specific “mapping and comparison factors” as defined by the “Creative Little Scientists” project:

I. education policies to support and develop creative teaching and learning in Early Education, using science and mathematics as main vehicles, referring to:

a) the aims and objectives of science and mathematics education at this age [24]:

- “assimilation of basic main conventional languages (reading, writing, arithmetic);
- child stimulation to enhance his/ her perception, knowledge and mastery of the surrounding environment;
- stimulation of child's creative potential, intuition and imagination;
- building up of motivation for learning, process understood as a social activity;”

b) the new dimensions of the national curriculum in its broadest sense [24]:

- “placing the learning process in the center of the school demarche …..;
- focusing on building learning skills and attitudes, by developing children problem solving skills and using strategies of participatory teaching;
- flexibility of the learning offer ….. structuring an education for everyone…;
- adapting the learning content to everyday life and concerns, to interests and aptitudes of the pupils;
- introducing new ways of selection and organization objectives and content, according to the "not much, but better" …….;
- creating the possibility of achieving individualized school approaches, motivating students towards innovation and personal accomplishment;
- increasing the responsibility of all educational factors in design, monitor and evaluate the curriculum.”

c) new approaches and official norms to be used for the assessment of the teaching and the learning processes;

d) national strategies in providing enabling environments (materials, tools, kits, instruments, consumables; printed and electronic resources; adequate space, enough human resources);

e) strategies in training, selecting and developing human resources;

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

f) involvement of other stakeholders (local authorities, parent associations, business communities, science centers, teachers' networks, etc.).

II. design of appropriate courses for teachers to empower them for creative teaching of science and mathematics.

5.1 Implications for teacher training

The conclusions of this report in relation to teachers' training programs have to be considered in the following limitative frame:

a) Teachers' training, in acceptance of this report, means the knowledge and skills teachers need in order to practice creative teaching during science and mathematics education classes, without specifying the context these qualities are acquired, initial teacher training or continuous professional development.

b) The recommendations of this report are derived from few cases, during a very limited time interval, and reflect a very small, and may be distorted reality:

- the research team was specially looking for good practice;
- it is biased by the criteria settings/ teachers were selected;
- may be special set-up, a carefully designed "show", not common practice were observed;
- economic, educational policy and cultural constraints are present.

c) The suggested solutions consider both the best practice examples found, as well as the noticed tensions existing between teachers' perceptions, declarations, beliefs and the way they practice science and mathematics teaching in class.

The design of courses for teachers' training has to be country and curriculum independent. Teachers have to learn using creative teaching by adapting the lessons learned to their own cultural, economic, educational environment. The major foci for this curriculum for teachers have to be:

a) good understanding of science and mathematics concepts to be taught;

b) good knowledge and understanding of environmental issues and natural resources;

c) knowledge on basic inquiry-based teaching and learning;

d) skills related to cross-curricular teaching (science combined with mathematics, arts, music, drama, sports, languages);

e) knowledge related to non-formal science teaching;

f) capabilities concerning communication, team work, project planning, networking;

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

g) basic knowledge on creativity;

h) understanding of outdoors education principles;

i) knowledge of formative assessment practice;

j) skills in handling instrumentations and ICT devices;

k) abilities to design and develop their own resources (texts, kits, teaching aids, etc.);

l) knowledge on applied mathematics and innovative methods on teaching mathematics.

5.2 Implications for policy development

The present report, with its inherent limitations as it concerns the time devoted to such a study, the number of sites/ settings analyzed, its more or less biased character, comes to complete the picture offered by the "Report on Mapping and Comparing Recorded Practices, National Report on Approaches in Romanian Policy" and "National Report on First Survey of School Practice in Romania" on the Romanian Early Education system. A selection of six case studies brings an inside view on the implementations of national policies and "grassroots" practice in relation to creativity development and inquiry-based teaching and learning of sciences and mathematics.

The Romanian educational system is for more than ten years under a "permanent" reform. Progress was made through the adaptation of the new Law of National Education. A lot has to be done in its implementation. Changes are still expected by practitioners, parents, society. Practice of innovative education continues to be a major challenge for pre-school and primary school teachers.

Creativity is barely mentioned in official documents and not as a focus of educational efforts. No reference to creative teaching, creativity development of children or learning for creativity was found. A new understanding of the role science and mathematics teaching on the creativity development at this age has to emerge.

Official policy has no focus on inquiry-based teaching. Applying this method in science and mathematics teaching will be a difficult endeavour, as far as Romania is not prepared even conceptually for it. There is no single document or collection of documents addressing unitarily IBSE principles and methodology. In any case, experiments/ investigations are mentioned in the documents but are rarely encountered in school life.

