BE_Class_ColouringWater_GWork

Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**T: Ped;** **M: Var;** **M: Expl;** **M: Cr;** **P: Collab;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 – Belgium
Case:	Case 4
Episode:	Colouring water
Teacher:	Lies
Age Group:	5–6
Selected episode present in D4.4 Appendix	Yes

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Children collaborating

The activity was part of a bigger project about American Indians that the children had chosen to do. The children found out that some American Indians use natural dyes to colour their clothes, so the children first explored how to dye cotton fabric and later on they made their own clothes.

This data focuses on four girls who chose to work in the corner where they were dyeing pieces of cotton fabric with dyes from natural products. On the table were a rich variety of materials, such as oranges, grass, herbs, coffee, tea (also rose hip tea), funnels, sieves (in different sizes), cutting boards, scissors, cups and knives. The children were also allowed to go outside to collect more natural materials if they wanted to do so.

To scaffold the children's technique for extracting the dye the children were given an instruction card with pictures showing how they have to handle the natural materials and how to separate these materials from the colored water to extract the dye. Lies only interacted when necessary or when the girls explicitly asked for her help.

The children were given the freedom to select the materials themselves and two of the girls decided to go outside to collect more grass and mud for their investigation.

Although the children had an instruction card to guide them, they were allowed to plan their own investigations, for example, they had to choose which sieve to use by investigating which size was most successful at separating the materials from the water. Indeed, one child chose not to sieve her coloured water at all. They could also chose how long to leave the cotton fabric in the water and one girl left her cotton fabric longer in the water and she noticed the colour deepened the longer it was in the dye.

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Based on the conversations between the girls it is also clear that the teacher encourages collaboration and dialogue. For example on the picture two girls are working together. They are trying to extract colour from the peel of oranges. They also discuss how big the pieces have to be. They search together for the best sieve.

Also in the other groups there is a lot of collaboration and discussion between the children. Although this results in some noise in the class, it also creates some very interesting conversations.

Girl 1 is still cutting with her tongue out of her mouth. ***Girl 3*** *is saying 'Little pieces' to her.*

Girl 1 *to Girl 3* 'But my fingers are almost broken.' *Girl 1 and Girl 3 are cutting further.*
Girl 1 'I'm curious what color this is going to be.'
Girl 2 'I'm also curious.'
Girl 1 'With you, it will turn yellow.' *She is pointing to girl 2 who is working with the curry.*
Girl 2 'That really stinks.' *Girl 2 is giving her cup to girl 1 who smells. .*
Girl 3 'And soon we are going to put a little water in it.' *She looks at the instruction card.*
Girl 1 'Later on we will bring water in it.'

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.3 Teachers should be able to organize group work, aligning ways of grouping children, task design, teaching and assessment strategies in different ways to promote collaboration amongst children in science and mathematics.
Factors linked with:	**G: SmallG;** **G: Abil;** **P: Colab;** **P:Dialog;** **A: Strat**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – Belgium report
Case:	Case 5
Episode:	Measuring and Estimating
Teacher:	Els
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Fostering mathematics learning during group work, stimulating agency of the children using a work sheet

Four girls are working on the measuring and estimating assignment. They have a metre and a string of beads with a length of 1 metre. They all have a worksheet with two columns. In the first column are pictures of several objects; they have to select a similar object (in reality) in the classroom or in the corridor and then they have to estimate the length of these objects. After they have estimated the object, they have to measure it. They may choose themselves the real objects, so they have to select a door, a window, a corridor, a board … They have to search for these objects in and outside the classroom.

Girl 1 *is putting the metre on the ground, just in front of the door.*
Girl 1 'The other metre *(the string of beads)'*
Girl 2 *is bringing the string of beads next to the metre.*
Girl 1 'No, not there.' *She sees the girl isn't replacing the metre.*
Girl 1 'Yes, ah so.' ***Girl 1*** *is replacing the metre she is holding and brings it on top of the other metre.*
Girl 3 '2 meters'
Girl 2 *places the string of beads, and brings it next to the other metre.* She says '2 metres'. *She gives the string of beads to girl 3.*
Girl 1 'Yes, 2 metres. I'm writing down 2 metres.'
They all are writing down the length on the worksheet.
Girl 4 'I have 2 metres.' *She is looking at her worksheet.*
Girl 1 'Oh, it was right, the door was right.' *She is pointing to the estimated length on her worksheet. She looks at the worksheet of girl 2 and says.*
Girl 1 'You have to erase it.
Girl 2 *is doubting.*
Girl 4 'That is noo ..ot'

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Girl 1 'No, you have to blot this out and write the length here' *Girl 1 herself is blotting out the estimated length on the worksheet of girl 2. Girl 2 and Girl 4 are watching.*
Girl 3 has measured the frame of the door alone and says to Girl 2 'Two metres' *while pointing at the frame.*

This specific episode provides several opportunities for mathematics learning. It is an episode about estimating and measuring, and about using a metre. Some concepts and skills are refreshed before starting the corner work. Then children are given the time to practice their mathematical skills in a group. In fact the assignment could be seen as a short guided inquiry. They have to plan an investigation, they have to estimate, then they have to measure and observe, finally they have to communicate the results. The children are instructing and guiding each other. There is room and time for collaboration and agency, the teacher is standing back. One of the girls is taking the lead. They are also checking each other's process and results – form of peer assessment.

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BE_Class_ModelingWax_LEnvironm

Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out.
Factors linked with:	**T:Ped**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Case 3
Episode:	Modeling Wax
Teacher:	Katrien
Age Group:	3
Selected episode present in D4.4 Appendix	No

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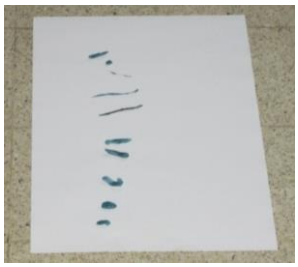
Young children learn about short and long through play and explorations in different activities. Afterwards reflection and reasoning is fostered.

The children are working about "Art", amongst others they learned about painters, e.g. Mondrian. When the children were working about the painter Mondrian, they came across different forms and lines. They copied some of his works, using paint, stitch beads; they made them in the sandbox … Based on these experiences the teacher taught of how she could do something about short lines. She created several activities with similar goals; these are described in the episode below.

This episode is introduced after the morning rituals, when all the children got a piece of modeling wax and were asked to make a sling. Afterwards the teacher asked to place their sling on a piece of paper (see picture).



The teacher asks: What do we see now?
Children: all different
The teacher asks: What kind of differences do you see?
Child 1: these ones are bigger
child 2: These ones are longer.

The teacher says that it's so and brings in slings of paper.

The teacher hands out slings of different length to the children. Once the children have received there sling they start to compare with each other. As she notices the children are moving with the sling, she decides to bring in music and she let the children dance with the slings, after a while she brings in another sling for each child. After this phase the teachers brings in the materials for the corners. The children may choose with which materials they will play, but all the activities are linked to the concept of large and short lines. The teacher has foreseen 7 activities, so not all the activities will be chosen by the children. After the choices have been made they are allowed to go to the different corners.

In all the corners there were chances for the children to experiment with the materials, in order to gain insights in long and short lines. In each corner the children started to compare spontaneously. If necessary the teacher acted as guide or coach, she went from one corner to the other.

Description of the 7 activities (corners):

1. Sand box: in the sand box, the children weren't offered any material but were given the assignment of making lines by making little holes in the sand with their fingers.
2. bottle closures: in this activity it was meant for the children to make lines of different length.
3. stitch beads: with the stitch beads the children could make lines of different length and placing them right below each other.
4. pearl necklace: with the pearl necklace the

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children could make a long and short necklace.

5. doll corners: making spaghetti: in the doll corner the children were cooking spaghetti, French fries, long sausages. In the conversation of the children you notice they were experimenting with the concepts of long and short.
6. building with boxes: in this corner there were two rows of boxes placed next to each other and the child was building by selecting the right box for each tower.
7. making slings with modeling wax: in this corner several children were making slings with the modeling wax, and so experimenting with long, short, big, thin, After a while they could start comparing their slings …

Another important factor of this approach was that the teacher had foreseen other activities after the play time; these were also building on the same goals. In that way, she offered opportunities for the children to transfer their constructed knowledge to another context. So the children could make long and short door ribbons, paint slings on paper, make painting with lines, making lines on a mirror that was covered with shaving foam.

During the activities the teacher was present in the classroom and she went in every corner and made conversations with several children. For example she was involved in a role play where she ordered long spaghetti; she went to the beauty salon where she wanted to buy a short neck less… After the activities the teacher called the children together to look at the processes and products of the different corners. For example in the short episode below the reflection about building with boxes is described.

The teacher goes with the children to the corner with the boxes. There she steps on the boxes using her fingers, first on the short one and then on the long one.
During this action she says: 'oh this goes fast and oh, this takes a while.'
Afterwards she asks one of the children to do this and then she asks which one is the shortest. Afterwards you see the children trying to walk with their finger on to the boxes themselves.

In the fragment above, you might notice that the children are given the opportunity to evaluate themselves. During these feedback moments (or flash back moments) the children are involved actively.

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Teacher Education Design Principle + code:	12. Teacher education should provide knowledge about early child development, the purpose and aims of science and mathematics education, and their place in the early years curriculum. **TE: SciMaths**
Specific Teacher Outcome(s):	12.3 Teachers should have knowledge of the role of creativity in child development and in the fields of science and mathematics. 12.6 Teachers should be able to support the diverse interests and needs of young children in engaging creatively within the fields of science and mathematics
Factors linked with:	**T: Ped;** **AO: Creative**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D 4.3 – Belgium report
Case:	Case 5
Episode:	Parallel lines
Teacher:	Els
Age Group:	6–7
Selected episode present in D4.4 Appendix	No

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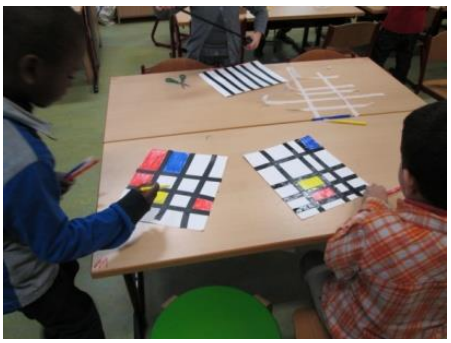
Planning to integrate mathematics and creativity

This activity is building further on previous content knowledge about parallel lines, in other terms they had already worked with the concept of parallel lines. As an introduction to the group work, the teacher reactivates the pre-knowledge in the 'kring'*. She starts off with a sort of reconstruction of parallel lines using tape placed on the ground, she allows the children to make parallel lines using their body, and allows them search for parallel lines in the classroom. During these actions she is asking questions to promote reasoning and reflecting. Then she brings in a Mondrian painting by using the digital and she reconstructs the drawing with tape on the floor. In addition, she shows one of the works of one of the little children of the other classroom. In order to give a more diverse image of the work of Mondrian, she shows several paintings on the digital board and notes on the white board the term "parallel" as common characteristic. After this introduction, the children are allowed to try and construct parallel lines themselves in groups of 4 with tape, and individually on paper.

The children are divided in small groups of four and all groups have the same assignment. During the activity some of the children are working faster and can work individually on paper. By doing so the teacher can differentiate based on the level of the individual child, without given others the feeling they can't do it. Everyone is allowed to work on his own pace and also the value of observing is validated.



The teacher had foreseen in specific materials and her classroom was set up in groups of 4 to make the group work possible in a natural way. All the materials in the class could be used, however most of the materials have a fixed place in the classroom where everyone has access to. As you will notice in the fragment below, the teacher hands out the materials and then observes what the children are doing.

The teacher hands out the materials after giving the assignment in the 'kring'.
[starting the activity]
Child 1 *takes the tape and starts to place a taped line on the table by ripping the tape.*
Child 2 *is helping* ***Child 1*** *to keep the tape in place.*
Child 3 *is watching*
Child 4 *is watching*

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* Kring* In the classroom there is a place where the children come together to reflect, to start the day, to discuss and debate. This circle, in which the children are sitting together with the children, is called the 'kring'.

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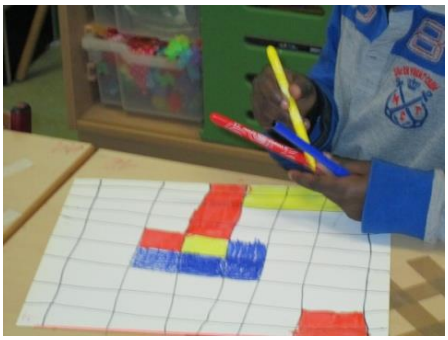
Another role of the teacher in this episode is the aspect of assessing the outcomes of the children. The teacher stresses on this strategy, because she finds it important to be sure that no misconceptions are created by allowing the children work on their own without guidance. Therefore she believes it's important to seek for opportunities to obviate the misconceptions, like illustrated in the example below.

The teacher comes back after one minute and says: "These are interesting lines!" and she calls all the children of the classroom to give some explanation.

Teacher: "What happens with two straight lines that aren't parallel?"
Child 1: "They cross."
Teacher: "Can you make those lines a bit longer."
Child 3: "They cross each other!"
Teacher: "So if we make them longer we can see if they are parallel or not."

In this activity the diversity of activities building further on the same goal are opening possibilities for keeping the motivation at a high level, because of the diversity there are challenges for all children.



The teacher states it as follow: "I find it important to *foresee a wide range of differentiation in order to reach children at the place they are able to learn the most, at their own individual level*."
As you can see in the picture one of the children is making a "Mondrian" on paper by using lines he draw himself, but he still has the challenge left of drawing them straight with the use of the tool, a lath."

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BE_Class_SandBox_GWork

Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**T:Ped**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Case 3
Episode:	Sandbox
Teacher:	Katrien
Age Group:	3 years
Selected episode present in D4.4 Appendix	Yes

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Children's play – observing effects of their actions

In the sand corner the teacher had placed materials to build with, including real bricks. They also had unfamiliar specialist tools to help with the building process such as plaster trowels and spirit levels, as well as the familiar bucket and spades.

Two children worked in the corner. First, the two children worked separately in order to make their own wall. However, after some time they started working together to build one wall and they share the tasks required to prepare their materials. The teacher guided the process by asking the children what they had done or what has happened. When, at the end of the activity, the wall fell down, the teacher (Katrien) interacted with the children to discuss the reasons why the wall fell down.

A.
The children, who were learning by doing, observed the effects of each other's actions and changed their actions accordingly. Child 1 watched Child 2 pouring the water into her bucket and she noticed that the sand was not mixing enough with that amount of water:

Child 2 *puts some more water in her bucket and starts stirring again. After a while she notices there is too much water and she pours out some water.*
Child 1 *assesses that only a small amount of water is required and so puts a little bit of water on the sand in the bucket.*

B.
The wall the children had been building fell down.
Child 1 *continued to prepare his brick ready to keep on building.*
Child 2 *tried to rebuild the fallen wall by replacing the bricks up on each other, but she failed to lift them up to be able to place them up on each other. After a few tries, she placed one brick on top of the two bricks next to her side of bricks.*
Then she grabbed the stone below and placed that one on top of that side of the wall.

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Child 1 *is finished with preparing his brick and looks at the actions of Child 2.*
Child 2 *is trying to place her two resting bricks on top of the tower, but she doesn't succeed. She seeks help from Child 1.*

Child 2*:* Child 1, can you make this?

Child 1 *grabs the bricks and places them one by one on top of the wall.*

Child 1*:* Please!
Child 2: I will place some more wet sand on top, so the next one will be fixed in a proper way.

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BE_Class_SandBox_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**AO: Creative;** **P:Ques;** **P:Scaff;** **P: Agency;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 – Belgium
Case:	Case 3
Episode:	Sandbox
Teacher:	Katrien
Age Group:	3
Selected episode present in D4.4 Appendix	Yes

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Teacher questions scaffolding children's thinking

In the sand corner the teacher had placed materials to build with, including real bricks. They also had unfamiliar specialist tools to help with the building process such as plaster trowels and spirit levels, as well as the more familiar bucket and spades.

Two children worked in the corner. First, the two children worked separately in order to make their own wall. However, after some time they started working together to build one wall and they share the tasks required to prepare their materials. The teacher guided the process by asking the children what they had done or what has happened. When, at the end of the activity, the wall fell down, the teacher (Katrien) interacted with the children to discuss the reasons why the wall fell down.

When Katrien did interact, the main focus was on appreciating what the children were doing and on supporting them to go on to a next step. **The teacher offered learning opportunities** just by making the suggestion to place the bricks next to each other, to offer new possibilities in the play of the children. Katrien scaffolded her questions to help the children reflect critically on their work in order to promote their conceptual understanding.

Teacher: Oh, look what happens? *(She lets the stone loose and they fall)*.
Teacher: How is this possible?
Child 2: Because it wobbles. (...) I will take some wet sand.
Teacher: Can you place the sand on the brick?

Child 2 places the sand on top of the brick.

Teacher: Can you make it completely flat?

Child 1 hands over the plaster trowel. Child 2 makes it flat with the plaster trowel.

Teacher: Can you place the next brick on it now?

Child 2 is placing the brick on top of it.

Teacher: Can you use your spirit level to see if the bricks are in balance?

Child 2 places the spirit level on the bricks and sees they are balanced.

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BE_Class_TheBags_CreatinqLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**T: Ped;** **P: Agency;** **M: Explor;** **M: Cr;** **M: Variet**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – Belgian report
Case:	Case 3
Episode:	The Bags
Teacher:	Katrien
Age Group:	2,5-3
Selected episode present in D4.4 Appendix	No

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Providing a variety of selected materials and instruments to initiate open inquiry in a small group of young children.

In this episode we will focus on the two children who were working for about 50 minutes with stones, filling instruments (such as funnels, spoons) and other containers.

The main focus of this activity is learning by exploring and experimenting. The teacher provides the materials and looks what children do with these materials. Everything is possible, it very open-ended inquiry. She does not know what the children want to explore.

Child 2 is grabbing a bottle and starts filling the bottle with stones by using a spoon.
Child 1 is filling her bag with one scoop.
Child 2 is grabbing a smaller scoop to fill the bottle.
Child 2 is grabbing a small glass to fill her bottle.

In the example above you see that the child noticed that there were falling a lot of stones next to the bottle when using a spoon. Then she noticed that she could put a lot of stones into a scoop and then she tried the glass, which has the same opening as the scoop but can contain more stones.

During the activity the teacher was very focused on allowing the children to play on their own. She only interfered when she observed she could foster the children to take a step further in their play. In the example below the teacher makes a connection between the individual play of two children.

Child 2 is using her small glass to put stones into the funnel.
Teacher: C1, do you also want to do this?
Child 1 is nodding.

In addition, they are exploring the characteristics of stones and the working principles of instruments such as funnels. They experience that the stone can only pass when there is some air between the funnel and the object to fill.

Child 2 is pushing with her glass on the stones and then pulls up her filling material.
***Child 2**: Look, they are gone!*
Child 1 is adding stones to her bag, but places the filling material again outside the bag.
Child 2 is repeating the action but she doesn't lift the funnel as high as before and she does it after every time she brings in stones with her glass.

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BE_Class_TheCarpenterCorner_CrossCurr

Teacher Education Design Principle + code:	16. Teacher education should provide teachers with knowledge of approaches to timetabling and organizing cross- circular project work. **TE: CrossCurr**
Specific Teacher Outcome(s):	16.1 Teachers should be able to use approaches to cross-thematic, cross-circular and project work to promote creativity in science and mathematics. 16.3 Teachers should be able to build connections across the curriculum of various kinds and with potential to contribute to children's inquiry and creativity.
Factors linked with:	**C: Sci/M Integ;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 – Belgium report
Case:	Cases 1 & 2
Episode:	The Carpenter Corner
Teacher:	Maaike
Age Group:	4-6
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Making connections – linking mathematics and science

Two children chose to work in the carpenter corner. One of the children was a four year old girl, she worked already in the carpenter corner. The other child was a five year old boy. For him everything was new as it was his first time in this atelier and this classroom.

The Carpenter Corner had a very rich physical environment with a special work bench and with real carpentry tools; several saws, nails, pincers, hammers, and wooden materials were made available. The children could also go outside the classroom to bring in other materials. Maaike stressed the importance of using real materials to design and inquire. The children could select the materials they wanted to use by themselves, so, ownership and agency was very much stimulated.

The boy wanted to measure the wooden box. He recognized the need for accurate measurements.

Child 1: I'm going to have a look with the metre *(ruler).*
Teacher: Yes, you can measure it.

The boy finds a fold metre (folding ruler) in one of the bins and he unfolds the metre. He kneels on the ground.

Child 1: I'm going to look how long this measures. *(He measures the wooden box.)*
Child 1: That's not going.
Teacher: Is it not good?
Child 1: I have to have a pen. *(He draws a line on the wooden box.)*
Teacher: Child 2 is it already OK?
Child 2: No
Teacher: Maybe Child 1 has to put there a line too, such as here.

The teacher showed the other measurement that was done by Child 1.

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BE_Class_TheCarpenterCorner_GWork

Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**T: Ped;** **M: Var;** **M: Expl;** **M: Cr;** **P: Collab;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 – Belgium report
Case:	Cases 1 & 2
Episode:	The Carpenter Corner
Teacher:	Maaike
Age Group:	4–6
Selected episode present in D4.4 Appendix	Yes

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Working with peers to encourage agency

Two children chose to work in the carpenter corner. One of the children was a four year old girl, she worked already in the carpenter corner. The other child was a five year old boy. For him everything was new as it was his first time in this atelier and this classroom.

The Carpenter Corner had a very rich physical environment with a special work bench and with real carpentry tools; several saws, nails, pincers, hammers, and wooden materials were made available. The children could also go outside the classroom to bring in other materials. Maaike stressed the importance of using real materials to design and inquire. The children could select the materials they wanted to use by themselves, so, ownership and agency was very much stimulated.

Peer tutoring was encouraged by placing older children with younger children.

Both children worked together to build a house.

The 4 year old girl, however, did not know exactly what to do, ***the teacher*** *said to the 5 year boy:* 'Could you explain it.'

The boy answered and showed what had to be done.

In this activity the boy was the designer and the girl liked to be doing things. Later, the boy continued to work on this house whilst the girl made lots more smaller houses.

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BE_Class_TheCircleandtheOval_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: ChildIdeas**
Specific Teacher Outcome(s):	9.1 Teachers should be able to recognize and value children's various forms of expression and representation of their ideas and learning in science and mathematics. 9.2 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development.
Factors linked with:	**T: Ped;** **LA: Quest;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Class
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Case 6
Episode:	The Circle and The Oval
Teacher:	Ilse
Age Group:	6–7
Selected episode present in D4.4 Appendix	No

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Learning mathematics at unexpected moments using the interests or ideas of children - fostering.

All children are sitting in a circle; the teacher is in the middle of the circle. The teacher reflects with the children on what they have learned about the different painters and art forms. These painters were in fact also inquirers, since they developed their own art form. At the end of this reflection moment the teacher links painters to mathematics and cubism to geometric figures.

'That's crazy, hey. Each artist has made his painting with a little mathematics. A lot of fantasy, many colors and a drop of mathematics.'

'Because Cubism, that is all geometric figures. That is a difficult word; I'm going to write it down on the white board.'

The teacher points towards the classroom and encourages the children to find geometric figures in the classroom. During the conversation which follows she is categorizing the figures on the white board. At a certain moment all known figures are on the board and one of the children is saying 'oval'. This is the start of a real inquiry about circles and ovals. Both are round and have no angles, but what is the difference between both. As the children are that curious, the teacher learns them more about radius and ovals in a very humoristic and expressive way, using tools to measure and to draw.

Although the teacher has planned a mathematics activity she is open for interests of children linked with the topic and the goal she wants to reach. As such she teaches them something about ovals which is not in the curriculum for these younger ages.

'I normally work with a brief agenda (teacher journal); I certainly don't write everything out. I create a calendar schedule for the week. The main objectives are important, how to reach them differs. The key for me is to work with and build upon the experiences and interests of the children. As a teacher you have to dare to let go if the activity (or the practice you have developed) doesn't work at that moment. Together with the children you must probably find a solution which does work. So, it is possible that an activity completely changes because of the interests of the children (what they say or do). This does not alter the fact that I do reach my goals with the children.'

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Boy 'Oval'
Teacher 'Where are the angles in an oval? But an oval … is that with points?'
Children 'no'
Boy 'Round is like this but an oval is like that.' The boy is drawing both forms in the air.
Teacher 'Come, draw.' The boy is drawing something on the board.
Teacher 'Is that an oval?' Some of the children say no.
Teacher 'Could you draw a circle?'

The teacher is working with a mixed ability group. Several of the children are no native speakers. Although they don't always express themselves in a proper way, they are used and engaged in the process of encouraging conceptual understanding and thinking. The concepts are not that simple however the children are very engaged.

The teacher is repeating the words and concepts because of the non native speakers in her classroom. She also is visualizing the content by creating drawings on the whiteboard. Or by asking the children to draw.

Teacher 'If you put in the middle of the circle a point and you measure from the middle to the end of the circle.' She measures several times and the children are saying the length.
Child 'That is equal round.' He shows it with his hands.

'The radius, actually we don't have to know it yet. But do you want to know?' *She is whispering it and saying sstt. She is saying it is content for the older children. The others may not hear this or know this.*

Children 'Yes'
Teacher 'Look this that they call in mathematics, the radius.' She draws a line from the middle point of the circle to the edge of the circle.
Teacher 'And the radius of the circle is equal everywhere.'
Teacher 'How much was it here?'
Child '5'
Teacher 'And this stick is 1 meter and a little piece of this stick is 1 cm, so how much is it then.'
Child ' 5 cm'
Teacher 'Suppose I would put a point in my oval.' She gives the pen to a boy. He places a point in the oval. The other children have helped him to search the oval on the board.
Teacher 'Is it in the middle? We shall see.'

The teacher chooses a girl and instructs her to measure the oval. It is a shy girl and the teacher asks if she wants to do it together with her. Another girl must read the sizes.

Child '11'
Child '3'
Child '10'
Child '3'

The teacher takes over the pen and writes the sizes near the lines. In fact she uses 2 colors, red for the horizontal lines and blue for the vertical lines.

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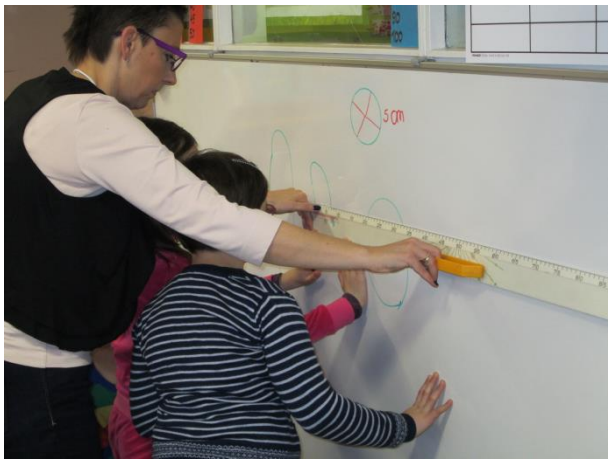
Teacher 'What is now the difference between an oval and a circle?'
Child 'With the circle it is round and with the oval it is straighter.'
Teacher 'With the circle the radius is always the same and with the oval it is not always the same, but the oval is round because the oval has no?'
Child 'rectangles, squares …
Teacher' No, what is this?' She is showing an angle.



The teacher is able to enhance the children's attitude towards mathematics by using humor, by interacting on their interests, experiences, opinions and preconceptions and by creating mystery (see opportunities for creativity). In the short episode below you will notice the playful interaction between the teacher and the children.

The teacher is drawing a circle on the board and she is using a tool, a round lid.
Child 'That is not fair.'
Teacher 'And why it is not fair?'
Child 'Because we may not use that and you are using it.'
Teacher 'I have thought about it. Did I say that you couldn't use a tool?'

Meanwhile there is a circle on the board.

Teacher 'Is this a circle?'
Children 'Yes'
Teacher 'How can you say 'Yes that is a circle'?'
Child 'Because it is round and it is thick.'
Teacher 'Yes, could be.' She asks a girl to say why she thinks that is a circle and the other form (oval) isn't.
Child 'It is not the same.'

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of forma land informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.1 Teachers should have knowledge of a range of formal, non-formal and informal learning, teaching and assessment approaches and strategies to promote creativity in their early years science and mathematics classroom. 7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries.
Factors linked with:	**T: Ped;** **P: Affect;** **M: Cr.;** **P: Scaff;** **P: Quest**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Cases 1 & 2
Episode:	The Giant
Teacher:	Maaike and Sarah
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Fostering children's curiosity and interests using a poster of a Giant. Using questions to support and extend inquiries.

A book of one of the girls in the classroom is discussed. It is a book about giants ('Het reuze reuzenboek' from Yvonne Deutch and Michelle Misra). In the book there is also a large poster of a giant. The girl presents the poster to the other children. The children are very amazed about the large poster.

The poster of the giant results in a comparison between the giant and the children. How large is a giant in comparison with a boy in the classroom? Do the children have also mushrooms growing in their armpits? Based on these questions some investigations are done, evidence is gathered by using the body of the children.

The giant has mushrooms growing under his armpits.

Maaike: Where is your armpit?

The teacher is asking this to all the children.

Sarah: Show your armpit.

Every child is showing and pointing to the armpit.

Maaike: Yes, here is the hole under your arm.
Sarah: Are there also mushrooms growing under your arms?

The children are saying no and are also shaking their heads.

Maaike: You know what, I'm going to check it by C2.We are going to see if there aren't any mushrooms growing in her armpits.

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All the children are watching the teacher and C2. The teacher is pulling the clothes of C2 up.

Sarah: Look at C2 her armpit.
Teachers: Are there growing mushrooms?

The children are saying no.

Sarah: Why does it happened with the giant?
Child: Because he is dirty.
Maaike: Because he is dirty?
Child: He has a pimple.
Maaike: Yes and it looks dark at his nose and his ears.
Child: Giants eat people.
Sarah What, do they eat people?
Maaike: Do you get mushrooms if you eat people?
Children: No - Yes - That is only with giants.
Sarah: A Giant, does he clean himself often?

Several children are shouting 'no'.

Maaike: Sarah, you are near the poster. Look on the poster, there are little letters and I also see a little mushroom, I think, is it so?
Sarah: Yes in that frame. We are going to listen to what is written.

A boy, who is already able to read, reads what is written in the frame.

Child (boy): Mushrooms are growing in the armpit of the giant, when he sleeps during the winter.

To assess the solutions and the data, the poster of the giant (information about the mushrooms in the armpits of the giant) is used. For example, according to the poster, the giant has mushrooms growing in his armpits because he sleeps during the winter.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of forma land informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of scinece and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.1 Teachers should have knowledge of a range of formal, non-formal and informal learning, teaching and assessment approaches and strategies to promote creativity in their early years science and mathematics classroom. 7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries.
Factors linked with:	**T: Ped;** **P: Affect;** **M: Cr.;** **P: Scaff;** **P: Quest**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Cases 1 & 2
Episode:	The Giant
Teacher:	Maaike and Sarah
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Fostering children's curiosity and interests
using the story of *Jack and the Beanstalk*
Using questions to support and extend inquiries and problem solving.
Assessing solutions and ideas of children using questions.

A book of one of the girls is discussed. It is a book about giants ('Het reuze reuzenboek' from Yvonne Deutch and Michelle Misra).

Based on the demands of the children, one of the teachers starts to read the story of 'Jack and the Beanstalk.' At a certain moment she stops reading. Jack is trapped in the oven.

Sarah: What does Jack has to do to escape?

Several children are now reacting on each other.

Child: I know, maybe there is a key nearby to open the oven.
Other Child: No, the giant has the key.
Other Child: If the giant opens the oven and he sees the child.
Maaike: Yes, what then?
Child: Then the child have go the between the legs of the giant. He has to loosen the goat and then the goat will attack the giant, who will fall.
Sarah: But a goat against a giant. How large is the goat?

One of the children is showing how large a goat is, almost his own length.

Sarah: Look at how large a goat is and C is a small child. C is maybe as large as Jack.
Child: oepsie
Maaike: You are large *(she is saying it to the child who showed the length of the goat*) but for a giant you are a little child.
Sarah: I think it will be impossible for a goat to attack a giant.

Several children are showing what will happen and there is some commotion in kring.

Maaike: I just think of something. Who lives with the giant?
Children: The giant's wife.
Maaike: The giant's wife, is she angry at Jack?
Children: No.
Maaike: Maybe Sarah, this wife can do something for Jack since she is not angry at Jack. She doesn't want to eat him. She has helped him to hide.

T1 asks a child what he would do.

Child: To hide in a different place, where it is hard for the giant to find him.
Maaike: Yes but that is a bit a problem, Jack can't get out of the oven on his own.
Child: Then he could ask the wife, can I get the key.
Other Child: But then the giant can hear it.
Other Child: And the key can't go through the glass.
Maaike: Yes, but do we need a key to open an oven?
Children: No
Child: You simply have to pull and then the oven opens.
Maaike: But if you are in the oven? He is in the oven.
Child: Someone else have to pull.

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Other Child: No, the giant can see this and will say: haha my meal is there.

Again different children have solutions and other theories.

Maaike: Maybe it is in the book?

Sarah starts to read the book again and they hear the solution of Jack. The teacher is reading further. At the end of the book the giant disappears in the sea. Again the teachers are asking the children several things. Where is the giant exactly? And how can he survive?

Again the children are reacting on the questions and on each other. There is a lot of fantasy and they have different theories. The kring ends with a physical activity which is linked to the story of Jack and the Beanstalk.

After the kring moment the children work in groups (they are divided over the two classrooms and they select themselves in which corner they will work, some are making drawings of the giant.

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BE_Class_TheHail_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	1.2 Teachers should be able to make children aware of connections between science and mathematics learning and their everyday lives, in order to engage their motivation, interest and enjoyment in science and mathematics and foster curiosity and creativity.
Factors linked with:	**P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Class
Originating from:	
Country report:	D 4.3 – Belgium
Case:	Case 6
Episode:	The Hail
Teacher:	Ilse
Age Group:	7 – 8
Selected episode present in D4.4 Appendix	No

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Connections between science learning and the everyday live of the children. Fostering reflection

All children are sitting in a circle, the teacher is in the middle of the circle. The day starts with a talk about the weather during the weekend. It snowed the days before and the children have created snow mans during the weekend. But then the snow mans melted. The children talk about these melted snow mans and the hail which was also coming down.

The teacher is very good in connecting science learning to the everyday live of the children. She also makes a lot of connections between different scientific topics, or to illustrate a scientific content (the Earth is round). By doing this, she tries to foster reflection and make children aware of connections.

C= Child
T= Teacher

C: There was ice coming down from above.
Other C: Hail
T: Hail. What is hail?

Several children raise their hands.

C: *Those little balls.*
T: Where are those small balls made of?
C: Of ice.
T: They are made of ice. But what was ice first?

Some of the children say 'Snow'. *And others say* 'No, water.'
Several the children are giving the answer and there is a lot of noise. The teacher reminds them of the agreements. The children are saying: 'Raise your hand. And do not shout.'

T: M. what was hail first?
C: Water
T: Water. Hail is in fact rain which is frozen.

She articulates the words.

T: Because above in the air it is much colder than down here on the Earth.
C: Sometimes it is warm on the Earth.
T: Yes, and then you get above … you are right actually, I'm going to draw that.

The teacher is saying to us that she is doing something different then what she has planned. But the children are very interested. She uses the whiteboard which is in the 'kring'.

T: May I First draw the Earth. How the Earth looks like?
Children: Round.
T: Round, the Earth is round.

She draws a circle on the white board.

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C: Miss, you do not see that it is round here, because here everything is right.
T: I was going to say exactly … because if the Earth is round then …

The teacher is pretending that she falls of the Earth.

C: Then you can fall of.
C: The Earth is straight.
T: Is the Earth straight?
C: No, the Earth is round however you can't see that she is round.
T: There is a place where you can see that the Earth is round.
C: Miss, I know.

The teacher interrupts because she wants that every child gets the opportunity to reply.
Other child 'With a telescope.' *The other children have some comments on this.*

T: Do you look to the Earth with a telescope or …?
Children: To the stars.
T: With it you look to the stars.

There is some buzz among the children, they have another proposal to use the telescope, they are also making some gestures. The teacher says that there proposal is rather difficult.

T: Who of you has been to the sea before?

Several fingers are going up. The teacher reacts to a child she didn't hear yet. She asks to the child if she has been to the beach.

T: You stand on the beach and you see the sea before you.

The teacher demonstrates where the sea is located. The children need to close their eyes and think of the sea before them. And then they have to look and look and look, until they see the spot where the air touches the sea.

T: If you look at the spot where the sea touches the air, is that a straight line or a …

The teacher is drawing a straight and a curved line on the floor.
Some children are saying 'Straight line'.

T: How do you call this line?

The teacher draws again a curved line.

C: Curved.
T: A curved line.
T: That is a curved line.
C: Otherwise it is straight.
T: Why is it a curved line?

The teacher repeats the question after the answer of some children about boats and waves.

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Teacher Education Design Principle + code:	16. Teacher education should provide teachers with knowledge of approaches to timetabling and organizing cross- circular project work. **TE: CrossCurr**
Specific Teacher Outcome(s):	16.1 Teachers should be able to use approaches to cross-thematic, cross-circular and project work to promote creativity in science and mathematics. 16.3 Teachers should be able to build connections across the curriculum of various kinds and with potential to contribute to children's inquiry and creativity.
Factors linked with:	**C: Sci/M Integ;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – Belgium report
Case:	Cases 1&2
Episode:	The Mask
Teacher:	Sarah
Age Group:	4–6
Selected episode present in D4.4 Appendix	No

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Incorporating science and mathematics in an art and craft activity.
Making connections.
Evaluating children's work

After the 'kring' moment (the central place in the classroom where the children gather at the beginning of the day) the children have to choose what they like to do, there are corners which are regular (such as the construction corner, the book corner …) however there is also a more special activity. The children can choose to design a mask (because of the carnaval). Children can choose to work in the classroom of Maaike or in the classroom of Sarah. Both are guiding a mask activity.

In the classroom of Sarah, there are 6 children working at the 'Mask' table. They are creating a mask with a flag on it (because of the 'Belgium in Europe and beyond' project); however children who don't want a flag on their mask may use their own ideas. So two girls decide to make a sprout as mask.

On the table there are several materials, there are different kinds of glue, different kinds of other adhesive materials, different kinds of decoration materials. The children are also allowed to take materials from the different bins in the classroom.

In the episode below the teacher is evaluating the mask together with the girl. As you will notice in the small episode with the girl, mathematics is integrated very naturally, initiated by the evaluation of the mask.

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Child 2 ‘I can’t do a hole.’
Teacher ‘Say Mrs. Sprout, how does a sprout look? Do you know sprouts?’
Child 2 ‘Yes.’
Teacher ’How?’
Child 2 ‘Green
Teacher ‘Green, and what is the format of a sprout?’
Child 2 ‘round’
Teacher ‘Do we have now a round already?’ *The teacher takes the mask and shows it to C2.*
Teacher ’Look.’
Child 2 ‘No’
Teacher ‘What do we have now?’
Child 2 ‘Rectangle.’
Teacher ‘We have a rectangle, very good.’
Teacher ‘But how can we make a round of it?

The design of the masks also enhances the knowledge of the girl concerning sprouts. She and the teacher searched for sprouts on the internet and together they have observed the sprouts and the leaves of the sprouts. Based on this observation she made her mask more round, using separate leaves. By encouraging the girl to observe real sprouts, the teacher uses the interests and the imagination of the girl to increase her knowledge about vegetables (nature).

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BE_Class_TheMask_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**AO: Creative;** **P:Ques;** **P:Scaff;** **P: Agency;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – Belgium
Case:	Cases 1&2
Episode:	The Mask
Teacher:	Sarah
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Questioning (and standing back) to inform reflection and reasoning, fostering agency and peers to interact

When the children have to choose what they like to do, there are corners which are regular (such as the construction corner, the book corner and so on) however there is also a more special activity. The children can choose to design a mask (because of the carnaval). Children can choose to work in the classroom of Maaike or in the classroom of Sarah. Both are guiding a mask activity.

In the classroom of Sarah, there are 6 children working at the 'Mask' table. They are creating a mask with a flag on it (because of the 'Belgium in Europe and beyond project); however children who don't want a flag on their mask may use their own ideas. So two girls decide to make a sprout as mask.

At a certain moment a child (a boy) who has worked in another group, also wants to design a mask. He wants to make a bunny.

On the table there are several materials, there are different kinds of glue, different kinds of other 'adhesive materials, different kinds of decoration materials. The children are also allowed to take materials from the different bins in the classroom.

During the episode, Sarah interacts with the boy who wants to make a bunny mask and with the girl who is making a sprout mask. Sarah knows that she has to guide the boy more intensively because he gives up easily. During the episode he tries to make eyes in the mask, in doing so he is trying out several tools.

Teacher 'Eyes and how can you make those eyes?'
Child 1 'With scissors.'
Teacher 'With scissors? Are you going to try with scissors?' *The teacher is saying this in a very encouraging way.*
Teacher 'And how do you know where your eyes have to be?'
Child 2 'In the middle.'
T 'hm.' *The teacher looks at Child 2 who is repeating what she has said.*
Child 2 'In the middle' *However straight after this she says* 'No here' *and she is pointing with her finger to her eyes. Child 1 is watching.*
Teacher 'The eyes are indeed here in the middle.' *She turns back to Child 1 and asks* 'How can you know that here?'. *She points to the paper from which the mask will be made.*

Child 1 shows with his finger where the eyes have to be. The teacher confirms this and asks the other children how they have worked earlier.

Two children show how they have done it and they also give a limited explanation while showing with their hands. They have held the paper before their eyes and the teacher has drawn circles on the paper at the height of their own eyes.

By using questions the teacher tries to stimulate the reflection and critical thinking of the children. Although she finds it not so easy to keep a balance between interacting and no interacting. Some children do not need much input, others, like the boy in the episode, need some more coaching otherwise he quits.

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Sarah: 'As a teacher you don't have to reveal everything too quickly. You have to keep asking questions, so children can give the answer or solution themselves. The children have to experience themselves and have to do investigations on the materials. Some children may need some advice sooner than others, in order to stimulate them further. Some children stop working if they don't find the solution easily or if something doesn't work.'

The latter is very well illustrated in the following episode. And also here the other children interact as peers.

C1 begins to cut but it is not going too easy, he cuts above the eyes and horizontal. It is hard for him to get the scissors in the paper. C2 says 'No' and shows how he should do it. She does prick movements. C1 puts the scissors otherwise and the scissors are now standing perpendicularly to the paper. However it does not work, and he looks around and watches the other children. He calls the teacher and indicates that it failed.

Teacher 'Do you have problems? How can you try otherwise?'
Child 4 'With a spike or something else.' *Child 1 looks with the scissor in his hand to the paper. The teacher is sitting beside him.*
Teacher 'How could you try it differently? How can you make a hole in there?' *He points towards the bins which are near the table.*
Teacher 'Have a look in the bins. Can you use something from there? Go and have a look.' *Child 1 goes to the cabinet with the bins and looks in a number of bins (taking 1 or 2 minutes). He doesn't seem to find anything.*

The teacher, who comes over, encourages him to take something out of the bin that pricks. He has found a stick.

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Teacher Education Design Principle + code:	16. Teacher education should provide teachers with knowledge of approaches to timetabling and organizing cross-curricular project work. **TE: CrossCurr**
Specific Teacher Outcome(s):	16.1 Teacher should be able to use approaches to cross-thematic, cross-curricular and project work to promote creativity in science and mathematics. 16.2 Teachers should be able to use a variety of approaches to timetabling, within the existing curriculum and policy expectations to allow space for cross-curricula project work and child-initiated exploration and inquiry. 16.3 Teachers should be able to build connections across the curriculum of various kinds and with potential to contribute to children's inquiry and creativity.
Factors linked with:	**LA: Connect;** **P: Quest;** **P: Express**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Cases 1 & 2
Episode:	The Pirates
Teacher:	Maaike and Sarah
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Investigation during the design of a pirate, resulting in mathematical concepts and understanding of the body.

The children have to choose between different activities. One of the suggested activities is to create a pirate for their Pirate boat. The children are working in small groups, in this specific activity they are working with 4 children.

The teacher comes and goes during the activity and takes time to observe the children. The children may use all the materials in the classroom to make their personal pirate (in the classroom there are a lot of different materials: different plastics, different papers, different tapes, different glues, …). Sometimes the teacher interacts by placing some additional materials at the table; as such she is making suggestions without steering the children. She also is very well trained to use questions in order to foster the problem solving and evaluation of children's work. At the end of the activity the children have their own personal pirate and have learned a lot *about the concepts 'bigger' and 'smaller', about several* materials, about connections between materials and about finding solutions for technical problems.

An evaluation of the child's work is important, did it work or not.

Below you find one of the moments in which the teacher observed a child who has his own idea of which material to use. She asks the child questions about the material, by using questions the teacher is guiding the evaluation process.

Teacher: "Is this then the body you want to use?" ... "Can you try to use this?"

The child places the box above a cardboard roll.

Child 2: "No, it's too big" ... "I will use this one." *And the child points at the materials next to the table.*
Teacher: "Can you try it once?"

The child is looking at the different materials

Teacher: "What do you need then?"
Child 2: "A smaller box."
Teacher: "Can you look for something smaller than this one?" *and she shows the big one the child selected at first.*

Child 2 is looking for a smaller box.

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By constructing their own pirates there are also opportunities to learn something about the human body, because they are making a link between their own body and their pirate. Again the teachers uses questions to evaluate a child's own idea (position of the feet).

Child 1 *grabs the box and holds it below the cardboard roll.*

Teacher: "Ah, his feet! Are your feet at your head?" *and she point at the feet of the child*
Child 1: "Here are my feet" *While she is pointing at her feet.*
Teacher: "Are this two feet or one foot?"
Child 1: "One foot!"
Teacher: "Oke, you may try!"
Child 1: "It doesn't work."
Teacher: "How many legs do you have?"

Child 1 shows with her fingers she has 2 legs.

Child 2: "And how many feet?"
Child 1: "Two!"

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BE_Class_ThePizza_Resources

Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations. 17.6 Teachers should be able to gain insights into children's developing explorations and creativity based on their use of resources.
Factors linked with:	**M: Expl;** **M: Cr;** **M: Variet;** **L: Indoors;** **P: Agency;** **A: Evid;** **P: Express**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – Belgium report
Case:	Cases 1 & 2
Episode:	The Pizza
Teacher:	Maaike
Age Group:	4–6
Selected episode present in D4.4 Appendix	No

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Using a variety of everyday materials and equipment to foster the explorations, problem solving and creative thinking of children.

The children are divided in small groups. The children have to choose themselves in which groups they want to be. In one of the groups, guided by Maaike, pizzas will be prepared. The children in her group are in fact the cooks on a pirate ship. The reason for this is quite interesting. The day starts in the 'kring'. Suddenly a girl sees two men entering the schoolyard and she says 'The crooks are there'. This fact is the start of a whole discussion about crooks and catching crooks. The discussion is ending with the hook of Captain Hook, the moustache of captain Hook and pirates. Since the children are that interested in these subjects, the teachers decide (at that moment) to reorganize the group activities and to link all the activities to the subject pirates and captain Hook. So, one of the activities 'making a pizza with ingredients given by the parents' is now integrated in the Pirates idea. The children are pirates on a ship and they have to make the pizzas for all the other pirates (children) on the ship.

The activity runs the whole morning. The teacher and children start with observing the ingredients the parents have given. In the beginning, their attention is caught by the cans with pineapples. They are discussing how to open the cans, and they also notice the different forms of the pineapple. Then some children and the teacher are searching for bowls. Others are placing the ingredients on a big table. Then the tomatoes and peppers are washed. Meanwhile the teacher is stimulating the reasoning of the children. Why do we have to wash the tomatoes? Why can't you put a bowl on your head?

Finally all ingredients and tools are on the table. From now on several events are running through each other. The teacher is dividing her time between the 9 children around the table who are all doing different things. Some of them are cutting mushrooms or tomatoes or pepper, others are making dough with the pizza mix, then there are children putting tomato on the roll out dough. During these different activities the problem solving of the children and their reasoning is continuously stimulated. They have to find solutions for cutting the mushrooms without a knife, for rolling out the dough without a rolling pin.

The teacher gives children time to think. However, she interacts when she notices that some of the children lose their attention, or do not find a solution (for example the second boy in the episode beneath).

Maaike 'I only have one knife. What else can we do?'
Boy 1 'Cut' The boy shows with scissors what he wants to do.
Maaike 'Are you going to cut with scissors? Try.'
Maaike 'Are you also going to use scissors or what are you going to do?' She is asking this to another boy who has also a bowl in front of him.
Maaike 'Try to think of another way to divide the mushrooms in small pieces.'

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After some time the boy is still watching the others, he hadn't started yet.

Maaike 'You have to do the mushrooms in pieces'. The boy reaches out to the scissors. Maaike 'But not with scissors. With something else.' The boy puts his finger on his chin and starts to think. After a while he shrugs his shoulders. The teacher has to help other children and the boy again is watching the others. Then the teacher notices for the second time, the boy still hasn't started.
Maaike 'X. think very well, I give you a mushroom, you have a bowl, try to divide it in small pieces and think with what you will do it. What do you think?
Boy 2 'With a knife?' 'Or with my hands?'
Maaike 'with your hands? Is it possible? Try it.' The boy asks for a mushroom and starts to divide the mushroom with his hands. He has a piece in his hand s and he his very pleased.
Boy 2 'Yes, done.'
Maaike 'Yes, try, is the mushroom hard?'
Boy 2 'No, soft.'
Maaike 'Ha, yes, then it has to work, doesn't it?

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering and extending inquiry and creativity, by for example prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events. 7.4 Teacher should be able both to build in new and to make the most of existing opportunities for child-initiated play, recognising and capitalising on the potential of children's explorations beyond the teacher's original intentions. 7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games.
Factors linked with:	**P: Express;** **AO: IBSE/PBL;** **AO: Creative**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Case 4
Episode:	The Tipi
Teacher:	Lies
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Using the children's preferred forms of expression (constructions) to support inquiry and their creativity development

This activity is building further on previous play in the sand box, during which they have used sand to create a tipi. At the beginning of that day, the children had collected twigs in the surroundings of the play ground. They asked the teacher if they could use the twigs in the classroom to build their tipi. During the activity they used different kinds of suture material, and were collaborating very intensively. At the end of the activity the children played with the Indian figures and their tipi construction(s).

In order to encourage the learning process, there is already a lot of material into the sand box, but the teacher is bringing in gradually other materials. This gives the children the opportunity to look for different solutions and offers chances to explore materials brought in by the teacher. The teacher also only interacts to foster the problem solving of the children (she is using questions).

C1 *is placing the rope around the twigs and makes a knot.* **C2 and C3** *are watching how* **C1** *is doing this.* **C2 and C3** *are grabbing some cloths to place on the twigs.*
T *comes in and offers some pieces wire (iron wire).*
C3 *places the cloths on the sand mountain, while* **C2 and C1** *are working together to cut off some pieces of iron wire using scissors.*

Teacher *comes in and asks:* "Do your Indians want a tipi for their own?" *She takes tree twigs and places them together in a piece of sand and she asks the question:* "How can we fix them now?"
Child 3 *keeps working on the mountain of sand.*
Child 1: "We can use a rope" *and he goes to the other side of the sand box to grab a rope.*

The teacher leaves the group.

Child 1 *and* **Child 2** *are working together to fix the tipi. One child holds the twigs, and the other one makes a knot.*

Teacher: "What will happen if it aerates*?" and she blows in the tipi.*

The children see the cloth move.

Child 1 *blows also into the tipi, and they look for materials to fix the cloth. They use more clothespins and* **Child 2** *asks at* **Child 4** *to help her with cutting a piece of iron wire.*
Child 4 *places the iron wire around the tipi and* **Child 2** *makes a knot.*
Child 2 *tries to blow again and sees that the tipi doesn't move anymore.*

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Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity 3.3 Teachers should be able to use the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**AO: Kn Sc;** **P: R&R**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 Belgium
Case:	Cases 1 & 2
Episode:	The Waterfall
Teacher:	Maaike and Sarah
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Fostering children's reflection and reasoning using holiday pictures.
Valuing children's ideas

In this classroom (about 50 children and 2 teachers), in order to stimulate conceptual understanding, all theories and reasoning of children are sampled. So time is given to the children to formulate their own opinions and theories. Teachers are not correcting the answers of the children, instead they are listening very well to what children are saying or they look what they are doing. Based on these observations they are using other questions to stimulate their critical thinking or to elicit other opinions, which is illustrated in the fragment below.

On the digital school board in the classroom of Sarah, a photograph of a big waterfall is projected (it is a holiday photograph of one of the children). Based on this photograph a discussion starts about the origin of a waterfall.

Maaike How do we call them, those great big stones?
Child Rocks
Other Child Rocks are stones of the mountains.
Third child Yes, a mountain is collapsed and because of that, a waterfall arises.
Sarah Yes, that could be Maaike.
Maaike From where the water comes?
Child From the city.
Maaike From the city?
Other child From the river.
Maaike Yes, water flows in a river. Or is there a river in the mountains above?
Child It could be from the sea.
Sarah It could be
Other Child The water is clean. It comes from the rain.
Sarah Of the rain, then there should be a lot of rain.
Maaike In the winter in the Mountains, what can we find there?
Child Snow. Snow can melt and then it becomes water.

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After this there is a short break because the children are very excited and want to give their explanations and ideas. So they are talking at the same time.

Other child It could also be that they are opening a water well and the water is very high. Then it may be that the water falls out and then it becomes a waterfall.
Maaike A well above, who knows?
Child Water all comes from a well and then that becomes a waterfall. And then the water runs over the mountain and you will no longer see the mountain.
Maaike Sarah, maybe we can look it up, because everyone thinks differently.
Sarah Yes, hey.
Maaike How a waterfall arises? And what types of waterfalls exist?

At the end, the internet is used to check the different theories and concepts of the children, and to discuss what is written by experts. In order to stimulate their visual and audio senses, YouTube films of waterfalls are used.

The children can bring in their solutions and ideas immediately without raising their finger. The teachers allow some noise, however if the children are too excited a little break is necessary. The reason for these discussions, even in this large group, is mentioned by Sarah:

'The children may also think further and react on each other, integrating fantasy. So children are then discussing and leading the kring 'talk'. At those moments, as a teacher, you have to let go. Children should be able to talk to each other and to discuss. Because you're with two teachers, you can much easier hear what all the children say and you can easily interact at the right time. We also believe that children don't have to wait to intervene, or that they have to put their finger on. Often when they have to wait, they have lost what they wanted to say. Eventually they also listen to each other. The more the children are going in discussion, the less they feel that they are the only one talking and they got less blocked. However as a teacher at some point you have to interact again. So, as a teacher you have to let go and then again interact.'

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BE_Class_TheWind_PractInvest

Teacher Education Design Principle + code:	2. Teacher education should provide teachers with skills and competences to carry out practical investigations of science and mathematics in the classroom. **TE: PractInvest**
Specific Teacher Outcome(s):	2.1 Teachers should be able to instigate and involve children in the design and conduct of practical investigations of science and mathematics in the classroom, as such activities can contribute to the development of children's creativity.
Factors linked with:	**LA: Plan**
Type of material (image – interview (int) – classroom extract (class):	Class
Originating from:	
Country report :	D4.3 – Belgian report
Case:	Case 4
Episode:	The Wind
Teacher:	Lies
Age Group:	5-6
Selected episode present in D4.4 Appendix	No
Link with	DP 6: IBSE DP 17: Resources DP 11: Question

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Planning investigations with wind

During the activity the children were allowed to experiment with different materials in front of a fan, to see if they move with the wind. After a while the teacher introduced boxes, the children had to arrange the objects in the boxes based on their reaction in the wind (before the fan). Later on they did a recheck and had to fill in an assignment card on which the objects were visualised. Then the children were also allowed to experiment with materials they found in the classroom. During the activity the teacher asked questions and encouraged the thinking process of the children. At the end of the activity they discovered that the canoe made a strange movement when placed in front of the fan.

In this activity the main focus of the teacher was encouraging children to conduct an investigation and to observe and explain. She tried to make them check their observations by using different strategies (the boxes, the assignment card) and encouraged them to reflect on the things that were happening, such as in the fragment below.

At this point one of the children brings in a canoe from the Indians.
Child 4: Teacher, the canoe doesn't move!
And at that moment the canoe goes sidewards.
Teacher: Oh, **C4** look what's happening.
Child 4: it moves sideways.
Teacher: And if we place it in the other direction, will it move too?
Child 4 places the canoe in the different direction and notices it doesn't move.
Teacher: How is this possible?

In this activity the children's curiosity is encouraged by the research questions. The children are eager to know if an object will move. However, also in her coaching the teacher tries to foster the discovery urge and she herself is also excited. As such, she becomes an inquirer herself.

Child 4 is placing the sheet of paper in front of the fan.
Teacher: Oh, should the paper always fly away?
Child 4 places the paper folded in two on the table in front of the fan.
Teacher: Look, does the paper fly away now?
All the 4 children are looking at the sheet of paper.
Teacher: How did it come it flew away before?
Child 2 is opening the sheet of paper and sees that it is flying away then.
Teacher: What did you do with the paper?
Child 2: I have opened it!
Teacher: You had opened it.

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Child 4 is picking up the paper and places it open in front of the fan, but pushes it completely against the table.
The children and the teacher are all looking what will happen. The paper stays at his place.
Child 1 is picking up the paper and places it a little bit further on the table, and then it flies away.
Child 3 is picking the paper up and places it back together with C1 on the table completely flat and then it doesn't fly away, until they pick it up a bit.

During their play, the children also discovered the possibilities of the fan, so they learned how handle this technical system in order to make it blow fast and slow, to change the direction of blowing,... So they got the opportunity to handle this technical system in a proper way.

The children discovered they could make the wind blow hard and soft, and this made them experiment with the other materials.

Teacher: C1, you wanted to know if the isomo still flew, if the wind blows softer.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations.
Factors linked with:	**M: Expl;** **M: Cr;** **M: Variet;** **P: Agency**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – Belgian report
Case:	Case 4
Episode:	Colouring water
Teacher:	Lies
Age Group:	5–6
Selected episode present in D4.4 Appendix	Yes

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Providing a rich variety of resources

The activity was part of a bigger project about American Indians that the children had chosen to do. The children found out that some American Indians use natural dyes to colour their clothes, so the children first explored how to dye cotton fabric and later on they made their own clothes.

This data focuses on four girls who chose to work in the corner where they were dyeing pieces of cotton fabric with dyes from natural products. On the table were a rich variety of materials, such as oranges, grass, herbs, coffee, tea (also rose hip tea), funnels, sieves (in different sizes), cutting boards, scissors, cups and knives. The children were also allowed to go outside to collect more natural materials if they wanted to do so.

To scaffold the children's technique for extracting the dye the children were given an instruction card with pictures showing how they have to handle the natural materials and how to separate these materials from the coloured water to extract the dye. Lies only interacted when necessary or when the girls explicitly asked for her help.

The children were given the freedom to select the materials themselves and two of the girls decided to go outside to collect more grass and mud for their investigation.

Although the children had an instruction card to guide them, they were allowed to plan their own investigations, for example, they had to choose which sieve to use by investigating which size was most successful at separating the materials from the water. Indeed, one child chose not to sieve her coloured water at all. They could also choose how long to leave the cotton fabric in the water and one girl left her cotton fabric longer in the water and she noticed the colour deepened the longer it was in the dye.

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BE_Img_TheCarpenterCorner_Resources

Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations.
Factors linked with:	**M: Expl;** **M: Cr;** **M: Variet;** **P: Agency**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – Belgian report
Case:	Cases 1 & 2
Episode:	The Carpenter Corner
Teacher:	Maaike
Age Group:	4–6
Selected episode present in D4.4 Appendix	Yes

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Rich variety of resources/ Agency – Children solving problems themselves

Two children chose to work in the carpenter corner. One of the children was a four year old girl, who had worked already in the carpenter corner. The other child was a five year old boy. For him everything was new as it was his first time in this atelier and this classroom.

The Carpenter Corner had a very rich physical environment with a special work bench and with real carpentry tools; several saws, nails, pincers, hammers, and wooden materials were made available. The children could also go outside the classroom to bring in other materials. Maaike stressed the importance of using real materials to design and inquire. The children could select the materials they wanted to use by themselves, so, ownership and agency was very much stimulated.

Child 1: Can I use that big bucket?
Teacher: Why do you need a bucket?
Child 1: I would like to transport the wooden materials in it, because otherwise I I can get a splinter in my finger.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.10 Teachers should value and be able to make use of varied forms of assessment evidence (including children's portfolios, individual or group records of activities), both to promote creative learning, through reflection and discussion in science and mathematics, and explicitly to inform teaching and longer term planning
Factors linked with:	**P: Affect;** **M: Cr;** **A: Evid**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report Belgium
Case:	Case 6
Episode:	The Circle
Teacher:	Ilse
Age Group:	7 – 8 years
Selected episode present in D4.4 Appendix	No

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Paintings as powerful tools to foster creativity in mathematics education
Drawings of children as evidence

This activity is integrated in the central theme of art (www.startwithart.org). The children had been introduced to a painting with a lot of circles on it. More specifically the children had been doing an exercise on counting geometric figures in paintings, after they had been offered classical information about the circle and the oval. They also had been active by coloring and counting for themselves on their work sheet. At a given moment the teachers calls them together to show them something new, they may use a new tool, a pair of compasses. After an instruction moment, the children may experiment with pairs of compasses. Later on in the week, they may use the pair of compasses to make their own piece of art with geometric figures as you can see in the picture below.

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Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out. 14.4 Teachers should be able to manage visits with children to the outdoor and wider environment beyond the school, addressing issues of health and safety, liaison with parents, building progression in experience inside the classroom.
Factors linked with:	**L: Out/Indoors;** **M: Outd.;** **M: Inf.**
Type of material (image – interview (int) – classroom extract (class):	Interview
Originating from:	
Country report :	D4.3 – Belgium report
Case:	Case 4
Episode:	/
Teacher:	Lies
Age Group:	5–6
Selected episode present in D4.4 Appendix	No

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Cooperation with (grand)parents and other experts - outdoors

In the day to day practice of this teacher, cooperation with other experts is common. For example, when Lies and the children in her class went to a nature park, she invited an expert to assist her during the explorative activity in the park.

As a teacher, Lies puts a lot of emphasis on the cooperation with for example (grand)parents. Consequently, they provide her with materials to use in the classroom; they assist her in making clothes for the school show, they invite her and the children in their garden (picture) and so on.

She also tries to make use of the talents and strengths of the parents and grandparents. For example, she organized an evening for the children and their parents. At this evening the 'special guest' was one of the parents; he was the expert in the topic of the week.

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FI_Class_AnimalFences_NoS

Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE:Nos**
Specific Teacher Outcome(s):	3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity. 3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**LA: Connect;** **LA: Expl;** **P: R and R** **AO: Kn.Sc;** **AO: Sc ProcSkills;** **P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Finland
Case:	Case 6
Episode:	2
Teacher:	Helen
Age Group:	6-9
Selected episode present in D4.4 Appendix	No

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Fostering processes of classifying, expressing existing ideas and reflection – the main processes of science

At first the children had a teacher led session where they name the animals together. Teacher asked justification for each: how you that this is squirrel or how you know that this is crow? After that the children start to work in small groups to find similarities and differences of presented animals.

Teacher "Now you can come to categorize these animals with your group. You can decide in your groups what kind of categories you want to make."

LUO-KIT-TE-LE E-LÄI-MET Classify animals

All groups created their own categorization and group tasks were saved on interactive whiteboard. Children had to name all their categories. When groups finished, they discuss the categories through with teacher and categorized animals together once more with supported questions (why this belongs to this group? Why cannot to be in other group?) of teacher to find scientific categorization such as birds, fishes, mammals etc.

The children became aware of process of generating biological classification of animals using their firstly their own existing knowledge and teacher's supportive questions.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations.
Factors linked with:	**M: Expl;** **M: Cr;** **M: Outd;** **M: ICT;** **M: Inf;** **M: Variet;** **L: Out/Indoors;** **P: Agency**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 - Finland
Case:	Case 5
Episode:	2
Teacher:	Rachel
Age Group:	6-9
Selected episode present in D4.4 Appendix	No

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Using tablet computers for learning map symbols in outdoor context

The aim of the lesson was to apply map symbols to concrete objects in the school yard. The children's understanding of the map symbols was confirmed. In addition, the children learned to use iPads for reporting their findings and sharing their findings with other children in the classroom.

Teacher 'Now each group take pictures of different objects, please listen. Each member of the group takes one photo and all photos must be from different objects. Can you each take four photos, Niklas?'
Child 'No!'
Teacher 'That's right, no! Now you try to find objects meeting the map symbols! Now you can go, Good luck! When I will ring the bell, you should come back!'

Children are looking for the objects and taking photos in playground. Teacher observes and provides feedback.

Teacher 'Okay, let's look! Who has taken this? Okay, what is this?'
Child 'Lintuemo *(Name of the Climbing frame)'*
Teacher 'Yes, and what is this?'
Child 'Pine'
Teacher 'Yes, pine tree! Okay!'

The children return to the classroom. Teacher gives feedback for the pupils:

Teacher 'I was very happy about your way to work in outdoors. Did all groups manage to take those four photos?'
Children 'Yes *[all together]'*

In the end, the teacher and children together learn to send photos from Ipads to email box.

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FI_Class_MeasuringOutside_IBSE

Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.
Factors linked with:	**P: Agency;** **P: Ques;** **P: R and R;** **LA: Ques;** **LA: Plan;** **LA: Obs;** **LA: Equip;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Finland
Case:	Case 2
Episode:	1
Teacher:	Kirsten
Age Group:	6
Selected episode present in D4.4 Appendix	No

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Fostering children's creativity in measuring activities

The teacher introduced the activities and asked the children to observe the environment and find the objects (plants, trees etc.) which had a same feature (the length or shape) than they have, or those are smaller or taller. After finding the appropriate object, the teacher asked the children to describe and describe what they have found and why they have chosen that object.

Teacher: Look for something bigger than you
Child I found a pit, it's bigger than me
Teacher What tree is it? Laura, what did find bigger than you?
Laura: This plant, I do not know what this is.
Teacher: OK, Juuso, what did you find?
Juuso: This kind of stick?
Teacher: What stick it is?
Juuso: A wood stick.
Teacher: Yes, it is aspen stick! Anna, why did you choose that?
Anna: This is taller than me!
Teacher: Ok, what kind of object you found?
Anna: A tree.
(Continue)
Teacher Can you find something this long? This is one metre.

Teacher gives measure sticks to everyone.
Children try to find and inform teacher when they are ready.
Activity continued with measuring snow as well.

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Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out. 14.3 Teachers should be able to elicit and build on children's informal learning of science and mathematics outside school, at home or in the wider environment. 14.4 Teachers should be able to manage visits with children to the outdoor and wider environment beyond the school, addressing issues of health and safety, liaison with parents, building progression in experience inside the classroom.
Factors linked with:	**L: Outdoors;** **L: Informal**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Finland
Case:	Case 2
Episode:	1
Teacher:	Kirsten
Age Group:	6
Selected episode present in D4.4 Appendix	No

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Measuring activities outside near the lake
(1½ km from kindergarten)

The teacher introduced the activities and asked the children to observe the environment and find the objects (plants, trees etc.) which had a same feature (the length or shape) than they have, or those are smaller or taller. After finding the appropriate object, the teacher asked the children to describe and describe what they have found and why they have chosen that object.

After measuring the length the children measured thickness and temperature of snow and ice. Measure stick created by one child was used for this.

Teacher "Now you need a pencil. Try to find a place where snow is the thickest. Measure the thickness and make a mark into the measure stick. Let's see who finds the thickest snow bank."

Children measure and come back. Then they compare the results together.
The boy who has found the thickest snow bank snows where it is.

Teacher "How could we measure the temperature under and above the snow?"

Teacher takes out thermometer and allows the boy to choose someone to go with him to measure the temperature.

Activity: Measuring ice.
One child measures the temperature of water.

Teacher "The temperature is the same as the last time."

Teacher and some children are watching when the child who created an instrument measures thickness of ice. Teacher helps the child.

In the end children have opportunity to ice fishing.

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After the measuring activities and snack the children had time for snow sliding and having fun in the forest.

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FI_Class_Multiplicationstories_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.2 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development.
Factors linked with:	**P: Express;** **AO: IBSE/PBL;** **AO: Creative**
Type of material (image – interview (int) – classroom extract (class):	Class
Originating from:	
Country report :	D4.3 – report Finland
Case:	Case 6
Episode:	3
Teacher:	Helen
Age Group:	6-9
Selected episode present in D4.4 Appendix	Yes

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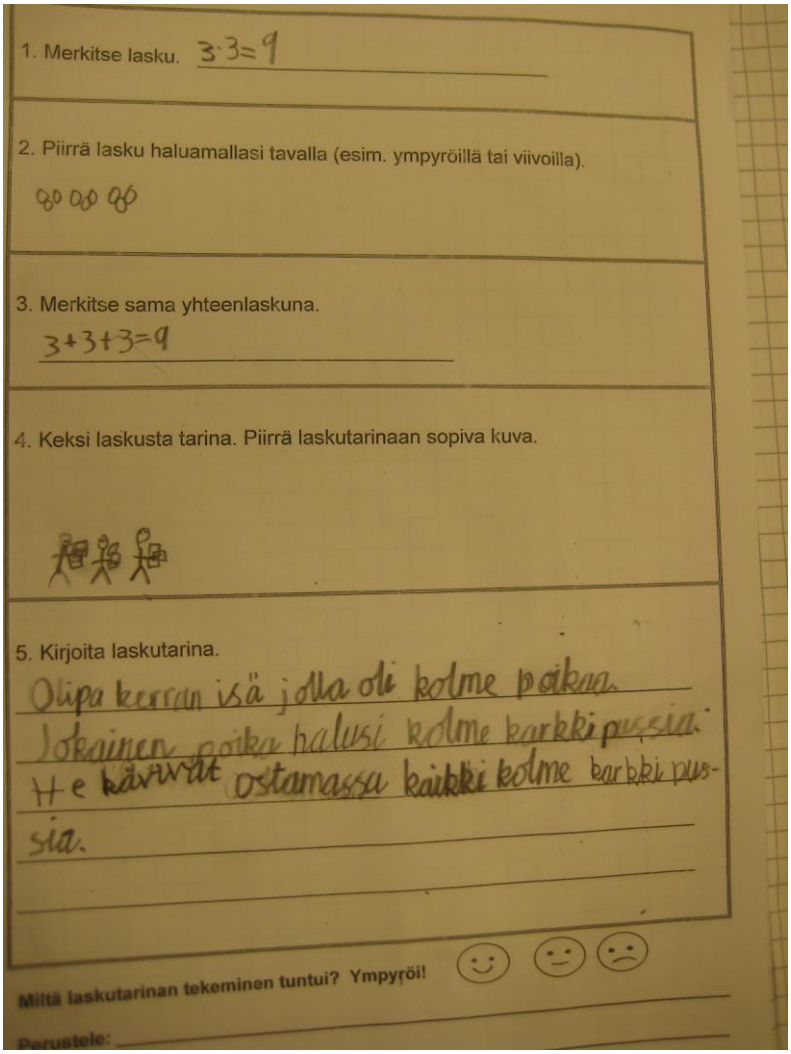
Creating stories to understand multiplications

Children are learning multiplications. At first there's a teacher led part where the whole group learns **how to make multiplication stories** from a picture teacher has made. After that children were asked make up stories in pairs based on the multiplication given by teacher.

At first the children wrote the mathematical operation. Secondly they drew the multiplication using ways they wanted. Thirdly they expressed the operation with sum. In the end they created a story linked to the mathematical operation presented above.


1. Merkitse lasku. 3·3=9

2. Piirrä lasku haluamallasi tavalla (esim. ympyröillä tai viivoilla).

3. Merkitse sama yhteenlaskuna.
3+3+3=9

4. Keksi laskusta tarina. Piirrä laskutarinaan sopiva kuva.

5. Kirjoita laskutarina.
Olipa kerran isä jolla oli kolme poikaa. Jokainen poika halusi kolme karkkipussia. He kävivät ostamassa kaikki kolme karkkipussia.

Miltä laskutarinan tekeminen tuntui? Ympyröi!

Perustele:

Example of working sheet: the child's mulplication story

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FI_Class_PairtoTen_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**AO: Creative;** **P:Ques;** **P: Scaff;** **P: Agency;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Finland
Case:	Case1
Episode:	1
Teacher:	Mary
Age Group:	6
Selected episode present in D4.4 Appendix	No

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Seizing informal opportunities to ask questions and teach simple addition

Children are getting ready to walk to the cottage.

TA "Here we have 3 children. What is the pair of ten for number 3?"
CH "Four"

TA asks again and the answer is the same.

TA "Ok, let's try to put 4 here. Are there 10 children now?
CHILDREN "No"

One child suggests number 5. TA adds a child and asks if it is ten now. Children agree that it's not.

CH "Seven!"
TA "Yes. So how many we need to add to these 5 children?"

TA asks again.

CH "Three"

They add 3 children.

TA "How many children we have now there?"

Couples of boys think that there are 7 in the group. Finally others disagree and one boy says there are 8 altogether.

TA "Let's go 3 numbers forward from number 8."

Children count.

TA "Is number 8 the pair of ten for number 3?"
CHILDREN "No"
TA "What I need to do to have a pair of ten for number 3?
CH "Take CH [*child's name*] off"

Everybody laughs and TA takes the child off.

TA "Now let's check if we got it right. Here are 3 children, how many are there?"
CH "Seven"
TA "Please, count who many children are there in a whole"
CH "Ten"
TA "So what is the pair of ten for number 3?"
CH "Seven"
TA "Good"

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FI_Class_Volcano_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	1.1 Teachers should be able to pursue the social and affective objectives of children's science and mathematics learning, in synergy with the corresponding cognitive ones. 1.2 Teachers should be able to make children aware of connections between science and mathematics learning and their everyday lives, in order to engage their motivation, interest and enjoyment in science and mathematics and foster curiosity and creativity.
Factors linked with:	**AO: Affect** **AO: Social** **P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 - Finland
Case:	Case 3
Episode:	Volcano
Teacher:	Rita
Age Group:	3-6
Selected episode present in D4.4 Appendix	No

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Importance of social and affective factors with cognitive one

Firsty, the children created the paper volcanos themselves. Secondly, they conducted an experiments with everyday ingredients with teacher (like a child led demonstration). The children became familiar with ingredients and shared their knowledge about the use of those substances.

Teacher: What is this (showing sugar/salt/soda)? How you can use sugar/salt/baking soda?

Teacher and children think of examples of how to use ingredients.

Teacher: You can use SALT, where?…
Children:

- in food
- in healthy food

Teacher: Why is it important?
Child: It gives flavour.

Teacher presents vinegar and asks how to use it and hands out mugs.
Children's answers for baking sugar:

- in baking
- in coffee
- in buns
- in ice cream
- in cakes

You can use BAKING SODA…

- in cakes

Teacher: What's this (VINEGAR)?
Children:

- ketchup
- blood

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- oil

Teacher: You can use VINEGAR…
Children:

- in mothers beetroot soup

Teacher: in preservation, for example in pickled cucumbers or in dressing

After knowing the ingredients, children move to another side of the table and teacher shows them the worksheet where they can mark their predictions when mixing dry ingredients with vinegar. Teacher explains how children should fill in the form. Children make their first prediction of what's going to happen when they mix vinegar and sugar.

Teacher: Everybody think for themselves. Ask if you don't understand.

Children measure sugar in to the volcano and Teacher gives them vinegar.
Teacher lets children to smell the vinegar.

Children: Terrible smell.
Teacher: Who knows how much there's vinegar in this dish?
CHILDREN: 600 litres, a litre, half litre
Teacher: The size of milk bottle is one litre. Is this the same size?
CHILDREN: No.
Teacher: This is one deciliter and you can put ten of them in one milk bottle.

Experiment continues and next the Children measure salt in to the volcanoes and teacher gives them vinegar.

Teacher: How did we work in the first case?
Child: You will give permission and then we carefully pour.
Teacher: Yes! And then?
Child: We turn backwards.

Teacher asks the children how they should work with the ingredients and then gives permission to pour vinegar.

Children: Nothing!

Nothing happens and the children mark the outcome in to the paper form. Next they mark the predictions for the last pair of ingredients (baking soda and vinegar). Children measure baking soda into the volcanoes and teacher gives them vinegar. Teacher asks them to move the volcanos in the middle of the table. Children pour the vinegar and look happy and excited when the volcanos boil over. Also the audience seems to be very excited.
Children Laughing.

Teacher: Did you manage?
Children: Yes.
Child: My Volcano can boil over once again!

Lots of fun and happiness among the children in the end!
The teacher presented/explained shortly why the volcanos boiled over.

Teacher: Soda and vinegar react together and produce carbonic acid, which makes our volcanos boiling. All ingredients do not react similarly.

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FI_Class_WaystoCount_ChildIdeas

Teacher Education Design Principle + code:	10. Teacher education should enable teachers to recognize and build on children's ideas, theories and interests for the teaching of science and mathematics. **TE: ChildIdeas**
Specific Teacher Outcome(s):	10.1 Teachers should be able to use a range of strategies for picking up on children's ideas, theories and interests.
Factors linked with:	**T: Ped;** **AO: Affect;** **A: Strat;** **AO:Strat**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Finland
Case:	Case 5
Episode:	2
Teacher:	Rachel
Age Group:	6-9
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Solving a mathematical problem with three different ways and presenting the results

The aim of the lesson is to support the children to solve mathematical problem when using several additional materials and tools. The children work in pairs and each pair has their own material or equipment. The children have to try to solve the mathematical problem and teach it to the others. The children work in pairs and teacher walk around and scaffold them when needed:

Child: How can you count 18 with finger? I don't have so many fingers.
Teacher: That's a good question. Let's see if we can find a solution to your problem soon.

After short time working in pairs the teacher asks the children come in turns to the front of the classroom and present their solution for the problem through using the provided equipment. The set additional questions:

Teacher: So what did you do to the number 18? Did you make it bigger or smaller? So what kind of problem is it then?

After each presentation the class gives applauses to the pairs of the children.

Teacher: As you can see there are many ways to solve these kinds of problems.

All groups presented their strategies to solve the mathematical problem

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FI_Image_Floorplan_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.3 Teachers should be able to select and use different approaches for and forms of recording children's ideas and learning in science and mathematics at different stages of the learning process and for various purposes, including to support children's reflection and reasoning processes.
Factors linked with:	**P: Express;** **M: Variet**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 Finland
Case:	Case 6
Episode:	Episode 1: Floorplan
Teacher:	Helen
Age Group:	6-9
Selected episode present in D4.4 Appendix	No

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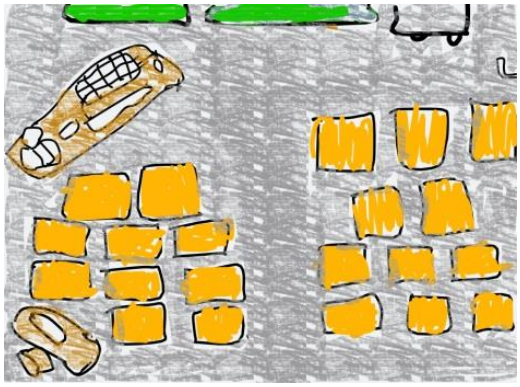
Using multimodal approaches to recording the children's ideas

First-graders work in small groups and build concrete models of the classroom, took photos of it with iPad and send it to email. Second-graders worked mostly alone with iPads. They draw the floor plan of the classroom based on their individual view of the classroom. The ready drawings were sent via email to teacher. The learners learned to use differently iPad as tool for reporting the outcomes. In this case they used draw free software.



View of classroom (floor plan) using iPad

View of classroom (floor plan) using concrete wood blocks

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FI_Img_Burr_Burr_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games.
Factors linked with:	**P: Play;** **P: Quest;** **P: Scaff;** **M: Expl**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report Finland
Case:	Case 3
Episode:	Episode 1: Burr-Burr game
Teacher:	Rita
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Cross curricular game to foster children's understanding of mammals

The children with teacher were playing Burr-Burr game, which is memory game. In the cards there are pictures of mammals that live in Finland. The name is also written in the card. The together selected one card which is Burr. One child started to collect the cards and other children had to follow the progress of the game and shout Burrr, when the signed card was taken off. The animals were named and spelled correctly together.

In the game the children learned mammals and spelling through game.

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FI_Img_MeasuringOutside_LEnvironm

Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out. 14.2 Teachers should be able to recognise and build on opportunities for informal learning in science and mathematics within the school environment, for example within day to day routines or child-initiated games and other activities in school classrooms or outdoor play areas.
Factors linked with:	**T:Prec**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 - Finland
Case:	Case 2
Episode:	1
Teacher:	Kirsten
Age Group:	6
Selected episode present in D4.4 Appendix	No

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Fostering children's creativity in measuring activities in outdoor context

The preschool children with their teacher use to go every Tuesday morning near to lake to make science activities. In this session the aim of learning focused on measuring. The children learned to make different kind of measuring activities using different kind of tools such as dipsticks, thermometer, their own hand, wood sticks etc.

The teacher introduced the activities and asked the children to observe the environment and find the objects (plants, trees etc.) which had a same feature (the length or shape) than they have, or those are smaller or taller. After finding the appropriate object, the teacher asked the children to describe and justify what they have found and why. The comparisons between different findings were done with all together.

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FI_Img_SmeltingSnow_LEnvironm

Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE:LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out.
Factors linked with:	**L. Out/Indoors;** **M:Explor.;** **M: Cr;** **M: Space;** **M: Outd.;** **M: Inf.**
Type of material (image – interview (int) – classroom extract (class):	**I**mage
Originating from:	
Country report :	D4.3 Finland
Case:	Case 1
Episode:	2
Teacher:	Mary
Age Group:	6
Selected episode present in D4.4 Appendix	Yes

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Investigative activities in the snow during winter

The children did an experiment with teacher about the water stages. They observed the experiments in which snow was smelted with camping cooker. After the experiment they were able to report their results through drawings and writings, as far they wanted and were capable.

Core issues:

1. Using camping cooker
2. Collecting snow from close environment with different measures
3. Making an experiments with predictions
4. Reporting own results based on observations

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FI_Img_SmeltingSnow_IBSE

Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.1 Teachers should have knowledge of all essential features of inquiry and problem solving (questioning, designing or planning investigations, gathering evidence, making connections, explaining evidence, communicating and reflecting on explanations), their different purposes, degrees of structure and guidance (including open, guided and structured inquiries), and varied opportunities they offer for creativity.
Factors linked with:	**T: Sci;** **T: Prec**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 - Finland
Case:	Case 1
Episode:	2
Teacher:	Mary
Age Group:	6
Selected episode in D4.4 Appendix	Yes

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Using practical investigative activities in early years science

The aim of the session is to observe the smelting process of snow and compare the amount of snow and water. The preschool activities are carried out in the forest. *Teacher has lit a fire in the camping cooker*. The children works in small groups (3-4 children in each) and the first group starts to work with teacher. She asks children to fill measures (*different shapes, all one litre size*) with snow. Teacher takes one dish and tells that they are going to put snow from the dish into the cooker and observe what happen. Before starting the experiment teacher and children were making predictions and discussion about the different opportunities. Here in Photo 1 the first part of experiment is going. The one measurement of snow has been put into the camping cooker and children follow what happen:

Photo 1

Teacher What do you think, how much water we have when snow is melted?
CHILDREN More, Less.
Teacher: What you can see here? *[showing steam]*
CHILDREN Steam.

In Photo 2 they are measuring the amount of water.

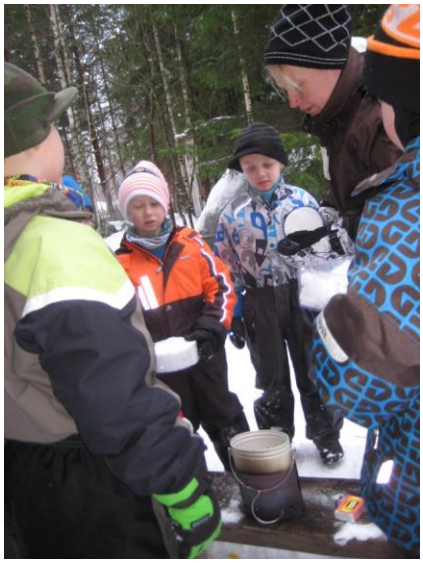

Photo 2

[*Snow has melted into water*]

Teacher pours water back to the dish.
Teacher What do you think now: Is there more or less water than there was snow?
CHILDREN Less.

TA Could you tell me how much it is?
CHILDREN: There is 3 litres, there is ½ litre, there is 1 litre.

After a discussion they agree that there's about half litre of water.

Teacher How much we had as show?

CHILDREN: One litre.
Teacher So when water is snow it needs more space.

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After the experiment the results were recorded by drawings.

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FRA_Class_Collaboration_GWork

Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**G: SmallG;** **G: Abil;** **M: Var;** **M: Expl;** **M: Cr;** **P: Collab;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 France
Case:	Case 5
Episode:	BodiesCounting
Teacher:	Joelle
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Fostering children's collaboration to succeed BodiesCounting

The activity from which this episode is drawn formed part of a class topic on mathematics lasting several weeks. The activity was initiated by the teacher, and involved children playing in whole-group in the gymnasium to investigate what would represent one and two. Depending on a noise made by the teacher the children have to be alone or to group themselves by two. The children work all together and help each other when it is useful. The aim of the activity is for the children to investigate the different ways to count, here through their bodies' action.

Children are walking/running around the houses [hoops] after a while the teacher makes the small bell ring. Children run in the room to find a house, when they do not move any more the teacher talks:

- **T**: So, are you all one by house?
- **Children**: Yes, No
- **T**: Explain it to her **Sa**! [***Sa*** *pushes her friend which is in the same house as her into another house*]. Good! **Ma** did you find a house? Go one that is it really nice. We said when the small bell ring it is one per house. Go one.

Because some children have another mother tongue language they can encounter difficulties:

- **T**: At the small bell we are one. *[Children adjust their place in the houses; some help others to find a house.* **Ri**, when the small bell rings children have to be alone in each house. Well done **El**. *[One child is walking, and does not seem to know what happen].* **Ri** doesn't understand the language that is why. **Ri** you have to be alone in your house, one **Ri** *[teacher shows to* ***Ri*** *one finger].*

Teacher encourages children to play in the gymnasium to solve problem.

- **T**: How many are you?
- **Children**: Two
- **T**: What have we said *[the teacher shows one finger to the children]?*
- **Children**: Just one
- **T**: Yes, just one. So what do you have to do **Lé** and **Cé**? [***Lé*** *looks forward*] Yes, go one [***Lé*** *runs to another house, but where there is already a child*].
- **Children**: No

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- **A child**: No, we have said one [*two other children come to help them*]
- **T**: That is nice.

This activity is creative in the sense that it is unusual to be able to make science or mathematics with our body. It constitutes an interesting idea to foster the interest of the children who have difficulties with abstract contents. Here, children who prefer to do things with their body can enter into mathematics learning. So, the activity constitutes a great opportunity to include more children into mathematical activities. Moreover, it allows children to consolidate they actual understanding by using it in different contexts. If the activity focuses apparently on cognitive dimensions, it also fosters social dimensions of the learning. Indeed, children exchange a lot and provide help to their friend which don't succeed. In other words, the activity fosters children collaboration.

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FRA_Class_IceCreamSticks_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games.
Factors linked with:	**P: Affect;** **M: Cr.**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report	D4.3 – report France
Case:	Case 4
Episode:	'Ice Cream Sticks'
Teacher:	Nany
Age Group:	7-8
Selected episode present in D4.4 Appendix	Yes

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To count 1743 ice cream sticks

The teacher work on children's understanding of number's composition (organisation in groups of 10, 100 and 1000). So she proposes to them to count a big amount of ice cream sticks.

Nani's way to propose the problem:

A child: You have eaten all of them? *[he is talking about the ice cream sticks]*
T: Yes, I've eaten all of them, can you imagine it? According to you, how many are they?
Children: 100, 2000… More than 100…
T: That is what I want to know, how many ice cream I've eaten…

At first, a child suggests counting the ice cream sticks every two. Because in her approach the best solution is collectively decided, she doesn't make any comment on this specific solution.

T: So, how will we do to know how many ice cream sticks there is?
A child: We will count them.
T: To count them, yes... **Sh?**
Sh: We will take them every two and count them.
T: To take them every two… and count them…
Some children: Every ten
A child: Every twenty.

Children will spend more than one hour to find collective solution to count the big amount of ice creams sticks.

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.4 Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations).
Factors linked with:	**T: Ped;** **T:Sci;** **P: Ques;** **P: Express;** **LA: Plan;** **LA: Obs;** **LA: Equip;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 - France
Case:	Case 4
Episode:	Ice Cream Sticks
Teacher:	Nani
Age Group:	7-8
Selected episode present in D4.4 Appendix	Yes

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Fostering children's understanding of numbers

Teacher's goal is to let children explore the material, and found a strategy to count the ice cream sticks.

A child: You have eaten all of them? *[He is talking about the ice cream sticks]*
T: Yes, I've eaten all of them, can you imagine it? According to you, how many are they?
Children: 100, 2000… More than 100…
T: That is what I want to know, how many ice cream I've eaten…

Children try to make sense to number's composition and decomposition. Teacher's goal is to make them understand, for example that 10 units compose a dozen, or that 10 dozens compose one hundred, and so one.

At first, a child suggests to count the ice cream sticks every two. It is an interesting idea, but it is not the one that Nani is expecting (every ten is more appropriated toward her goal). Nevertheless, because in her approach the best solution is collectively decided, she doesn't make any comment on this specific solution.

T: So, how will we do to know how many ice cream sticks there is?
A child: We will count them.
T: To count them, yes... **Sh?**
Sh: We will take them every two and count them.
T: To take them every two… and count them…
Some children: Every ten
A child: Every twenty.

The teacher fosters children reasoning and expressions of their own solution and collective decision making. It can be notice that children develop a large understanding of number through the activity. Numbers are not just representing ice cream sticks; they are useful to count faster (e.g. *'hundred is easier'*).