The change has to come with a new curriculum which has to reflect the policy principles as it concerns creativity and IBSE. More time devoted to practical class work and outdoor activities, less children assigned to one teacher, a better balance between minds-son and hands-son, between theory and practice are needed. Further support to the development of basic and transversal competences is required. Multi-disciplinary and cross-curricular approaches in science and mathematics teaching have to be promoted. Closer links of science and

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

mathematics teaching with everyday life challenges have to be pushed forward. A change in mathematics teaching, towards "applied" mathematics, starting from pre-school level is mandatory.

The lack of resources and the under funding of the educational system are major barriers in promoting creative teaching. On the other side, educators have to be taught for a better use of materials and objects from the surrounding environment.

A progression is noticeable in relation to students' achievements assessment, as the practice stars to shift from summative towards formative, continuous, more structured assessment, and this trend has to continue to be implemented at all levels, in every single class.

The build up of communities of practice in creative teaching or inquiry-based education can offer additional support in implementing these methods at large scale, efficiently.

Equal opportunities in teaching and learning science and mathematics at early age according to the creative / IBSE approaches have to be a national priority.

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

6. References

[1] Ministry of Education, Research, Youth and Sports, 2012. Programa scolara pentru disciplina "TEHNOLOGII DE INFORMARE SI COMUNICARE (JOCUL CU CALCULATORUL)", Proiect propus pentru dezbatere, Februarie 2012. [pdf] Bucharest. Available at: http://clasapregatitoare.suntparinte.ro/wp-content/uploads/2012/02/document-2012-02-29-11627495-0-tehnologii-informare-comunicare.pdf.

[2] Ministry of Education, Research, Youth and Sports, 2011. L E G EA educaţiei naţionale, Legea 1/2011. Available at: http://www.unibuc.ro/n/organizare/biro-perf/docs/2012/ian/16_12_49_00Legea_Educatiei_Nationale.pdf.

[3] Ministry of Education, Research, Youth and Sports, 2001. ŞTIINŢE, Clasa a IV-a, (*Programa de Ştiinţe pentru clasele a III-a – a IV-a a fost aprobată prin Ordin al ministrului nr. 4301/ 22 august 2001,* Available at: http://www.google.ro/url?sa=t&rct=j&q=%C5%9Ftiin%C5%A3e%2C%20clasa%20a%20iv%20a%2C%20(programa%20de%20%C5%9Ftiin%C5%A3e%20pentru%20clasele%20a%20iii-a%20%E2%80%93%20a%20iva%20a%20fost%20aprobat%C4%83%20prin%20ordin%20al%20ministrului%20nr.%204301%2F%2022%20august%202001&source=web&cd=4&ved=0CFUQFjAD&url=http%3A%2F%2Fadministraresite.edu.ro%2Findex.php%3Fmodule%3Duploads%26func%3Ddownload%26fileId%3D4250&ei=NzfnT_H9NY_1sgbL1ZGvAQ&usg=AFQjCNG-zOs1jdZCK2261IxcNmGrx8F6yg.

[4] Ministry of Education and Research, 2005. Programe scolare pentru clasa a IV-a – stiinte ale naturii, Anexa nr. 2 la Ordinul ministrului educaţiei şi cercetării nr. 3919 / 20.04.2005, Available at: www.edu.ro_index.php_articles_c538.

[5] Ministry of Education, Research, Youth and Sports, 2007. Educatia ecologica si de protectie a mediului, Ghid metodologic pentru cadrele didactice, invatamantul primar. Available at: www.edu.roindex.phparticles9330.

[6] Cerkez, M., Singer, M., Oghina, D., Sarivan, L., Capita, L., Ciolan, L., Tacea, F., Crocnan, D., 1999. Curriculum national – programe scolare pentru clasele a III-a- a VI-a. Aria Curriculara: matematica si stiinte ale naturii, stiinte. Available at: http://administraresite.edu.ro/index.php/articles/curriculum/c539/?startnum=61.

[7] Ministry of Education, Research Youth and Sports, 2012. Ordin privind aprobarea planurilor-cadru de invatamant pentru invatamantul primar, ciclul achizitii fundamentale – clasa pregatitoare, clasa I si clasa a II-a si a Metodologiei privind aplicarea planurilor-cadru de invatamant pentru invatamantul primar, ciclul achizitii fundamentale – clasa pregatitoare, clasa I si clasa a II-a. Available at: www.edu.roindex.phparticlesc1003.

[8] Ministry of Education, Research, Youth and Sports, 2012. Notă privind* elaborarea planului-cadru pentru învăţământul primar Clasa pregătitoare şi clasele I – a II-a (Proiect), [pdf]

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

Bucharest. Available at: http://clasapregatitoare.suntparinte.ro/wp-content/uploads/2012/02/document-2012-02-29-11627502-0-plan-cadru-achizitii-fundamentale.pdf.