T: Wait, wait, and listen, there is another idea which is arriving, listen, then we will choice the best idea, the easiest to count. **An** you say that we have to make?
An: Hundreds.
T: Packets of 100, because you have a lot of dozens…

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T: So do we make packets of 100? Or, the other idea is to count all the dozens on the table the other idea is that we take all the units on the tables to make dozens. So what do we do?
Al: If you count all the dozens on the table you can forget some… when hundred is easier.

The teacher and the group of children will construct a new material based on ice cream sticks organization in groups of 10, 100 and 1000. This material will follow children for the entire school years. The teacher will send them to the ice cream sticks corner for any difficulty with numbers. Here children became actor of the own pedagogical material.

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FRA_Class_MagnetAttractionOrNot_NoS

Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists.. **TE: NoS**
Specific Teacher Outcome(s):	3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity.
Factors linked with:	**AO: Social;** **LA: Connect;** **LA: Expl;** **P: R and R** **T: Ped;** **T: Sci**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 France
Case:	Case 1
Episode:	Magnet Attraction or Not
Teacher:	Ivette
Age Group:	3-4 and 4-5
Selected episode present in D4.4 Appendix	Yes

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Fostering children's reflection and comprehension of magnets' properties

Firstly, children work in small groups. Each child has a magnet. They have to categorize different objects in two groups: objects attracted or not by magnet. For that, each child has two boxes a green and a red one. They have to place objects attracted by magnet in the red boxes, and those which are not attracted in the green boxes.

Secondly, the teacher emphasizes the difficulty associated to ambiguous object such as the scissors which are attracted in one side (the side in iron), and not in the other side (the side in plastic).

Teacher (T): So, I have a look on what you have done the red container. The red containers are all at the same place, the green are also together. Nobody has said to me 'I don't know'… You did know, it sticks or it don't. **Ax** told me the scissors sticks *[**T** takes the scissors].* Ah! They are in the box where it doesn't stick!
A Child: I've tried and it didn't stick!
T: Ah... Come **Ax**, we will try, if we don't know *[**T** is sitting, near her is **Ax**].* I've heard many children who said the name of the object... No? Don't you know the object's name?
Children: No
T: Fé you told it! **Ma**?
Ma: A magnet
T: Yes! Magnet! I've heard many children who have said it!

The teacher and the children are still talking about the ambiguous object. Some children have already tested it and known that magnets stick on scissors. Other children have already tested it and known that magnets don't stick on scissors. The teacher tries to foster them to explain why scissors can stick or not. A child tries to explain that magnet sticks on iron, but because of language difficulties he takes time to express what he has in mind.

T: We can place it in both containers… So why in a side, it sticks and not on the other side? Yes, the red, what do you want to say **Ca?**
Ca: The red, because it is scissors.
T: Yes, it is scissors you are right, **Ma**?
Ma: Because it is big.
T: because it's big. **Ax**?
Ax: It doesn't stick because it only sticks on the green.
T: On the…? *[in French, glass, green, and iron have closed spelling]*

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Ax: Only on green, as green… you know, green
T: Wait, are you talking to me about glass *[**T** shows to the child a pot in glass]*
Ax: Yes, *[**Ax** scrubs his head]* no, in iron *[**Ax** shows the iron part of the scissors]*

Thirdly, the teacher and the group of children will organize collectively a common categorization of the objects on a big sheet of paper. This material will be used later in the week by the teacher to progress in the exploration of magnet's properties.

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FRA_Class_MagnetDiscovery_IBSE

Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics.
Factors linked with:	**T: Ped;** **T:Sci ;** **LA: Ques;** **LA: Connect;** **P:Ques;** **P: Express**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report	D4.3 France
Case:	Case 1
Episode:	'Magnet Discovery'
Teacher:	Ivette
Age Group:	3-5
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

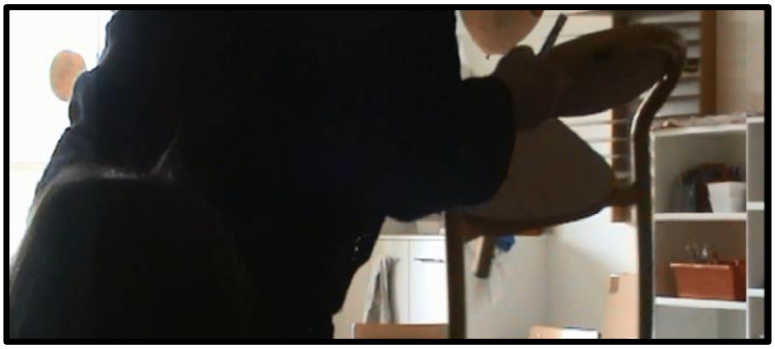
Children exploration and intuitive ideas

Both extracts appear at two different steps of the teaching. Firstly, the teacher proposes to children to explore a new object a magnet, then she collects children intuitive ideas in the discussion corner.

During the exploration phase, the teacher encourages children exploration by using their senses:
T: What does it smells? I see that you smell!

Then, during the sharing phase, the teacher takes into account all children observations, without making selection between 'scientific' versus 'nonscientific' observations:
Fé: it tilts a little
T: It tilts a little?! Ok, **Vi**?
Vi: It smells the chocolate
T: Ah, it smell the chocolate
A Child: No, I did smell anything
T: At the moment, I write everything, we will see after. **Ax**?
Ax: It rests on tables

During the sharing phase, the teacher makes some tests to check critical observations:
Ti: It sticks under the chairs
T: It sticks under the chairs, I agree. I can see one of them under a chair! Wait, we will see if it is stick. *[The teacher takes the chair and shakes it, FRA1Ivette_Pre_Sch_Image_1_MagnetDiscovery].* You are true, it doesn't fall.



FRA1Ivette_Pre_Sch_Image_1_MagnetDiscovery

T: There is on one that furniture. Do you think it is glue?
Some children: Yes
Some children: No
T: No, you are true *[The magnet is on a wooden table*].

Children existing ideas about magnets are taken into account to constitute a base on which discussions and experimentations will be realized to fit to science expectations.

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FRA_Class_Share_GWork

Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.3 Teachers should be able to organize group work, aligning ways of grouping children, task design, teaching and assessment strategies in different ways to promote collaboration amongst children in science and mathematics.
Factors linked with:	**T: Ped;** **G: SmallG;** **G: Abil;** **P: Collab;** **P: Dialog;** **A: Strat**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – France
Case:	Case 6
Episode:	Share
Teacher:	Sandy
Age Group:	4-5
Selected episode present in D4.4 Appendix	Yes

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Fostering children's exploration of their own world to create sense collaboratively

The teaching assistant and a small group of children discuss what 'equally' means. It can be noticed that each child knows clearly what share means but the notion of 'equality' is more difficult for them. It can be stressed that for children colour might be one of the criterions to share equally (e.g. '***Ro**: And the same colour*!').

- **Teaching assistant (TA)**: So, we will share. To share we have to pay attention. If I share without paying attention, like this: Sweets for Henry, for Christopher, for Raphael. That is it. I've shared. According to you, is it fair?
- **Children**: No
- **TA**: Why it is not fair?
- **Fl**: Because it is not the same.
- **TA**: So, we will try to share them fairly. That means… Who can remind me what it means? What will we have to do?
- **Fl**: To provide the same.
- **TA**: We will try to provide the same number of sweets in each plate. All right?
- **Ro**: And the same colour!
- **TA**: No, the colour is not important here. We will not take the colour into account! Ok?
- **Ro**: All right.

As it can be seen from the next extract, it is not so easy for children to share equally the sweets in three equal parts for the Three Little Pigs (Henry, Christopher and Raphael).

- **TA**: So, **Ro** I will give you a handful of sweets. We will do it one after the other, we will work together. Here are the three plates, one for Henry, one for Christopher and one for Raphael. So, **Ro** starts the sharing. We look carefully what **Ro** does, because if she makes mistakes we will have to help her. So how will we do? Afterwards, you have to give out all your sweets. [***Ro** starts to put one sweet in Henri's plate, then two in Raphael's plate, then one in Henri's*
- **Ro**: I don't have!
- **TA**: Why didn't you provide some sweets to Christopher?
- **Ro**: Oh!
- **TA**: Could you do something in order that Christopher has some sweets?

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- **Ro**: I will remove some [S*he picks up some sweets to put them in Christopher's plate*]
- **TA**: It has to be equitable… That means that everybody has to have the same number of sweets in his plate. Do you prefer to do it again?

When children encounter difficulties the teaching assistant does not provide solutions but fosters children's collaboration and own exploration of their strategies.

- [***Ro*** *starts again and puts 4 sweets in a plate*]
- **Fl**: What is she doing?
- **TA**: She is trying.
- [***Ro*** *places 4 sweets on another plate and the last 2 sweets on the third plate*].
- **Ro**: I don't have enough sweets!
- **TA**: There is still a problem!
- **Fl**: She doesn't have enough!
- **TA**: Do you want to try **Fl**? [***Fl*** *shakes his head to say yes*]. You will all try, all right?

The activity is rich and challenging as it is based on counting from 1 to approximately 20. Children have to find a strategy to share equally the handful of sweets between the three plates for the three pigs. It seems to be difficult for those children to share equally. They manage to share, to place sweets into each pig's plate but they encounter difficulties in placing the same number of sweets in each plate. Nevertheless, the group of children provides to each of them a scaffolding space to develop their own understanding of "equally" sharing.

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.2 Teachers should be able to purposefully use a variety of patterns of collaboration, shifting between individual and collaborative activity over time, to support children's inquiry processes and creative learning. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**T: Ped;** **P: Collab;** **G: SmallG;** **G: Abil;** **M: Var;** **M: Expl;** **M: Cr;** **P: Collab;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report	D4.3 France
Case:	Case 4
Episode:	Ice Cream Sticks
Teacher:	Nani
Age Group:	7-8
Selected episode present in D4.4 Appendix	Yes

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Collaboration and collective decision making

The teacher is working with the whole group. They try a strategy to know how many ice cream sticks the teacher has in a big aquarium.

At first, a child suggests counting the ice cream sticks every two. It is an interesting idea, but it is not the one that Nani is expecting (every ten is more appropriate toward her goal). Nevertheless, because in her approach the best solution is collectively decided, she doesn't make any comment on this specific solution.

- **T**: So, what will we do to know how many ice cream sticks there are?
- **A child**: We will count them.
- **T**: To count them, yes... **Sh?**
- **Sh**: We will take them every two and count them.
- **T**: To take them every two… and count them…
- **Some children**: Every ten
- **A child**: Every twenty.

It is quite clear for children that democratic solution deciding is their way to do daily activity ('***Sh**: The children on the tables, if they agree…*'). According to Nani, this kind of lesson can be proposed to the class only when this classroom functioning is accepted and acquired by children.

- **T**: Hey children, 10 seconds of attention. **Sh** has said that after we will count and see how many ice cream sticks there are.
- **A child**: Yes, but we have to agree on something
- **T**: We have to agree on something. And, we have to be able to check. If you say to me 'they are 48', I have to be able to check that they are 48!
- **Hi**: We will count them again!
- **T**: Again?!
- **Sh**: The children on the tables, if they agree, will count every 10, when they will have the correct number and we can do 10, 20, 30 and it doesn't take a lot of time, and we will be able to know the number.
- **T**: Ok, it doesn't take a lot of time to do 10, 20, 30, 40… Does everybody count every 10? Does someone count every two? Ah, why do you count every ten all?
- **Children**: Because it goes faster!

Moreover, the teacher shifts from whole classroom discussion to practical work in pairs (please see below).

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Teacher Education Design Principle + code:	7. Teacher education should familiarize teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering and extending inquiry and creativity, by for example prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events. 7.6 Teachers should be able to use strategies for making and building on science and mathematics real life connections and applications for engaging creatively young children in science and mathematics learning. 7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries. 7.9 Teachers should be able to use different assessment approaches and strategies and in particular those that involve children in the assessment processes, such as peer and self assessment, dialogue and feedback on progress, in the early years science and mathematics classroom.
Factors linked with:	**T: Ped;** **L: Formal/Informal;** **P: Agency; P: Scaff; P: Affect;** **M: Cr; M: Explor;** **A: Form; A: Peer/Self; A: Evid**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Germany
Case:	Case 1
Episode:	Building Blocks
Teacher:	Bea
Age Group:	5
Selected episode present in D4.4 Appendix	Yes

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Children are creatively engaged building the "Leaning tower of Pisa"

Inspired by photographs of real buildings on the wall, the children decided to build the 'Leaning Tower of Pisa' using wooden building blocks. The teacher stood back and let the children take the lead. She encouraged the children to express themselves clearly and she valued their ideas.

A photo camera is frequently used for assessment purposes. Children are allowed to use it and to document work and products on their own.

Classroom extract:

C1: Look, there is the Leaning Tower of Pisa! *[points to a picture hanging on the wall]*

C2 and C3 *look at the picture.*
[…]
C2 *wants to build the tower.*

B [to C2]: Well, C2, now you really have to explain to me how such a Leaning Tower has to be built. I actually have never built one.
C2 *[places for bricks in front of her and explains]*: You always have to put one like this and another one like that.
B: You mean always to one side?

C2 *nods*

B: And then it won't tumble down?

C2 *shakes his head*
[…]

C2 and B *quickly build the tower which does lean extremely wide to the left. B follows C2's instructions.*

B: I'm excited till were we'll get
[…]

Tower tumbles down.

B: Oh, now it tumbled down. How could that happen?
C2: It was too screw maybe.
B: Too screw? Hmhm. Why does it tumble down when it is too screw?
C2 is silent and starts building a new tower

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B: Do you think it was too heavy on one side? […] Shall we try to construct it a little bit less screw this time?
C2: The 'Leaning Tower of Pisa' was also screw. About this screw [*again shows the degrees with the help of a brick]*
B: Alright, we'll try again. Again to this side?

C2 *nods.*
C3 *joins them*. **B** *moves back and stays in the background.*

C2: You always do this side and I always do this side
C3: Now it tumbles, C2!
C3: Oh no!
B: Why does it fall in again and again? What do you think?
C3: Because there is no space …for this *[points to the tricky spot]*
B: Yes, it doesn't have enough support there, right? We have to think about something else there

C3 *starts to pile up bricks as a sort of supporting pillar.*

C3: We build a tower from below to fix it.

C2 *starts to carefully slide bricks in the tower from the side.*

B: Ah, you're adding a supporting step!
C3: C2! Good idea!
[…]
B: Wow, that looks great already!

End of activity, reflection and assessment after tower finally gave in:

B: Maybe it was too heavy on top?
C2: If we hadn't placed more bricks on top, it wouldn't have given in
B: And why wouldn't it have given in?
C2: Because on both sides it was a little bit more. Because *[takes two bricks to show what he means]* they have to protrude a little bit then. At the same time.
B: So the weight is equally distributed?

C2 *nods.*

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GE_Class_Fermi1_CreatInqLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**T: Ped;** **LA: Plan;** **P: Agency;** **A: Evid**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 Germany
Case:	GE case 4
Episode:	Fermi1
Teacher:	Andrea
Age Group:	7
Selected episode from D4.4 Appendix	Yes

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Use of "Fermi questions" to promote non-traditional problem solving strategies.

Fermi questions encourage multiple approaches and emphasize process rather than the answer/result. They seek a rough estimate of quantity which is either difficult or impossible to measure directly. Example here: "Use a piece of chalk and draw a 1m-line, a 10-cm-line, and a 1-cm-line on the board. Three lines. Without ruler."

Classroom extract (class)

Children working in small groups. They estimate : How long is one meter?
As a team, the children make a guess and then discuss their estimations: they ask for the other's opinion and - based on their everyday experiences - find innovative methods in order to check their estimates.

C5 "I jumped down from a 1-m-board in the swimming bath on Saturday" *[shows the distance between board and water surface with his hands]*
C6 "I'd say a meter is more or less as long as a leg"
C7 "Till here, right? Or till here?" *[using C5's body to demonstrate it]*

***C5** tries to maintain the distance between his hands while moving them to the board. Holds them close to the board, C7 draws a line between C5's hands.*

C7 "T-h-a-t long?"
C6 "No. This long"[…]
C7 "I don't think that this is one meter" *[laughing]*
C6 "I don't think that either"
C5 "Right. Much too short"

***C6** draws a longer line.*
[…]

The teacher walked around in class, observed the children during group work, using formative ways of assessment (e.g. *"How does a child behave in the group?, What does it contribute to the group work?, How does it interact with others?, How does it approach such a task?",* teacher interview). She occasionally gives advice or answers questions. However, her advice exclusively referred to the working approach, methods, and relevant question, but never to the solution itself.

At the end, children write down how they had proceeded. Then they present the working process as well as the result to their class members.

***Teacher:** … children get into interaction and they have to think on their own about questions like: "How can I approach this?", "What am I doing here right now?", "How can we solve such a task?" And they just have to talk to each other a lot and to think about "How does this actually work?" and not only to solve a ready-made maths problem.*

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GE_Img_WaterInquiry_PractInvest

Teacher Education Design Principle + code:	2. Teacher education should provide teachers with skills and competences to carry out practical investigations of science and mathematics in the classroom. **TE: PractInvest**
Specific Teacher Outcome(s):	2.1 Teachers should be able to investigate and involve children in the design and conduct of practical investigations of science and mathematics in the classroom, as such activities can contribute to the development of children's creativity.
Factors linked with:	**LA: Plan**
Type of material (image – interview (int) – classroom extract (class):	Images
Originating from:	
Country report :	D4.3 Germany
Case:	Case 5
Episode:	Ice & Water
Teacher:	Nadja
Age Group:	6
Selected episode present in D4.4 Appendix	Yes
Linked with	DP6: IBSE

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Children plan and conduct their own investigations to prove that ice and steam both come from water

The children were asked to plan and conduct their own experiments to investigate the changing states of water. They were allowed to use any of the equipment in the room (school lab) and to go outside as well. Before the children could start their experiments, they had to document their plan by writing down or drawing their ideas and procedures on a prepared „Scientist's sheet".

Children draw their plans and assumption on their "Scientist Sheets":
1. How does ice become water?
2. How does water become steam?

Children apply different sorts of heat to make the ice melt.

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.3 Teachers should be able to organize group work, aligning ways of grouping children, task design, teaching and assessment strategies in different ways to promote collaboration amongst children in science and mathematics. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics. 15.5 Teachers should be able to assess group work. 15.6 Teachers should be able to use effective strategies for sharing ideas and discussions from different groups.
Factors linked with:	**T: Ped;** **P: Collab;** **G: SmallG;** **A: Strat;** **M: Var;** **M: Expl;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class), Interview (int)
Originating from:	
Country report :	D4.3 - Germany
Case:	Case 3
Episode:	Materials
Teacher:	Alex
Age Group:	6
Selected episode present in D4.4 Appendix	No

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Emphasizing the role of group work.

This episode was observed during a lesson sequence on materials and their properties. In small groups (3 children, groups randomly assigned,) the children had to explore one kind of material (e.g. wood) and to set up a poster (prepared A3-worksheet) with the specific characteristics of this material. The teacher placed emphasis on the role of collaboration and reflected about the group work with the children.

Classroom extract

A: Think about in your group. Each group gets o-n-e poster und you have to fill it in t-o-g-e-t-h-e-r as a group.
[…]
A: It is always very, very important that you think about your common goal as a team. […] How do you feel when 2 or 3 of your group don't help you with your work […] or are kidding around all the time? […]
C: Then it's actually not a group anymore.
A: What is it instead?
C: It's only 1 or 2 children then who work. It's only a real group if everyone works together. For example, like we did it […], everyone had got something to do. […]
A: The better you work together as a group, the better your result. […] The more you work together as a team, the better is the result at the end.

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Interview

I: In both lessons, you decided to let the kids work in small groups and you randomly assigned them to groups. […]

A: Exactly, with the help of playing cards. I always do it randomly. One reason is that otherwise it's always the same children working together. And the other reason is that there are always some children who are left over. That's really unsatisfying for everyone. […] And the great advantage is that children who usually don't have much to do with each other, suddenly start to interact. That makes group work very dynamic. I don't influence group composition as regards the amount of boys and girls. I leave that to chance. They can cope with that, they know it, and it's important for the years to come.

I: That's also one of your goals, isn't it?

A: Absolutely.

I: You also made that very clear. That it matters to you that everyone works with everyone. And what's with the difficulties? […] How do you deal with that?

A: […] I actually try to intervene and help in the concrete situation. But mostly, I'm alone and that means that often I just don't notice it. That's why it's so important in the early years to reflect not only on the content at the end of the lesson. You also have to take time to reflect on the group work; to just talk about it with the children: What worked out well? What didn't? Why didn't it work out? And then, to make the children understand little by little that the advantage of working in a group is to have much more ideas and therefore to have the chance of a much better result. But in order to make that work, it is necessary to remain reticent sometimes and to discuss things within the group. But that's part of a learning process and children just cannot do that at the beginning and that's why you still have to […] start early to practice that. […] It won't happen overnight. But you have to talk about it again and again, and to give advice. […]

I: Talking about assessment. How do you do that?

A: Yes, that's a difficult topic. Absolutely.[…] There are certainly group works […] where you can see very well the result of their common work. And of course you observe a lot then. […] I often take notes.

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GE_Int_Materials_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	1.2 Teachers should be able to make children aware of connections between science and mathematics learning and their everyday lives, in order to engage their motivation, interest and enjoyment in science and mathematics and foster curiosity and creativity.
Factors linked with:	**AO: Social;** **AO: Affect**
Type of material (image – interview (int) – classroom extract (class):	Interview (int)
Originating from:	
Country report :	D4.3 - Germany
Case:	Case 3
Episode:	Materials
Teacher:	Alex
Age Group:	6
Selected episode present in D4.4 Appendix	No

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Connecting science learning to everyday life.

Inquiry with items that the children had brought from home.

The goal of this learning sequence was to get to know different materials and their main characteristics. Small items which the children had brought from home (such as hair needles, corks, stones and nails) were used for inquiry. The children were asked to compare the different materials and to group them according to self-defined criteria.

Interview

I: *The children brought their own materials. […] Was there a specific reason for that? […]*

A: *[…] Well, two reasons. The first reason is that I think the children are more connected to the items if they bring the materials themselves. It's just to avoid presenting any old material to them which has been chosen by me. But it also had practical reasons. […] Because I want that there are many materials. I want to start a collection of materials. […]*

I: *And this collection is sort to speak the basis for continue to work with different materials […]?*

A: *..swimming, sinking […] electricity.*

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning.
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.3 Teachers should be able to organize group work, aligning ways of grouping children, task design, teaching and assessment strategies in different ways to promote collaboration amongst children in science and mathematics. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**P: Affect;** **P: Collab;** **P: Express;** **LA: Connect;** **LA: Comm;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 5
Episode:	3 – Beebot
Teacher:	Stavros
Age Group:	7-8
Selected episode present in D4.4 Appendix	Yes

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Setting the context for a collaborative learning activity (competition)

The lesson began with children revising what they had heard about orientation in the previous lessons using a nearby church as their point of reference since all churches are oriented a certain way. Then, Stavros announced that they were going to play a treasure hunt game using the bee-bot, similar to a game they had played in a previous lesson. Stavros went over the rules of the game they were going to play. There would be two teams (dolphins and lions) from 4 children each competing for a treasure chest which when opened would reveal a puzzle that the children of the winning team had to solve.

An important part of the lesson was right at the start when Stavros went over the process that children had to follow in order to win the challenge and collect the prize. These were presented as general rules, with the specific game's instructions presented immediately after. The general rules were:

- Read the instructions carefully because they will lead us to the prize
- Have patience with the go button – the teacher has to be informed before the beginning of an attempt
- Collaboration always helps in reaching the goal

Each team then chose their instructions at random in a small piece of paper. An addition to the game compared to the last time children played it was that this time they had to record their attempts and when successful they had to present the correct solution in writing. After receiving their instructions both teams were left to discuss their strategy. Stavros again reminded them of the rules and children started to discuss how they were going to win the treasure. After 5 minutes the first team was ready to begin their first attempt for the treasure.

The first attempt was unsuccessful and Stavros commented that he could see that the bee-bot was disoriented. He advised the children to go to their table and discuss what they thought went wrong and try to come up with an alternative solution. He asked the children to also think about what went wrong. "Was it poor collaboration? Was it not paying attention to the instructions? Please think and come back."

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The first team (dolphins) went back to their table and started discussing their mistake.

A: If you did not press the right button then…
Z: But I was the captain of the team, I had to handle the bee
A: Yes, but you need to listen to all of us
E: We need to decide what to do together, we made a mistake and now if they are correct they will win
A: He is doing everything in a hurry
E: No he just wants to press the buttons on the bee
K: It doesn't matter who presses the buttons, it only matters if we win.
Z: Let's start again then.

The children then began to plan the path of the bee-bot but Stavros arrives.

Stavros: Where do you think you got it mixed up?
A: K pushed the button to go right, and then E said that we should press forward but K pushed right again
Stavros: Did this *[the bee cut-out]* help you?
All 4 children: Yes it did a little.
Z: But we need to fold it so it won't get wrinkles. In order to use it we have to fold it like this.
Stavros: Oh right, now I see. Now what do you have to do to reach the goal?
K: We need to work together
Stavros: You need to listen to what the others are saying. For example A and K might have to different ideas. You need to discuss both ideas first before making up our minds.
A: But Z does not hear us and he pushes the buttons himself.
Stavros: Z is the captain of team but he needs to listen to everybody. Best way is for all of you to take turns pushing the buttons. Discuss what you should do now.

As Stavros commented in his interview *'Children especially enjoy similar activities. Whenever we have competition their excitement and interest is sustained throughout the lesson.'*

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE:CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.6 Teachers should be able to use strategies for making and building on science and mathematics real life connections and applications for engaging creatively young children in science and mathematics learning. 7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries.
Factors linked with:	**P: Affect;** **LA: Obs;** **LA: Expl;** **LA: Comm;**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Greece
Case:	Case 4
Episode:	2 – Building Mr. Zip
Teacher:	Sonia
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Using a story to introduce a learning activity in science

The activity presented here was part of a theme titled 'Feelings'. Children had spent time discussing about feelings (names, facial expressions of feelings) in previous lessons, so the teacher decided that this would be a great opportunity to let the children experiment with balloons to better understand anger as one of the important feelings. The content of this episode focuses on the process of getting to experiment with balloons starting from a short story related to a Mr Zip, a fictional character who serves as the manifestation of anger for the children. The activity provided children with a chance to choose their material to 'build Mr Zip' providing sufficient justification for their choice.

At the start of the lesson Sonia referenced an incident from earlier in the day when two children had an argument. She asked the two children to tell her how they felt, to which both responded they felt angry. This prompted Sonia to start telling the children the story of Mr Zip, a man who is always angry. The angrier he gets, the more his head gets bigger. The story of Mr Zip served as an opportunity to get the children to pick the best representation of Mr Zip from the material available in the classroom. Sonia asked the children to choose one item in the classroom to build Mr Zip and provide an explanation for their choice. Sonia specifically told children to use their imagination when picking their item for Mr Zip.

Sonia: I would like us to talk about something I heard happened this morning between D and A. Did you get into a fight? I think this is because of anger. Do you remember what anger is?
All: Yes.
Sonia: This reminds me of Mr. Zip. Mr. Zip was angry when it was sunny. He was even angrier when there were clouds in the sky. He was angry at the birds that were singing in the trees. He was angry at the people who wore hats. He was angry with everything.
N: What does he look like?
Sonia: Use your imagination. Every time he gets angry his head fills up and starts to grow.
Sonia: Look into this bag to see if there is anything that we can use to make Mr Zip.

[Each child picks one object from the bag and starts to play with it]

Sonia: Why do you think that ... is Mr. Zip? *[repeated to each child]*

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GR_Class_Game_of_swallows_CreatInqLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries.
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**T: Ped;** **LA: Plan;** **P: Agency;** **M: Explor.;** **P: Play**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 4
Episode:	2 – Game of swallows
Teacher:	Sonia
Age Group:	5-6
Selected episode from D4.4 Appendix	No

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Introducing an open-ended activity

In the days prior to the lesson observed Sonia had started to work topics related to Spring with the children. At the beginning of the lesson Sonia reminded children of a story they heard the previous day involving swallows and commented on the good work done by children. The materials for the activity that would follow were presented by Sonia as she asked children to think about what they would like to do with the materials in front of them. The materials provided by Sonia were 5 plastic yogurt containers, 5 pudding containers, a large wooden dice and a regular dice and, cutouts of swallows, pieces of paper with numbers 1 to 10 and symbols, strips of shredded paper, an empty paper tissue box and a large box of white hard candy.

She said '*Your mission today is to find out what you can do with all these materials. How can you play with these?*' Sonia allowed time for all the children to think about what they wanted to do ('*We need to think now. We need your ideas').* Children started to ask questions about what they could/should do and what they couldn't/shouldn't and Sonia responded that it is completely up to them and that they could create anything they wished.

M was the first to try out and present her idea. She started to build a nest for the swallows using the material provided. It was evident that M would use the given material to construct the nest and not

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try to make a game for the children to play. This was also apparent in the children's ideas that followed and could be attributed to the limited instructions provided by Sonia, as well as the fact that the Greek word for both play and game is the same. It is possible that children understood that they had to construct something to play with and not establish the rules of a game. Sonia throughout the length of the ideas presented by children did not make any attempt to correct or divert the children's focus to her intended type of activity, but rather facilitated their ideas while trying to bring out mathematical concepts and processes linked to the presented ideas by consistently asking the children questions (mostly to count or recognise which of two numbers is bigger/smaller).

Although Sonia didn't instruct children to contribute their ideas to the one presented, she did not interfere when the children started to offer ideas but rather brought the ideas she thought needed to be explored further in front of the entire classroom *('Oh N, what a very good idea. Please share it with the rest of the classroom').* This allowed the children to feel actively involved in the activity with limited occurrences of children being impatient about trying out their idea.

When P got up to share her idea she started building a nest similar to the one before. When she was ready to start placing eggs inside the nest Sonia asked how she would decide how many she would put in there.

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GR_Class_Game_of_Swallows_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry. 11.2 Teachers should value and be able to build on the potential of children's own questions to foster their curiosity in science and mathematics, and support their generation and follow up, including those that are investigable.
Factors linked with:	**P:Ques;** **P: Scaff;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom, image
Originating from:	
Country report :	D4.3 Greece
Case:	Case 4
Episode:	2 – Game of swallows
Teacher:	Sonia
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Using questioning to encourage children's reflections and explanations, and extend their inquires

In the days prior to the lesson observed, Sonia had started to work topics related to Spring with the children. At the beginning of the lesson Sonia reminded children of a story they heard the previous day involving swallows and commented on the good work done by children. The materials for the activity that would follow were presented by Sonia as she asked children to think about what they would like to do with the materials in front of them. The materials provided by Sonia were 5 plastic yogurt containers, 5 pudding containers, a large wooden dice and a regular dice and, cutouts of swallows, pieces of paper with numbers 1 to 10 and symbols, strips of shredded paper, an empty paper tissue box and a large box of white hard candy. She said "Your mission today is to find out what you can do with all these materials. How can you play with these?" Sonia allowed time for all the children to think about what they wanted to do ("We need to think now. We need your ideas"). Children started to ask questions about what they could/should do and what they couldn't/shouldn't and Sonia responded that it is completely up to them and that they could create anything they wished. This extract contains the classroom interaction between the teacher and the children during one child's attempt at making a game using the provided materials.

When a child, M, managed to build the nest, she placed a number of hard candies in the centre as swallow eggs.

Sonia: A problem presents itself now. How did you know how many eggs you had to place inside the nest? Why not put more or less in there?
M: That's how many eggs are made by the swallow.
Sonia: How many is that?
M: Should I count? *(She starts counting without removing the "eggs" from the nest)* Seven. They are seven.
J: No it is not seven.
Sonia: M, are you sure?
M: Yes.
J: No she is not. She did not count the rest at the bottom.
Sonia: So J please come here to verify the result since you do not agree with M.

J starts to remove the eggs one by one from the nest to count them.

N: Do not take them out.
J: They are ten.
Sonia: Since I am being Ms Grumpy today, I want to ask difficult questions. Which one of the two managed to find the best way to count the eggs correctly?

All children yell for J

Sonia: What was different about what J did?
N: He took them out.

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Sonia: What was different about M's attempt?
E: She counted one by one inside the nest.
P: I don't know exactly what I will be doing
Sonia: Is there was something that could assist you in making that decision?
P *[pulls a piece of paper with the number ten]:* I got this.
Sonia: How is that helpful?
P: It helps me to put ten eggs inside the nest.
Sonia: Look everybody, P had a very different idea. P, could you share it with us please?
P: no response *[starts adding eggs to the nest]*
Sonia: Could you please explain what are doing? How do you decide what to do?
P: No response
Sonia: M, what did P do? Did you observe?
M: I think the number helped her to count the eggs she puts in the nest.

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Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE:Nos**
Specific Teacher Outcome(s):	3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity. 3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**LA: Connect;** **LA: Expl;** **P: R and R** **AO: Kn.Sc;** **AO: Sc ProcSkills;** **P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 - report Greece
Case:	Case 4
Episode:	1 – Ice Balloons
Teacher:	Sonia
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Fostering children's questioning and curiosity

Child (K): Miss, I see something here. It's like the prickles of a hedgehog.
Teacher (to all): What is the tool that can assist K in seeing the inside of the ice?
Child: The magnifying lens
Teacher: Do you want to go and get the tool that you think will assist you in seeing inside the ice?
[More kids comment on the hedgehog similarity of the inside of the ice.]
Child (E) *[to the teacher]:* I observed this thing.
Teacher: What is there inside there? What does the inside of the ice remind you of? What does it look like?
Child (E): It's like shivers.
Teacher: Oh how interesting! 'Shivers' - what a nice word to say.
Child [to another child]**:** Give me the magnifying glass.
Child (E) *[inviting her friend]:* Do you want to see inside how the ice cube is?
Other child: Wow! It's amazing!
[Children take turns looking through the magnifying lens commenting on what they see]
Child (E): Guys can we look at the juice on the table now*? [She proceeds to look at the liquid through the magnifying lens]*
Teacher: Like a hedgehog? Wow! […] Has the ice ball broken? Try and put your finger through the hole there.
Child (D): It pricks.
Teacher: Does the ice prick?
Children: Oh, yes it pricks!
Child (K): When it breaks it pricks.
Teacher: Does your hand fit inside? Leave your hand for some time inside to see what will happen.

Children pick up the magnifying lens to look at the 'shivers'

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GR_Class_IceBalloons_NoS

Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE:NoS**
Specific Teacher Outcome(s):	3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity. 3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Greece
Case:	Case 4
Episode:	1 – Ice Balloons
Teacher:	Sonia
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Fostering children's free exploration and thoughtful use of physical resources

Discussion as a whole group, with the aid of the puppet 'Frosty'.

Child: Shall we talk to Frosty? We want to see him.
Teacher: Shall we tell our news to Frosty?
[…]
Children [chanting]**:** Come, come Frosty.
Teacher: Shall I give him my voice to start talking? Because if I don't give him my voice, he will not be able to understand anything.
[…]
Teacher (as Frosty): It was about time that you gave me voice to speak – I have been sitting over there for so many days.

[Children are addressing him showing him the things they have done.] […]

Teacher (as Frosty): D. what are you showing me over there?
Child (D.): We made balloons which turned into ice cubes.
Teacher: We will now tell Frosty what we did and I, because I am getting old and start forgetting, what should I be doing? What should I be doing so as not to forget them, and if I forget them to be able to remember them again?
Children: You should write them down.

[A child brings two marker pens for the teacher to write on a poster paper.]

Teacher: Each team will now tell everybody what they did, how they worked, what they saw, what impressed them, what made them go wow!!! […]
Child (D.): We had some balloons and put inside water, which turned into ice cube.

[Teacher writes down "We made ice…"]

Teacher: D. How did you make the ice?
Child: We put some water and turned into ice.
Teacher: We put some water. Where did we put the water?
Child: Inside the bubble.
Teacher: And then?
Child: It turned into water.
Teacher: By itself?
Child (1): Yes.
Child (2): From water.
Child (3): From the freezer.
Teacher: We filled the bubble with water and left it lying around and it became ice?
Child (3): From the freezer.
Teacher: So, we put it in the freezer.

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[Teacher writes it down.]

Teacher: Anybody else from the same team? Something that you found, that you SAW, that impressed you? M. what did you do there that you liked very much and want to tell us about it?
Child (M.): It impressed me that the water turned green - dark green.

[Teacher writes it down.]

Teacher: Let me now ask you. Where did we get the water from?
Child: We had not added any water.
Teacher: Had we put any water in the tub?
Children: NO.
Teacher: G., where did we find the water?
Child (G.): From the colour paints. We added some paints.
Other Child: We put the ice, the ice melted a bit, we added the paints, we stirred them up and it happened.
Teacher: So what do you believe that happened? The water came only from the paints, as suggested by one of you, or the ice melted into water and then we added the paints as well? Which do you believe is the most correct idea? Let's vote.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity.
Factors linked with:	**M: Expl;** **P: Play**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 4
Episode:	1 – Ice Balloons
Selected episode:	Yes
Teacher:	Sonia
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Fostering children's free exploration and thoughtful use of physical

The activity observed was part of a series of lessons entitled "Winter". A part of the Winter lessons was dedicated to ice and snow. The teacher used brainstorming to allow the children to control their learning path but also to assess previous knowledge and any major misconceptions before any activities were planned. The following day children participated in a second brainstorming activity aimed at bringing out specific activities and material which would allow them to study ice properties. In the first activity picked by the children pieces of fruit were placed in a bowl of water which was then placed in the freezer. Pieces of fruit were also left in the classroom to facilitate comparisons (children wanted to see which ones would go bad first). The second activity which children chose was to fill balloons with water and place them in the freezer to see what happens. The teacher then added one balloon that had red dye in the water before being placed in the freezer without children knowing.

A variety of materials were placed on the floor of the classroom in the centre of the spot where all the children gather. The materials included syringes, paintbrushes, watercolours, dyes, bottle of vinegar and magnifying lenses. Children were free to add to the material chosen by the teacher.
The activity began with the teacher asking the children to think about the materials on the floor and what their purpose is. K replied that they are going to be doing experiments with colours. The teacher, after seeing that the children were more interested in the materials themselves (used for the first time in the classroom based on the pre-interview with teacher) than the topic of ice, asked children if they wanted to just play with the materials instead of looking at the ice cubes they made yesterday. Children brought up the two activities they had done during the previous day (fruit and balloons) and they decided to vote the most popular to carry out during the lesson. After counting the votes, it was decided that the children were going to play with the ice balloons. The teacher then asked if they remembered what they had done the day before and if they remembered how they made ice.

When the ice started to melt and more water started to gather in the bowl the teacher asked the children if a different material could help them in seeing the ice better. E said that colours could do that and proceeded to pick colours to paint the ice. The teacher allowed children to use whatever they wished (vinegar, newspaper, tin foil), constantly encouraging them to try out their ideas ('*Just get what you want and play with the ice', 'Of course you can do what you like').*

Teacher: Are you thinking of what else can we put in the tub to study better what happens with ice? […] Take a look at the newspaper. What can you do with the newspaper?

Team 1 uses the coloured water to paint over the newspaper.
Team 2 same as team 1.
Team 3 cuts paper into little pieces and puts them in the tub.

Teacher: What are you doing with the newspaper?
Team 1: I am painting it.
Team 3: We are cutting it in little pieces and throwing them inside.
Teacher: We have forgotten to use one material *(tin foil).* Does anybody want to use it?
Team 2: We need it.
Teacher: Take a big piece of tin foil and think about what you can do with it.
Children: We also need the syringe.

[Children start to dip the tin foil in the tub, scratch the ice using the tin foil, etc.]

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Children add tin foil and newspapers to study the ice balloons

Children add tin foil and newspapers to study the ice balloons

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The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Teacher Education Design Principle + code:	7. Teacher education should familiarize teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games.
Factors linked with:	**P: Affect;** **M: Cr.**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Greece
Case:	Case 3 - Sotiris
Episode:	1 - Little Prince travels to the Solar system
Teacher:	Sotiris
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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The teacher uses the tale of 'The Little Prince' to introduce a series of lessons and activities about the planets and the solar system.

This extract refers to the first of a series of lessons and activities dedicated to the solar system. The aim of the lesson was for children to be able to name the planets and compare them in terms of size and distance from the sun. The idea came to the teacher after the class had watched an episode from the animated series "The Little Prince" and had expressed the wish to know more about the planets.

The lesson started off with the teacher asking the children if they wanted to hear a story he had written about the Little Prince and his latest adventure. The children responded with enthusiasm and the teacher started the narration. The narration was accompanied with a presentation on the whiteboard of brief animations of the solar system and the planets (from www.kidsastronomy.com) as well as of digital images of the Ancient Greek gods, after whom the planets are named.

The story was about the Little Prince, who had finished all his chores and was left with nothing interesting to do. He decided to look at the stars which seemed magical and interesting. He then remembered a gift he got from his friend from Earth, the aviator. The gift was a telescope which made the faraway stars and planets seem closer. However, when the Little Prince tried to look at the Earth where his friend the aviator was, he realised that he did not know where the Earth was in the sky. That made the Little Prince very sad. The solution was given by another friend of his, the crow, who helped the Little Prince to learn about the Earth and the rest of the planets of the solar system.

Using the voice of the crow, the teacher introduced the name of each of the planets connecting it to the myth of the relevant god. He also provided some basic information about the planets (size, distance from the sun, colour, surface) which he elaborated further with the children in following activities. The children showed increased interest and concentration throughout the story, contributing with pieces of information they knew about either the gods or the planets, as well as with comments and questions about what they saw and heard.

Children's learning of the planets' names was subsequently checked using a game called "Help the Little Prince to name the planets" in which children in groups of four had to match small printed tags bearing the planets' names with the images of the planets on a laminated poster featuring the Little Prince next to the solar system.

The following extract of the lesson focuses on the story the teacher used to introduce the planets, omitting most of his exchanges with the children.

The Story

The Little Prince woke up. He went to his little planet, B612; he took his morning walk, cared after his plants, cut off the weeds. He did all his chores. He watered his rose plant, cleaned all his volcanoes, had breakfast and then got bored. He got so bored; he had nothing else to do as he had finished off all his chores. He thus started to look at the stars, the nearby galaxies, the surrounding planets. But he was so far away from them that he could not see them well.

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Then he had an idea. In his previous travel, his friend the aviator had given him as a gift, in addition to a pencil and a book to draw, a telescope.

With this telescope the Little Prince could see the stars and the planets bigger than what they appeared with the naked eye.

He thus tried to look towards our neighbourhood, our galaxy, to try to see his friend the aviator. He looked and he saw this:

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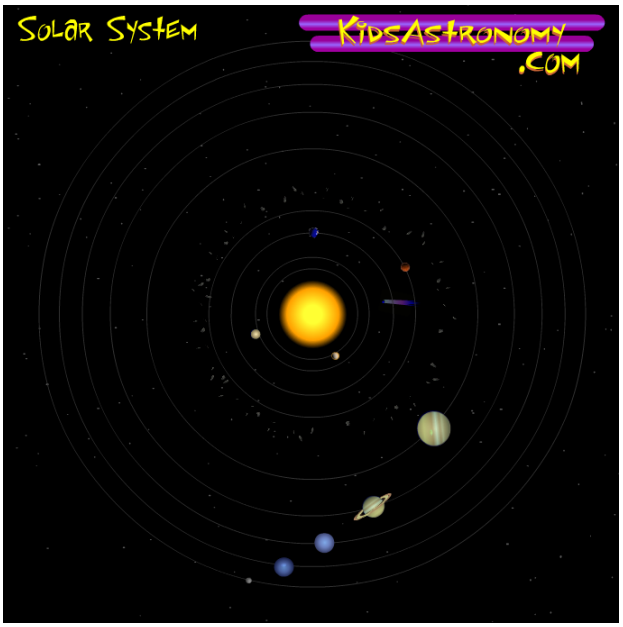
He got very sad that he could not understand which of the dots is Earth and where his beloved friend lived. So, he went back to staring at the stars feeling alone. And then his friend the crow arrived and started asking him why he looked so sad.

The Little Prince said:
"I cannot see where my friend the aviator lives. He gave me this telescope, but I am very little and do not know where to look. Everything looks so small…"

The Crow laughed and said:
"Ah Little Prince you do not know yet how to make the telescope work, because if you use the zoom to magnify you can see better" and the crow got hold of the telescope and showed him a better picture; he showed him this picture:



http://www.kidsastronomy.com/solar_system.htm

Now, the Little Prince could see our Sun and around it all the planets that turn, that dance. The Little Prince observed that he could see the Earth where his friend the aviator lived. But apart from the Earth he could see other planets as well, smaller and bigger planets. So he asked his friend the crow: "Crow, apart from the Earth, around this huge Sun there are many planets that I have not visited yet and I do not even know their names." The crow sat down and after drinking some water to rest he told him that he knew all the names of the planets. He also told the Little Prince that every planet got his name from one of the gods, themselves named by Ancient Greeks. He thus started telling him the story of every god.

And the Crow said: "Can you see a very very small planet, very near the Sun?"
"Yes", said the Little Prince, "it is this planet, which is very close to the Sun".
"This planet is called Hermes", and the Crow started telling him few words about the god Hermes.

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Hermes was the postman of the gods. When the gods wanted to send a message to people or to other gods, they sent Hermes. Hermes was also the god that protected merchants, but because when he was young he was a little naughty, he also protected the thieves. It is not good to be a thief, but Hermes protected them as well. Because when Hermes was very young he got jealous of the oxen his brother Apollo had and he stole them from him. Apollo got very angry. He did not know who had stolen his oxen, but the oxen had left behind their footprints which he followed and found Hermes in a cave with the oxen. Hermes had killed an ox to eat it and had taken its guts to make strings and its horns to make a guitar using also a turtle shell. Apollo heard his brother playing the guitar and forgot how angry he was; he offered Hermes the oxen in exchange for the guitar. […]

Then the Crow said: "Beyond the planet Hermes there is a planet that is similar to Earth but is not very warm. This planet has taken its name from goddess Aphrodite." […]

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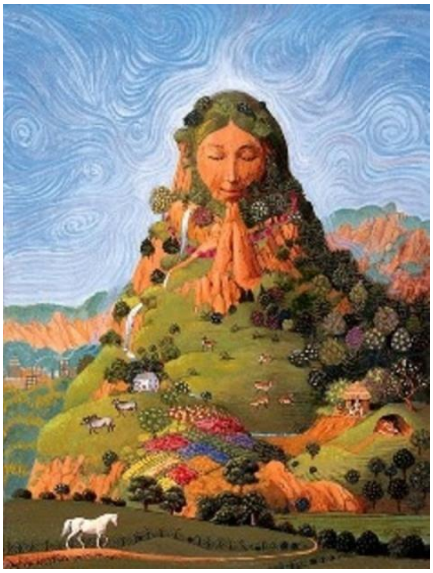
Aphrodite was the goddess of beauty. Goddess Aphrodite was the prettiest of all goddesses and was called Aphro-dite, because she emerged, they say, from the foaming spume ("aphros") of the sea. […]

And the Crow continued: "Beyond Aphrodite there is the planet Earth, where your beloved friend the aviator lives. Earth ("Gee" in Greek) got its name from goddess Gaia."



Goddess Gee or Gaia was one of the first goddesses worshipped by people, because without Gee people could not plant anything, nor find anything to eat. This is why people made her into a goddess. And as if this was not enough, they wanted her to be married with god Uranus. God Uranus has also given his name to a planet.

Beyond Earth, there is a very very red planet, Mars ("Ares" in Greek) – red like Olympiakos (a Greek football team). "Ares" took his name from… [**Children**: "From the football team called 'Aris'; **Teacher**: Not from the football team – the football team took its name from the god "Ares" – not the other way round]. "Ares" was the god of war. There he is.

He was insatiable, he wanted everybody to fight so that he could be happy. Can't you see how happy he is that people are fighting? And because he was the god of war, in paintings he appears with all his gear on, his sword, his shield, his helmet – with all his military uniform on.

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Beyond Mars, there is the biggest of all planets, Jupiter ("Zeus" or "Dias" in Greek). Jupiter was the father and king of all gods and all people. He was so strong that he had as weapon a thunderbolt. When Jupiter was angry, thunderbolts fell on Earth.

Another symbol for god Jupiter, whom you can see how strong he is, is the eagle. Jupiter has two symbols, the thunderbolt and the eagle. Jupiter protected the strangers. In Ancient Greece if someone was a stranger and visited somebody's house, the latter would open the house for him/her, because all strangers were protected by Jupiter. This is why Jupiter was also called "Xenios", because he protected the strangers ("xenos" in Greek). All strangers visiting a place were considered holly by the Ancient Greeks and thus they had to care for them. So, M. if I were a stranger in Ancient Greece and came to your house, you would need to open the door, let me in, feed me, give me some water, offer me a bed to sleep in, and in exchange I had to entertain you in the evening; I told you stories, tales from my life. Because as I were a traveler and thus very tired, I was protected by Jupiter. But I had to be a good person, I could not be a crook or a thief. […]

Beyond Jupiter is Saturn ("Kronos" in Greek). Saturn is the planet that has rings around it and it is the gem in the Sun's neighbourhood. Ancient Greeks said that Saturn was the father of Jupiter. Here he is, seating on his chair.

He is holding an upside-down sickle. We use a sickle to reap the wheat. Saturn was Jupiter's dad. He was a Titan and because he was afraid that one of his children might grow up to be very strong and take the throne from him – and he would then cease to be king – every time his wife gave birth to a

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child, he ate it. [**Child**: The father?] Yes, the father ate his children. Because he was afraid that one of his children would grow to be very strong, send him away and become king in his place. But Jupiter's mother, Rea, when Jupiter was born, took pity of him and instead of giving him to Saturn to eat, she gave Saturn a rock and hid Jupiter in a mountain here in Crete. Do you know which mountain this is? It is here near us. Which mountain is this? […] She hid him in Psiloritis. Rea went to Psiloritis and hid Jupiter in a cave called "Ideon Andron". The cave was guarded by some Cretan warriors called "Kourites' who every time the baby cried danced a military dance whacking their shields and swords to cover the noise. They made music so that Saturn would not hear Jupiter's crying. When Jupiter grew up he went and secretly gave his father a drink to make him go to sleep; he then opened his belly so that all his brothers and sisters got out, and Jupiter became the king. […]

Beyond Saturn there is Uranus. […] Uranus was the father of Saturn and husband of Gaia. Let's have a look at him. He is handsome, isn't he? He looks a bit like Jupiter.

[**Children**: He is a girl. **Teacher**: How can he be a girl, he is wearing a beard? **Children**: He is a girl because he is wearing a dress. **Teacher**: In the old times, they did not wear dresses, they wore cloaks. Both men and women wore the same clothes. **Children**: Yuck.]

Beyond Uranus there is Neptune ("Poseidon" in Greek). God Neptune was the brother of Jupiter and he was the god of the seas and as symbols he had the horse and the trident. There he is coming out of the sea.

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[**Children**: *[Laughter]* He is not wearing clothes. **Teacher**: He was in the sea. They did not have swimming clothes then.]

And then the last planet, the smallest which is far far away…, which we now do not anymore consider to be a planet, is Pluto, who is also Jupiter's brother. Here he is.

Pluto was the god of the underworld, the king of the dead. Next to him he had a terrifying dog Cerberos, which guarded the dead, so that they do not leave Pluto's kingdom. This dog had three heads and his tail was a snake. […]

And the Little Prince said: "Now I know the names of the planets."

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Teacher Education Design Principle + code:	16. Teacher education should provide teachers with knowledge of approaches to timetabling and organizing cross-curricular project work. **TE: CrossCurr**
Specific Teacher Outcome(s):	16.3 Teachers should be able to build connections across the curriculum of various kinds and with potential to contribute to children's inquiry and creativity.
Factors linked with:	**LA: Connect;** **C: Sci/M Integ;** **AO: Creative;** **AO: IBSE/PBL**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 3
Episode:	3 - The magic flute
Teacher:	Sotiris
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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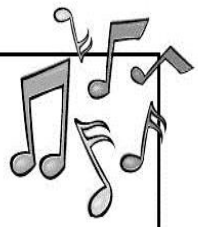
Using a workshop to combine assessment of science learning and literacy skills with imagination

Children completed this worksheet at the end of the first day of a two-day lesson on sound, which began with the teacher reading the story of the Pied Piper of Hamelin to the class. The children then watched a Walt Disney's 'Silly Symphony' animation of the same story and created their own 'magic' pan flute using straws, a pair of scissors and pieces of scotch tape. During the hands-on activity the children had to cut seven straws to different lengths, sort them from shorter to longer and fasten them together with the scotch tape. They thus worked on a mathematical sorting activity before moving on to exploring and thinking about how it was possible to produce music out of straws.

The worksheet below was used at the end of the lesson and asked children to draw themselves with the magic flute and write underneath it what they would like to happen if their flute was magic. With this worksheet, the teacher wanted on the one hand to assess whether children had understood the basic features of a pan flute and on the other to develop further their writing skills, while contributing at the same time to children's development of imagination and creativity.

I draw myself together with the magic flute.



If my flute was magic…

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Examples of children's work

"…it would fly high in the sky."

"...my mother woud sleep and I would do all the housework."

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Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teachers should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**P: Ques;** **P: Scaff;** **P: Agency;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 3
Episode:	3 - The magic flute
Teacher:	Sotiris
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Using questions to scaffold children's reflections on and explanations about how it is possible to make music out of straws.

The following extract refers to the classroom exchanges that took place during the first day of a two-day lesson on sound, which began with the teacher reading the story of the Pied Piper of Hamelin to the class. The children then watched a Walt Disney's "Silly Symphony" animation of the same story and created their own 'magic' pan flute using straws of different colours, a pair of scissors and pieces of scotch tape. During the hands-on activity the children had to cut seven straws to different lengths, sort them from shorter to longer and fasten them together with the scotch tape. Having created their 'magic flute' children were asked to explore it, thinking about how it was possible to produce music out of straws. The exploration and several small group discussions on the issue were followed up by the classroom discussion below, in which the teacher is seen using questions to scaffold the children's reflections and explanations.

Teacher: Now that we're done playing with our flutes, I want you to explain to me something. How is it possible to go from just having drinking straws to being able to do this *[he plays his own flute]?* How can I produce sound by placing straws one next to the other from shorter to longer?

Child 1: Because we blow.

Teacher: Where?

Child 1: Into the straw.

Teacher: And where did we find the air to blow Child 2?

Child 2: In our mouth.

Teacher: Do you mean that our mouth has the air?

Child 3: Yes.

Teacher: Oh I get it now. So if I get a straw and hold it close to somewhere that air is blowing, will I get this sound?

All: Yes.

Teacher: Today, it is raining. If there was wind and I held the straw like this in the wind, would it make sound?

All: Yes.

Teacher: What if I put it in front of a small fan? What do you think would happen then? Would it make the same sound?

All: Yes, yes.

Teacher: So now that I don't have such a fan, what do I do?

All: You blow with your mouth.

Child 4: Because they also have many colours.

Teacher: So if I get black tape and wrap it around the straw, do you think that it will stop making sound?

Child 4: Yes.

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Other children: No, it will still make sound.

Teacher: Let's do it all black to see. I don't think colour has anything to do with it, but I am not really sure, maybe it has. If I make it all black, maybe it stops making sound. It might be about the colour you never know.

Few children: It will still make sound.

Teacher: I do not know. How many think that it will still make sound if I make it black? How many say that it won't?

*[Most **children** say that it will still make sound, but several children say that it won't.]*

Teacher: Should I cut the straw a bit? I don't want to spend the entire tape on it. [He cuts the straw smaller and fastens the black tape around it.] Is it black now?

All: Yes.

[The teacher blows into the black straw. The children that thought that it would still make a sound cheer 'We won'.]

Teacher: So we see that the black straw produces sound as well. Because I made it thicker it might even produce a louder sound than the 'normal' one. Let's see. Let's take another similar piece of straw.

*[**Teacher** takes a different coloured straw of the same length and shows it to the children.]*

Teacher: Child 5 are they the same *[length]*? Are they equal?

Child 5: Yes.

*[**Teacher** blows into the two straws alternately.]*

All: The same.

Teacher: The two sounds are?

All: The same.

Teacher: So, it does not appear to matter if one is thicker than the other. So they make the same sound depending if they are…?

All: ... equal.

Teacher: Whereas if I have a tall one and a short one? Let's try. I have here a tall and a short one. Let's hear.

*[**Teacher** takes two straws of different length and blows into them alternately.]*

Child: It is like playing the piano and you hear *[the notes]* Sol (G) – Mi (E), Sol (G) – Mi (E).

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Teacher Education Design Principle + code:	10. Teacher education should enable teachers to recognize and build on children's ideas, theories and interests for the teaching of science and mathematics. **TE: ChildIdeas** 3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	10.2 Teachers should be able to build flexibility into planning to take advantage of unexpected events, children's interests and questions. 3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity. 3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**AO: Kn.Sc;** **AO: Sc ProcSkills;** **AO: Und. SI;** **P: R and R;** **P: Affect;** **T: Ped**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 1
Episode:	2 – Measuring Tables
Selected episode?	Yes
Teacher:	Mina
Age Group:	5-6

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Children share their findings: The problems of the short ribbon and the wrong way around number.
Teacher turns children's mistake into a learning opportunity.

This lesson focuses on children taking measurements of their work tables using any of the measuring tools provided or a measure the dimensions of the table using a tool of their own conception. The teacher started the activity off by reminding children that they have been talking about getting new tables for the classroom. The children would be divided into 8 teams (6 made of 4 children and 2 more with 3 children) to help the teacher with a problem she had. The teacher went on to inform children that she spoke to the carpenter to place an order for new tables, but when he asked her to tell him exactly what tables she wanted, she did not know how to respond. She concluded by asking the children if they wanted to help her measure the tables so that she can alert the carpenter. The teacher felt that it is every important to connect mathematics to the children's everyday life using appropriate activities and making sure that the children are motivated.

The children started working together, with one child holding the tool, one in charge of the recording to the note book and two more assisting the child that was taking the measurement. Some teams kept these roles throughout the activity, while others rotated to take all the roles possible. After 15 minutes Mina invited all the teams to present and discuss their findings.

Each team had the opportunity to present their measurements and findings as Mina wanted to know what they had noted in their notebook. Mina was asking them to provide their measurements for shape, measurement tool used, length, width and height of the table.

T: Team 5 used the ribbons to measure the table. What did you measure? The width?
A child (M): Yes. And the legs.
T: And the legs? Let's see how you managed to do all this. Could I have your attention here please? This is important. Let's see how they managed to measure the table with something different, such as the red ribbon. Team 5, how did you measure the table's width for example? Tell me how - I have never measured anything before in my life.
A child: We start here *[places the end of the ribbon to the ground]* and go…
T: Wait, you start from here and go where? Here? But, where does our table end? *[children looking]* Mmmm… Isn't it a bit shorter, or longer?
A child: Longer.
T: Is it longer? The table or the ribbon? Which is longer?
A child: The table.
T: So the ribbon then is ...
A child: shorter
T: You needed a little bit more, didn't you?
All: Yes we did.
T: So, is this the correct measurement for our table then for its width?
All: No.
T: We have to try again.

[Children seem disappointed]

T: It does not matter. It does not matter that there is an unsuccessful attempt, as long as we understand what we have to do. When we make an attempt and then we go to check it and it is not

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right, we try again. *[Mina grabs the ribbon]* The example of team 5 shows us that we have to try again. Because we realize from the checks we have done that this ribbon... What do we realize **M**? Say it in your own words - you know this better than me.
M: The ribbon is shorter than the table.
T *[to all]:* The ribbon **M** says is shorter than the table. So are we going to give the carpenter the correct measurements?
All: No.
T *[to all]:* What table is he going to make? Bigger or smaller?
All: Smaller.
T: When we realize this, we get the ribbon again, we stretch it and make the correct measurements. OK? Good.

[The teacher identifies another team's mistake, this time in the measurement the children had recorded for the height of the table, caused by writing down the number the wrong way around - 85 cm instead of 58 cm. She asks them to and helps them verify their measurement. She then explains what the mistake was.]

T: Bravo. So children of the team, you have taken the correct measurement, but you have put the digits the other way around. OK? Bravo! Can you see this? Bravo, Team 6. Very good.
But, there are other things to observe in the measurements you took. Because, from what I see, if we give these measurements to the carpenter as they are, he won't know exactly what to do. He might probably get confused a bit. We thus need to reach a conclusion about the measurements. And in order to do this we have to do what? *[No answer]* What do we have to do? What did we do with the previous measurements? I will tell you a new word. It's called 've-ri-fi-cation'. What does this difficult word mean? We will thus see, we will check if the measurements we took are "real". In order to do the verification, I will help you and you will help me. We will not do the verification now, because you are a bit tired [**A child:** and we are hungry] and you are hungry. I will however collect all the materials, so that we can make the verification tomorrow morning. Do you agree?
All: Yes.

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Teacher Education Design Principle + code:	10. Teacher education should enable teachers to recognize and build on children's ideas, theories and interests for the teaching of science and mathematics. **TE: ChildIdeas** 3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	10.2 Teachers should be able to build flexibility into planning to take advantage of unexpected events, children's interests and questions. 3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity. 3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**AO: Kn.Sc;** **AO: Sc ProcSkills;** **AO: Und. SI;** **P: R and R;** **P: Affect;** **T: Ped**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 1
Episode:	2 – Measuring Tables
Selected episode?	Yes
Teacher:	Mina
Age Group:	5-6

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Children share their findings: The problems of the short ribbon and the wrong way around number.
Teacher turns children's mistake into a learning opportunity.

This lesson focuses on children taking measurements of their work tables using any of the measuring tools provided or a measure the dimensions of the table using a tool of their own conception. The teacher started the activity off by reminding children that they have been talking about getting new tables for the classroom. The children would be divided into 8 teams (6 made of 4 children and 2 more with 3 children) to help the teacher with a problem she had. The teacher went on to inform children that she spoke to the carpenter to place an order for new tables, but when he asked her to tell him exactly what tables she wanted, she did not know how to respond. She concluded by asking the children if they wanted to help her measure the tables so that she can alert the carpenter. The teacher felt that it is every important to connect mathematics to the children's everyday life using appropriate activities and making sure that the children are motivated.

The children started working together, with one child holding the tool, one in charge of the recording to the note book and two more assisting the child that was taking the measurement. Some teams kept these roles throughout the activity, while others rotated to take all the roles possible. After 15 minutes Mina invited all the teams to present and discuss their findings.

Each team had the opportunity to present their measurements and findings as Mina wanted to know what they had noted in their notebook. Mina was asking them to provide their measurements for shape, measurement tool used, length, width and height of the table.

T: Team 5 used the ribbons to measure the table. What did you measure? The width?
A child (M): Yes. And the legs.
T: And the legs? Let's see how you managed to do all this. Could I have your attention here please? This is important. Let's see how they managed to measure the table with something different, such as the red ribbon. Team 5, how did you measure the table's width for example? Tell me how - I have never measured anything before in my life.
A child: We start here *[places the end of the ribbon to the ground]* and go…
T: Wait, you start from here and go where? Here? But, where does our table end? *[children looking]* Mmmm… Isn't it a bit shorter, or longer?
A child: Longer.
T: Is it longer? The table or the ribbon? Which is longer?
A child: The table.
T: So the ribbon then is ...
A child: shorter
T: You needed a little bit more, didn't you?
All: Yes we did.
T: So, is this the correct measurement for our table then for its width?
All: No.
T: We have to try again.

[Children seem disappointed]

T: It does not matter. It does not matter that there is an unsuccessful attempt, as long as we understand what we have to do. When we make an attempt and then we go to check it and it is not

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right, we try again. *[Mina grabs the ribbon]* The example of team 5 shows us that we have to try again. Because we realize from the checks we have done that this ribbon... What do we realize **M**? Say it in your own words - you know this better than me.
M: The ribbon is shorter than the table.
T *[to all]:* The ribbon **M** says is shorter than the table. So are we going to give the carpenter the correct measurements?
All: No.
T *[to all]:* What table is he going to make? Bigger or smaller?
All: Smaller.
T: When we realize this, we get the ribbon again, we stretch it and make the correct measurements. OK? Good.

[The teacher identifies another team's mistake, this time in the measurement the children had recorded for the height of the table, caused by writing down the number the wrong way around - 85 cm instead of 58 cm. She asks them to and helps them verify their measurement. She then explains what the mistake was.]

T: Bravo. So children of the team, you have taken the correct measurement, but you have put the digits the other way around. OK? Bravo! Can you see this? Bravo, Team 6. Very good.
But, there are other things to observe in the measurements you took. Because, from what I see, if we give these measurements to the carpenter as they are, he won't know exactly what to do. He might probably get confused a bit. We thus need to reach a conclusion about the measurements. And in order to do this we have to do what? *[No answer]* What do we have to do? What did we do with the previous measurements? I will tell you a new word. It's called 've-ri-fi-cation'. What does this difficult word mean? We will thus see, we will check if the measurements we took are "real". In order to do the verification, I will help you and you will help me. We will not do the verification now, because you are a bit tired [**A child:** and we are hungry] and you are hungry. I will however collect all the materials, so that we can make the verification tomorrow morning. Do you agree?
All: Yes.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering and extending inquiry and creativity, by for example prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events. 7.4 Teacher should be able both to build in new and to make the most of existing opportunities for child-initiated play, recognising and capitalising on the potential of children's explorations beyond the teacher's original intentions. 7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.6 Teachers should be able to use strategies for making and building on science and mathematics real life connections and applications for engaging creatively young children in science and mathematics learning.
Factors linked with:	**P: Play;** **P: Quest;** **P: Scaff;** **P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Greece
Case:	Case 6
Episode:	1 – Pansies
Teacher:	Katia
Age Group:	4-5
Selected episode present in D4.4 Appendix	No

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Teacher supports children's engagement in exploring within a creative context to provoke children's interest, motivation and

The particular topic chosen by the teacher as the context of this activity was plant growth and it focuses on day one of the two-day lesson that involved the experiment with the pansies. During the first day, children would make predictions about the growth of the pansies and make an 'observation folder' to record their predictions and observations. On the second day, 5 days later, the children would observe the pansies and record their findings in regard to teacher growth and come to conclusions on the influence of each of the factors.

The lesson began with Katia asking the children if they remembered Mr. Planty, an agriculturist who loves all plants. In the story Mr. Planty had to leave his greenhouse to tend to a lettuce garden that was threatened by snails. That meant that he was forced to leave his 5 newly planted pansies to be tended by his five assistants. Each of the five assistants chose to keep his/her pansy during Mr. Planty's absence. Katia then explained how each assistant tended to the pansies.

What did each assistant do?

- Assistant 1: put the pansy in a box
- Assistant 2: covered the pansy with a plastic bag
- Assistant 3: stored the pansy in the refrigerator
- Assistant 4: placed it right next to the other flowers on the greenhouse
- Assistant 5: similarly placed the pansy in the greenhouse but forgot to water it

As Katia was telling the children what the different assistants did, the children were yelling out their comments and objections.

Katia: I want you to imagine, if the assistant placed the pansy in a box what might happen to the pansy during the next few days?
O: It will wither *[two more children agree]*
J: It will get hot
Katia: I am writing everything down in your observation notebook. Does anyone else from this team have anything to add? An, what do you think?
An: It will wither.
V: but they *[the assistants]* watered it every day. All except this one *[shows the 5th pansy]*
Katia: I agree, but is water the only thing a plant needs?
All: No
O, V, J: the sun
F: and food
Katia: So it needs the sun and food. What is the food for plants?
F: fertiliser
Katia: What is fertiliser? Is it liquid?
F: No it's something soft.
Katia: Like what?
F: Like dirt
Katia: and it contains nutritional elements right?
F: Yes to feed the plant
Katia: What else does a plant need?
O: Soil
Al: Rain. And water without the rain

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Katia: That's right. If the weather does not rain for a while we need to water the plant ourselves. What if now we placed the plant inside the box, what will be missing?
Al: The sun
Katia: OK so what symbol would you use to describe your team then? Do you think that it should be the sun?
All: Yes
Katia: One of you should come here and draw the sun on your observation notebook.
An: I can use the orange marker as well
Katia: Yes you can
An: Sometimes the sun is orange so I can use this one.
Katia: That is right
O: there is also a red sun
Katia: Yes
O: When it rises in the morning
Katia: Very nice. Now do you want to write all your names on the observation notebook?

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Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.1 Teachers should be able to recognize and value children's various forms of expression and representation of their ideas and learning in science and mathematics. 9.2 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development. 9.3 Teachers should be able to select and use different approaches for and forms of recording children's ideas and learning in science and mathematics at different stages of the learning process and for various purposes, including to support children's reflection and reasoning processes. 9.4 Teachers should be able to use the various modes of children's expression and representation of science and mathematics ideas (e.g. pictures, graphs, gestures, physical activities) for assessment purposes.
Factors linked with:	**P: Affect;** **P: Collab;** **P: Express;** **LA: Connect;** **LA: Comm;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Greece
Case:	Case 5
Episode:	1 – Plants
Teacher:	Stavros
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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Setting the context for a collaborative learning activity

From the beginning it was apparent that the main learning objective of the session was to use this investigation as an opportunity for children to learn particular areas of knowledge about plants, particularly the main parts of plants. Children were learning through the use of inquiry based approaches within a series of planned and scaffolded activities. The lesson took place both indoors and outdoors and included both formal, teacher-led aspects and informal, child-initiated aspects.

At the outset of the lesson the children were asked to form two teams (red and yellow) of four, go out to the yard for 5 minutes, gather plants and bring one per child back to the classroom.

Each child would then present his/her plant to the rest of the class and highlight what impressed them about it. Children took turns to present the plants they brought in (olive branch, lettuce, turnip, rose). When presenting the plants, children included any information they knew about the plants with Stavros asking them questions.

Stavros then asked the children to compare the different plants they had brought and spot similarities and differences. Children were asked to observe the different plants and guided Stavros to draw the different parts of a plant on the blackboard. Children described the parts as Stavros provided the scientific terminology. The entire classroom discussion ended with Stavros announcing that in the days that would follow the children were going to plant lentils and provided children with general instructions.

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During the second day, the lesson began with a revision of the activities of the day before and a brief evaluation of the parts of plants. The typical phrase used during this part of the lesson was “What did we say about...yesterday?”. For the next forty minutes children looked at the photographs they had taken the day before and tried to find and name the different parts of each plant.

Stavros supported children with the proper terms to use for previously mentioned characteristics and introduced new terms (e.g. stamens) when children observed and commented that specific characteristic of the plant. Stavros insisted on children observing the photos and describing the different parts of the plant or the shape of its flower. He used questioning to allow children to elaborate on their thoughts and correct their misconceptions. Children were also required to make comparisons, predict on the evolution of different plants and provide explanations.

The concluding activity of this two-day lesson, which is the focus of this episode, was a role playing exercise.

Stavros: We are already divided into two teams. I will remind you the basic characteristics of herbs, bushes and trees (the three categories that characterise plants) and I want you to form a living statue.

K: Ahhh, this is very nice
Stavros: The first team will show me what a herb looks like, the second team will show me a bush and so on.
Z: How are we going to do that?
Stavros: Using your body
D: With our hands?
Stavros: You can use your whole body; you can do whatever you like. First off the herb. This means soft sprout for example. Then you will do the bush and finally the tree. I want you to think about the herb. You can discuss and rehearse for five minutes and then you will come back here to show me.

Children start discussing what to do, trying to agree on an idea. The first idea is pictured in the image below with four children standing up with their hands over their heads.

Stavros: What are you supposed to be?

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An: We are a pine
Stavros: Why do you have your arms up?
All four: It's the branches.
Ar: and the hands are the leaves
Stavros: That is very good. You can try to move your hands to show that there is wind blowing. Try to do a bush now.

The other team yells for Stavros to come and see what they have done.

Stavros: Let's see. What are you doing here? Why are you on the floor?
E: You are looking at us from above.
Stavros: I understand now. What are you then?
All: A herb
Stavros: So what is E supposed to be then?
E: The sprout
Stavros: What about the others?
K, Z, ??: Leaves
Stavros *(as he is standing above them):* So what am I supposed to be now that I am standing here.
K: The roots?
Stavros: Now I could be the roots as I am under the trunk

By the time that Stavros was done with the second team, the first team was trying to do a herb. Stavros reminded them the basic characteristics of herbs.

Stavros: What about you then?
All four: We are a poppy
Stavros: Oh that is very nice. What are you doing now?

Children all yelling, inaudible in the recording.

Stavros: So you three are the leaves and D is the flower. I get it now, well done.

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Stavros: That was very good. Let's see what the others have done. What are you supposed to be?
All four children: A tree
E: A tree with three branches
Stavros: That is very good.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity.
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations.
Factors linked with:	**P: Affect;** **M: Inf.**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 2
Episode:	3 – Playing with the microscope
Teacher:	Gianna
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Children introduced to a microscope. Beginning of an open-ended lesson/exploration with the microscope

Gianna: I want to introduce you to a friend of mine who is small. Very small in fact. Smaller than everybody.
[Children ask who]
Gianna: In order to meet my friend we have to use another one *[friend],* Mr Microscope.
Z: What does he do?
Gianna: People use him to look at very small things. The microscope has a better eye than humans so it allows us to see things we have trouble seeing clearly.
K: Even an ant?
Gianna: Can you see ants?
K: I can, but not the arms and legs.
N: You have to get very close to the ant if you want to see arms and legs.

Introducing the microscope

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Examining Z's ear

Observing an eye with the microscope

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning.
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.5 Teachers should be able to assess group work. 15.6 Teachers should be able to use effective strategies for sharing ideas and discussions from different groups.
Factors linked with:	**P:Ques;** **P: Scaff;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 1
Episode:	1 – Shape trees
Teacher:	Mina
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Assessing both cognitive and affective dimensions of learning in a collaborative learning activity

This preschool lesson involved children playing with geometrical shapes. Children had to gather objects from the classroom ('The shape hunt'), discuss their shape with the teacher, comment on specific shapes' mathematical properties and finally make 'shape trees' using paper and a variety of other material.

The lesson started as children seemed very excited from the beginning when Mina let them know they would be working in groups and playing with shapes and objects. After splitting up the 4 teams Mina told the children: *'I will tell you what I would like from you and you can then go about it your own way. Do whatever you want.'* Each team was assigned a colour and the only instruction provided by Mina was for children to find objects that are the same colour as their team's and bring them back to her. The children were given 3 minutes to do so and at the end a variety of shapes was brought back to the tables. Mina asked the children to share their findings with the rest of their classmates.

After the 4 presentations were done, Mina started a discussion about the nature of the activities that proceeded, mostly trying to bring out what the children felt about working in groups and collaborating.

> **Mina:** Take a look around to see your friends' work and compare it to your team's work. How did you feel working within the team? What did you like? What didn't you like? What made you feel happy? I want you to think for a bit.

Children said that they enjoyed making the shape trees together. F said that he enjoyed working with shapes, measuring the rectangles to cut and glue them to the trees. Measuring shapes was what L mentioned as particularly enjoyable, while Li said that she enjoyed seeing what the other teams had done, especially the team working the triangles. Mina, after allowing every child to assess the day's activities, concluded the lesson by letting the children know what she felt about their work.

> **Mina:** Let me tell you what I really liked. The way you worked together, collaborated. You worked very well as a team and any disagreements and conflicts were kept to a minimum. You did everything very well and managed to complete all your tasks within the time provided. Let's give ourselves a big round of applause. Well done, you were great!

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Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**P:Ques;** **P: Scaff;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Class
Originating from:	
Country report :	D4.3 Greece
Case:	Case 1 - Mina
Episode:	1 – Shape trees
Teacher:	Mina
Age Group:	5-6

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Encouraging children's reflections through questioning

In this classroom extract, children had to gather objects from around the classroom ('The shape hunt'), discuss their shape with the teacher, comment on specific shapes' mathematical properties and finally make 'shape trees' using paper and a variety of other material. This activity illustrates the ways in which the teacher sought first to support children in becoming familiar with shapes and their properties using everyday objects and get them to construct a depiction of a tree.

Children were split up into 4 teams Mina told the children: '*I will tell you what I would like from you and you can then go about it your own way. Do whatever you want.*' Each team was assigned a colour and the only instruction provided by Mina was for children to find objects that are the same colour as their team's and bring them back to her. The children were given 3 minutes to do so and at the end a variety of shapes was brought back to the tables. Mina then asked the children to share their findings with the rest of their classmates. The children had to raise their hand to speak and after that they had to name their shape. Mina then asked them questions to assess their knowledge of shapes. The questions used by Mina during this activity were almost identical for each of the children. She started off by asking '*what is this?*' and continued by asking '*how do you know?*' Her final question was '*How did you reach this conclusion?*' and was aimed at children using both their language skills and their bodies to show what they were talking about.

Mina: Let us now hear from the yellow team. Were you good investigators?
All: Yes we were.
Mina: Let us see what you are here to present to the rest of us. Tell what you found or you think you found. N?
N: This is a circle.
Mina: How do you know?
N: It is round.
Mina: What does everybody else think? Do you agree with N? Is that the name of this shape?
All: Yes.
Mina: Do we see shapes like that around us?
Ni: It is the shape of the planet Earth.
Mina: Oh is that right?
A: I have two more shapes. Circle and square
Mina: A has two shapes in her hands. Lift them up so everybody can see. A, what makes you say that these are a circle and a square?
A: One shape does not have any...
Mina: What does one shape not have?
A: The circle does not have any sides while the square has four.
Mina: Did everybody hear A?
All: Yes.
A: Four identical sides.
Mina: Oh that is a nice observation. Can all of you see that?
All: Yes we can.
Mina: D, you also have two shapes.
D: Yes they are a circle and a triangle.
Mina: How did you reach to the conclusion that they are a circle and a triangle?
D: Because the triangle has three angles while the circle does not have any.
M: I also have a triangle.

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Mina: How can you be sure?
M: It has three sides and three angles.

When talking about the rectangle (presented by V), D mention that it has 4 right angles.

D: There are 4 four right angles
Mina: How did you come to this conclusion?
D: The angles are 'longer' than the other angles *(forming a right angle with his hands)*
Mina: What is the shape called?
D: It's called rectangle *(orthogonio in Greek)*. Right *(ortho in Greek)* and angles *(goni-es in Greek)*
Mina: So we have a word that is made up from two other words, right?
D: Yes. Ortho and gonio.
Mina: Very good.
D: And if you change it you can make it into a square. If you go like this *(showing that the longer two parallel sides should be shortened to equal the remaining two sides*).

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Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE:LEnvironment**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out. 14.2 Teachers should be able to recognise and build on opportunities for informal learning in science and mathematics within the school environment, for example within day to day routines or child-initiated games and other activities in school classrooms or outdoor play areas.
Factors linked with:	**P: Affect;** **M: Inf.**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 Greece
Case:	Case 2
Episode:	1 – Baking cheese pies
Teacher:	Gianna
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Using the school's kitchen to teach mathematics

Children measuring spoonfuls of olive oil to add to the dough mix

Counting spoons of flour for the cheese pie dough

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Adding vinegar to the dough

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GR_Img_BranchesLeavesPinecones_Resources

Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity.
Specific Teacher Outcome(s):	17.7 Teachers should be able to develop the school grounds and the outdoor classroom for use in science and mathematics education.
Factors linked with:	**M: Outd.**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 6
Episode:	6 – Branches, Leaves and Pine Cones
Teacher:	Katia
Age Group:	4-5
Selected episode present in D4.4 Appendix	No

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Using the school outdoor grounds to explore early numeracy concepts

This activity took place at the start of a three-day lesson which aimed at developing children's pre-numeracy knowledge and skills: understanding of simple space and time concepts, such as big-small, wide-narrow, long-short, before-after; use of mathematical language; making comparisons and classifications.

The children had to go around the school outdoor grounds and collect tree sticks, leaves and pine cones, which they then had to sort out into long and short, wide and narrow and big and small respectively. The purpose of the activity was to collect suitable material for a hedgehog to build its nest. The activity was presented in the context of a story taken from a children's book titled "Ouch!" (Scammell and Terry, 2006) about a hedgehog trying to get into its nest to sleep for the winter (hibernate). The following day the children acted out the story using some of the materials gathered. The third day (few days later) the children were asked to work in groups of four and put the same materials in order of size (the pine cones), length (the branches) and width (the leaves).

The images below depict the collection of the materials and children's attempts to classify them. The children had to work in groups, with each group tasked to collect specific kind and size of materials. During the activity some children thought that they had spotted a tortoise's shell under a bush, only to realise that they had instead found a different kind of cone, a cypress cone. Lively exchanges occurred between the children and the teacher about whether the materials gathered were 'small' or 'big', 'long' or 'short', 'wide' or 'narrow', preparing the ground for discussion about relative sizes, as part of the third-day lesson.

Examples of materials to collect and containers to put them in

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Children busy collecting and sorting materials

A long stick together with the other long ones.

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'Mrs Katia, come to see, we found a tortoise's shell.'

'Can't you see? There it is.'

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GR_Int_IceBalloons_ChildIdeas

Teacher Education Design Principle + code:	10. Teacher education should enable teachers to recognize and build on children's ideas, theories and interests for the teaching of science and mathematics. **TE:ChildIdeas**
Specific Teacher Outcome(s):	10.1 Teachers should be able to use a range of strategies for picking up on children's ideas, theories and interests.
Factors linked with:	**P: Ques;** **P: Express;** **LA: Plan;** **LA: Obs;** **LA: Equip;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	**Interview**
Originating from:	
Country report :	D4.3 Greece
Case:	Case 4
Episode:	1 – Ice Balloons
Selected episode	Yes
Teacher:	Sonia
Age group:	5-6

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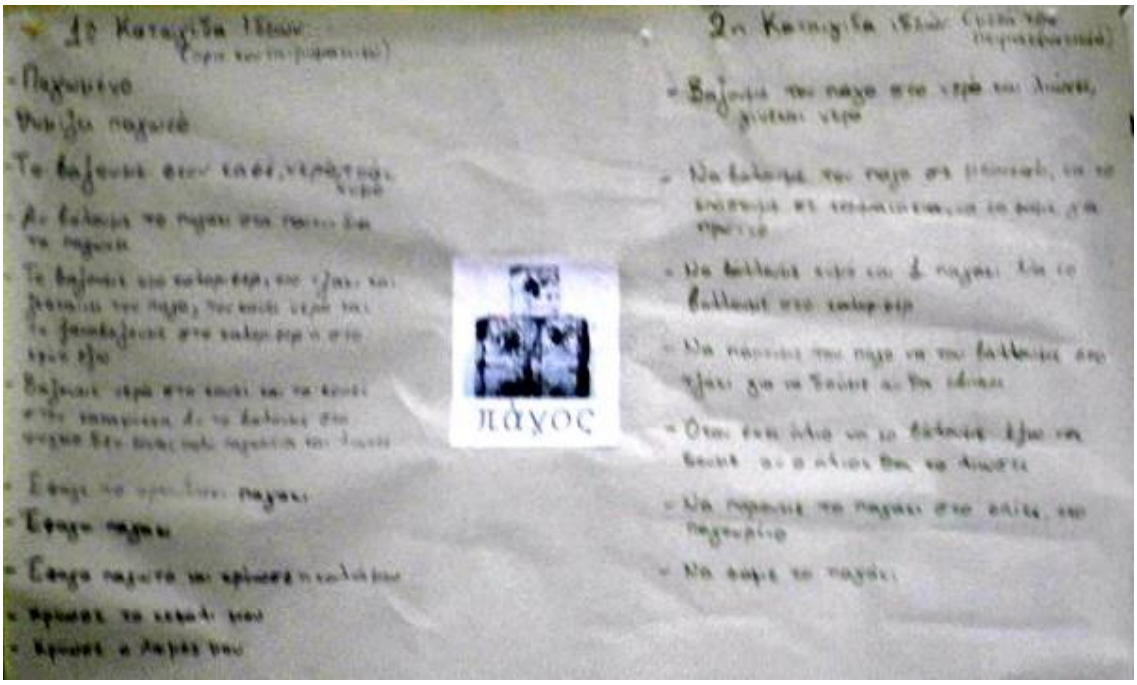
Fostering children's questioning and curiosity



Results from the two brainstorming sessions (1st on the left column and 2nd on the right column)

Sonia: 'Yesterday children participated in a second brainstorming activity and we worked with ice and children decided what they wanted to do with it without me providing many materials. They got many ideas that they wanted to carry out and they began to ask questions and find problems they wanted to solve.'

[…]

'The children chose to fill balloons with water and place them in the freezer to see what happens. I only added one balloon that had red dye in the water without children knowing to see if they notice today. All the balloons we put in the freezer came from children's suggestions and ideas on specific things they wanted to observe. Now, they will start guiding me and we will see where it goes.'

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GR_Int_MeasuringTables_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE:SocialAffectAims**
Specific Teacher Outcome(s):	1.1 Teachers should be able to pursue the social and affective objectives of children's science and mathematics learning, in synergy with the corresponding cognitive ones. 1.2 Teachers should be able to make children aware of connections between science and mathematics learning and their everyday lives, in order to engage their motivation, interest and enjoyment in science and mathematics and foster curiosity and creativity.
Factors linked with:	**AO: Affect;** **AO: Social**
Type of material (image – interview (int) – classroom extract (class):	Interview
Originating from:	
Country report :	D4.3 - Greece
Case:	Case 1
Episode:	2 – Measuring Tables
Teacher:	Mina
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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The teacher embeds the task in an everyday life context.
She encourages collaboration and fosters children's agency.

T (Mina): Since few days ago we have said that we would like to order a new table from a carpenter. The carpenter rang me and said: Mrs Mina, I will make the table you want. However, you have not given me any instructions. You have not told me how you wish the table to be: what shape you want it to be; how high you want it to be; how wide you want it to be. If you do not give me any instructions, if you do not give me any measurements, I cannot make the table you want, and they you will tell me: Mr Carpenter the table you have made is not good for our classroom.

I want you to help me to give instructions to the carpenter. OK? So this is what we are going to do: Every team will go to their table and take its measurements. I will give you notebooks so you can write down your notes. I will provide some instructions. […] Each team will decide how they are going to take their measurements. We need to provide three measurements to the carpenter: shape, height and width. Last time we said that we can use different tools for measurement. Each team will deliberate and decide on the measuring tool they wish to use: a ruler, a (wooden) meter, a ribbon, the palms of their hand, their fingers, their spoons? You will decide. Meet as a team now and decide on the way you wish to measure your table.

[Teams decide on the measuring tool to use. The teacher makes sure that the team's decision is unanimous.]

Next step: To every team I will give a notebook. In the notebook you will write your notes after taking the measurements. What do we need? Shape, height and width. […]

Just a minute. Before you start taking the measurements… I know that the materials you now have on your table have caused a pleasant excitement in you. However, one more instruction: To make it easier for you, you need to collaborate. If every one of you wants to keep the tool for himself/herself, the team will not succeed in the task.

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Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.1. Teachers should be able to advance children's understanding about the nature of science and how scientists work, confronting stereotypical images of science and scientists. 3.2. Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity. 3.3. Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**P: R and R;** **LA: Expl**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 5
Episode:	5.2 Capacity
Teacher:	Gillian
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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Conducting a scientific procedure involving predictions, estimations and testing whilst allowing space for children to generate ideas and evaluate own predictions

Testing predictions

The teacher has on the interactive board a table with volumes (< 1l, 1l,>1 l). A number of children are called out and the teacher asks them to estimate the volume of the container that she shows them. The children make their predictions and write it on the interactive board. The teacher then tells the children that they need to test it. The children fill the container with a capacity of 1l and pour this volume into the container. They notice that it is half full. The children realized that the volume is more than 1 l and that their estimation was correct as they had placed it in the column of >1l.

Gillian: Let's see how many litres does it hold.

The teacher refers to the clothes fabric conditioner container of 5l capacity that they had used.

Gillian: How many litres does it have?

The children are unsure and suggest different values. They go on to pour more water, and then count the number of times they have poured 1 litre into the container.

Gillian: How many litres did we pour?
Child: 3 litres.
Gillian: How full is it?
Child: Half full.
Child 2: More than half-full.
Gillian: Where do we write it down?
Child: More than one litre, it holds more than 1 litre.
Gillian: How many litres in total?
Child: 5 litres.

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The teacher now takes out a plastic coke bottle and asks the children:

Gillian: Do you think that the bottle has the same volume as this?
Points to the conditioner container
Child: No...
Gillian: How is it, more or less?
Child 2: It is less?
Gillian: How much volume do you think that you have here?
Child 3: 2 litres.
Child 2: 3 Litres.
Child 4: More.
Gillian: O.K, you now have to find out.

The teacher fills the 1 litre containers and the children take turns to fill in the coke bottle to find that its capacity is that of 2 litres. The teacher then moves to another container and they repeat the exercise.

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MA_Class_CountingCaterpillar_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should familiarize teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games.
Factors linked with:	**P: Scaff;** **P: Play;** **P: Affect;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 6
Episode:	6.1 Counting Caterpillar
Teacher:	Fleur
Age Group:	7-8
Selected episode present in D4.4 Appendix	Yes

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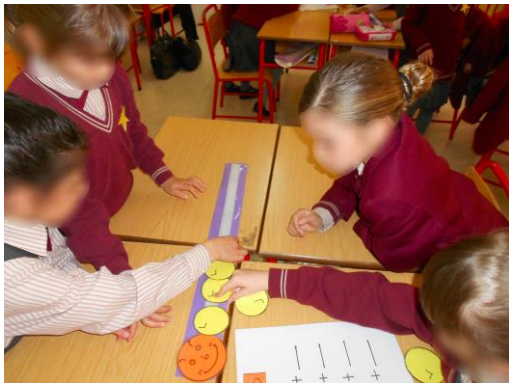
Provide opportunities for child-initiated exploration as the students play and manipulate the caterpillar resource in a unique way to solve a mathematical problem



Manipulating their caterpillar to be able to solve the mathematical problem presented

The teacher ensures that the children have understood. She then moves on to explain what the group work in which the children are going to engage in is to involve. The activity involved building number pairs where children worked together.

Child 1: How are we going to work it out?
Child 2: We need to find the numbers, we have number 6.

The children count six segments on the caterpillar and remove the other segments.

Child: We can start with 1...then counts the rest...we need 5.

The children are a little perplexed as they look at the caterpillar's head.

Child 1: Do we need to count this?

After some thought the children decide to remove the caterpillar's head so that all they have on their caterpillar is the number of segments which amount to 6 segments. They then work out the examples with no difficulty. At the end of the group activity, the teacher asked the different groups to share the strategies that they used to work out the number pairs. The children then shared the way in which they used the caterpillar and the number pairs, which they had identified. Actually some groups had taken off the caterpillar's head as without it, they said, it was better to check the number pairs.