[9] Ministry of Education and Research, 1998. Matematica – Curriculum Clasa a IV-a. Available at: http://administraresite.edu.ro/index.php/articles/4861.

[10] Ministry of Education, Research, Youth and Sports, 2002. Strategia Dezvoltării Învăţământului Preuniversitar în perioada 2001 – 2004. [pdf] Bucharest. Available at: http://www.gov.ro/upload/articles/100025/strategiepreuniv.pdf.

[11] Ministry of Education, Research, Youth and Sports, 2012. Programa scolara pentru disciplina "MATEMATICA SI EXPLORAREA MEDIULUI", Proiect propus pentru dezbatere Februarie 2012. [pdf] Bucharest. Available at: **Error! Hyperlink reference not valid.**.

[12] Ministry of Education, Research and Youth, 2004. Programe scolare pentru clasa a III-a – Educatie tehnologica. Available at: www.edu.ro_index.php_articles_c538.

[13] Ministry of Education, Research and Youth, 2008. Curriculum pentru învăţământul preşcolar (3-6/7 ani). Available at: http://educatie.inmures.ro/fileadmin/docs/curriculum/curriculum%20final_18%20septembrie.pdf.

[14] Ministry of Education, Research, Youth and Sports, 2007. Educatia ecologica si de protectie a mediului, Ghid metodologic pentru cadrele didactice, invatamant prescolar – nivelul II (5-6/7 ani). [pdf]. Available at: http://www.isjbraila.ro/actedu/Ed_eco-Ghid_prescolari.pdf.

[15] Ministry of Education, Research, Youth and Sports, 2012. Programa scolara pentru disciplina "TEHNOLOGII DE INFORMARE SI COMUNICARE (JOCUL CU CALCULATORUL)", Proiect propus pentru dezbatere, Februarie 2012. [pdf] Bucharest. Available at: http://clasapregatitoare.suntparinte.ro/wp-content/uploads/2012/02/document-2012-02-29-11627495-0-tehnologii-informare-comunicare.pdf.

[16] Ministry of Education, Research, and Youth. LEGEA ÎNVATAMÂNTULUI PREUNIVERSITAR, PROIECT ÎN LUCRU. Available at: http://www.isj.albanet.ro/_documente/139_Proiect%20de%20lege%20invatamant%20preuniversitar.pdf.

[17] Bilt, M., Chirea, V.G., Dumitriu, C., Ionescu, M., Litoiu, N., Negreanu, M., Tacea, F.A., Tesileanu, A., 2009/10. *Structures of Education and Training Systems in Europe.* [pdf]. Available at: http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/structures/041_RO_EN.pdf.

[18] Ministry of Education, Research and Youth, 2003. Programa scolara – cunoasterea mediului, clasele I-a, II-a. Available at: http://curriculum2009.edu.roCiclul_primar.

[19] Ministry of Education, Research and Innovation, 2009. Raport asupra stării sistemului naţional de învăţământ, Bucureşti – 2009 . [pdf] Bucharest. Available at:

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

http://www.adevarul.ro/actualitate/social/Raport_asupra_starii_sistemului_national_de_invatamant_ADVFIL20101024_0001.pdf.

[20] Ministry of Education, Research and Youth, 2003. Programe scolare revizuite – Abilitati practice, clasele I-a, II-a. Available at: www.edu.ro_index.php_articles_c538.

[21] Ciascai, L., Haiduc, L., 2009. Is Romanian Science school Curricula open towards the Development of School Students' Critical Thinking Skills? Acta Didactica Napocensia, Volume 2, Number 3, ISSN 2065-1430. Available at: http://dppd.ubbcluj.ro/adn/article_2_3_2.pdf.

[22] Ministry of Education, Research, Youth and Sports, 2007. Evaluarea nationala la finalul clasei a IV-a, Raport tehnic, 2007. Available at: http://administraresite.edu.ro/index.php?module=uploads&func=download&fileId=6505.

[23] OECD Publications Service, 2000. Reviews of National Policies for Education, Romania, Education and skills. [pdf]. Available at: http://www.see-educoop.net/education_in/pdf/analiza-politici-rom-enl-t05.pdf.

[24] Siraj-Blatchford I., Sylva, K., Muttock, S., Gilden, R. and Bell, D., 2002. *Researching Effective Pedagogy in the Early Years*. Department of Education and Skills Research Report RR 356. Norwich: DfES p. 24.

[25] van den Akker, J., 2007. Curriculum Design Research. In Plomp, N. and Nieven N. (Eds.) *An Introduction to Educational Design Research.* SLO Netherland Institute for Curriculum Development pp. 37 – 53.

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