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Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.1 Teachers should be able to advance children's understanding about the nature of science and how scientists work, confronting stereotypical images of science and scientists. 3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity.
Factors linked with:	**P: R and R;** **LA: Connect;** **P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 3
Episode:	3.3 Drums
Teacher:	Sabrina
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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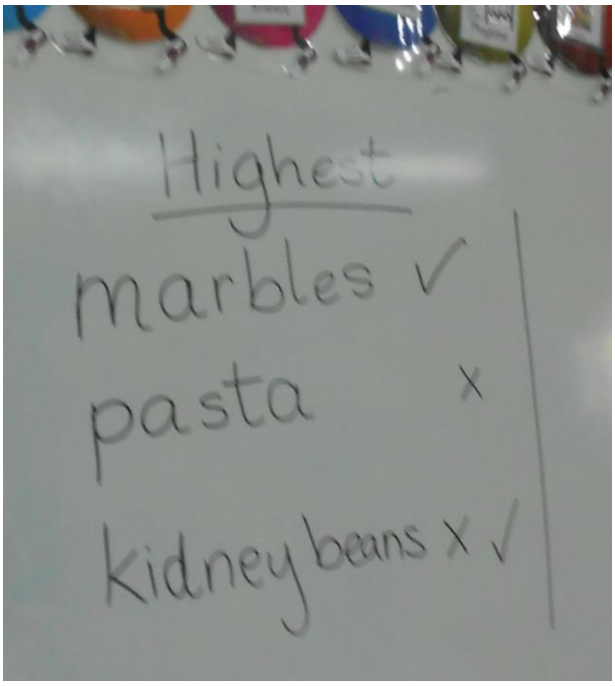
Context for Drums episode extract:

The teacher introduced this inquiry activity by demonstrating how to build a drum out of different materials. She provides the children with time to build their own drums mirroring scientists who build their own equipment for experiments. She then presents a set of research questions and asks children if they can find an answer. The children on their own communicate that in order find the answer they must experiment and try the different objects "one by one" to see which object vibrates the most when placed on drum and when the drum is struck. This also mirrors the nature of science as the teacher provides the children with scientific questions, encouraging children to think and design their own experiment. When evaluating the different answers the children came up with, the teacher looked at the most common answer and communicated that the majority rules when answering a research question. Therefore, it becomes evident that the teacher wanted to make an explicit link between the inquiry activity in class and the nature of scientists and how scientists go about answering their different questions. An implicit link between the nature of science and this episode includes the idea that in science outcomes of experiments are not always clear-cut. This could have been followed up by a discussion about the kidney beans and what happened during the experiment that made the children conclude that it vibrated the most, also commenting on how common this instance occurs during scientific experiments scientists conduct.

Introducing children to the nature of science; predictions, investigation and results.



Uncovering the Nature of Science: Scientific experiments do not always lead to clear-cut answers

The teacher then takes out a lot of things from a large bag and places them on the front table. The teacher shows the children how to cover a bowl so that they can produce a drum. The children are excited. The teacher then repeats the process, but this time placing the beans on it and striking it

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with a stick. The children perform the experiment. The beans fall on the floor. The teacher asks the children if they think that the sound changes if she uses a smaller bowl.

Sabrina: If I use different size of container, will the sound vary?
Child: Yes!
Sabrina: But can you test it?
Child: Yes, we try them out one by one.

The teacher tells the kids that they have beans, pasta or marbles to test.

Child: Yes, ... we have them here.

The children do the experiments in groups.

Sabrina: We have two questions:

1. Do different containers produce different sounds?
2. Will the different things bounce the same or not, and see which ones bounces best. Which do you think?

Child 1: The marbles...it shows.
Child 2: Because they are harder and it is faster, it bounces more...if you bang it harder it goes up high.
Sabrina: What about the pasta?

The teacher then calls all the children to attention and collects the observations from each of the groups. Three groups noted that the marbles bounced most while one group identified the beans. The teacher concluded with the children that the most common conclusion – preference for the marbles was the answer. The teacher here provides an example of nature of science where the outcome is not always clear-cut.

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MA_Class_Drums_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**P: R and R;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 3
Episode:	3.3 Drums
Teacher:	Sabrina
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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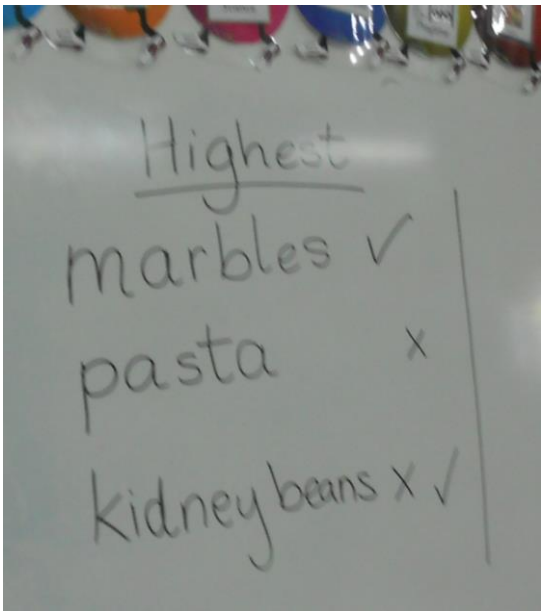
Introducing the children to research questions to encourage reflection

In this example, the children were introduced to research questions to encourage reflection, and were guided through the experiment in order to reach a conclusion based on the evidence collected.



Creating drums to test which object will vibrate and bounce more when the drum is struck; Conclusions drawn are not exclusive of one another representing the nature of science.

The teacher takes out a number of items from a large bag and places them on the front table. The teacher shows the children how to cover a bowl so that they can produce a drum. The children are excited. The teacher then repeats the process, but this time placing the beans on it and striking it with a stick. The children perform the experiment. The beans fall on the floor. The teacher asks the children if they think that the sound changes if she uses a smaller bowl.

Sabrina: 'If I use different size of container, will the sound vary?'
Child: 'Yes!'
Sabrina: 'But can you test it?'
Child: 'Yes, we try them out one by one.'

The teacher tells the children that they have beans, pasta or marbles to test.

Child: 'Yes, ... we have them here.'

The children do their experiments in groups.

Sabrina: 'We have two questions:

1. Do different containers produce different sounds?
2. Will the different things bounce the same or not, and see which ones bounces best. Which do you think?'

Child 1: 'The marbles...it shows.'
Child 2: 'Because they are harder and it is faster, it bounces more...if you bang it harder it goes up high.'

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Sabrina: 'What about the pasta?'

The teacher then calls all the children to attention and collects the observations from each of the groups. Three groups noted that the marbles bounced most while one group identified the beans. The teacher concluded with the children that the most common conclusion – preference for the marbles was the answer. The teacher here provides an example of nature of science where the outcome is not always clear-cut.

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Teacher Education Design Principle + code:	7. Teacher education should familiarize teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.9 Teachers should be able to use different assessment approaches and strategies and in particular those that involve children in the assessment processes, such as peer and self assessment, dialogue and feedback on progress, in the early years science and mathematics classroom.
Factors linked with:	**A: Strat**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 1
Episode:	1.3 Feet 2
Teacher:	Natasha
Age Group:	3-4
Selected episode present in D4.4 Appendix	Yes

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Using varied forms of formative assessment (group and individual) during mathematics activity to inform future teaching; Using blocks and numicon resources as an assessment tool and to promote creative learning.

Formative assessment during class activity by using numicon resources

The children sit down on the mat. The teacher mentions that spring has begun. The children started talking about butterflies that they saw at home in their garden. The teacher then reminds them about previous work on footprints which they had by now decorated with coloured paper.

Teacher: What can you see on the wall? Do you remember what you did?
Children together: Our footprint.

Children look and point at the footprints that were hanging from the wall. The teacher then took off the footprints and distributed them to the children as they went to their place. Children count the number of blocks that cover the length of their decorated footprint. They built a tower and counted the total. On completion of the task, the children played with the blocks.

Child 1: This is a robot, look…
Child 2: This is a number one...
Child 3: With this I can dig...

The last child made gestures of using his machine as if he was digging.

Children then practice with the teacher identifying numbers using numicon resources. The teacher gives some of the numicon resources to the different children, and then they have to identify which one fits with the chart on the wall. One of the boys chosen was the child with learning difficulties (within the autism spectrum). The children counted the holes on the numicon resources correctly as well as identified the correct matching picture and number on the wall chart.

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Comments:

The teacher provided both numicon resources and blocks to both assess the children's knowledge of numerical concepts and measuring skills already tackled in previous lessons. The assessment methods used also have the potential to open up dialogue between teachers and peer, peer and peer and also self assessment as the child can match the numicon resource with print out charts and identify if they were correct.

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Teacher Education Design Principle + code:	7. Teacher education should familiarize teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.6 Teachers should be able to use strategies for making and building on science and mathematics real life connections and applications for engaging creatively young children in science and mathematics learning.
Factors linked with:	**P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 6
Episode:	6.2 Fruit
Teacher:	Fleur
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Using songs and video to engage the children's interest and promote positive attitudes towards science;
Providing links between everyday life and science to make the exploration relevant to the children's lives.

Food chart was followed by a song and video promoting eating fruits

The teacher asked the children what they were talking about in the previous sessions. The children mentioned the food pyramid. The teacher and children looked at the food pyramid chart, which was displayed on the wall and went through the different foods.

Fleur: How many vegetables do you have to eat a day?
Child: 5 a day.
Fleur: At least 5, you can eat more.

The teacher then showed the children two videos of cartoons, fruity- tunes. The video had a song that promotes eating fruit among children. The children were very interested and engaged. The teacher then moved to another part of the lesson by sharing a video about the need to wash fruit. This led to the explanation of what the children had to do for their group work. The teacher then explained to the children that they were going to do some investigation of fruits and to look at them closely. She gave each group a different fruit that she had cut in half. These included a banana, strawberry, apple, kiwi, tangerine and grape. Each group had a different fruit. She also gave each

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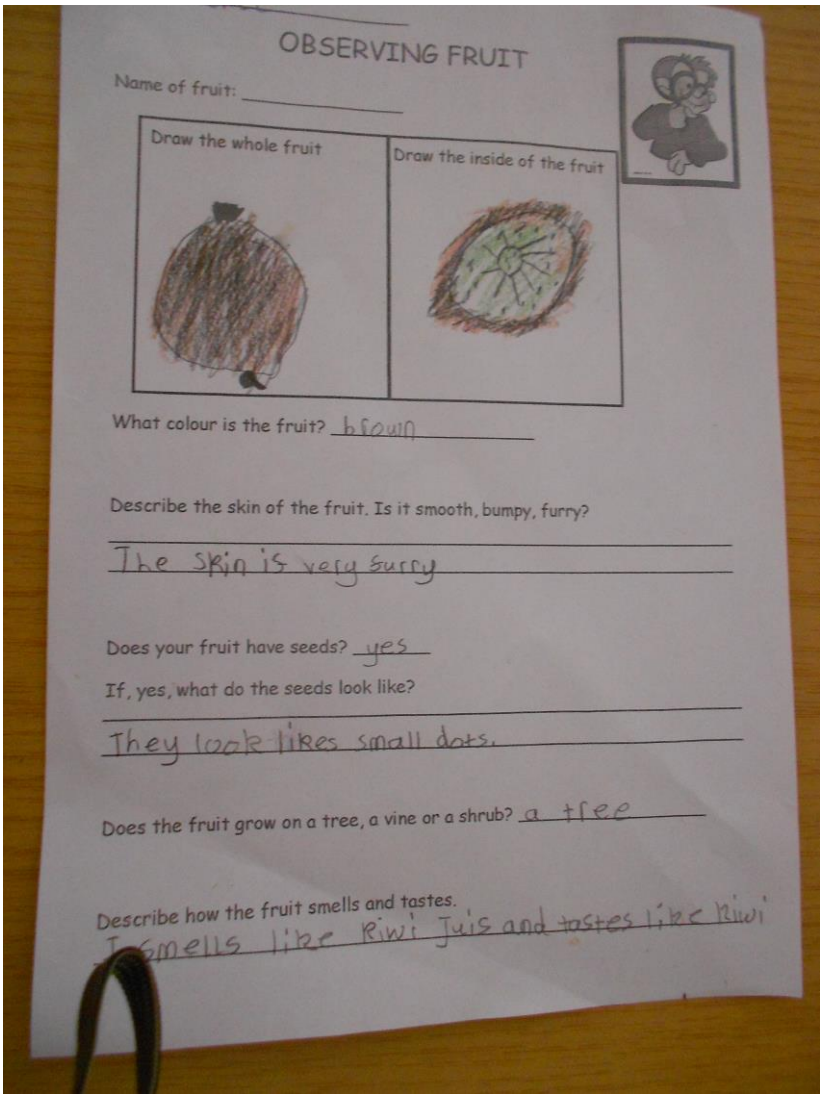
group a picture of the plant/tree that produces this fruit.



Completed worksheet after children explored fruit

She also gave the children a magnifying glass and a worksheet where they had to record their observations. This was an engaging activity as the children read the questions on the worksheet that directed their observations and they had to use the magnifying glass to look more carefully.

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MA_Class_Fruit_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.4. Teachers should be able to use the various modes of children's expression and representation of science and mathematics ideas (e.g. pictures, graphs, gestures, physical activities) for assessment purposes.
Factors linked with:	**P: Express**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 6
Episode:	6.2 Fruit
Teacher:	Fleur
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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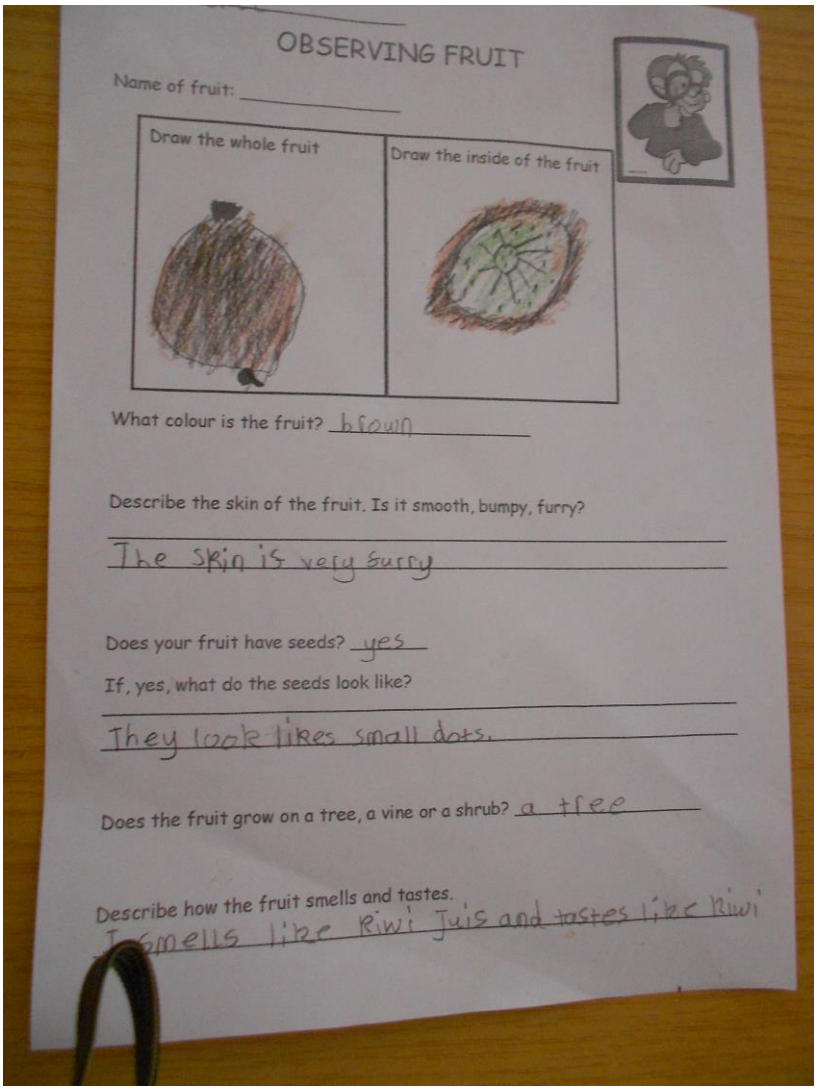
Using Drawing and writing to record the children's ideas and learning in science during their exploration of fruits


OBSERVING FRUIT

Name of fruit: _____

Draw the whole fruit

Draw the inside of the fruit

What colour is the fruit? brown

Describe the skin of the fruit. Is it smooth, bumpy, furry?

The skin is very furry

Does your fruit have seeds? yes

If, yes, what do the seeds look like?

They look likes small dots.

Does the fruit grow on a tree, a vine or a shrub? a tree

Describe how the fruit smells and tastes.

It smells like Kiwi Juis and tastes like Kiwi

Completed worksheet after children explored fruit

The teacher then explained to the children that they were going to do some investigation of fruits and to look at them closely. She gave each group a different fruit that she had cut in half. These included a banana, strawberry, apply, kiwi, tangerine and grape. Each group had a different fruit. She also gave each group a picture of the plant/tree that produces this fruit. She also gave the children a magnifying glass and a worksheet where to record their observations. This was an engaging activity as the children read the questions on the worksheet that directed their observations and they had to use the magnifying glass to look more carefully.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity.
Factors linked with:	**M: ICT**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 6
Episode:	6.2 Fruit
Teacher:	Fleur
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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Using a range of resources to introduce a science topic involving fruits, increasing children's attention and motivation, fostering positive attitudes towards science and introducing the inquiry

Food chart was followed by a song and video promoting eating fruits

The teacher asked the children what they were talking about in the previous sessions. The children mentioned the food pyramid. The teacher and children looked at the food pyramid chart, which was displayed on the wall and went through the different foods.

Fleur: 'How many vegetables do you have to eat a day?'
Child: '5 a day.'
Fleur: 'At least 5, you can eat more.'

The teacher then showed the children two videos of cartoons, fruity- tunes. The video had a song that promotes eating fruit among children. The children were very interested and engaged. The teacher then moved to another part of the lesson by sharing a video about the need to wash fruit. This led to the explanation of what the children had to do for their group work. The teacher then explained to the children that they were going to do some investigation of fruits and to look at them closely. She gave each group a different fruit that she had cut in half. These included a banana, strawberry, apply, kiwi, tangerine and grape. Each group had a different fruit. She also gave each group a picture of the plant/tree that produces this fruit.

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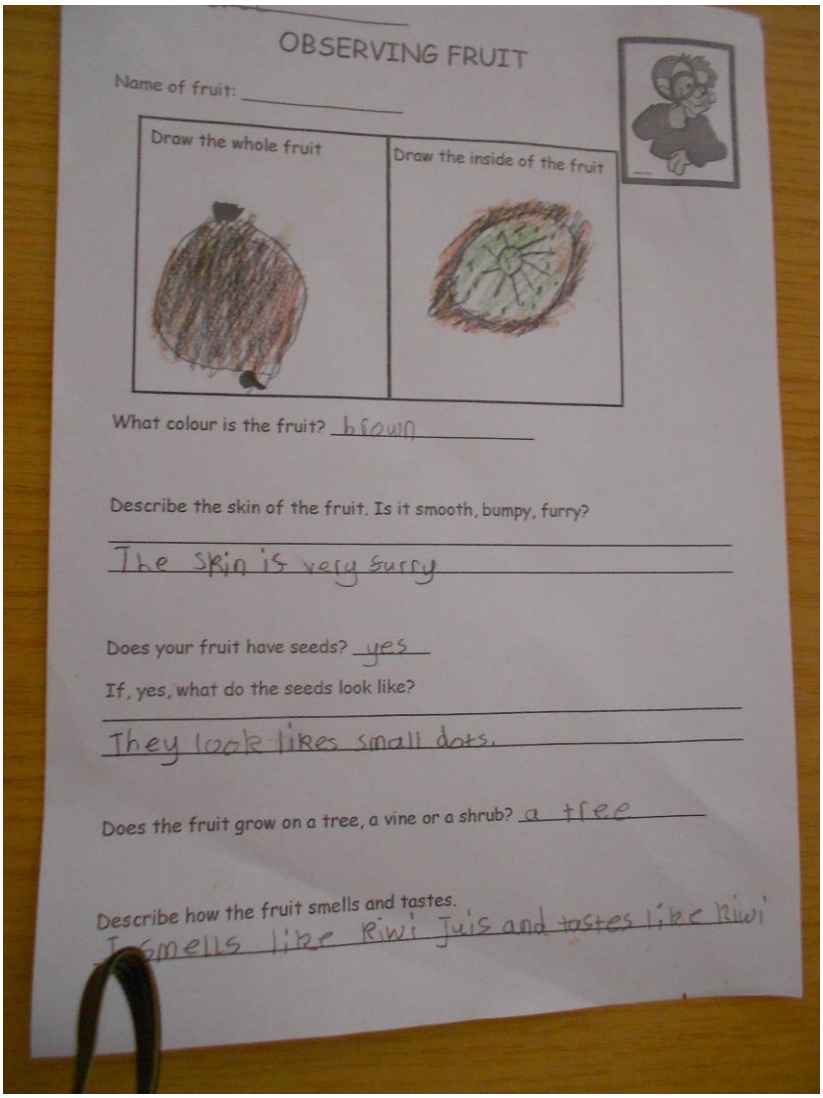

OBSERVING FRUIT

Name of fruit: _____

Draw the whole fruit	Draw the inside of the fruit

What colour is the fruit? brown

Describe the skin of the fruit. Is it smooth, bumpy, furry?

The skin is very furry

Does your fruit have seeds? yes

If, yes, what do the seeds look like?

They look likes small dots.

Does the fruit grow on a tree, a vine or a shrub? a tree

Describe how the fruit smells and tastes.

It smells like Kiwi Juis and tastes like Kiwi

Completed worksheet after children explored fruit

She also gave the children a magnifying glass and a worksheet where to record their observations.

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Teacher Education Design Principle + code:	7. Teacher education should familiarize teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering and extending inquiry and creativity, by for example prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events. 7.4 Teacher should be able both to build in new and to make the most of existing opportunities for child-initiated play, recognising and capitalising on the potential of children's explorations beyond the teacher's original intentions.
Factors linked with:	**P: Play**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 1
Episode:	1.1 Measuring Robots
Teacher:	Natasha
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Exploiting the value of play by providing time for the children to engage in child-initiated play to foster creativity in mathematics.

Child-initiated play gives way to creativity as child constructs a model of the Eiffel Tower

The teacher starts off the activity by giving the children pegs and asking them to count them, whilst explaining that:

Natasha: Today we are going to measure our robots; but let us count our pegs first.

Children are provided with a number of pegs on their tables. The teacher initiates an independent activity where the children start counting their pegs, and when ready, they are given some time to play with their pegs. The children are given time to introduce child-initiated play. One child attracts the researcher's attention and shows her what he has made.

Researcher: What is that? What have you made?
Child 1: I made a tower, the Eiffel Tower...It is high *(model made looks similar to the shape of the Eiffel Tower).*

The child quickly dismantles the tower and builds a new model and attracts the researcher's attention again.

Child 1: Look, a big fish eating a small fish.

Additional information: This activity followed a measuring task, where the children were given robots they had made in a previous activity and measure the height of these robots by using and counting blocks.

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MA_Class_Minibeasts_CreatIngLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**M: Expl**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 2
Episode:	2.2 Minibeasts
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	Yes

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Design open-ended inquiry activities by encouraging children to explore their surrounding and discuss scientific knowledge about minibeasts

Reflecting and hypothesizing about the pupa stuck to the tree

Lydia: "O.K. You are now in the yard and I am going to ask you to work in your groups and to try and find minibeasts.... You have to record what you find in your sheets..."

The children look at their worksheets and prepare the pencil in their hands.
They wander around.

Child 1: "See what this is..."
Child 2: "That is a pupa...is was a caterpillar once"
Child 3: "Yes, we had one in our garden...it turns into a butterfly..."
Child 1: "Look, how it is stuck to the tree...will it fall?"
Child 2: "How long do they take to become a butterfly?"
Researcher: "They can become moths too...you know..."

The children look at the pupa for some more time, make a note in their worksheet under caterpillar and move on to look for other minibeasts.

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Children asking each other questions and sharing own experiences to make sense of evidence or minibeasts found

Another group saw some ants walking on the soil.

Child 1: "Look, we have lots of those, ants at home too..."
Child 2: "How many are there?"

Children are counting the ants that they see...1...2...3 etc.

Child 1: "We also have them in garden, the ants..."
Child 2: "We also have them inside, my mum does not like them in the kitchen..."
Child 1: "Look how they run about, they go fast...do they have food?"

Children are busy recording the number of ants in the worksheet. They ask the researcher to help them on how to fill it in as they were not sure where they had to put in the number of ants that they had observed.

Concluding Activity:

The teacher then calls the students back, and takes them back up to the classroom. When the children have settled down, the teacher asked them to share the different types of minibeasts that they had observed in the yard. The children list the minibeasts observed. The teacher promises to take the children again another time, as it was time for school break. The activity ends.

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.2 Teachers should be able to purposefully use a variety of patterns of collaboration, shifting between individual and collaborative activity over time, to support children's inquiry processes and creative learning. 15.3 Teachers should be able to organize group work, aligning ways of grouping children, task design, teaching and assessment strategies in different ways to promote collaboration amongst children in science and mathematics. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**P: Collab;** **M:Expl**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 2
Episode:	2.2 Minibeasts
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	Yes

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Providing the students space and freedom to work in groups and to direct their own groups as they explore their outdoor environment; Generating ideas and connecting evidence they collect to their own experiences whilst sharing it with the group

Reflecting and hypothesizing about the pupa stuck to the tree

Lydia: O.K. You are now in the yard and I am going to ask you to work in your groups and to try and find minibeasts.... You have to record what you find in your sheets...

The children look at their worksheets and prepare the pencil in their hands.
They wander around.

Child 1: See what this is...
Child 2: That is a pupa...is was a caterpillar once
Child 3: Yes, we had one in our garden...it turns into a butterfly...
Child 1: Look, how it is stuck to the tree...will it fall?
Child 2: How long do they take to become a butterfly?
Researcher: They can become moths too...you know...

The children look at the pupa for some more time, make a note in their worksheet under caterpillar and move on to look for other minibeasts.

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Children asking each other questions and sharing own experiences to make sense of evidence or minibeasts found

Another group saw some ants walking on the soil.

Child 1: Look, we have lots of those, ants at home too...
Child 2: How many are there?

Children are counting the ants that they see...1...2...3 etc.

Child 1: We also have them in garden, the ants...
Child 2: We also have them inside, my mum does not like them in the kitchen...
Child 1: Look how they run about, they go fast...do they have food?

Children are busy recording the number of ants in the worksheet. They ask the researcher to help them on how to fill it in as they were not sure where they had to put in the number of ants that they had observed.

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**.
Specific Teacher Outcome(s):	6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics.
Factors linked with:	**LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 2
Episode:	2.2 Minibeasts
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	Yes

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Fostering opportunities for children's agency and creativity as the children directed their own inquiry, made connections between evidence found and made sense of it by using own experiences and ideas

Children asking each other questions and sharing own experiences to make sense of minibeasts found

Lydia: O.K. You are now in the yard and I am going to ask you to work in your groups and to try and find minibeasts.... You have to record what you find in your sheets...

The children look at their worksheets and prepare the pencil in their hands.
They wander around…

Child 1: See what this is...
Child 2: That is a pupa...is was a caterpillar once
Child 3: Yes, we had one in our garden...it turns into a butterfly...
Child 1: Look, how it is stuck to the tree...will it fall?
Child 2: How long do they take to become a butterfly?
Researcher: They can become moths too...you know...

The children look at the pupa for some more time, make a note in their worksheet under caterpillar and move on to look for other minibeasts.

Another group saw some ants walking on the soil.

Child 1: Look, we have lots of those, ants at home too...
Child 2: How many are there?

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Children are counting the ants that they see...1...2...3 etc.

Child 1: We also have them in garden, the ants...
Child 2: We also have them inside, my mum does not like them in the kitchen...
Child 1: Look how they run about, they go fast...do they have food?

Children are busy recording the number of ants in the worksheet. They ask the researcher to help them on how to fill it in as they were not sure where they had to put in the number of ants that they had observed.

Comments:

This episode also connects to another design principle 7 (**TE: CreatInqPed):** Teacher education should familiarize teachers with a range of formal and informal inquiry - and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics.

The teacher recognizes the value of play and exploits this by encouraging free exploration of their surroundings. The children were engaged in inquiry based learning in science and mathematics as they observed their school's garden, asking each other questions and exchanged ideas regarding insects their habitats and also were heard counting the amount of ants. The freedom provided by the teacher during the activity encouraged child-initiated play, and fostered the children's explorations to go beyond the teacher's original intentions.

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Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out.
Factors linked with:	**M: Explor**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 2
Episode:	2.2 Minibeasts
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	Yes

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Making use of outdoors in observing, reflecting and recording minibeasts and their habitats

Reflecting and hypothesizing about the pupa stuck to the tree

Lydia: "O.K. You are now in the yard and I am going to ask you to work in your groups and to try and find minibeasts.... You have to record what you find in your sheets..."

The children look at their worksheets and prepare the pencil in their hands.
They wander around.

Child 1: "See what this is..."
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Child 2: "How long do they take to become a butterfly?"
Researcher: "They can become moths too...you know..."

The children look at the pupa for some more time, make a note in their worksheet under caterpillar and move on to look for other minibeasts.

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Children asking each other questions and sharing own experiences to make sense of evidence or minibeasts found

Another group saw some ants walking on the soil.

Child 1: "Look, we have lots of those, ants at home too..."
Child 2: "How many are there?"

Children are counting the ants that they see...1...2...3 etc.

Child 1: "We also have them in garden, the ants..."
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Children are busy recording the number of ants in the worksheet. They ask the researcher to help them on how to fill it in.

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Teacher Education Design Principle + code:	16. Teacher education should provide teachers with knowledge of approaches to timetabling and organizing cross-curricular project work. **TE: CrossCurr**
Specific Teacher Outcome(s):	16.3 Teachers should be able to build connections across the curriculum of various kinds and with potential to contribute to children's inquiry and creativity.
Factors linked with:	**AO: Creative**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 2
Episode:	2.1 Money
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Encouraging children to solve mathematical problems through pretend play organizing group work, providing time for the children to be creative by providing resources to elicit role-plays.

Pretend play and inquiry based learning when sorting tens and ones

The teacher then gives the children an example. She gives one child some paper coins and asks him to count the total.

Lydia: 'How much money do you have? What are you going to count first?'
Child: 'The tens...20c.'
Lydia: 'Where shall I write the 20c?'
Child: 'The tens... And the other money.'
Child: '5c, 2c...7c in the units.'
Lydia: 'The total then is...'
Child: '27c'
Lydia: 'Good.'

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The teacher gives the children some other tasks. The teacher then tells the children that they are going to work in groups. She distributes baskets with plastic money inside them, giving one to each group. The children are to play buying and paying in pairs. Two girls working together are discussing what to buy. They decide to buy fruit: apples, two apples. They put the money in separate columns (tens/units) and count a total of 25c. The children engage in role-play with one playing the role of a customer; finding the money and paying, and the playing the role of the shopkeeper; receiving the money.

Child 1: 'I am going to buy an apple, no two.'
Child 2: '25c please, they cost 25c.'

Child 1 gives child 2 the money who places them on the small whiteboard where they had drawn the same figure for tens and units as the teacher had drawn on the board. They check that they had chosen the correct amount of coins. The girls then decide to buy chickens...continuing to invent more things to buy.

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MA_Class_Money_GWork

Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.2 Teachers should be able to purposefully use a variety of patterns of collaboration, shifting between individual and collaborative activity over time, to support children's inquiry processes and creative learning. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**P: Scaff;** **P: Collab**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 2
Episode:	2.1 Money
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Shifting from individual to group work to facilitate collaboration; Provide resources and materials that foster collaboration to engage in creative exploration and pretend play whilst solving a mathematical question.

Pretend play and inquiry based learning when sorting tens and ones

The teacher then gives the children an example. She gives one child some paper coins and asks him to count the total.

Lydia: 'How much money do you have? What are you going to count first?'
Child: 'The tens...20c.'
Lydia: 'Where shall I write the 20c?'
Child: 'The tens... And the other money.'
Child: '5c, 2c...7c in the units.'
Lydia: 'The total then is...'
Child: '27c'
Lydia: 'Good.'

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The teacher gives the children some other tasks. The teacher then tells the children that they are going to work in groups. She distributes baskets with plastic money inside them, giving one to each group. The children are to play buying and paying in pairs. Two girls working together are discussing what to buy. They decide to buy fruit: apples, two apples. They put the money in separate columns (tens/units) and count a total of 25c. The children engage in role-play with one playing the role of a customer; finding the money and paying, and the playing the role of the shopkeeper; receiving the money.

Child 1: 'I am going to buy an apple, no two.'
Child 2: '25c please, they cost 25c.'

Child 1 gives child 2 the money who places them on the small whiteboard where they had drawn the same figure for tens and units as the teacher had drawn on the board. They check that they had chosen the correct amount of coins. The girls then decide to buy chickens...continuing to invent more things to buy.

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MA_Class_Numbers_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.2 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development.
Factors linked with:	**AO: Creative**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 4
Episode:	4.3 Numbers
Teacher:	Diane
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Supporting the children's different ways of expressing and representing numbers

Exploring alternative ways of generating a mathematical answer

Diane: 'We can now move to the group work and I am going to give each group something different to do.'

The teacher gives resources to each group. They all have different things to do and different activities. She explains to the children in the different groups what they have to do in their activity:

Group 1: The children were given a puzzle pieces to match the number in numerals with the number written in words.
Group 2: The children were given sheets of matching numbers and wording and they had to colour the matching ones.
Group 3: The children had playing dough. The teacher asked the children to make the numbers with play dough both in numerals and in writing.

Diane: 'What did you do?' (Asking group using play dough)
Child: 'We have number 6.'
Diane: 'Let me see how did you write it?'

The children show the teacher the number six written in numerals.

Diane: 'And so, how do you write it now?'

The children use the play dough and make the word SIX. They are very happy with their number.

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.2 Teachers should be able to purposefully use a variety of patterns of collaboration, shifting between individual and collaborative activity over time, to support children's inquiry processes and creative learning. 15.3 Teachers should be able to organize group work, aligning ways of grouping children, task design, teaching and assessment strategies in different ways to promote collaboration amongst children in science and mathematics. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**P: Collab;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 3
Episode:	3.1 Senses
Teacher:	Sabrina
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Shifting from individual to collaborative activity to support children's inquiry processes; using different assessment strategies such as dialogue and worksheets; organizing equipment in a way to foster collaboration by giving each group one set of tools.

Examining the lemon and seeds with different equipment during group work.

The teacher invites one child to go to the front of the room, she blindfolds him and takes a box with something inside. The teacher invites the child to smell the object in the box.

Sabrina: 'Smell what is in the box...what do you think that it is?'
Child: 'Lemon. '
Sabrina: 'Why do you say so?'
Child: 'It smells like that.'
Sabrina: 'Now hold it in your hand – what does it feel like?'
Sabrina: 'Now take off your blindfold...see what it is...'
Child: 'It is a lemon.'
Sabrina: 'When was it easiest to know what it is?'
Child: 'When I felt it...'
Sabrina: 'OK, let's try something else.'

Teacher asks another boy and now uses a leaf as an example. She crushes it and put is in the box.

Sabrina: 'Smell it...can you tell what it is?'
Child 2: 'Nothing...no.'
Sabrina: 'Now I am going to give it to you to touch...what do you think that it is?'
No answer
Sabrina: 'Now take off your blindfold and see if you know what it is.'
Child 2: 'Leaf.'
Sabrina: 'What was easiest to help you what to do?'
Child 2: 'When I saw it!'

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Teacher then moves to introduce group work and the task that she is going to give the children to do. The teacher tells the children that she is going to give them tools that they are going to use to study the things on the table.

Sabrina: 'These are the tools that I am going to give you a mirror, magnifying glass and eyes' *(indicating the children's own eyes*).

She then gives each group a lemon a leaf and a stone. The teacher introduces the inquiry question.

Sabrina: 'Which tool shows most detail?'

The teacher explains to the children what the task is about. She asks them to first hypothesize which tool would be the best.

Sabrina: 'Which tool do you think is the best?'

She writes answers suggested on the board. The children start investigating the different things with their different tools. They have to indicate which one was the best to see in a worksheet that the teacher had prepared. Children at this point are involved in group work.

Child: 'In the mirror you can see your eyes.'
Child 2: 'With the lens it is really looking bigger.'
Child 3: 'Why, what is this? A magnifying glass...'

The teacher calls the children to attention:

Sabrina: 'We are going to see what you found out. Which tool helped you see most detail?'
Child 4: 'With the magnifying glass.'
Sabrina: 'What happened? What did you see?'
Child 4: 'The lemon looked bigger.'
Sabrina: 'What do the other groups think?'
Red Group: 'With the magnifying glass.'
Blue Group: 'With the magnifying glass.'

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations.
Factors linked with:	**P: Agency**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 3
Episode:	3.1 Senses
Teacher:	Sabrina
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Introducing different tools to extend the children's exploration as they were asked to decide which one is more useful to see the most details in a given object

Examining the lemon and seeds with different equipment.

Teacher then moves to introduce group work and the task that she is going to give the children to do. The teacher tells the children that she is going to give them tools that they are going to use to study the things on the table.

Sabrina: 'These are the tools that I am going to give you a mirror, magnifying glass and eyes' *(indicating the children's own eyes).*

She then gives each group a lemon a leaf and a stone. The teacher introduces the inquiry question.

Sabrina: 'Which tool shows most detail?'

The teacher explains to the children what the task is about. She asks them to first hypothesize which tool would be the best.

Sabrina: 'Which tools do you think is the best?'

She writes answers suggested on the board. The children start investigating the different things with their different tools. They have to indicate which one was the best to see in a worksheet that the teacher had prepared. Children at this point are involved in group work.

Child: 'In the mirror you can see your eyes.'
Child 2: 'With the lens it is really looking bigger.'
Child 3: 'Why, what is this? A magnifying glass...'

The teacher calls the children to attention:

Sabrina: 'We are going to see what you found out. Which tool helped you see most detail?'
Child 4: 'With the magnifying glass.'
Sabrina: 'What happened? What did you see?'

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Child 4: 'The lemon looked bigger.'
Sabrina: 'What do the other groups think?'
Red Group: 'With the magnifying glass.'
Blue Group: 'With the magnifying glass.'

The teacher then moved to the stone.

Sabrina: 'What has helped you see it best?'
Child 5: 'Magnifying glass.'
Sabrina: 'What did the magnifying glass help you see which you could not see before? Did you see more holes and bumps?'

The children took up the magnifying glass again.

Child: 'I can see holes, bumps...yes.'

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**.
Specific Teacher Outcome(s):	6.4 Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations).
Factors linked with:	**LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	MA Case 2
Episode:	2.4 Shooting Balloons
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Recognizing children's key ideas; Eliciting and building on their ideas through using questioning; Providing opportunities to elicit children's ideas and reasoning during inquiry based learning.

Set up for Shooting Balloons experiment

The teacher blows up a balloon and asks the children what happens if she lets it go. The children indicate that it will fly off. The teacher explains that they are going to do an investigation. They are going out in the yard, tie a string between two chairs placed apart. A straw has been made to go through the string between the chairs. The balloon is drawn up.

Lydia: How can you make the balloon go faster?
Child: Push it faster.
Child 2: Ah...You can blow the balloon bigger.
Lydia: Ah... and you think that it can go faster? Let us try all the different ideas.

The children were very excited. They went out in the small yard where the chairs and string had been prepared. The children start blowing up the balloons very excited.

Researcher: What do you think that you are *(pointing at the balloon)* going to do?
Child 1: It will be a rocket...it will go this way fast *(points to the direction with own hands).*

The teacher takes the balloons, one small, one medium and one large.

Lydia: What do I have here?

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Children: 3 balloons.
Lydia: How are they? How is this one?

Shows the large balloon. The teacher then provided the children with instructions who then carried out the experiment. One balloon moved out immediately while the other took a little longer.

Lydia: Which balloon was faster?
Children: This one' *(there was consensus with this answer).*
Lydia: Why was it faster?
Child: It was bigger!
Lydia: Not only that.
Child 2: It had lots of air.

The teacher prepares the next 2 balloons. The big one was again faster and the small balloon did not even take off.

Lydia: What happened?
Child: The faster one was the first.
Lydia: What was your prediction? The more air in the balloon...
Child: The faster it goes.
Lydia: What happened ... this stopped, why? Don't touch it...this is evidence.
Child: It did not have enough air...it was all out.
Lydia: And this one...*(points out at the balloon, which had moved more.)*
Child: It had too much air, went too fast and turned back again.
Lydia: Why was that?
Child: It went very fast.

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MA_Class_ShootingBalloons_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**P: Scaff;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 2
Episode:	2.4 Shooting Balloons
Teacher:	Lydia
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Teacher using questioning to guide children through an exploration, engage and reflect

Teacher using questioning to guide children through an exploration, and engaging them in reflecting about the evidence to test their predictions and understand the science learning outcome.

Set up for Shooting Balloons experiment

The teacher blows up a balloon and asks the children what happens if she lets it go. The children indicate that it will fly off. The teacher explains that they are going to do an investigation. They are going out in the yard, tie a string between two chairs placed apart. A straw has been made to go through the string between the chairs. The balloon is drawn up.

Lydia: 'How can you make the balloon go faster?'
Child: 'Push it faster.'
Child 2: 'Ah...You can blow the balloon bigger.'
Lydia: 'Ah... and you think that it can go faster? Let us try all the different ideas.'

The children were very excited. They went out in the small yard where the chairs and string had been prepared. The children start blowing up the balloons very excited.

Researcher: 'What do you think that you are (pointing at the balloon) going to do?'
Child 1: 'It will be a rocket...it will go this way fast' (points to the direction with own hands).

The teacher takes the balloons, one small, one medium and one large.

Lydia: 'What do I have here?'

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Children: '3 balloons.'
Lydia: 'How are they? How is this one?'

Shows the large balloon. The teacher then provided the children with instructions who then carried out the experiment. One balloon moved out immediately while the other took a little longer.

Lydia: 'Which balloon was faster?'
Children: 'This one' (there was consensus with this answer).
Lydia: 'Why was it faster?'
Child: 'It was bigger!'
Lydia: 'Not only that.'
Child 2: 'It had lots of air.'

The teacher prepares the next 2 balloons. The big one was again faster and the small balloon did not even take off.

Lydia: 'What happened?'
Child: 'The faster one was the first.'
Lydia: 'What was your prediction? The more air in the balloon...'
Child: 'The faster it goes.'
Lydia: 'What happened ... this stopped, why? Don't touch it...this is evidence.'
Child: 'It did not have enough air...it was all out.'
Lydia: 'And this one...'(points out at the balloon, which had moved more.)
Child: 'It had too much air, went too fast and turned back again.'
Lydia: 'Why was that?'
Child: 'It went very fast.'

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MA_Class_Totals_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.2 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development.
Factors linked with:	**P: Express**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 3
Episode:	3.2 Totals
Teacher:	Sabrina
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Supporting the children's different ways of expression and use of materials provided to solve mathematical problems.

Exploring alternative ways of generating a mathematical answer

The teacher starts talking about numbers adding to 10. She introduces 7 blocks, but she explains she wants 9. She writes the example on board:

7 + ___ = 9

The teacher works out the example with the children using blocks. The teacher then works out a second example using blocks.

5 + ___ = 8

The teacher then moves on to explain what group work the children are going to do. She gives each table some blocks, straws, beans and plastic cups. They also had two small sheets with examples that they had to work out. The children could choose to use any of the different things that they were given.

Group Work:

- **Blocks:** Most of the groups used the blocks. For example one group had 5+ ___ =7. The two boys built two block towers, one with 5 blocks and one with 7 blocks. They then put them one next to the other and noted the difference.
- **Straws**: In the case of the straws, the children counted the number of straws that they had initially, and then counted on till they reached the total, in this case 8.
- **Beans:** The beans were very attractive and many were those children who played with them.

The children counted the number of beans in the first part of the sum. 4 + ___ = 6. So 4 beans were placed under one cup. Then they added 2 and with these they made a total of 6. They decided that the answer was 2.

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MA_Class_Totals_Resources

Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.6 Teachers should be able to gain insights into children's developing explorations and creativity based on their use of resources.
Factors linked with:	**P: Express**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 - report Malta
Case:	Case 3
Episode:	3.2 Totals
Teacher:	Sabrina
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Teacher providing space for the children to freely explore their resources in different ways

Exploring alternative ways of generating a mathematical answer

The teacher starts talking about numbers adding to 10. She introduces 7 blocks, but she explains she wants 9. She writes the example on board

7 + ___ = 9

The teacher works out the example with the children using blocks. The teacher then works out a second example using blocks.

5 + ___ = 8

The teacher then moves on to explain what group work the children are going to do. She gives each table some blocks, straws, beans and plastic cups. They also had two small sheets with examples that they had to work out. The children could choose to use any of the different things that they were given.

Group Work:

- **Blocks:** Most of the groups used the blocks. For example one group had 5+ ___ =7. The two boys built two block towers, one with 5 blocks and one with 7 blocks. They then put them one next to the other and noted the difference.

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- **Straws**: In the case of the straws, the children counted the number of straws that they had initially, and then counted on till they reached the total, in this case 8.
- **Beans:** The beans were very attractive and many were those children who played with them. The children counted the number of beans in the first part of the sum. 4 + ___ = 6. So 4 beans were placed under one cup. Then they added 2 and with these they made a total of 6. They decided that the answer was 2.

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Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.2. Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity.
Factors linked with:	**P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 – report Malta
Case:	Case 5
Episode:	5.3 Waterproofing
Teacher:	Gillian
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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Making predictions and reflecting on evidence created to evaluate the generated ideas; Following up the children's ideas with experiments

The teacher then distributes a worksheet to the children and asks them to go through the examples. The children are asked to predict which of the materials presented they think would be a good material to use as a hat to protect a boy from getting wet.

Gillian: We have a container of plastic covered with the material *(paper napkin).* What do you think is going to happen if I were to pour water on it? Does the water go through it?
Child: Yes.

The teacher tries it out. The children say in chorus:

Children: Yes!
Gillian: Now we try paper...do you think that it is waterproof?
Child 2: Of course not!

The teacher pours water and the children notice that the water passes through the paper into the container. The children shout with delight as they had predicted correctly. The activity went on trying out different materials e.g. cloth, sock, tin foil, cardboard etc. Cardboard was the most controversial example as the children disagreed on whether they thought it was waterproof or not. The cardboard dilemma required further investigation as some children predicted that if they leave it to set for some time the water would eventually pass through it. After trying it out they concluded that in fact it did and therefore was not waterproof.

Comments:

The extended experiment with the cardboard clearly demonstrates how children were not only conducting the experiment but also given time to evaluate its progress. After some debates the children decided that the cardboard needed to be soaked in water for a longer period of time. Thus this episode illustrates how the teacher recognized her students' capabilities to conduct inquiry activities, evaluate its progress and generate ideas concerning science. The students who knew that the cardboard paper leaked water could demonstrate this idea to the other students who thought otherwise, engaging both groups of students in creative learner.

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics.
Factors linked with:	**LA: Ques;** **P:Ques**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D 4.3 – report Portugal
Case:	Case 2
Episode:	Sun distance
Teacher:	Carol
Age Group:	5 years
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

The aim of this activity is to understand the relative sizes of the Sun and the Earth and the distances between them, using proportions.

This activity is integrated into a bigger project, the scholar year project of this class, The Solar System. The idea of the project came up in a conversation with the children.

After some sessions talking about the Solar System, the teacher prepared an activity where the children may compare the Sun and Earth sizes as well as the distance between them: If the Sun is represented by a ball what would be the Earth size? And what is the distance between them?

The teacher makes questions to begin the exploitation of a theme where the children show and represent their ideas about it.

First, in their classroom, they had a conversation with questions and hypotheses about the Sun size, the Earth size and the distance between them. Through a dialog between the teacher and the children, they gathered many facts about the Sun and its importance for life.

The children became interested in the notion of proportion and relative sizes and wanted to compare sizes further.

Children's questions and hypotheses:

(One child takes a big piece of plasticine.)

Child B What if this was the Earth?
TA: In that case, what would be the size of the Sun?
Child B: Much bigger.

(The teacher shows the ball and says it represents the Sun and the little piece of plasticine represents Earth.)

TA: If the Earth was this size, what would be the people's size?
Child A: I think people were the size of microbes.
(…)
Child C: If the ball was the Earth, what would be the Sun's size? And what would be the size of people?
Child B: The people would be the size of microbes.

(Children ask questions about the sizes of the Sun, the Earth and people)

Children: What if the Earth was this size *(ball size)?* / And if the Earth was this room size?

Teacher's scaffolding questions / representation using varied materials

TA: If the Sun was this size (the ball) and the Earth this size *(the grain)*, what would be the distance between them? *(Teacher put both objects on the table)*
TA: This would be a good distance?

(A child departs the two objects.)

Child D: Maybe the Sun would be here and the Earth would be in the next room.

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The teacher uses the hands of each child to measure the diameter of the ball

TA: Do you see this length? What is the name of it?
Children: Diameter of the ball.
TA: Do you know how many of this we have to use to make the distance between both?
TA: One hundred
Children: Ah!
(…)
TA: How far is the Sun from Earth?
Children: 150 millions of km
TA: What is 1km?
Children: Is the distance from that wall *(the opposite)* to the window / The size of this school / From Braga to Lisbon
(…)
TA: Let's go to the corridor and see the distance between the ball and the grain.

(They go to the corridor. They put the ball on the floor and start to put the papers through a line.)

TA: What are we doing?
Children: We are going to see where we put the Earth.
TA: How many papers do we have to put between them?
Children: One hundred.
(They put the papers – following a certain pattern - between the two objects and they notice they can't see the plasticine from the ball)
Children: We can't see the piece of plasticine from the ball!

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PT_Class_SwinggameRope_CreatInqLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**M: Variet**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Portugal
Case:	Case 4
Episode:	SwinggameRope
Teacher:	Olivia
Age Group:	5 years
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

The swing game

The aim of the activity is to build a pendulum (swing game) and explore the factors that affect its motion (movement).

The teacher prepared in advance a set of diverse materials that could be eventually used in the course of the activity. The starting point was a simple string: to every child and the teacher was given a string of equal length. What could be done with such a string hanging in a hand was the first exercise.

They started the activity by exploring the string and making it to swing. After this short exploration phase, children are confronted with specific scientific problems concerning the swing game:

Teacher: If you want to make a swing *(game),* then you need a good swing. What is a good swing?

At the beginning of the activity students weren't fully aware that the foothold of the string would affect its motion. One of the first objects used at the end of the string was a very nice silver paper cut heart: it was too light, and the swing didn't get better with that object.

(…)
Child M: With the plastic bag we hold the oranges fasten to the rope, and there is the pendulum!

Later on, there was the idea of turning down some objects with the pendulum.
So there was a tripod to hang the string from it; plastic bottles to turn down; plastic bags and solid objects to hang at the end of the string; and many other objects that could be used following the children´s suggestion (wood block, pieces of fruit, paper cut drawings, raw cotton, etc.). In due course of the activity, a wall and a door lintel were used, after children´s suggestion.

A variety of materials

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.2 Teachers should be able to open up everyday learning activities to allow greater opportunities for inquiry, problem solving and scope for creativity. 6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics. 6.4 Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations). 6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.
Factors linked with:	**P:Ques;** **LA: Connect;** **LA: Equip;** **P: R and R;** **LA: Obs;** **P: Express;** **AO: IBSE/PBL**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Portugal
Case:	Case 4
Episode:	SwinggameRope
Teacher:	Olivia
Age Group:	5
Selected episode present in D4.4 Appendix	Yes

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The swing game

The aim of the activity is to build a pendulum (swing game) and explore the factors that affect its motion (movement). Every child and the teacher had a string and could be wagging the string and observe its motion.

The teacher started questioning and dialoguing with the students about the length of the string and its effects in the pendulum motion, *"Which string should we use? A long one or a short one? If you want to make a swing (game), then you need a good swing. What is a good swing?"*

The children began the discovery of the simple pendulum. They explored a possibility with a string holding an espresso capsule at one end, and they gave the suggestion where the pendulum could be mounted. The first attempt was not successful because it was hanging from the wall (see Image 1) and therefore the pendulum was bumping against the wall.

Image 1

Many children tried to make it swing, unsuccessfully. Finally, they reached a conclusion:

Children: The swing can't be fixed in the wall, because it's impossible to make it swing, hanged in there.
A child suggests: Maybe we can fix it to the top of the door opening.

So it was done, and the pendulum could swing at last (Image 2).

Image 2

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An open-ended problem

Teacher: If you want to make a swing (game), then you need a good swing. What is a good swing?
(…)
Child M: With the plastic bag we hold the oranges fasten to the rope, and there is the pendulum!
(…)
Child R: Attach the swing to the wall, hanging something in the end of the rope.

Children's own investigations / Children gathering evidence through observation / Rich physical environment for exploration

The teacher helped a child to attach a capsule of coffee to the end of the rope and fix it to the wall. Children tested their hypotheses, trying to swing it.

Child R: This isn't a swing! It hits the wall and doesn't swing.
Child S: Pull away from the side.
Child J: Take it more out.
Children: Let me try, I think I can make it swing and don't hit the wall.

Many children tried to make it swing, unsuccessfully. Finally, they reached a conclusion:

Children: The swing can't be fixed in the wall, because it's impossible to make it swing, hanged in there.
Child R: Maybe we can fix it to the top of the door opening.

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Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.1 Teachers should be able to advance children's understanding about the nature of science and how scientists work, confronting stereotypical images of science and scientists. 3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity.
Factors linked with:	**LA: Expl;** **LA: Comm;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Class
Originating from:	
Country report :	D4.3
Case:	Case 3
Episode:	Wolf, sheep and cabbage
Teacher:	Florence
Age Group:	8
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

The activity WolfSheepCabbage

Problem: A man needs to bring a wolf, a sheep, and a cabbage across the river.
The boat is tiny and can only carry one passenger at a time.
If he leaves the wolf and the sheep alone together, the wolf will eat the sheep.
If he leaves the sheep and the cabbage alone together, the sheep will eat the cabbage.
How can he bring all three safely across the river?

Examples of children explaining why certain ideas would work and would not work

Child R: If we took the sheep first, then the cabbage, then the sheep will eat the cabbage.
Child R: So we have to leave the sheep and bring the cabbage back.
Child R: If we took the cabbage in first place, the wolf will eat the sheep. (…)
Child G: First we take the sheep across, then we go back and get the cabbage, then we take the sheep back and take the wolf across, then we take the sheep across

Every time a group would reach a solution, it was demonstrated to the teacher using their paper models and moving the boat from one shore to another.

Children's **problem solving skills** were fostered as they suggested and tried different potential solutions and gave **reasons** why certain ideas work or would not work. Children used and developed science skills such as predicting, observing, analysing and describing, demonstrating scientific or mathematical creativity in generating alternative ideas and strategies and **reasoning critically between them**. They also had to **make connections** between the combinatorial / mathematical aspect of the task and their knowledge of food chains.

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PT_Class_WolfSheepCabbage_NoS_2

Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**AO: Kn.Sc;** **AO: Und. SI**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 Portugal
Case:	Case 3
Episode:	Wolf, sheep and cabbage
Teacher:	Florence
Age Group:	8
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

The activity WolfSheepCabbage

Problem: A man needs to bring a wolf, a sheep, and a cabbage across the river.
The boat is tiny and can only carry one passenger at a time.
If he leaves the wolf and the sheep alone together, the wolf will eat the sheep.
If he leaves the sheep and the cabbage alone together, the sheep will eat the cabbage.
How can he bring all three safely across the river?

Working in groups, the children could think of the problem, make their hypothesis and try their solutions. They could use paper models of the boat and passengers to play the game.

The context of the game provoked children's **imagination**, and the informal and fun nature of the task **motivated** the children to become engaged in the problem. Working in groups encouraged children to articulate their ideas and reasoning. Children **collaborated** in sharing and discussing different ways to solve the problem.

Every time a group would reach a solution, it was demonstrated to the teacher using their paper models and moving the boat from one shore to another.
When the solution was correct the teacher would send them to the computer to play that same game using their sequence of moves. Otherwise, the teacher would point out the move in which the game was failing, asking the children to find another solution.

Children's **problem solving skills** were fostered as they suggested and modelled different potential solutions and gave **reasons** why certain ideas work or would not work. Children used and developed science skills such as predicting, observing, analysing and describing, demonstrating scientific or mathematical creativity in generating alternative ideas and strategies and **reasoning critically between them**. They also had to **make connections** between the combinatorial / mathematical aspect of the task and their knowledge of food chains.

Reflecting on learning

Child LA: With this activity we learned that to solve a problem we have to make relationship between what we are 'analysing'

Reflection by the researcher: In the end, when all the groups had found a solution, some reflection of the activity was guided by the teacher, namely addressing the processes they went through to find a solution to the problem: questioning, collaborating, making hypothesis, discussing, testing. Then the children were told that it was much similar to what scientists do: they have to work and think before they find anything new.

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PT_Img_SunDistance_LEnvironm

Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out.
Factors linked with:	**L. Out/Indoors**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 Portugal
Case:	Case 2
Episode:	Sun distance
Teacher:	Carol
Age Group:	5
Selected episode present in D4.4 Appendix	Yes

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Using corridor space /varied materials to represent the distance between the Sun and the Earth

(The teacher gives to each child a set of colored papers of the size of the ball diameter.)

TA: Let's go to the corridor and see the distance between the ball and the grain.

(They go to the corridor. They put the ball on the floor and start to put the papers through a line.)

TA: What are we doing?
Children: We are going to see where we put the Earth.
TA: How many papers do we have to put between them?
Children: One hundred.

(They put the papers – in pattern - between the two objects and they notice they can't see the plasticine from the ball)

Children: We can't see the piece of plasticine from the ball!

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PT_Img_WolfSheepCabbage_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should familiarize teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering and extending inquiry and creativity, by for example prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events. 7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries.
Factors linked with:	**P: Scaff;** **P: Quest**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report Portugal
Case:	Case 3
Episode:	Wolf, sheep and cabbage
Teacher:	Florence
Age Group:	8
Selected episode present in D4.4 Appendix	Yes

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

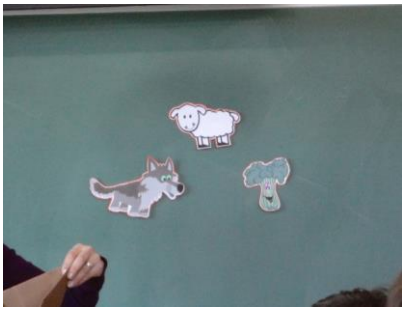
The activity WolfSheepCabbage

Problem: A man needs to bring a wolf, a sheep, and a cabbage across the river.
The boat is tiny and can only carry one passenger at a time.
If he leaves the wolf and the sheep alone together, the wolf will eat the sheep.
If he leaves the sheep and the cabbage alone together, the sheep will eat the cabbage.
How can he bring all three safely across the river?

Materials and preparation:
A few days before, the teacher had put the children to paint and cut images of a wolf, a sheep, a cabbage and an *origami* boat.

Working in groups, the children could think of the problem, make their hypothesis and try their solutions. They could use the paper models of the boat and passengers to play the game.

The informal and fun nature of the task helped in engaging children



Throughout the activity, the children **collaborated** with their peers to think of different possibilities; to try out the different potential solutions; and to **give reasons** why certain ideas would not work.

The teacher was supervising, going from one group to another, answering questions about the rules of the game, questioning children about the implications of each move of the game and letting them to find the whole sequence of moves to finish successfully the task.

Every time a group would reach a solution, it was demonstrated to the teacher using their paper models and moving the boat from one shore to another.

When the solution was correct the teacher would send them to the computer to play that same game using their sequence of moves. Otherwise, the teacher would point out the move in which the game was failing, asking the children to find another solution.

Children's **problem solving skills** were fostered as they suggested and tried different potential solutions and gave **reasons** why certain ideas work or would not work. Children used and developed science skills such as predicting, observing, analysing and describing, demonstrating scientific or mathematical creativity in generating alternative ideas and strategies and **reasoning critically between them**. They also had to **make connections** between the combinatorial / mathematical aspect of the task and their knowledge of food chains.

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.4 Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations). 6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.
Factors linked with:	**LA: Connect;** **LA: Plan**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D 4.3 – report Portugal
Case:	Case 3
Episode:	Wolf, sheep and cabbage
Teacher:	Florence
Age Group:	8
Selected episode present in D4.4 Appendix	Yes

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The activity WolfSheepCabbage
Problem: A man needs to bring a wolf, a sheep, and a cabbage across the river.
The boat is tiny and can only carry one passenger at a time.
If he leaves the wolf and the sheep alone together, the wolf will eat the sheep.
If he leaves the sheep and the cabbage alone together, the sheep will eat the cabbage.
How can he bring all three safely across the river?

Materials and preparation:
A few days before, the teacher had put the children to paint and cut images of a wolf, a sheep, a cabbage and an *origami* boat.
The teacher has presented the problem to the class and divided it into groups of four children.
Working in groups, the children could think of the problem, make their hypothesis and try their solutions. They could use paper models of the boat and passengers to play the game.

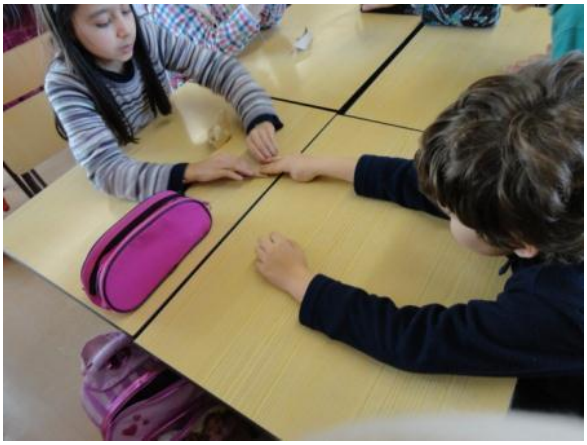
Throughout the activity, the children **collaborated** with their peers to think of different possibilities; to try out the different potential solutions; and to **give reasons** why certain ideas would not work.

The teacher was supervising, going from one group to another, answering questions about the rules of the game, questioning children about the implications of each move of the game and letting them to find the whole sequence of moves to finish successfully the task.

Working in groups encouraged children to articulate their ideas and reasoning. Children **collaborated** in sharing and discussing different ways to solve the problem.

An example of children collaborating and giving reasons

Child L: The sheep eats the cabbage.
Child R: The sheep has to go first because the wolf doesn't eat the cabbage.



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Examples of children explaining why certain ideas would work and would not work

Child R: If we took the sheep first, then the cabbage, then the sheep will eat the cabbage.
Child R: So we have to leave the sheep and bring the cabbage back.
Child R: If we took the cabbage in first place, the wolf will eat the sheep. (…)
Child G: First we take the sheep across, then we go back and get the cabbage, then we take the sheep back and take the wolf across, then we take the sheep across

Children testing.

Every time a group would reach a solution, it was demonstrated to the teacher using their paper models and moving the boat from one shore to another.

When the solution was correct the teacher would send them to the computer to play that same game using their sequence of moves. Otherwise, the teacher would point out the move in which the game was failing, asking the children to find another solution.

Children's **problem solving skills** were fostered as they suggested and tried different potential solutions and gave **reasons** why certain ideas work or would not work. Children used and developed science skills such as predicting, observing, analysing and describing, demonstrating scientific or mathematical creativity in generating alternative ideas and strategies and **reasoning critically between them**. They also had to **make connections** between the combinatorial / mathematical aspect of the task and their knowledge of food chains.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.3 Teachers should be able to evaluate and select creativity enabling ICT resources for children to use in their inquiry.
Factors linked with:	**M: Variet;** **M: ICT**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 - Portugal
Case:	Case 3
Episode:	Wolf, sheep and cabbage
Teacher:	Florence
Age Group:	8
Selected episode present in D4.4 Appendix	Yes

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The activity WolfSheepCabbage

Problem: A man needs to bring a wolf, a sheep, and a cabbage across the river.
The boat is tiny and can only carry one passenger at a time.
If he leaves the wolf and the sheep alone together, the wolf will eat the sheep.
If he leaves the sheep and the cabbage alone together, the sheep will eat the cabbage.
How can he bring all three safely across the river?

Materials and preparation:
Previously, the teacher had given the children images of a sheep, a wolf, and a cabbage. They also have made a boat of paper.
Working in groups, the children could think of the problem, make their hypothesis and try their solutions. They could use the model of the boat and the images to play the game.
After each group had solved the problem, they could verify their findings using a computer game (there are many available online).

The integration of ICT for children to verify their solution

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.2 Teachers should be able to open up everyday learning activities to allow greater opportunities for inquiry, problem solving and scope for creativity. 6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics. 6.4 Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations). 6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.
Factors linked with:	**AO: Creative;** **P: Express;** **P: Agency**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class), image
Originating from:	
Country report :	D4.3 – Report Romania
Case:	Case 1
Episode:	Float and sink
Teacher:	Maria
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Through story telling the teacher tries to induce creative dispositions to pupils. The development of creativity is specifically planned. Diverse forms of expression are valued, and children's agency is encouraged.

The teacher starts the lesson with a story about the diligent little ant living in the forest.
The little ant is looking for food. The ant arrived near the creek and dropped into water. A dove flying around saw what happened and came to help the ant. Children are asked *'How can the dove help the ant?'*

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.
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.

Additional children's ideas:

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.

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Additional data: In the second part of the lesson, the teacher offered a selection of materials which can be found in the forest and asked children to select some of them based on their hypothesis and test if these materials float or sink.

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. They receive also worksheets on which they have to draw or write their results, so they can indicate which materials can float and save the ant. Worksheets are filled individually with drawings or text.

According to their skills, children run and investigation and fill the distributed worksheets, by writing or making a drawing

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Teacher Education Design Principle + code:	6. Teacher education should provide knowledge about how children's creativity development could be enhanced and assessed within science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics. 6.4. Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations).
Factors linked with:	**LA: Ques;** **P: Ques**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Romania
Case:	Case 1
Episode:	Magic water
Teacher:	Maria
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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The teacher encourages children to ask questions. She is fostering questioning and curiosity, either by very well designed questions or by organizing demo experiments.

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.
T: Any thing else about water?
Ch2: Water has no smell.
T: Clean water has no smell.
Ch5: Water has no colour.
Ch6: Water does not poison you and has no acid.
T: Let's repeat. Water is a liquid. Liquids flow. No colour, 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 colour, in order to be transparent.

As shown, at the beginning of the class the teacher asked some questions to which it is expected children previously learned the answers (e.g. water characteristics – colour, smell, water as an example of liquid, etc.). This starting dialog brings to pupils attention previous knowledge and capture their attention. The next step to follow is to focus their interest towards new ideas by pushing them into an apparent contradiction, as per their common sense and earlier information they have about water (e.g. water is not listed as a liquid use to glue paper).

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?
The teacher 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.
The teacher 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.

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RO_Class_Measuring_volumes_non_standardized_units_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**AO: Creative;** **P:Ques;** **P: Agency**
Type of material (image – interview (int) – classroom extract (class):	**Classroom**
Originating from:	
Country report :	D4.3 Romania
Case:	Case 4
Episode:	Measuring volumes: non standardized units
Teacher:	Sanda
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Teacher's questions guiding children's learning of process skills and understanding

T: The lesson of today is about measuring liquids. Who knows what the unit for measuring liquids is?
C: The liter
T: Yes, the liter is a measuring unit for liquids; today we shall not use the liter, but various other units. We shall measure water using glasses, cups, cylinders and bottles. What other liquids can we also measure?
C: oil.. vinegar.. milk.. juice.. beer.. tea.. wine..
T: Yes, very good. Let's see how we can measure water. We shall use the smallest vessels first. Look at these and tell me please if they are the same. **Calin**, would you like to pour the water from this tube into the little cylinder? **Calin** pour the water.
T: Did you pour all the water?
Calin: Yes the tube is smaller than the cylinder.
T: Now let's see the next experiment. You will pour water from the bottle in the cylinder till you will reach the last line on the scale.
Anca: The bottle is bigger than the cylinder because there still is some water in the bottle…
T: Yes, now let's see if the whole quantity of water in the cylinder can fill this glass on the table
Alex: The glass has been filled and I used the whole water from the cylinder
T: How these two recipients are, if the water from one of them can fill the other one?
Alex: They are the same, they are equal.
Sonia: In my glass is not the whole amount of water, there still is some water in the cylinder.
T: And what can you say about the two vessels?
Sonia: The cylinder is bigger than the glass.
T: And you **Didi**, did you manage to pour the entire amount of water from the cylinder in the glass?
Didi: Yes, all the water is now in the glass and there is still place to the edge of the glass.
T: 'What can you say about the two vessels? Are they the same, in terms of volume?
Didi: Yes
Andu: Nooo… the glass is bigger than the cylinder!
T: Now, you pour water from the cup into the cylinder.
Ana: The cup is bigger because there still is some water in it that does not fit in the cylinder.
T: Let's compare some other cups. You have water in the cylinder and now pour it in the cups. Does water fit in the cups?
Some children: They are the same, the water from the cylinder fits in the cup!

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.7 Teachers should be able to assume a variety of roles in their interactions with the children e.g. allower, leader, afforder, coordinator, supporter, tutor, motivator and facilitator, to support children's creativity and inquiry in science and mathematics. 7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries. 7.9 Teachers should be able to use different assessment approaches and strategies and in particular those that involve children in the assessment processes, such as peer and self assessment, dialogue and feedback on progress, in the early years science and mathematics classroom.
Factors linked with:	**A: Peer/Self;** **P: Dialog;** **P: Scaff;** **P: Quest**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 – report Romania
Case:	Case 5
Episode:	Natural phenomena
Teacher:	Cora
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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Pupils' engagement in science learning is triggered by questions and a permanent dialogue with peers and teacher.

In this way, children's interest on the subject, curiosity and motivation are supported. During all these interactions, the teacher changes roles permanently from tutor to observer, advisor, evaluator, consultant, active participant. In this manner, he/she is able to judge children progresses from various perspectives: content knowledge, process skills, communication capabilities, social relationship, ability to handle materials. In some cases, it is useful to encourage students to self and/or peer assessment.

T: We shall speak about natural phenomena and your task was to make some drawings or to look for images that illustrate them. Could you find some? Mara please, can you show us?
Mara: I like lightning, I brought a picture …
T: Yes, very good. When the lightning is produced?
Mara: The lightning is produced during storms, when it is a lot of electricity in the clouds.
T: Yes, good. Who want to present another phenomenon? Yes Daria, what natural phenomenon did you choose?
Daria: I chose the rainbow, I like it!
T: very good, could you tell your colleagues what the rainbow is? It is really difficult to understand what happen in the sky, when it becomes coloured…
Daria: Yes, it is something with little drops of water in the sky and the sun… it is after the rain… and it is very nice…
Alex: I chose rain.
T: Yes, very good; when it is raining a lot, in what season?
Alex: In spring and in autumn, and sometimes in winter.
T: Yes, you are right, in winter when temperatures are higher it rains, it does not snow.
T: Who can tell me what the seasons are?
Doru: There are four seasons: winter, spring, summer, and autumn.

T: Now you shall receive a worksheet where four trees are presented and you have to colour them according to their appearance in each season: you have to imagine how the tree looks like in spring, in summer, in autumn and in winter.
Mara: In spring the trees are blossoming! I shall colour some pink flowers..
Alex: I shall colour some red fruit for the summer and some green leaves
Daria: For autumn I shall colour using brown, yellow and red for the tree, these are the colours of the autumn…
Radu: In winter there are no leaves no more, I shall colour in brown only the stem and the branches of the tree… and on the ground I shall leave uncoloured because it is snow…
T: Yes, very good; please start colouring!

T: We shall stop here and you will finish to colour the trees at home. Now, what can you say about the weather of today? We have to register on our worksheets 'The calendar of the nature'. You have to select from the legend what is the most appropriate symbol for today
Sandu: It is cold… I was cold…
Lia: And there are a lot of clouds
T: Yes, it is cold and many clouds are on the sky. What about the wind?
Laura: It is wind, but not so strong…
Dona: it is raining now…

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T: Yes, very good, now please draw on the worksheet what do you think it is specific for expressing the weather of today.

After discussing about natural phenomena, children either fill some worksheets or color the 'Calendar of Nature'. In this way, in addition to the information obtained through the dialog with pupils, the teacher has the opportunity to assess their individual knowledge and understanding of the subject by observing their class work and by evaluating the worksheets content and quality.

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RO_Img_Colouredfingersstamps_EYSciMaths

Teacher Education Design Principle + code:	12. Teacher education should provide knowledge about early child development, the purposes and aims of science and mathematics education, and their place in the early years curriculum. **EYSciMaths**
Specific Teacher Outcome(s):	12.3 Teachers should have knowledge of the role of creativity in child development and in the fields of science and mathematics. 12.4 Teachers should be able to contribute towards the goal of preparing creative citizens, who have scientific and mathematic literacy.
Factors linked with:	**AO: Creative**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 - Romania
Case:	Case 3
Episode:	Colored fingers stamps; Mixing colored water
Teacher:	Anca
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Planning to integrate science and mathematics teaching with creativity and imagination

During this lesson, children have to understand the production of new colours through colour mixing, based on the mixing of two differently colored water samples. The teacher and her assistant distribute 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. She asks pupils to comment on the color and clearness of the water in the bowls they received, with the intention to link the subject of the lesson with children previous knowledge. After this dialog, the teacher instructs 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 asked one after the other to identify the newly formed colors and to name them. During this discussion, pupils have to reflect on the way new colors can be obtained by mixing two liquids having different colors. They are free to explore the new situation, as the teacher and her assistant supervise them not to split the liquids or to smear all around. By the end of the lesson, children are required 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. In this situation one again science is combined with mathematics, as elementary geometrics shapes have to be compared. A correct answer is rewarded.

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At very early age children are encourage to learn in a combined method both science and mathematics. They are learning in the mean time colors and geometric shapes. They are simultaneously learning about primary colors, secondary colors and geometric shapes.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations. 17.5 Teachers should be able to develop and extend their own classroom resources to foster creativity in the early years science and mathematics classroom.
Factors linked with:	**M: Expl;** **M: Cr;** **AO: Creative**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 - Romania
Case:	Case 3
Episode:	Coloured lights
Teacher:	Anca
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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A rich physical environment and the variety of teaching resources are assumed to be the foundation for an efficient science teaching program.
Experienced teachers are valuing the potential of physical materials which can be found in the household, as the basis of hands-on activities. Such an environment fosters creativity in science and mathematics education offering opportunities for discussions and social learning. Teachers need to understand the role played by such resources and have to plan in advance for their creative use.

In order to prove various way secondary colors can be obtained the teacher uses a torch and different optical colour filters. By projecting the torch light on the ceiling and interposing one or two filters she produces secondary colours. This set of experiments completes the demonstration of colour mixing based on water colours and coloured water.

In addition, the teacher introduced color mixture using watercolor which has to be mixed by pupils in order to obtain secondary color, or colored liquids which have to be mixed to obtain liquids with a new color.

In this way, very young children learn that there are various means to be employed in order to obtain new color from the primary ones.

By the end of the class, pupils are asked to identify the primary and secondary colors they play with in colored diagrams or small pieces of color plastic.

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RO_Img_FloatSink_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.10 Teachers should value and be able to make use of varied forms of assessment evidence (including children's portfolios, individual or group records of activities), both to promote creative learning, through reflection and discussion in science and mathematics, and explicitly to inform teaching and longer term planning.
Factors linked with:	**LA: Comm;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report Romania
Case:	Case 1
Episode:	Float and sink
Teacher:	Maria
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Children are trained to communicate their results and to provide explanations. Such a presentation is a good opportunity for the assessment of pupils in a formative manner

There are two purposes for the use of pupils' results presentations: a) to teach them to communicate their findings, as scientists do; b) for children learning formative assessment

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

Class dialog (CD) 4
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.

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.

The teacher concludes on the results of the first team, in this way the entire class agrees.

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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.

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RO_Img_FloatSink_NoS

Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.1 Teachers should be able to advance children's understanding about the nature of science and how scientists work, confronting stereotypical images of science and scientists.
Factors linked with:	**LA: Comm;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report Romania
Case:	Case 1
Episode:	Float and sink
Teacher:	Maria
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Children are trained to communicate their results and to provide explanations. Such a presentation is a good opportunity for the assessment of pupils in a formative manner

There are two purposes for the use of pupils' results presentations: a) to teach them to communicate their findings, as scientists do; b) for children learning formative assessment

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

Class dialog (CD) 4

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.

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.

The teacher concludes on the results of the first team, in this way the entire class agrees.

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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.

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RO_Img_Partsofaplant_Resources

Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity.
Factors linked with:	**AO: Affect**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 - Romania
Case:	Case 6
Episode:	Parts of a plant
Teacher:	Delia
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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In order to motivate children in science and mathematics learning, to increase their interest on such subjects, the teacher role explore the affective part of the educational approach, linking the lesson with cognitive elements familiar to pupils from their every day life experience.

In explaining the constitutive parts of a plant the teacher plays a cartoon, known to children, where a little elf describes these parts using a magic wand.

The teacher engages pupils in acquiring new knowledge taking advantage of their interest in stories, animations and the use of ICT.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.3 Teachers should be able to evaluate and select creativity enabling ICT resources for children to use in their inquiry. 17.4 Teachers should be able to evaluate provision for free flow play in their school settings.
Factors linked with:	**M: Cr.;** **M: ICT;** **P: Play**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 - Romania
Case:	Case 5
Episode:	Seasons
Teacher:	Cora
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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A lesson on Seasons is a good opportunity for the teacher to ask pupils to bring from home various materials to be used in designing posters, specific to each season. By playing with all these materials children approach creatively the subject, inspired by Vivaldi's music. The ICT is employed not only to play the music but also for displaying various seasons' scenes. Children explore the characteristics of various materials and combine them in unexpected manners to set up a scene / a short illustrated story significant to each season. Physical and virtual resources are handled with ability by the teacher, who succeeds to create the inspiring atmosphere for teaching science in an informal learning environment.

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In order to introduce children to the subject of seasons, the teacher uses a PC to show some images and to play Vivaldi's music. Pupils are asked to prepare one poster for each season based on specific signs of the season and its associated festivities. At the end of the class, they display their posters and discuss in groups about their meaning and messages.

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UKEN_Class_Art_CreatInqLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**T: Ped;** **LA: Plan;** **P: Agency;** **A: Evid;** **M: Explor.;** **M:Cr.;** **M: Variet**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract, focus group, photographs
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 2
Episode:	Art
Teacher:	Louise
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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The teacher uses pictures they had looked at in other subjects as the context for open-ended mathematics questions.

In this lesson the children were presented with three pictures by the Japanese artist Hokusai and then split into groups to solve open-ended questions based on these.

The children with *The Ferry Boat crossing the Sumida River* picture had to estimate how many people there were on the river.

Child A - I was doing that one. It was quite hard seeing how many boats there were and how many people there could be.
Child B - Because everyone had a different number

The children had to decide on their own way to calculate an answer once they had decided how many boats and people per boat.

Child A - We were thinking how many people were in the boat and how many boats there were. There was a holiday family boat and we thought a holiday boat that would take people to France or somewhere we thought like 90, 90 people.

For *The Great Wave off Kanagawa* the children were asked to estimate how big the boat and wave were.

The children started by estimating the proportions of the boat and wave.

They chose a trundle wheel to measure and mark out the boat and wave.

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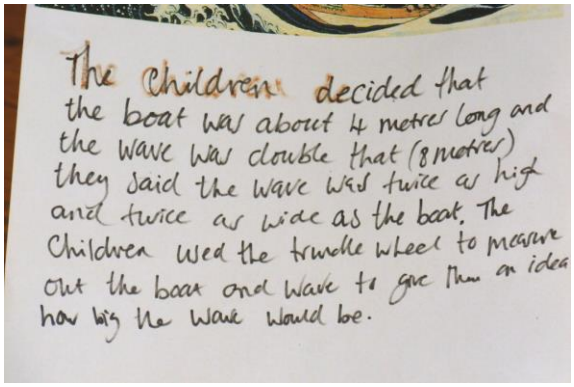


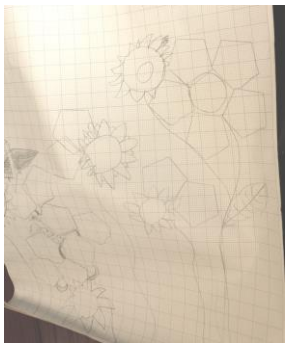
The Children decided that the boat was about 4 metres long and the wave was double that (8 metres) they said the wave was twice as high and twice as wide as the boat. The Children used the trundle wheel to measure out the boat and wave to give them an idea how big the wave would be.

The teaching assistant recorded what the children had done.

Hibiscus and Sparrow was used to explore shape and symmetry.

The children used mirrors to explore symmetry in the picture.

The children used plastic shapes to explore shape in the picture.



The children then drew their own shape picture using similar techniques.

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Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE:GWork**
Specific Teacher Outcome(s):	15.1 Teachers should have knowledge of the value of collaboration for inquiry and creative thinking and learning. 15.2 Teachers should be able to purposefully use a variety of patterns of collaboration, shifting between individual and collaborative activity over time, to support children's inquiry processes and creative learning. 15.3 Teachers should be able to organize group work, aligning ways of grouping children, task design, teaching and assessment strategies in different ways to promote collaboration amongst children in science and mathematics. 15.4 Teachers should be able to use resources and teacher intervention appropriately to foster collaboration in science and mathematics.
Factors linked with:	**P: Collab;** **P: Dialog;** **M: Var;** **M: Expl;** **P: Collab;** **P: Scaff;** **G: SmallG;** **A: Strat**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (Class)
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 11
Episode:	Balancing pens
Teacher:	Emily
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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This classroom extract focuses on a 'Weighing' activity (outlined below) that took place at the weighing table as just a small part of the wider lesson consisting of a carousel of measuring activities including 'Filling Boxes', 'Capacity of a Jug', 'Building Towers' and 'Measuring Length using a Metre Stick'. The extract also includes part of whole class plenary at the end of the session. It illustrates the play-based approaches emphasised by Emily, and her concern to foster alternative ideas and reasoning through dialogue and collaboration.

The tasks were planned to allow problem solving in mathematics. Children were provided with a wide range of materials to support their inquiries. The children worked in pairs and were encouraged to collaborate, to talk and discuss together. The tasks were designed to promote questioning and reflection on what happened and why.

The activities were carried out in mixed ability groups in a rotation over two consecutive days. A particular feature of Emily's approach to learning and teaching is that children are organised into mixed ability groups for classroom activities. Children are allocated talk partners (the children are paired with another child who they are asked to discuss things with and also work with in the classroom) and these are changed each week. When the children come in on Monday they have a new talk partner. Small working groups are then made up of three pairs of talk partners.

Variety of materials

The weighing table was set up with a range of materials and equipment, including small pens, Berol pens (larger), small animals, paintbrushes and a balance scale to be shared between two children. The children were asked to use the balance to find out how many of each object was needed to weigh 100gms. They had a worksheet to fill in as they went along. On the worksheet they had to record the object and how many of that object weighed the same as 100gms.

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Children working collaboratively

Two children, Neil and Henry, were using Berol pens to weigh how many pens would balance 100gms. They were working collaboratively. They were having difficulties in getting the scales to balance.

Neil: It's not balancing.
Henry: Put on another one.
Neil: But now it's too heavy.
Henry: Take one off.
Neil: It's still not balancing. It doesn't make sense.

Henry offered an alternative idea - that they use smaller pens to balance the 100g weight. Prompted by Neil, he explained his suggestion and his estimation of how many would be needed.

Henry: Let's try the mini pens they will work better.
Neil: Why?
Henry: Because they are smaller.
Neil: It isn't 100.
Henry: Think we will need 30 to balance the 100g weight.
Neil: This is too little because they weigh nothing. 100gms is not heavy.
Henry: It's 39 that's right. 39 is 9 more than my guess.

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Opportunities for formative assessment and for fostering children's reasoning through teacher questioning

Teacher: Which would you use – there is a choice of unifix, a ruler or a metre ruler?
Child Grace: Metre stick
Child Sarah: *(disagreeing)* The bedroom is bigger than a metre stick. Cubes would be better because there were lots and you could use lots of them. It would be better if you had 2 rulers. It won't stay like that if not enough sticks.
Teacher: What would choose if there were enough sticks?
Child Audrey: Using a metre stick isn't good because when you get to 10 then you have to go back to zero.

The discussion in the plenary provided Emily with valuable assessment information to inform future planning. In evaluating the session she suggested that it was not clear that the children understood how to use a metre stick to measure longer lengths.

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Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry. **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**P:Ques;** **P: Scaff;** **P: Agency;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 10
Episode:	Beebot
Teacher:	Jennie
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Planning of resources and teacher questions to foster inquiry

This session involved children working with programmable floor robots called Bee-Bots. They are used widely in nursery and primary schools for introducing control, directional language and programming to young children. They are attractive and simple to use with buttons to press to make the Bee-Bot go forwards and backwards and to turn left and right through 90 degrees. The Bee-Bot has a memory that can store up to 40 steps.

Each child had a Bee-Bot. Dawn, the teacher, had prepared cardboard pathways for each Bee-Bot marked out with four steps, each to a different planet – for example Moon, Mars Venus, or Neptune. The session was planned to allow time for children to familiarise themselves with the functions of the different Bee-Bot buttons and then apply their knowledge to making their Bee-Bots go to their planet and back. Children were free to participate as they wished, provided space was available. Key questions were identified in the teacher's plan to encourage children to

- plan what they would do next for example: *'What do we need to do first? Which way do you want to go?'*
- reflect on experiences for example '*What happened when you pressed that button? How did you make it go?'*
- think about how to make the robot perform particular actions for example '*Could you tell it to move over there? How could you make it do that?'*

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Teacher questioning to scaffold knowledge of the functions of buttons on the Beebot and promote confidence and independence

The first group of children Diana, Zena, Lamont and Nash had managed to get their Bee-Bots to their planets and were now trying to get them to turn round and come back home, but were having difficulties.

Lamont: My Bee-Bot's gone the wrong way Dawn *[He had continued to press forward when he needed to press backwards or to turn the robot round to get it back home. Zena next to him was having the same problem.]*

Dawn: Watch – just leave him there for a minute. *[She indicated to watch Zena's Bee-Bot*]. He wants to go back to Zena – what have we got to do?

Lamont and Diana trying to find way to get their Beebots home.

Nash stretched out his hand to show his idea.

Dawn: Just look and say [*encouraging him to articulate his idea*]
Nash: Push here [*to turn the robot round a quarter turn*]
Dawn: Ok Nash – do you want to have a look what happens?

Nash pressed turn and go.

Nash: It went that way [*pointing to indicate looking sideways*]
Dawn: Is that what we want?
Nash: You got to push that one again.
Dawn: Ok [*she pressed the turn button*] – and then what do I do?
Nash: Go zzzz [*copying the sound of the Bee-Bot*]
Dawn: Is he facing the right way now to get back to Zena?
Children: Yes**.**

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Having turned her robot round, Zena then set about trying to get her Bee-Bot to travel home.

Zena: [*out loud*] You need to press clear and then that one. [She presses backwards]. He has not moved? What do I do?
Dawn: Diana can you help us?

Diana pressed go and the robot goes backwards away from Zena. This provoked much laughter.

Lamont: I know I know – back.
Dawn: Nash – what's your idea – can you do it?
Nash: [Pointing to the forwards button] Forwards.
Dawn: How many times?
Nash: 1234 and press the green button.

[Robot goes back almost to home.]

Dawn: What have we got to do now Daphne?

Dawn pressed clear and with one more move forwards the robot arrived at home base. The children clapped their hands.

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Teacher questioning to encourage sharing of strategies and explanations and extend learning

With the second group of Hakim, Jemma, Josef and Devon, Dawn again started the session by saying that their Bee-Bots are 'going to the planets'. She asked the children if they could remember what the buttons do, reminding them in particular about CLEAR and GO. The children then started to make their robots move forwards a step at a time.

Dawn: What do we need to make him go again Josef?

[Josef pressed clear, then forward, then green.]

Dawn: Ok keep going- they need to go to the planet.

Josef starting his Bee Bot

The children all got their robots to the planets quite quickly. Dawn now encouraged the children to offer ideas about how many steps it took to get their robots to the planets and then about how they might get their robots to travel all the way to the planets in one go.

Hakim: We've got to the planets. *[He cheers]*
Dawn: Because how many times did you push?
Josef: Six times.
Dawn: Jemma – how about yours – are you going to land on the planet?
Jemma: I'm on the planet next to you.
Dawn: Devon has yours come – how many times did you need to push it.
Hakim: Lots of times.
Dawn: How can we make it go all in one go – how many times would we need to push?
Josef: 123456.
Dawn: Lets try out and see.

[Josef presses 123456. The robot sets off towards Mars – but also goes beyond.]

Dawn: Wow you did it - but now he's going to another planet – he's not stopping!
Josef: Gone in there *[in the kitchen]***!**

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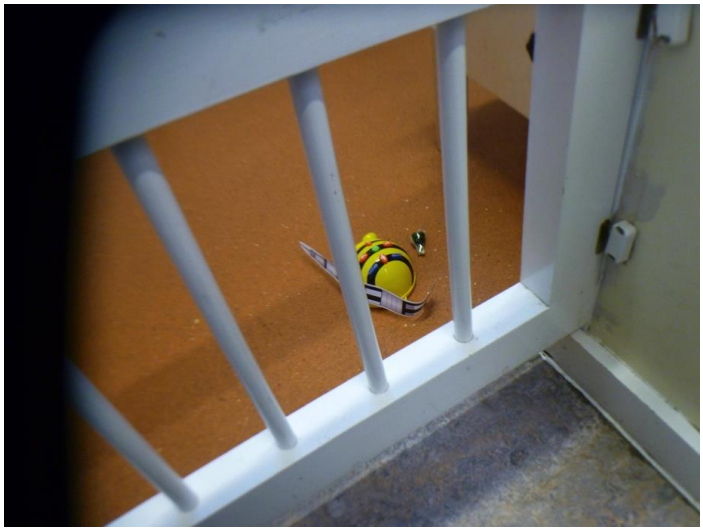
Dawn: I think he's going for lunch – is he still going or is he stopped?
Josef: Stopped.

[All the children are laughing.]

Dawn: Thank goodness for that. How are we going to get him back?



The Bee Bot has gone under the gate into the kitchen!

This prompted others to try out how many moves to get their robot past their planet into the kitchen. This was followed by similar explorations to those undertaken by the earlier group, concerning how to get their robots to come back to planet Earth using quarter turns to change direction.

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UKEN_Class_Bubbles_PractInvest

Teacher Education Design Principle + code:	2. Teacher education should provide teachers with skills and competences to carry out practical investigations of science and mathematics in the classroom. **TE: PractInvest**
Specific Teacher Outcome(s):	2.1 Teachers should be able to instigate and involve children in the design and conduct of practical investigations of science and mathematics in the classroom, as such activities can contribute to the development of children's creativity.
Factors linked with:	**LA.Plan**
Type of material (image – interview (int) – classroom extract (class):	Classroom Observation
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 3
Episode:	Bubbles
Teacher:	Fleur
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Planning an investigation

Using the class water tray children had to investigate and record from which objects bubbles could be blown.

The children were encouraged to experiment with the different objects and identify which ones enabled them to blow bubbles; they recorded on a chart which allowed them to blow bubbles and which didn't. The children were encouraged to select objects to experiment with from around the classroom.

The children were supported during their play by a teaching assistant who encouraged them to think about why certain objects allowed them to blow bubbles and others didn't encouraging them to think about the properties of the objects.

Dot stickers were used to make a simple recording of which objects allowed them to blow bubbles

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Some objects made better bubbles than others

Recording the activity gave it an added 'scientific dimension' and was in a format which was easily accessible for the children.

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Teacher Education Design Principle + code:	12. Teacher education should provide knowledge about early child development, the purposes and aims of science and mathematics education, and their place in the early years curriculum. **TE: EYSciMaths**
Specific Teacher Outcome(s):	12.1 Teachers should have knowledge of the various purposes and aims of science and mathematics education in compulsory schooling. 12.2 Teachers should have knowledge of the prevailing academic rationale for the place of science and mathematics in the early years curriculum.
Factors linked with:	**T:Ped**
Type of material (image – interview (int) – classroom extract (class):	**Teacher interview**
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 4
Episode:	Buttons
Teacher:	Fleur
Age Group:	3-4
Selected episode present in D4.4 Appendix	Yes

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Developing child-agency in creativity curriculum

As part of a topic on changing states of materials children melted chocolate buttons in their hands – the teacher was interviewed afterwards.

R So the activity you did today, and the one you did on Tuesday… where did the idea come from?

F It mainly came from the bubbles which was the initial experiment, and obviously we've had the snow and ice lately so thought it would be recap for them… it was mainly for recording… with the cameras, although that didn't go as well as expected so we didn't do that today. It came from the idea that something changes but it doesn't change its complete form… so they see something change and think it isn't that any more

R I liked the idea of the poem – it gave them a focus away from the melting button, I noticed the button didn't melt in your hand, did the children notice that?

F In the morning they did because a little girl's button didn't melt either, she was quite upset until I said mine hadn't melted either

R Awww, were you pleased with how it went?

F Very, it was something I'd never done before, I'd seen ice used a lot because it's something they can play with, but never thought of chocolate, and they get to eat it

R You said you'd made some amendments for this time

F Yes, I took the cameras away as they didn't really work, the introduction was the same and the activity, but in the planning I added in some of the words they had used, that I hadn't thought of…. And the scene was different… more things hidden in the ice. Oh and the plenary changed, instead of a story we watched the video so they could see changes rather than listen

R So were you assessing?

F Not as such…I made notes from their comments, the first time I videoed it and took photos, there were some focussed observations, their comments for us to look at…but it helped me to plan the next one

R So your planning is very detailed – does it need to be?

F Yes, there is a lot, sometimes I write in shorthand, but one time I wasn't here and it needs to help people who might be covering, they might not know what was in my head

R So what about next steps… they have done this for a week now… is that as long as they can sustain a topic

F Yes, we will bring it back again after something different, but we are going on to the next stage now, rather than change of state change over time. I wanted to start with something quick, now we are doing growth, from a little seed, it takes much longer to see results. We will do some controlled experiments, growing in the dark, without light and so on, then the control one we will eat the cress in a sandwich.

R In terms of from the child, how far is it important that you plan the activities for the child and how far should it be child led?

F I think… it depends on the level of the child, some need more help to be able to discover whereas others become aggravated if you keep butting in, or keep saying try this...you have to get the balance right. I planned the first activity from the child's interest but it was partly what I wanted them to do

R I noticed that if you sit down the children just come to you…is that normal?

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F A few require lots of support so they will follow you, then others get interested, it sparks an interest. At the beginning of the week the children are not that interested the first time, but the second time they come back to it, they get fed up if I keep asking them to come to me so it to is better just to let them come when they are ready

R So what do you think the children learned from this?

F The first time most said it wasn't chocolate anymore but straight away this time they remembered it was still chocolate, they understood just because it looks different it's still the same and that's hard for them to understand. They knew you had to have warmth to make something melt, and I asked the more able how to stop it melting and they knew fridge or freezer, some said go outside and it was very cold so that was a good idea

This activity led on to the children exploring the changing state of ice as part of a free flow activity.

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UKEN_Class_Cafe_LEnvironm

Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.2 Teachers should be able to recognise and build on opportunities for informal learning in science and mathematics within the school environment, for example within day to day routines or child-initiated games and other activities in school classrooms or outdoor play areas.
Factors linked with:	**P: Affect;** **L: Informal;** **L. Out/Indoors;** **M: Inf.**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract with photographs
Originating from:	
Country report :	D 4.3 – report UK England
Case:	Case 1
Episode:	Fruit Cafe
Teacher:	Jenny
Age Group:	4-6
Selected episode present in D4.4 Appendix	Yes

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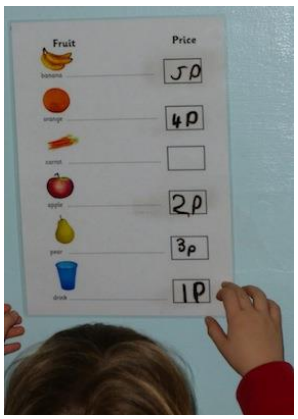
The teacher uses daily fruit time to encourage the children's application of mathematics and develop problem solving.



The Fruit Café was just outside the classroom in a small room, with a sink and small refrigerator and two tables with chairs. There was a menu on the wall with the available fruits, vegetables and drinks and the prices the children had set for that day. There was a large basket of fruit and a tray with cups in different colours and a jug of water. Two children had been selected for the day to run the Fruit Café. One had a list of all the children in the class down the side and columns for each day of the week. The TA sat at the door with pots of money and supported the children coming in, helping them choose what they would have, find the price and then find the right coins. The two children in charge took the money, checked it was the right amount, supplied the fruit and poured the drinks. The boy would ask what colour cup the child wanted before serving.

The children are in charge of setting the prices, checking all children have participated, serving the food and drink, and making change.

The Teaching Assistant supports a customer in finding the right coins.

Teacher interview

"…they are enjoying this fruit café and there's just so many opportunities with it.

I'm just going to plan an adult in there because there's so much, it's really worth doing, even if it means sometimes there's an adult in here on their own. But I'm hoping by the end of the summer term they might be doing it independently. Because you can see some of them have got it."

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE:IBSE**
Specific Teacher Outcome(s):	6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics. 6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.
Factors linked with:	**P: Agency;** **P: Ques;** **P: R and R;** **LA: Ques;** **LA: Plan;** **LA: Obs;** **LA: Equip;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 10
Episode:	Cars and Ramps
Teacher:	Jennie
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Planning of resources and teacher questions to foster inquiry

This episode took place in the outdoor area outside the classroom. Two ramps were set up alongside each other. The ramps consisted of two lengths of white guttering with blue ladder-like supports at each end with rungs, so that the height of each end of the guttering and therefore the slope of the ramp could be varied. Alongside there was a box containing a range of vehicles of various sizes. The activity was left out all afternoon for children to come and go and there was plenty of space and time for children to follow their own ideas and interests. Chioma's planning for the session identified key questions that staff could ask to '*promote sustained shared thinking*' including: '*What is happening to the car? How can it go faster/slower? Which car do you think will go fastest/slowest? What do you think will happen if..?*' Key vocabulary that might be introduced was also identified for example '*fast, faster, fastest, slow, slower, slowest, ramp, high and low*' to support children in articulating their observations , predictions and explanations.

Children make decisions about how to use materials. Teacher questioning fosters observation, comparison and explanation.

Initially Zared and Rosalie were working alongside each other.

Zared: Look *[he puts a new car on the ramp]* – fast really fast.
Chioma: Why do you think that one went fast and Romilly's slow?
Zared: *[Gesturing with his hands]* – Sideways does not go.
Chioma: What happens if you change it?
Zared: It goes fast.

The car sideways on the ramp goes slowly

Rosalie: That one really fast.
Chioma: Look how fast it went – what about other cars?
Rosalie: *[She tried a truck on the steeper slope.]* Went faster on this one.
Chioma: Went faster on the first ramp than on the second ramp?

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Rosalie: Faster on second.
Chioma: Why do you think?
Rosalie: Because really high?

Later on another group of children, Diana, Aiden and Daniel tried out a range of larger vehicles including a fire engine and a bus. These did not travel so smoothly down the ramps - as they wobbled or got stuck. The children tried to solve these problems by varying the height of the ramp and shaking it to make the vehicles move.

For example Aiden tried a bus on the ramp commenting *'it turns over – turned again – it makes a rattling noise'*. Aiden tried it on the lower ramp and it wobbled slowly down. He then repeated again the wobbly bus, several times, down the steeper ramp.

Aiden trying the bus on the ramp

Diana trying the fire engine

Diana tried the fire engine. It went really slowly. She then moved the ramp to horizontal.

Aiden tried his bus on the horizontal guttering and said *'Bus needs pushing'*. He lifted up the guttering to bump the bus along. He then lifted up the guttering to a higher slot and the bus went down by itself.

In another period of exploration that drew in a large group of children, Hilton and Inanna started a race. This part of the episode focused again on the height of the ramps. Hilton had a fire engine with his ramp set to the highest possible slope and Inanna a little green car. Her ramp was on a lower rung. Deanna (a Learning Support Assistant) asked '*Who do you think is going to come first*?' Hilton **predicts** *'my one'*. They noticed the fire engine came down first.

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.4 Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations).
Factors linked with:	**P: Ques;** **P: Express;** **LA: Plan;** **LA: Obs;** **LA: Equip;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract with photographs
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 1
Episode:	Cars
Teacher:	Jenny
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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The teacher builds on the children's interests and own questions to encourage an investigation.

Jenny reminded the children about yesterday when C brought in a car and they had asked questions about it. Some of these questions were '*Does it go on carpet?'* and '*Does it go on fluffy carpet?*' A few of the children had tried this using some materials in the classroom. She showed some thick fur material they used. She asked C to bring the car back so that more children could test it. The challenge is to find the best surface for using the car. Children are given the choice of participating in this or playing in the classroom or outdoor area. Several boys choose to work with the car. *'What about this?'* (chooses a large fleece blanket)

The boys test the car on fleece and fur

The teacher uses questioning to focus the children on the idea of gathering and explaining evidence.

Jenny – Which do you think is best? [between the fleece and the thick fur]

The boy pushed the car on the fleece and marked the landing with his hand then pushed it on the fur and compared. Several boys push the car on the two surfaces. The fleece has been laid out roughly with many bumps, which slow the car down. The boys smoothed out the fleece to remove the bumps, which had been interfering with the car.

Jenny – Does it always go the same distance when you push it on there?

More pushing. The boys are inconsistent about how hard they push it and in what direction so the car goes all over the place.

Jenny – That's funny. It went farther when H pushed it.
More pushing.
Jenny – I still wonder why it went farther when H pushed it. What makes a difference?
More pushing.
One boy suggests – What about paper?
Children went and got lots of pieces of A4 paper and lined them up.

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One boy suggests testing paper as well

K and T test the car on the fleece then K on the fur.

K – It's bumpy.
T – Which do you think is the best?
K – paper
T - fleece
Jenny – K thinks the paper is the best, T thinks fleece is the best. What about you C?
C thinks it is the fur.
Jenny – But how will we know?
K – What should we do if it goes over there and goes far away?

Jenny suggests using the ramp to help determine the best surface.
T tests the car twice but then we talk about whether it's the same distance or not and how would we know.
T works out that they need something that doesn't move to mark where the cars finish. C suggests using Beebots (turned off) as markers.
They try several more times, marking the landing spot with Beebots. Surprisingly none of the car trials crash into the BeeBots.

Jenny – You pushed it that time. You just let it go before. Is it going to go farther if you push it?
T – yes

The boys have now tried a few times on the fleece and a few on the fur. It has travelled farther on the fleece.

Jenny – So is the blanket the best surface?

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UKEN_Class_Classifying_Question

Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**AO: Creative;** **P:Ques;** **P: Scaff;** **P: Agency;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom Extract and Image
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 6
Episode:	Classifying
Teacher:	Wendy
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Encouraging children to share their ideas and clarify them through discussions with others or through research

As part of a topic on animals children were asked to classify animals into two sets according to common properties. Children were given sorting circles to sort model animals into.

The teacher explained to the children examples of sorting reasons from a previous session e.g. hot places / cold places; mammals / other animals; farm animals / zoo animals / pets.

Wendy: I don't mind how you do it. There's lot of different animals so get a handful and sort. You just need a good reason. As long as you have a good reason you can't be wrong. I wouldn't do it by colour. You can get lots of black animals, like a black cat or a black dog or a black horse. It would be a reason but I don't think it would be a **good** reason.

The activity generated much discussion from the children and also encouraged them to ask their own questions and find the answers in order to classify the animals correctly.

Wendy said they needed to check if they put their answers in the right place. She raised the issue that sometimes they didn't know. E.g. whether an animal lived in a hot place or a cold place. They also got into a discussion about hot places versus sea. The children don't know if the sea counted as a hot place and if some sea animals, like whales, are only in hot parts of the sea or if they travel from hot to cold.

Wendy: Let me make a list of the things we need to know and we'll go to the library and find out.
Wendy: So yours are all in the water. Let's check because you're the ones that have to do the checking now. Could you help me to check?
Children: Yes

Wendy pulls out the animals one by one from one pairs' collection and gets the children to say yes or no. Sometimes the children add additional remarks about the animals or the places to justify their decision. William is very knowledgeable about animals and contributes frequently and at length.

She pulls out a tortoise from the water group. William says that one lives on land and (gesturing to a turtle in the pets group) that one lives in the water. He explains that one has a hard shell and hard feet but the other one has flippers.

Wendy – Do you mean that one is a turtle and one is a tortoise?

William tells the other children a lot of information about turtles and tortoises. He agrees with Wendy that turtles can go on both land and water.

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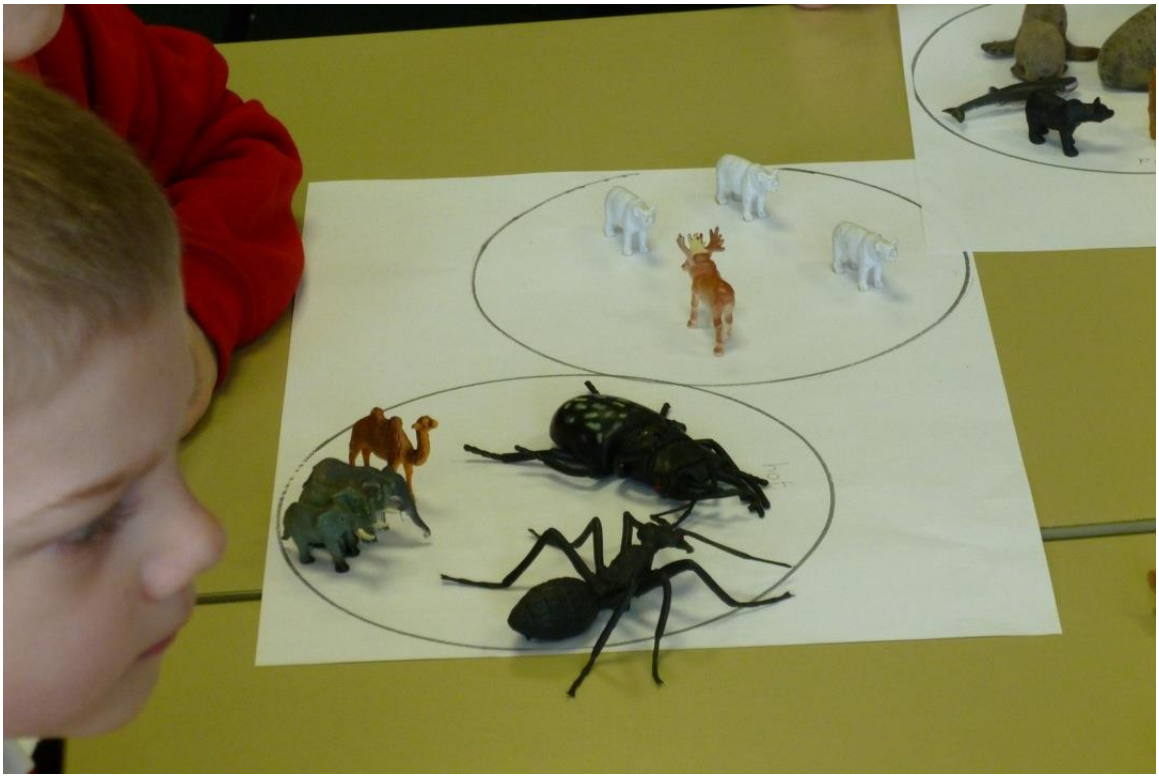
Wendy – We need to find out more information about these. *[She adds turtles and tortoises to her library research list.]*
Wendy - M has polar bears and a reindeer in the cold and some insects, a camel and some elephants in the hot country. M says that elephants and camels both live in hot places but not in the same country.



William explains that camels live in the desert and talks about riding on one.

Wendy also talks about riding on one on holiday and talks about how a camel's feet are adapted for walking on sand by being very broad.

In the pets hoop some children say no to the spider but another says that Z has a spider as a pet. They call over to Z (at another table) who confirms this and other children talk about people they know who own spiders. A similar discussion happens for the rat / mouse.

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UKEN_Class_CountingMinibeasts_PractInvest

Teacher Education Design Principle + code:	2. Teacher education should provide teachers with skills and competences to carry out practical investigations of science and mathematics in the classroom. **TE: PractInvest**
Specific Teacher Outcome(s):	2.1 Teachers should be able to instigate and involve children in the design and conduct of practical investigations of science and mathematics in the classroom, as such activities can contribute to the development of children's creativity. 2.2 Teachers should have a more detailed knowledge about the nature of inquiry and investigations in early years science and mathematics in order to be able to recognise the opportunities they offer both for creative learning and developing children's creativity.
Factors linked with:	**LA: Plan;** **LA: Comm;** **P: Express;** **P: Scaff**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (Class)
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 12
Episode:	Counting Minibeasts
Teacher:	Lisa
Age Group:	4-5
Selected episode present in D4.4 Appendix	Yes

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The lesson from which this extract is taken aimed to provide varied opportunities for children to devise strategies for counting objects and to encourage them to communicate results in their own ways. The selected episode is drawn from a group of three children, namely Aahil, Desiree and Eleesha, who were asked to sort, count and record how many plastic minibeasts there were in a bucket.

Children were given opportunities to design their own methods to count the minibeasts

Aahil was overheard saying to his talking partner that *'When you're lining them up … 'cause you know when you're lining them up, and there's only one … I don't know where to put it'*. Looking back at the photos of his work, it can be seen that he had four rows of five dragonflies and extra dragonflies were placed on both ends of the fifth row, highlighting Aahil's creative thinking in dealing with remainders.

Children were able to use the carpet space as a blank canvas to show their counting methods and to learn from others

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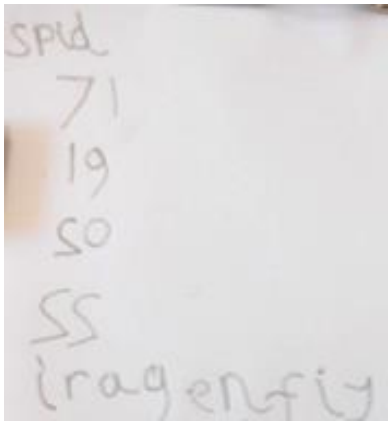
Teacher scaffolding to encourage children to communicate their findings

Through teacher questioning, Aahil was supported in thinking about how to improve the quality of his data recording:

Teacher: Aahil, how do I know which of those numbers are spiders that you counted?
Aahil: 'Cause (sic) we write the numbers.
Teacher: You wrote those numbers? But how do I know those numbers mean spiders, and it doesn't mean the flies.
Aahil: Because if we write flies and spiders then we know it means they fliers and spiders.
(See the left s right image)
Teacher: Fantastic! Fantastic! Thank you!



Another similar example was when the teacher came back to look at Desiree's and Eleesha's work a few minutes later:

Teacher: How many were there?
Pointing at the flies.
Eleesha: 21.
Desiree: I've got another one! 22!
Teacher: So what do you need to do now to remember it's 22?
Eleesha: Write it down.
Drawing a picture of a flies next number 22 (see the above right image).
Teacher: Well done. I think that's a brilliant idea. Desiree, how many of these are there?
Also, pointing at the flies
Desiree: 22.
Drawing a picture of a flies
Teacher: So what do we need to do?
Desiree: Write 22.
Teacher: Well done! I like the way you're doing.

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organise and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity. 17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations. 17.3 Teachers should be able to evaluate and select creativity enabling ICT resources for children to use in their inquiry.
Factors linked with:	**M:ICT;** **M: Variet**
Type of material (image – interview (int) – classroom extract (class):	Classroom Observation
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 5
Episode:	Digiblue
Teacher:	Sally
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Investigating cress seeds

The children had been investigating growth through growing seeds – cress and runner beans. Progress was being monitored through use of a digiblue microscope which was connected to a class computer.

Sally 'What are these?'
'Planting things'
Sally 'Yes we plant them – can you remember what they are called?'
'seeds'
Sally 'Yes, we call them seeds'

Sally brought out a seed which had begun to sprout;

Sally 'What's happened to the seed?'
'it's come out'
Sally 'What's come out of it?'
'Are those seeds the same' *(looking at the other bean seed)*
Sally 'Do they look the same?'
'That one's bigger.'

At this point the teacher had to explain that she had taken the seed out of the soils and it had begun to sprout.

Sally 'What's happening to it?'
'It's starting to grow.'
Sally 'It is – what did we do to help it grow?'
'Put water on it.'

The children then put the bean under the microscope to look at the sprout.
Sally produced some cress seeds that the children had been growing.

Sally 'Can you remember what these are called?'
'flowers'
Sally 'Yes they are like flowers … but it has a special name'
'cress'

Sally showed the children the seeds before they grew to remind them.

Sally 'What did we do with them?'
'gave them sun and water'
Sally 'Yes, what happened to them?'
'grew'
Sally 'Yes, what are these bits at the top?'
'leaves'
Sally 'Good. They are growing'

The children then looked at the seeds under the microscope and were able to talk together about what they could see.

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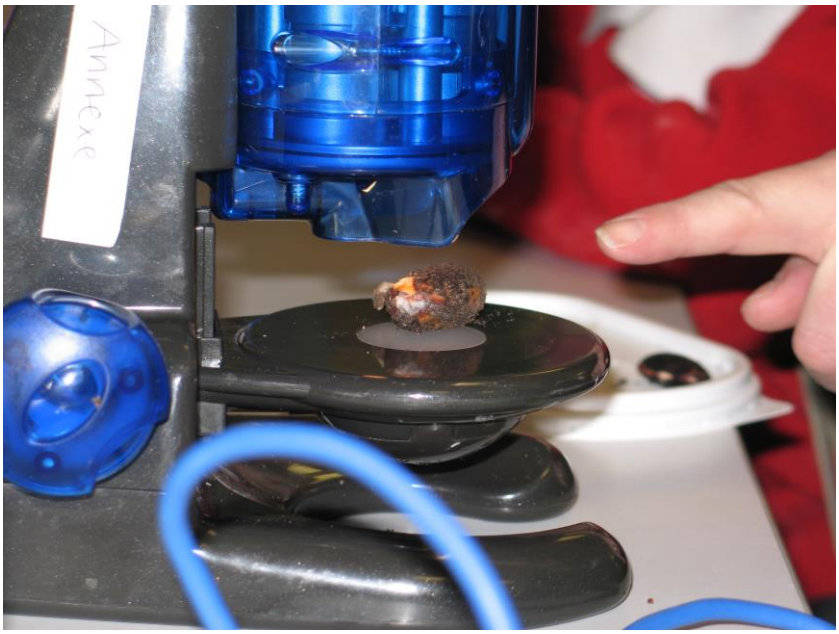
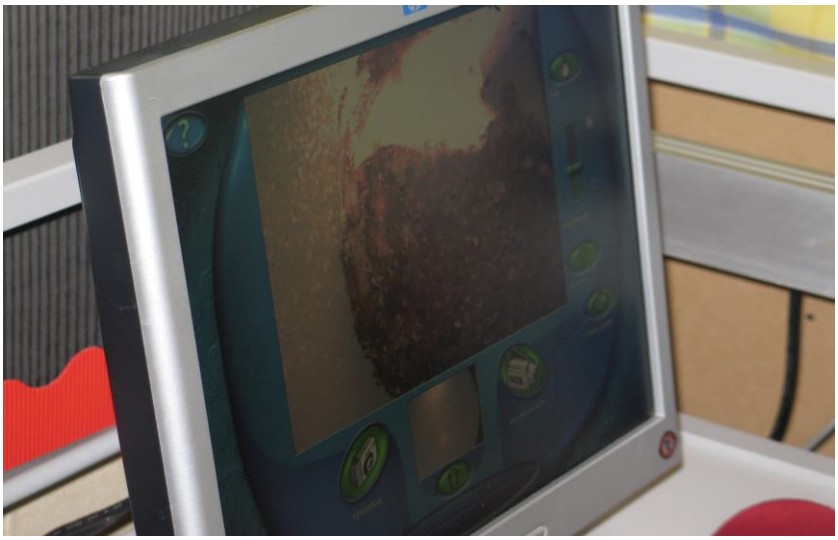
The teacher was able to link ICT with an ongoing class project and being able to view the seeds under a microscope attached to a computer added another dimension to the activity.



A seed under the digiblue microscope



Enlarged image on computer monitor which was printed off and put in children's learning journey books

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.9 Teachers should be able to use different assessment approaches and strategies and in particular those that involve children in the assessment processes, such as peer and self assessment, dialogue and feedback on progress, in the early years science and mathematics classroom.
Factors linked with:	**P: Express;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 13
Episode:	Habitat
Teacher:	Ella
Age Group:	6-7
Selected episode present in D4.4 Appendix	Yes

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This extract illustrates the teacher's use of peer and self assessment to support learning.

The session involved the children exploring how the colour of some animals enables them to be camouflaged in their habitat.

Using questioning to focus on the aims of the session

At the start of the session, Ella showed the children paintings of the American artist Abbott Handerson Theyar (1849-1921) on the interactive whiteboard. Theyar painted animals that were almost completely disguised by their background.

This painting is called *'Copperhead Snake on Dead Leaves'*. Ella used questioning to introduce children to the focus of the session and to encourage children to express their own views for example: *'What animal has he painted? How has he made it look camouflaged? What do you like/dislike?'*

Ella pointed out the colours the artist had used to paint the background. The children were then set the task of producing a picture of an animal camouflaged in its environment. They were asked to chose just three different colours to create the background environment and to make it hard to see the animal in the picture.

Peer assessment using the visualiser

Half way through the lesson the teacher modelled a peer assessment strategy by selecting a child's lizard picture to show to the rest of the class using the visualiser.

She asked the children to identify the three colours used to colour in the background of the animal picture. She asked *'Were these the colours of the animal? Did these colours help hide the animal?'*

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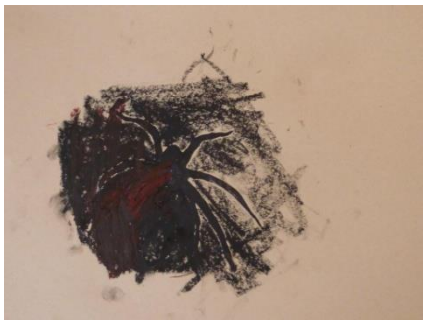
Modelling positive feedback and identifying ways forward



During the lesson Sadik was upset as some children had criticised his picture of a black spider which he had scribbled over with a black pastel. The teacher stopped the lesson and put his picture on the visualiser. She asked the children if they could see the animal on the picture; they replied *'No'*.

She asked them why they could not see the animal and the children agreed it was because the background hid it so well.

She praised Sadik for choosing the right colour but asked him how he could have improved his work. He said that he would not scribble right over the spider next time but just shade in the background.

Final review and evaluation

Towards the end of the lesson the children stopped to view each other's pictures and, using the same questions to evaluate their drawings, assess the work of their peers.

In the discussion at the end of the lesson, the children gave their feedback to the rest of the class, making reference back to the aims of the activity.

Finally children read out a description of an animal's colouring and its habitat. The rest of the class had to suggest what the animal was and justify their answer using vocabulary used in the lesson such as:

Prey Predator Camouflage Survival Habitat

This provided the teacher with opportunities for assessing children's understanding of the role of camouflage in helping some animals to survive.

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UKEN_Class_Ice_CreatInqLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**LA: Plan** **P: Agency**
Type of material (image – interview (int) – classroom extract (class):	Classroom Extract with photograph
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 4
Episode:	Ice
Teacher:	Fleur
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Investigating ice during small world play

Children were investigating the properties of ice during their free play. Materials were set out on the small world table and children had the opportunity to observe the changing state of ice over the course of an hour. Children were able to come and go freely as this was a free flow play activity, however it was noted that many of the children stayed for the duration of the session as the ice was continually changing. The teacher had set up the activity to support a whole class session on changing states of materials she then supported the children's play by remaining at the activity and supporting the children with questions as follows.

Their exploration was supported with questions:

Fleur - 'What does the ice feel like?'
Child 1- 'hard'
Child 2 -'very, very cold'
Child 3 - 'it's slippy'
Fleur - 'Does it feel like the chocolate?'

(This question was used because the activity followed a carpet session whereby children melted chocolate buttons in their hands and discussed the changing state.)

One child suggested putting the pots in the oven.

Fleur - 'What would happen then Declan?'
Declan - 'It would bake like a cake'
Child 1 - 'It would be nice and warm in the oven'
Fleur - 'But would it melt a bit too fast?'
All - 'yessss'

As the ice melted children became more interested in the water.

Child 1 - 'Look Fleur the penguin is paddling'
Fleur - 'Where has the water come from?'
Child 1 - 'The ice'
Fleur - 'Yes the ice has…'
Child 1 -'melted'
Fleur - 'Can we get the ice back?'
Child 1- 'We could put it outside.'
Fleur - 'Yes it might be cold enough… but where would be colder.'
Child 1 -'In the fridge.'

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Look the ice has melted

The scene is set

Squelch

The session ended when the children went out to play, however the materials remained so the children had the opportunity to see the final state of the ice.

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Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out.
Factors linked with:	**L. Out/Indoors;** **M:Explor.;** **M: Cr;** **M: Space;** **M: Outd.;** **M: Inf.**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract with additional photographs
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 1
Episode:	Ice
Teacher:	Jenny
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Flexible use of the indoor and outdoor environment and capitalising on weather conditions to teach science creatively

The class were in and out of the classroom throughout the morning.

9:05 The children had previously made ice sculptures by arranging leaves and twigs and the end of a piece of string into various baking pans with water and then placing them outside to freeze. The adults brought them in and the children pulled on the string to pull the sculptures out of the pans. The children were sitting in a big circle on the floor.

9:10 The class went outside with the ice sculptures to hang them on the bushes in the playground. They chose the locations carefully to display the sculptures.

The children hung the ice sculptures outside on the playground.

9:15 The children returned to the classroom.

JENNY – 'I wonder what they'll be like at playtime?'

The children discussed their ideas with their talking partners.

Jenny *called on several individuals to share their ideas.*
'The wind will turn them around.'
'They will get bigger.'
'They'll get drippy.'

JENNY – 'Why didn't we use them to decorate the classroom?'
'They would melt because it's hot.'

This was followed by a story and a mathematics lesson inside.

11:00 At the end of playtime the children stayed outside a bit longer to look at their ice sculptures. The teacher reminded the children of their predictions. They noticed that many of the sculptures had broken or melted. They compared some which were completely melted with some which were only partially melted and considered why this might be. Size and position were thought to be factors.

11:10 Back in the classroom the teacher explained to the class that she had made some ice balls using a mould another teacher had given her. She gave an ice ball to each pair of children and challenged them to think of a way of preventing melting once out of the freezer.

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These children buried their ice ball in the snow to keep it frozen.

11:20 The class went outside to place their ice balls. Some children needed to be reminded about their suggestions. Others kept changing their minds and moving their balls. The children were quite spread out over the playground. As well as considering shade issues several of the children think about protecting the ice balls from other children during lunchtime so they hid the balls or put them in places that are usually out of bounds.

11:35 Back in classroom exploring ice balloons and then free choice of activities.

12:13 Class went outside to check their ice balls. Some appeared to have melted a bit, one was broken and some appeared unchanged. Teacher challenges the children to think about why.

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UKEN_Class_Ice_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	1.1 Teachers should be able to make children aware of connections between science and mathematics learning and their everyday lives, in order to engage their motivation, interest and enjoyment in science and mathematics and foster curiosity and creativity.
Factors linked with:	**P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract with additional photographs
Originating from:	
Country report :	D4.3 – UK England
Case:	Case 1
Episode:	Ice
Teacher:	Jenny
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Making Connections between science & mathematics and children's everyday lives and understanding.

The focus of the day was freezing and melting. This was not part of the official school topic but was a response to the current weather conditions and the children's interests. The teaching assistant (TA) selected a relevant story, The Ice Bear, to read to the class to help establish the topic and engage the children's interest. As she read the story she interspersed this with questions and comments, helping the children to see the relevance to their lives.

TA: What's the weather like where the polar bear lives? Talk to your partner.
TA: So how is the polar bear made for the cold? What's he got to help him live in the cold land?
Child: Fur
Child: White fur
TA: Why is polar bear fur white?
Child: So he keeps warm.
TA: Is white fur warmer than brown fur?
Child L : No, so it blends with the snow.

TA came to part of the story that talked about camouflage.

TA: That's what you said L.

The story said the temperature could get to -40C.

TA: My car said it was -1C this morning. Imagine how cold -40C would be.

The story referred to the polar bear's weight. TA compared this to a group of the children's fathers standing on the scales together.
The story said polar bears can swim 100 miles.

TA: That's like going to London. Who's been to London?

The story said that the baby polar bear was the size of a guinea pig.

TA: Show me the size of a guinea pig. Children held hands apart at approximate guinea pig size. Show me the size of an adult polar bear.

Children spread hands as wide as they could but recognised that this was still too small.

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How big is a guinea pig?

How big is a polar bear?

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UKEN_Class_MothersDay_GWork

Teacher Education Design Principle + code:	15. Teacher education should promote teachers' use of group work to support children's inquiry processes and creative learning. **TE: GWork**
Specific Teacher Outcome(s):	15.6 Teachers should be able to use effective strategies for sharing ideas and discussions from different groups.
Factors linked with:	**P: Dialog**
Type of material (image – interview (int) – classroom extract (class):	Photographs and classroom extract
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 2
Episode:	Mother's Day
Teacher:	Louise
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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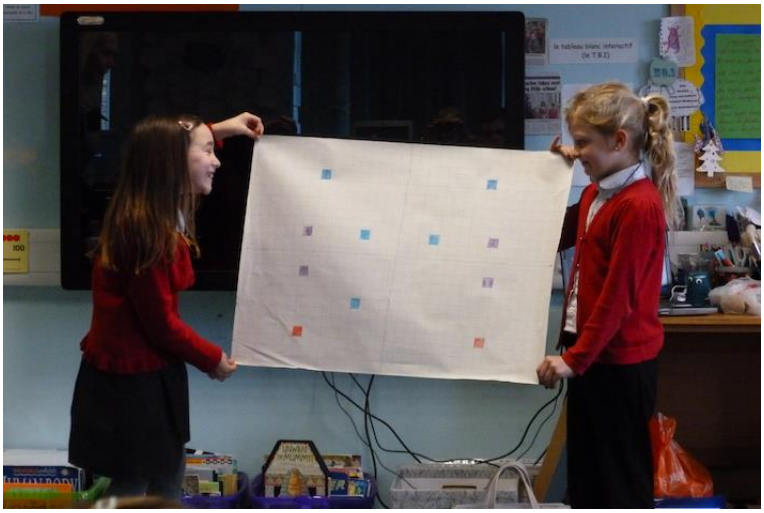
Louise uses plenaries at the end of the lesson for the groups to report back to the rest of the class.

The children were working in groups on different activities for a Mother's Day celebration. The different groups were designing symmetrical placements, creating their own recipes for fruit punch, planning cake baking and ordering a take-away meal. Each group presented their work to the rest of the class, sometimes with questions from the teacher.

Placemat group
Children - We were making placemats.
Louise - How many lines of symmetry were there?
Child - Two
Louise *[to whole class]* - Thumbs up or down - Can you see two lines of symmetry?



The children showed their placements and explained how they had made them.

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Punch group

The two groups had named their punches – Apple and pear with a twist and orange pineapple with another twist.

Child A – We had to measure and cut up the fruit into halves then quarters and eighths even.
Child B - What's the twist?
Child A - That's the surprise!
Louise - Do we have the recipe so we can make it again?

All of the children chose which of the two punches to taste and were asked to guess the twist (lime in one and lemon in the other)

The children enjoyed tasting the punch that one of the groups had made for the Mother's Day party.

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UKEN_Class_MothersDay_NoS

Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE: NoS**
Specific Teacher Outcome(s):	3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**P: RandR**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract, group interview, photographs
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 2
Episode:	Mothers' Day
Teacher:	Louise
Age Group:	7-8
Selected episode present in D4.4 Appendix	No

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The teacher wants the children to think about the problem realistically and not just as a disconnected mathematical problem.

The cake group had to plan enough cake for 20 people for a Mother's Day party. Their questions were:

- What ingredients will we need to buy from the super market?
- How much will we need to buy?
- Is there a way we can find out how much it will cost?

Researcher - Why did you decide three cakes?
Child - Because if there's going to be 20 people we might have two but if they're going to want seconds we might need three.
Researcher – Ah, so if you're having cake do you sometimes like to have seconds?
Child – Yes, I love having seconds.
Child - I always have a bit of both if I love both.

Louise - What's the latest time you could start making the cakes?
Child - We know the preparation time for 1 cake but we're doing 3.
They talked about the variables – e.g. whether it was 3 people making 1 cake each or 1 person making all 3 cakes. Then, whether the one person would make the 3 cakes in turn or in 1 big batch and whether they would all fit in the oven at the same time.

Louise - It depends on how many cakes fit in the oven. In ours we can only fit about one.
Child – I've got a giant oven. It's as big as these two tables.
Louise – That's fantastic! You must do a lot… Your mum doesn't do cooking.
Child – My dad does it. My dad always cooks.
Researcher - We'll bake the cakes at your house then.

The children working on the cakes reported back to the rest of the class.

Child - We were finding the ingredients for a cake. We had to see how many cakes we needed because there were 20 people coming.
Louise - What was the discussion we had at the end there?
Child - How long it would take to make it and bake them.
Louise – Were there any problems with that? What were the things we had to think about?
Child – Whether we would make them all at once or do them one after the other.

Louise - When you got the recipe what was the first thing you had to look for?
Child - The ingredients.
Louise - So it was a bit like a word problem.

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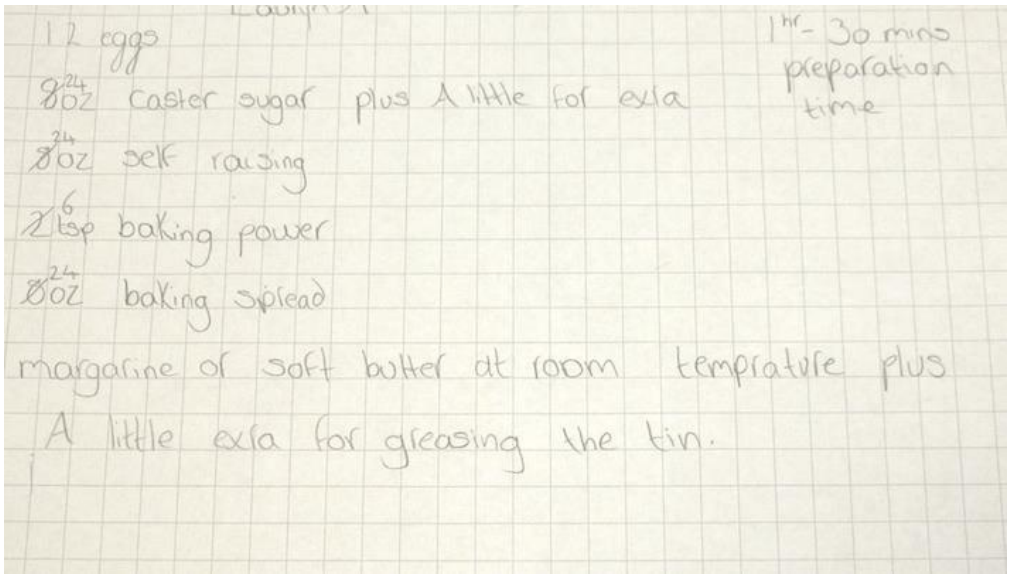

Child's recording of what they need for three cakes.

Child - That's how much eggs and stuff we need.
Researcher - What sort of maths did you have to do when you were thinking about your cake?
Child - We had to double and then…
Child - We had to times it by three. Whatever number we had to times it by three.
Researcher - Was it easy or hard?
Child - It was a bit easy for me but I think L and H found it a bit hard.
Researcher - Did you do the tripling on the grams or the ounces or both?
Child - We did it on the ounces. Mostly.
Researcher - They're easier numbers aren't they? Because three 8s is much easier than three 225s.
Child - 225 would be 600…, 7 maybe… somewhere around seven or eight hundred

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.4 Teacher should be able both to build in new and to make the most of existing opportunities for child-initiated play, recognising and capitalising on the potential of children's explorations beyond the teacher's original intentions. 7.7 Teachers should be able to assume a variety of roles in their interactions with the children e.g. allower, leader, afforder, coordinator, supporter, tutor, motivator and facilitator, to support children's creativity and inquiry in science and mathematics.
Factors linked with:	**P:Play;** **P:Affect;** **P:Collab**
Type of material (image – interview (int) – classroom extract (class):	Classroom Observation
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 3
Episode:	Pulleys
Teacher:	Fleur
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Collaborative work in a play based situation.

A pulley system had been constructed in the outside play area and children were provided with a ball and dual level guttering system for the ball to travel through. They then had to use the pulley system to return the ball to the top of the platform.

The children were able to organise themselves into a team in order for efficient travelling and return of the ball, working out the best position to stand for the most efficient use of the pulley.

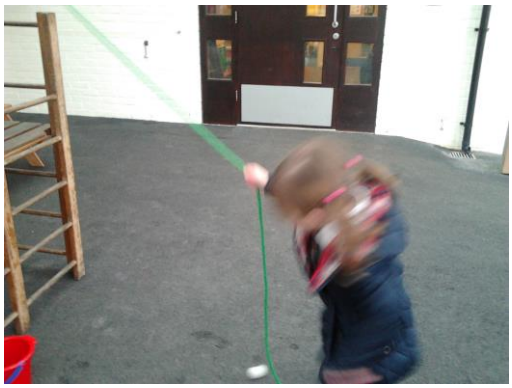
Extract from observation

'The children quickly established a routine of dropping, collecting and hoisting the balls. This was largely child led with minimal adult intervention, where this was evident was in encouragement i.e. 'hoist it up', 'quickly collect those balls', 'whoops, try again'. There was also little interaction between the children as they concentrated on the jobs they had assigned themselves.

The child at the base of the platform who was responsible for hoisting the bucket to the top began experimenting with standing position, standing to the side of the platform, closer and farther away. The teaching assistant began to make reference to this by adding narrative to the investigation:

'it's much harder when you stand closer isn't it'
'goodness you are a long way away – what's going to happen now'
'you can hoist the bucket up faster when you stand at the side can't you'

Team work in Action



Finding the best place to stand

This is a good example of maximising the learning environment and allowing children to explore and discover as part of their free play, scaffolded by adult questioning.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering and extending inquiry and creativity, by for example prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events. 7.4 Teacher should be able both to build in new and to make the most of existing opportunities for child-initiated play, recognising and capitalising on the potential of children's explorations beyond the teacher's original intentions.
Factors linked with:	**P: Play;** **M: Expl** **P: Agency;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Classroom Observation and photographs
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 4
Episode:	Ramps
Teacher:	Fleur
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Child initiated play

During a free play session a small group of children built a ramp on the carpet area of the classroom and sent toy cars down it. What was particularly interesting was a child who placed herself at the base of the ramp and sorted the cars as they arrived at the bottom.

The ramp is built

The ramp builder realised if he changed the angle of the ramp the cars would travel faster, however this became unsteady so was soon removed.

Parking the cars – the little girl decided she was going to organise the cars at the base of the ramp, she realised if she straightened the cars she could fit more in

Stop the car park is full
At this point the girl 'parking the cars' realised there was no space left so created a barrier to stop any more cars being sent down the ramp

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Teacher Education Design Principle + code:	16. Teacher education should provide teachers with knowledge of approaches to timetabling and organizing cross-curricular project work. **TE: CrossCurr**
Specific Teacher Outcome(s):	16.1 Teacher should be able to use approaches to cross-thematic, cross-curricular and project work to promote creativity in science and mathematics. 16.3 Teachers should be able to build connections across the curriculum of various kinds and with potential to contribute to children's inquiry and creativity.
Factors linked with:	**LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Classroom Observation and photograph
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 5
Episode:	Soft Play
Teacher:	Sally
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Using a cross curricular opportunity

The teacher demonstrated how a topic on animals could be linked to a physical development opportunity using the soft play room.

Sally told children they were going to move like animals.

Sally: 'What animal shall we do first?'
'Elephant'
Sally: 'Ooh, how do elephants move?'
'big'
Sally: 'Yes they are big – so they might stomp like this.' *(models a movement)*

Children moved around the area like elephants, returned to the spot and Sally suggested they move like snakes. Children start to move around the floor on their tummies.

Sally: 'Ok slither back to your spots, now what shall we move like?'
'zebra'
Sally: 'What a good idea, how many legs does a zebra have?'
'4'
Sally: 'Yes, how many legs did the snake have?'
'none'
Sally: 'Good so lets move on our 4 legs like a zebra.'

Children moved around like zebras back to their spots

Sally: 'W was a very good zebra, W show us how you moved like a zebra…..children what is W walking on?'
'hands and feet'
Sally: 'Good….now I want to be an animal that jumps… what animals jump?'
'Kangarilla'
Sally: 'Kangaroo…yes, lets all jump like a kangaroo'

Children jump around and back to their spots

This was then consolidated with the use of a story

Sally: 'Now children you need to have your listening ears because I am going to tell you a story about some animals, and when you hear the animal I want you to move around like the animal'

Sally told a story using the animals that the children had been moving like.

She made use of vocabulary to remind children of how the animals moved:
'the snake slithered across the grass'
'the elephant stomped'
'the kangaroo hopped'

At one point the snake stopped for something to eat. One child asked, *'What did he have to eat?'*

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Slithering like a snake

Stomping like an elephant

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The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal** 7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	9.1 Teachers should be able to recognize and value children's various forms of expression and representation of their ideas and learning in science and mathematics. 9.4 Teachers should be able to use the various modes of children's expression and representation of science and mathematics ideas (e.g. pictures, graphs, gestures, physical activities) for assessment purposes. 7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries. 7.9 Teachers should be able to use different assessment approaches and strategies and in particular those that involve children in the assessment processes, such as peer and self assessment, dialogue and feedback on progress, in the early years science and mathematics classroom.
Factors linked with:	**P: Express;** **A: Form;** **A: Evid.**
Type of material (image – interview (int) – classroom extract (class):	Photographs and classroom extract
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 2
Episode:	Sound
Teacher:	Louise
Age Group:	7-9
Selected episode present in D4.4 Appendix	Yes

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The teacher asked the children to self-assess, showing her how confident they were about being able to explain how sound is made.
Those children who were asked to explain to another group.

The teacher had set up tables around the room with different equipment for making and exploring sounds, such as drums, woodwind instruments, straws, rice, tuning forks, bottles, cups and water. The children had to work in groups and use the equipment to explore how sounds were made and how sound travelled. While exploring the children had to find a way to record the way sound was made by drawing a picture. After the children had finished exploring at the first table the teacher asked them to show her their understanding with a thumbs up (for yes) or a hand wiggle (for not sure) in a simple self-assessment.

Louise – Thumbs up if you found a way for showing sound. Wiggle if you're not quite sure. Have you learned something more about sound? Who wants to move on? Show me with thumbs up.
Louise - Let me just check everyone is on something different. How does sound work? What is making it travel? Yes you can see sound or I'm not really sure. Show me.

Children show thumbs up or hand wiggles.

This form of self-assessment was used again after the children had explored a second set of equipment. Those children who showed that they had understood were asked to explain to another group.

In addition to using this simple self-assessment at two points in the lesson, the teacher assessed understanding by observing and questioning the children while they were exploring.

Louise – So some are higher and some are lower. But which is which? Can you find out? Can you put them in order?

These questions helped to scaffold the children's explorations and observing the children's actions helped the teacher to assess the children's understanding.

The children try to order the bottles by pitch in response to the teacher's question.

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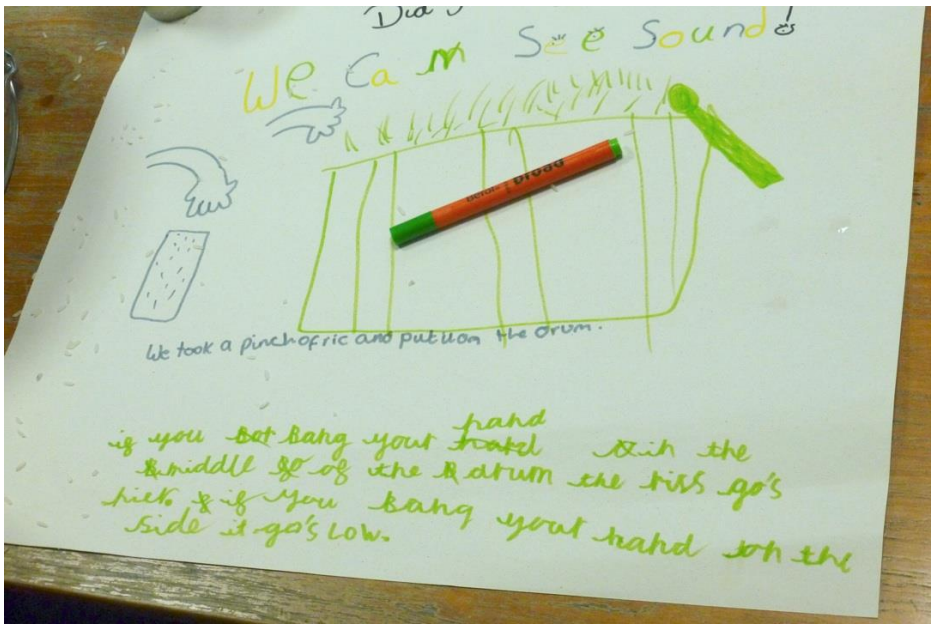
After the lesson the teacher looked through the posters to see the children's explanations for further assessment.

Louise – Lovely explanation. You can really see it.



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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.
Factors linked with:	**P: Agency;** **P: Ques;** **P: R and R;** **LA: Ques;** **LA: Plan;** **LA: Obs;** **LA: Equip;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Photographs and classroom extract
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 2
Episode:	Sound
Teacher:	Louise
Age Group:	7-9
Selected episode present in D4.4 Appendix	Yes

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Encouraging exploration and explanation through resources, group work and recording

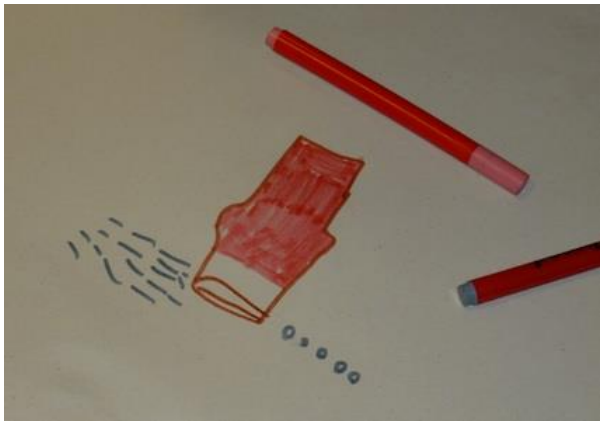
The tables are set up with equipment for exploration: bass drum, snare drum and steel pan, each with a cup of rice; bottles and coloured water in a jug; trays, jugs, water and tuning forks; wind instruments; hollow tubes of different lengths; frog guiro. All tables have large paper and felt tip marker pens. The children had about 30 minutes to explore the resources on two tables and then had to find a way to represent on paper how sound is made.

Louise - The adults are there to help but only if asked. You have to decide how the things on the table will show you how *[sound travels].*

Some of the children used the resources as the teacher expected, such as putting rice on the drums, but others used them in unexpected ways, such as using the rice cups as maracas.

Joseph and Maisie added different amounts of water to the bottles and discussed the impact when they clinked them together.

Maisie- When the bottles have water and you ban them together they bounce off each other but when they don't they just clang.
Joseph- It makes it darker. Thought it would be lighter.
Maisie- That one's gone really high pitched.



The children explored making sounds using the resources and then recorded how the sound was made.

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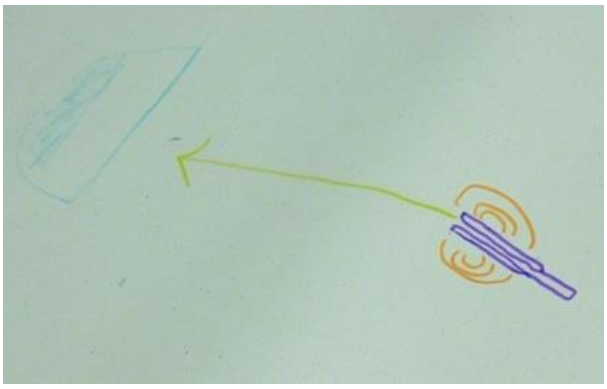
Two children demonstrated blowing with bottles and different amounts of water. George explained the difference in the pitch.

George- Because there was more air for the sound to go in and get back out and less for Marek because the water was taking up the space.

He then related this to a flute.
George- If you cover the holes the air has to travel farther to get out

Child- I just noticed when you whistle you make a column of air.



Child 1- I can make it jump really high.
Child 2- It's the vibrations.

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Specific Teacher Outcome(s):	7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries. 7.9 Teachers should be able to use different assessment approaches and strategies and in particular those that involve children in the assessment processes, such as peer and self assessment, dialogue and feedback on progress, in the early years science and mathematics classroom. 9.1 Teachers should be able to recognize and value children's various forms of expression and representation of their ideas and learning in science and mathematics. 9.4 Teachers should be able to use the various modes of children's expression and representation of science and mathematics ideas (e.g. pictures, graphs, gestures, physical activities) for assessment purposes.
Factors linked with:	**P: Express;** **A: Form;** **A: Evid.**
Type of material (image – interview (int) – classroom extract (class):	Photographs and classroom extract
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 2
Episode:	Sound
Teacher:	Louise
Age Group:	7-9
Selected episode present in D4.4 Appendix	Yes

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The teacher asked the children to self-assess, showing her how confident they were about being able to explain how sound is made.
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Children show thumbs up or hand wiggles.

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In addition to using this simple self-assessment at two points in the lesson, the teacher assessed understanding by observing and questioning the children while they were exploring.

Louise – So some are higher and some are lower. But which is which? Can you find out? Can you put them in order?

These questions helped to scaffold the children's explorations and observing the children's actions helped the teacher to assess the children's understanding.

The children try to order the bottles by pitch in response to the teacher's question.

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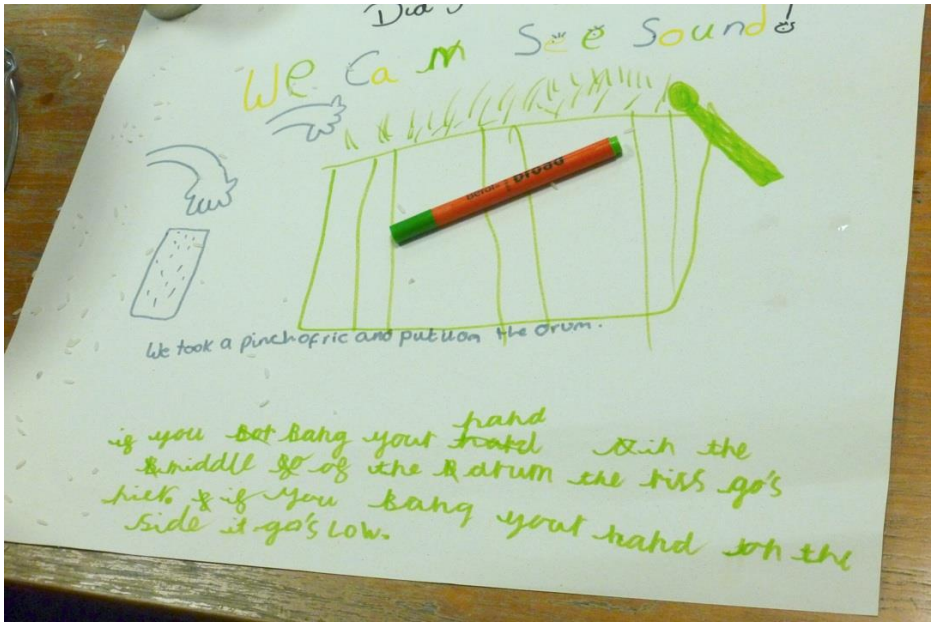

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Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics.
Factors linked with:	**LA: Ques;** **LA: Connect;** **P:Ques;** **P: Express**
Type of material (image – interview (int) – classroom extract (class):	Photographs and classroom extract
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 6
Episode:	Starting Point
Teacher:	Wendy
Age Group:	6-7
Selected episode present in D4.4 Appendix	Yes

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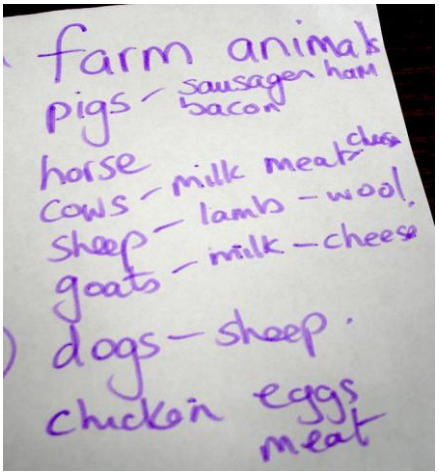
Eliciting existing knowledge and children's own questions

Wendy (interview): Well, we have an idea of what we will be including in our planning because this is part of a two year cycle, so we have experience, but we try and go from what the children are interested in…. there's no point teaching them what they know already.

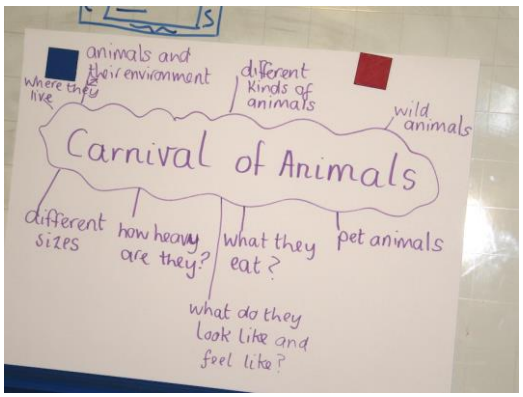
Wendy: We are starting a new topic today, perhaps you can guess what it is… Who has looked at the new role play area?

Child: It's a pet shop.

Children: animals
Wendy: Yes, our topic is called 'a carnival of animals'. What do you think that means?
Child: Lots of animals
Teacher: Yes, what do we know about animals?
Child: carnivore
Child: herbivore
Teacher: Well done, you remembered that from last time, anything else?



Teacher: What could we find out about animals?
Children: Where they live. What they eat.
Child: Antarctica is the only place you don't get frogs.
Teacher: Is that right?… I didn't know that, perhaps this is something we could find out children. Remember I don't know everything. Sometimes we have to write questions to find out later – Let's write the questions down.
Teacher: Where do we find this information?
Child: From home. Ask mum.
Teacher: Yes… good idea. Anywhere else children?
Children: Books, internet.



The teacher creates a topic web based on the children's questions

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Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.1 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development. 9.3 Teachers should be able to select and use different approaches for and forms of recording children's ideas and learning in science and mathematics at different stages of the learning process and for various purposes, including to support children's reflection and reasoning processes.
Factors linked with:	**P: Express;** **P: R and R**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 10
Episode:	Volcano
Teacher:	Jennie
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Using questioning to elicit children's ideas at each stage in the activity

This session focused on an experiment called *Volcano* in which warm water, red food dye, baking soda and vinegar were mixed together in a large plastic water bottle. Materials for the session were prepared in advance with the additional equipment of measuring spoons and a funnel to aid to aid the mixing processes and a large washing up bowl in which to stand the water bottle and catch the eruptions from the 'volcano'. For safety reasons the activity was a teacher demonstration carried out with a group of children sitting round a table. As the different ingredients were added together the teacher, Karin used questioning to elicit children's ideas at each stage in the activity, sharing her own excitement and lack of certainty about what might happen.

For example at the start of the activity children offered predictions:

Nash: It might go everywhere.
Zena: Will explode – go all round.
Karin: Do you think it will go in our face?
Zena: In the bowl.
Calvin: Think it will go in sky – there is going to be a hole in the roof.
Mabel: Might melt.

Adding baking soda to the mixture

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Adding vinegar

Watching the bubbles

As the vinegar was added children were very excited. There was much laughing, screaming and commentary, for example:

Zena: It's going up and falling down.
Nash: Everything is making it erupt from the bottle into the container.
Karin: Cloe can you explain it?
Cloe : Makes the fresh air come out.

Drawing as a context for dialogue and reflection

At the end of the activity both Karin and the children together made drawings to record what they had seen. This allowed further opportunity for dialogue and reflection.

Drawing the volcano

Nash's drawing

Karin: Zena what do you like about this?
Zena: Red at the bottom and pink at the top – bubbles at the top get pink.
Karin: Charity, what do you notice?
Charity: I liked the bubbles coming up.
Karin: Pearl, what did you like?
Pearl: Bubbles.

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Karin: What about the bubbles?
Pearl: White now – look a bit soapy.
Nash: Like it when the bubbles explodes.

Discussion fostered growing interest and attention in both staff and children.

Children and staff observing the volcano

Conversations with children about their drawings after the session underlined their excitement and gave insights into their observations. For example Nash said:

'All came out of the top and flowed right down - because put baking powder and the vinegar and all poured out the top – and the teacher put food colouring and it came into the container in the bottom – so it went into the container to make it come out very lots of bubbles. And it erupted - that's what happened'.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.6 Teachers should be able to use strategies for making and building on science and mathematics real life connections and applications for engaging creatively young children in science and mathematics learning.
Factors linked with:	**P: Affect;** **M: Cr.**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (Class)
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 11
Episode:	Waterproof materials
Teacher:	Emily
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Setting a motivating context for investigation
Making links with everyday life experiences

The session on *Waterproof Materials* was part of a half term science-based project on materials. The context for the session was the need to select the best material to make an umbrella. Emily began the lesson by talking about the class puppet MAX who needed a new umbrella because he had left his on the bus. Emily then explained that MAX wanted to see them as real scientists who can record. She showed the sheet for recording and emphasised the task was collaborative. They needed to work out how to carry out their investigations, share tasks between them and agree on the findings in order to give advice to MAX.

Reflecting on findings and their applications
Making real life connections

In reviewing their investigations Emily asked the children to share their conclusions about which materials would not make a good umbrella and to explain their ideas drawing on their observations.
Emily: Can you tell me what the puppet should NOT use?
James: Blue fabric?
Emily: What was the matter?
James: The water went through.
Charlie: Foil - no. *(Some of the children agree).*
Chloe: Don't use newspaper.
Emily: Why?
Chloe: Holes?
Emily then commented that you see a newspaper on people's heads when it's raining if they don't have an umbrella and asked *'Why does this work?'*
Dan: Because if you have so many bits it is very strong and water doesn't go through it. It would work for part of the day but then would soak through if it was used all day.
Emily: What else would we not use?
Sophia: MAX should use plastic.
Several children agreed. The children continued to discuss what might make the best material for an umbrella, suggesting ideas about other properties that might be important.
Billy: Sugar paper - it went through.
Emily: So we've got some saying yes to plastic.
Emily: Why?
Clara: What's good is it runs off and it doesn't stay on it. Plastic is good.
Emily: What 's good about foil?
Leo: You can't see where you are going. You might crash into people.
Jodie: But foil is sparkly and will make a sparkly umbrella.
Grace: But plastic is better as an umbrella because you can put it down rather than foil. Foil gets all scrunched up.
Emily: Fantastic thinking that makes lots of sense. Which is stronger?
Benjy: Plastic when you pull it will stretch.
Emily: MAX will read all the scientific reports and see what you found out. The more you tell me the more help he will get.

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UKEN_Img_CaseJennie_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.10 Teachers should value and be able to make use of varied forms of assessment evidence (including children's portfolios, individual or group records of activities), both to promote creative learning, through reflection and discussion in science and mathematics, and explicitly to inform teaching and longer term planning.
Factors linked with:	**A: Evid.;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Images
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 10
Episode:	No episode – general photographs of children's portfolios
Teacher:	Jennie
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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There are regular times each week for children to update and share their portfolios

Each week pairs of staff, a teacher and a nursery nurse are allocated responsibility for a particular area in the nursery (indoors or outdoors). They undertake detailed planning for provision including a mixture of adult led and free flow child directed activities.

Children's experiences are recorded using photographs stored in children's profiles. Children are invited on a regular basis to update their profiles and to reflect on what they have learnt.

Activities are reviewed in a team meeting each week. Pairs of staff report on the success of their planned activities in each area and on the responses and progress of individual children. This information is used to discuss the development of plans for the coming week and ways to meet the needs of particular individuals.

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UKEN_Img_CaseJennie_Resources

Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE:Resources**
Specific Teacher Outcome(s):	17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations. 17.4 Teachers should be able to evaluate provision for free flow play in their school settings. 17.5 Teachers should be able to develop and extend their own classroom resources to foster creativity in the early years science and mathematics classroom. 17.6 Teachers should be able to gain insights into children's developing explorations and creativity based on their use of resources.
Factors linked with:	**M: Expl;** **M: Cr.;** **P: Agency;** **P:Play;** **P: Express;** **A: Evid**
Type of material (image – interview (int) – classroom extract (class):	Images
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 10
Episode:	No episode – general photographs of provision
Teacher:	Jennie
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Photographs of general provision in the nursery

The nursery is divided into three indoor areas and one outdoor area. Each week pairs of staff, a teacher and a nursery nurse are allocated responsibility for a particular area (inside or out). They undertake detailed planning for provision across the curriculum including a mixture of adult led and free flow child-directed activities. Children are free to move between areas and activities. Examples of free flow activities are shown below.

Activities are reviewed at a team meeting each week. Pairs of staff report on the success of their planned activities in each area and the responses and progress of individual children. This information is used to discuss the development of plans for the coming week and to meet the needs of particular individuals. Children's experiences are recorded using photographs stored in children's profiles. Children are invited on a regular basis to update their profiles and to reflect on what they have learnt.

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UKEN_Img_CattBoots_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.1 Teachers should be able to recognize and value children's various forms of expression and representation of their ideas and learning in science and mathematics.
Factors linked with:	**P:Express;** **A:Form**
Type of material (image – interview (int) – classroom extract (class):	Images
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 7
Episode:	Caterpillar Boots
Teacher:	Caroline
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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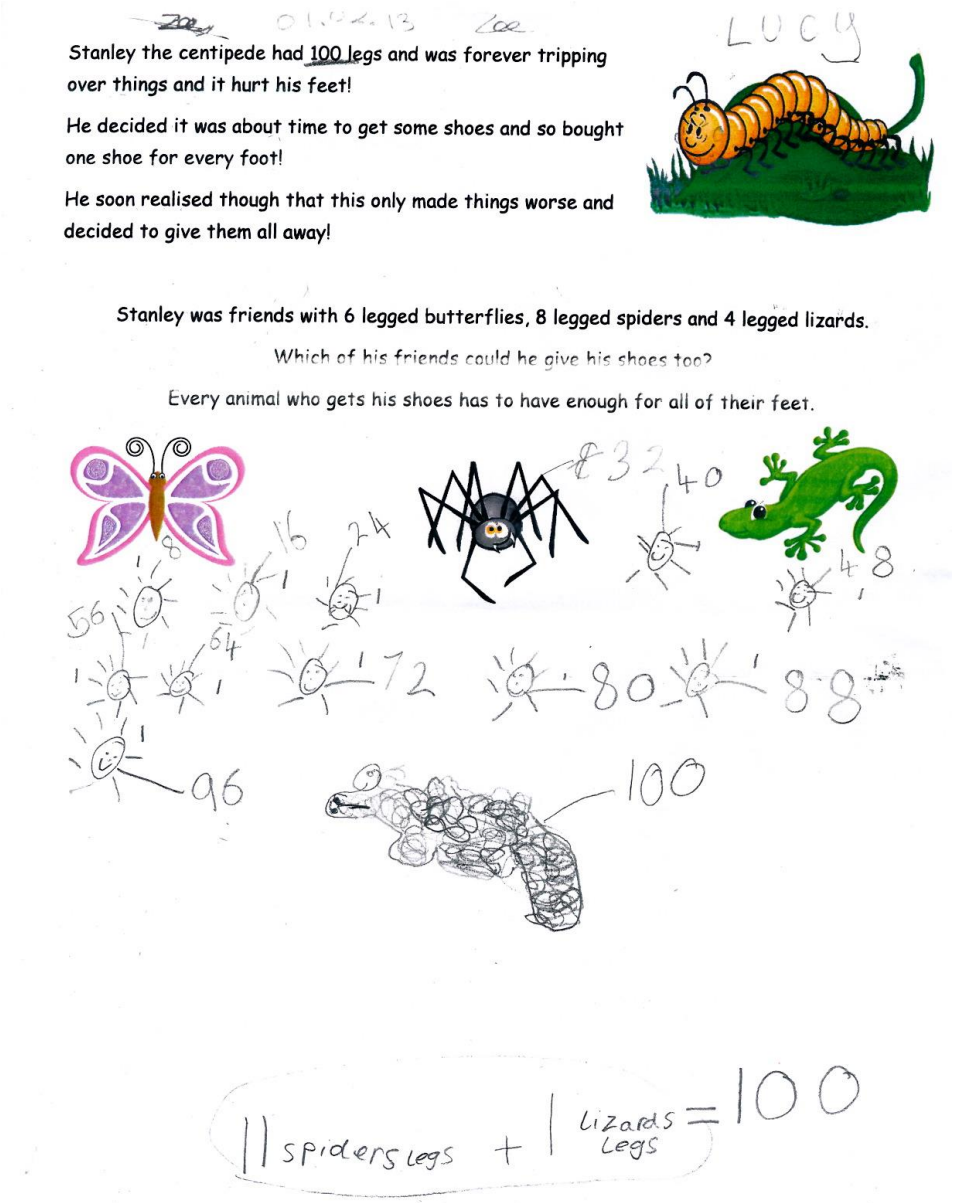
Children's different forms of expressions of solutions to the same mathematics activity

Below are five 'answer sheets' from children in 'Caroline's class to the same problem solving activity. As can be seen, all approach the task in different ways. Caroline welcomed each of these and discussed their various merits with both the individuals and the class.



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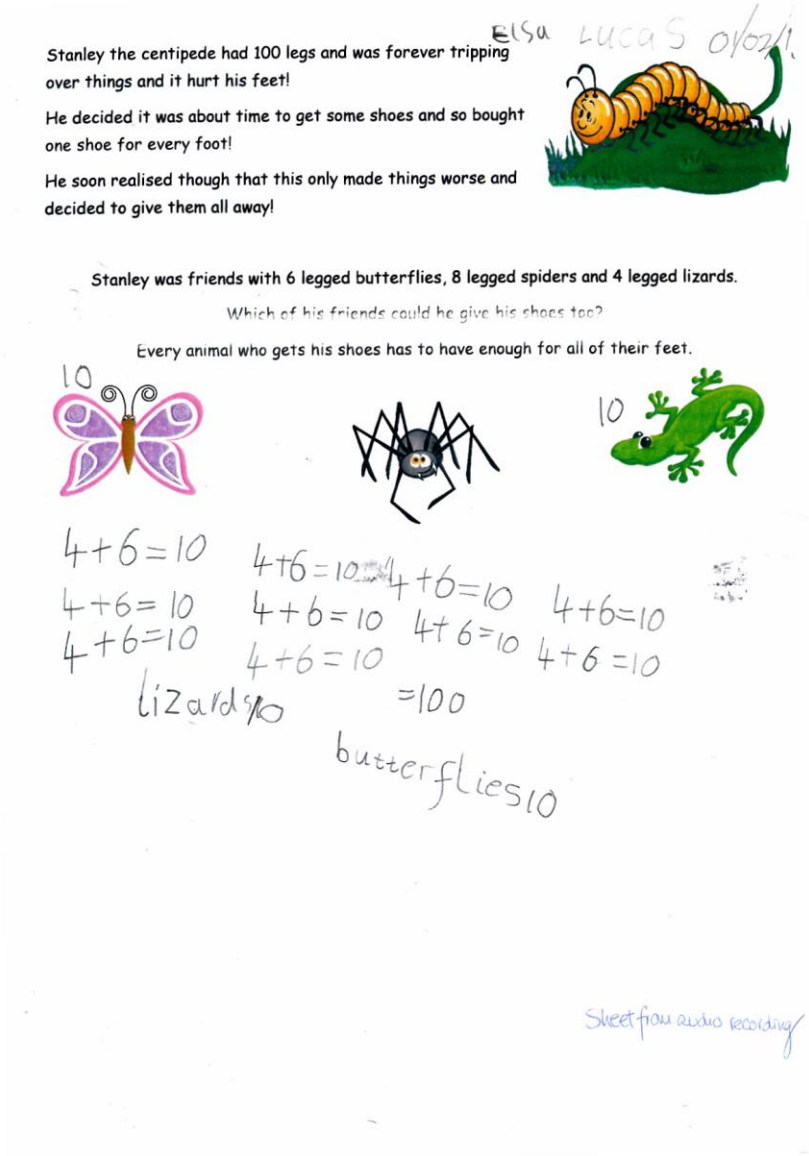


Elsa Lucas 01/02/1

Stanley the centipede had 100 legs and was forever tripping over things and it hurt his feet!

He decided it was about time to get some shoes and so bought one shoe for every foot!

He soon realised though that this only made things worse and decided to give them all away!

Stanley was friends with 6 legged butterflies, 8 legged spiders and 4 legged lizards.

Which of his friends could he give his shoes too?

Every animal who gets his shoes has to have enough for all of their feet.

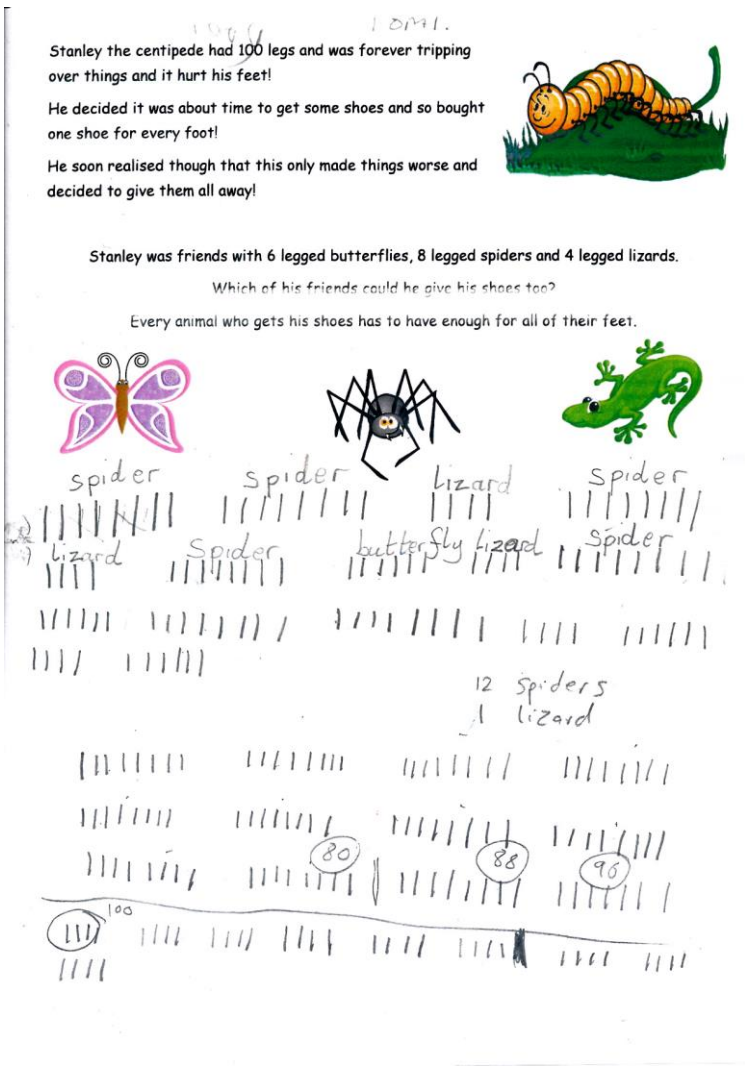
10 10

4+6=10 4+6=10 4+6=10 4+6=10
4+6=10 4+6=10 4+6=10 4+6=10
4+6=10 4+6=10 4+6=10

lizards 10 =100

butterflies 10

Sheet from audio recording



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Which of his friends could he give his shoes too?

Every animal who gets his shoes has to have enough for all of their feet.

spider spider lizard spider

lizard spider butterfly lizard spider

12 spiders
1 lizard

80 88 96 100

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Sophie 01.02.13 Lauren

Stanley the centipede had 100 legs and was forever tripping over things and it hurt his feet!

He decided it was about time to get some shoes and so bought one shoe for every foot!

He soon realised though that this only made things worse and decided to give them all away!

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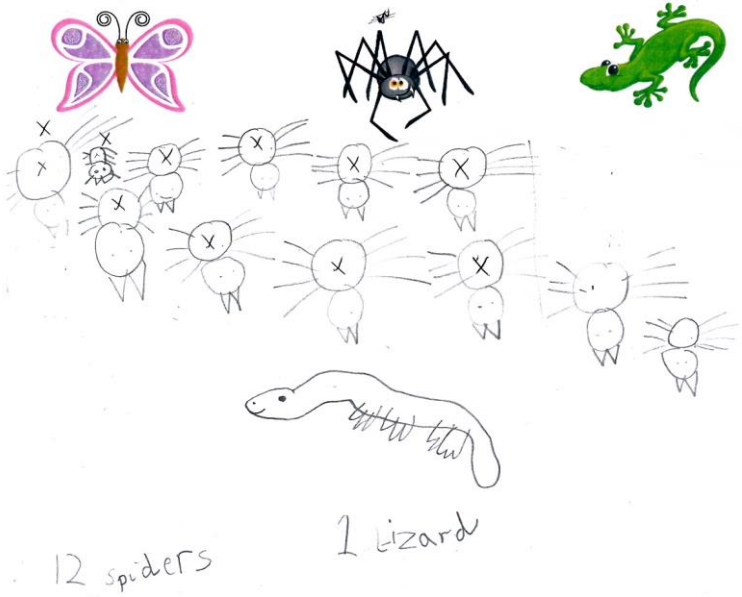

Joe Caitlin W 01/02/1

Stanley the centipede had 100 legs and was forever tripping over things and it hurt his feet!

He decided it was about time to get some shoes and so bought one shoe for every foot!

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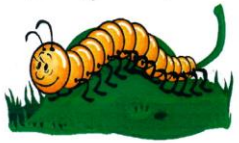

Stanley was friends with 6 legged butterflies, 8 legged spiders and 4 legged lizards.

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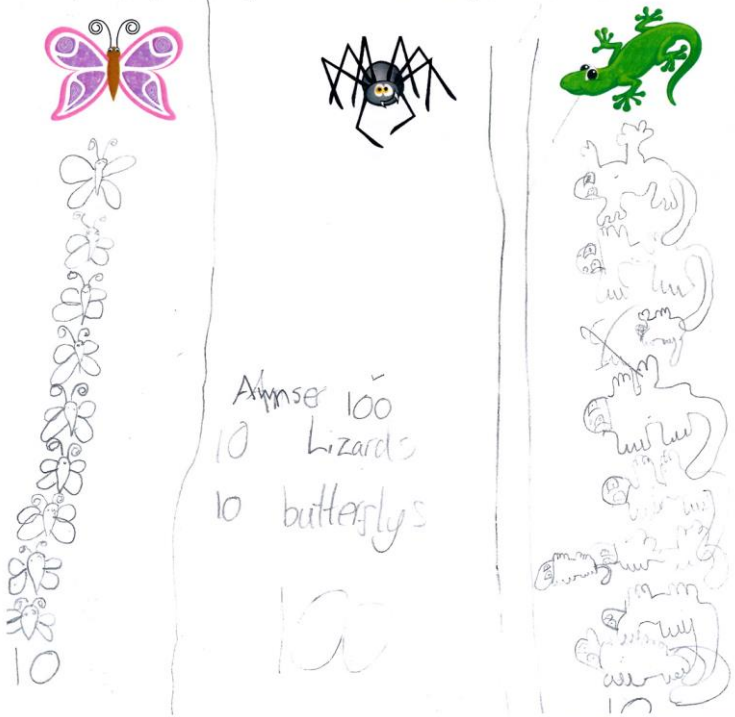

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UKEN_Img_Syrup_IBSE

Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.2 Teachers should be able to open up everyday learning activities to allow greater opportunities for inquiry, problem solving and scope for creativity. 6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics. 6.4 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes
Factors linked with:	**AO:IBSE/PBL** **AO:Creative**
Type of material (image – interview (int) – classroom extract (class):	Image, FNotes
Originating from:	
Country report :	D4.3 – report UK England
Case:	Case 9
Episode:	Syrup
Teacher:	Anita
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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A practitioner-led activity as the start of children's inquiry activity

This activity was, initially, practitioner-led, with the lead practitioner, Anita, modelling what the children would do and demonstrating the outcomes of adding water, vegetable oil and golden syrup into a glass jar. The learning objective centred very much on developing descriptive language such as 'floating' and 'sinking'. Each of the children had their own glass jars and undertook the activities themselves.

Children following the instructions and model of the practitioner, Anita

During this activity, one child, Juliet, began to ask her own questions, such as what might happen if the liquids were stirred. As a result, the enquiry took on a new and unplanned dimension initiated by a child. This provided Anita an opportunity to allow the children to follow a new, unplanned direction of inquiry, from which the learning objectives could be further reinforced.

Juliet extending the activity, stirring and mixing the liquids in the glass jar.

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UKEN_Int_Doubling_NoS

Teacher Education Design Principle + code:	3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists. **TE:NoS**
Specific Teacher Outcome(s):	3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity. 3.3 Teachers should be able to use foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.
Factors linked with:	**LA: Expl;** **P: R and R;** **AO: Kn.Sc;** **AO: Sc ProcSkills**
Type of material (image – interview (int) – classroom extract (class):	**Interview (int)**
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 11
Episode:	Doubling
Teacher:	Emily
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Context for the interview

This material is based an interview with children following a *Snakes and Ladders* game.

The teacher had planned a series of activities focused on doubling to be carried out in mixed ability groups in rotation across the week. The tasks were set up to foster problem solving in mathematics. The children worked in pairs. The activities were as follows:

1. Snakes and Ladders game- This was a Snakes and Ladders game using doubles. The children had to roll the dice, then depending on the number the dice landed on, they doubled the number and moved that up the board.

2. Doubling larger numbers - There were number cards in a box and the children had to take out number cards at random and double them, using unifix if needed.

3. Finger painting- Children picked a card and printed a few dots on one side of a piece of paper that was then folded to make a butterfly with symmetrical dots on the wings. They were asked to write the number sentence representing the total number of dots for example 4 + 4=8.

4. Number towers - Children picked a number card (for example 10). They then must build two towers of unfix made of the number on the card (for example 10 + 10) and write the double number sentence on paper.

Reflection on practical activities focusing on doubling Considering alternative ideas

Following the taught session the researcher had a discussion with a small group of children about their learning during the Snakes and Ladders game. These children had been observed during the session. Although it was not clear at the time they were observed what learning was taking place, afterwards they were able to use their learning effectively to reflect on strategies with double numbers.

Researcher: Did you learn anything when you were playing the Snakes and Ladders game?
Chloe: I learnt Doubles. Doubles in the Snakes and Ladders.
Researcher: Doubles you didn't know?
Chloe: Yes
Researcher: What was the biggest double that you could have when playing?
Charlie: Biggest was 3+3.
Researcher: Was it? Was there no larger number than 3?
Freddie: It did have 6.
Ben: No it didn't no 6?
Children: It had 2 3's, 2 2's and 2 1's. 1 2 3.
Researcher: What if there had been a 6? How far could you have moved then?
Alec: 12 steps.
Audrey: I think I know why it's up to 3, so it's not too easy.
Ben: That is easy, it should challenge you.
Audrey: If it was 6 or 10 it would get finished straight away.
Ben: If it was little numbers it would be so easy.
Audrey: You just got there but if you had 20 you move 20 steps. You had 20 steps without moving you'd be at the finish.

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Teacher Education Design Principle + code:	16. Teacher education should provide teachers with knowledge of approaches to timetabling and organizing cross-curricular project work. **TE: CrossCurr**
Specific Teacher Outcome(s):	16.1 Teacher should be able to use approaches to cross-thematic, cross-curricular and project work to promote creativity in science and mathematics. 16.3 Teachers should be able to build connections across the curriculum of various kinds and with potential to contribute to children's inquiry and creativity.
Factors linked with:	**P: Affect;** **M: Cr.**
Type of material (image – interview (int) – classroom extract (class):	Interview
Originating from:	
Country report :	D4.3 UK (England)
Case:	Case 13
Episode:	Egg Carrier
Teacher:	Ella
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Using a cross-curricular project to promote inquiry and creativity

The unit the class was working on was 'From A to B, Travel and Transport'. As part of this unit the children had travelled around London to see as many different modes of transport as possible: overground train, DLR train, underground train, cable car, boat, bus, airplane and helicopters. They had made a display of their travels in the classroom as shown below.

The Transport Project display

The content of this episode focuses on an activity where the children had to design and make an egg carrier to transport a fresh egg safely when dropped from a height. The children were expected to draw on their observations of modern modes of transport as well as studying the structure of the Wright brothers' first airplane and so make connections with their prior learning. The teacher did not rely on the school's scheme for this activity. She had adapted it for the adults to step back to enable the children to learn by trial and error.

Ella: 'I think it's nice to say 'Right, here are your resources, go and experiment' and allow them to use their creativity and their knowledge, previous learning to, sort of, come up with what they want. ... if they have got a solid foundation from previous lessons, we've had a whole topic around it *[transport]*, I think they had the knowledge there to be able to go and use their creativity and imagination to create fantastic egg carriers, and it worked.'

The resources set out on the tables provided a rich source of materials for the children to choose from: cardboard boxes (various sizes), plastic bottles (various sizes), straws, string, balloons, various fabrics, plastic shopping bags, rulers, scissors, sticky tape and glue. The children worked individually and could also make connections with a previous topic on Materials as they knew the properties of some of the materials.

Resources for the Egg Carrier

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Reflecting on findings and their applications
Making real life connections

Jameel designed an egg carrier with a hole stuffed with tissue paper, when asked by the researcher what the tissue paper was for he replied: *So we don't break it.* He joined two plastic straws together with some masking tape, as shown in the photograph below, to make wings. Jameel planned the design of his structure using prior learning:

Researcher: How did you know to use straws to make wings?
Jameel: In Brown class *[Year 1 last year]* we did an experiment to see which material was best.

Jameel's Winged Egg Carrier

Ella noted how Jameel's design seemed to have based his carrier on the Wright brothers' aeroplane and indeed the structure of the wings was similar to a photograph of the airplane on the classroom display.

Ella *described how Jameel:*

> '... was very creative He very quickly realised he had to cut a hole out of his coke bottle for the egg. He knew he wanted to do an aeroplane so very cleverly; he came up with his own way of making the wings. [...] I think that shows real creativity. He didn't cut out a piece of cardboard like most of the children did. He thought about the structure of the aeroplane. We'd looked a lot about the Wright Brothers with their first aeroplane and you can see he has almost copied their ideas of the wings.'

Ella had planned for the children to draw on previous experiences and make connections with the transport topic and Jameel's design is clearly linked.

Another child designed a structure based on a hot balloon.

Researcher: So when you were choosing your materials to make your carrier, what made you choose particular things?
Tolga: My brain
Researcher: What did your brain tell you to do?
Tolga: It told us to get a balloon and tie it on to a bottle.
Heri: *[inaudible]*

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Researcher: Why did you choose a balloon?
Tolga: I was trying to make a hot air balloon.
Researcher: So when your brain was telling you to choose the balloon, why was your brain telling you that a balloon would help stop the egg crack?
Tolga: Like it would make it slow until the egg. The air would go by the side of the balloon.
Researcher: What happened to your egg?
Tolga: It didn't break.

Tolga's Hot Air Balloon design

In discussion with the researcher, the children also highlighted the motivating context by the need to protect the egg and the opportunity to do something new and for themselves.

Researcher: So how did you sort out your choices by yourself? Did you talk to other children? Or other adults?
Tolga: I just used ... My only partner was my head and my brain.
Heri: I just did the same thing as that.
Int: Would you say this lesson was using your creativity?
Tolga & Heri: Yes.
Researcher: What does creativity mean to you?
Tolga: Creativity means like .. that .. that you are creating something...
Heri: ... that you've never created before.
Tolga: Exactly.
Researcher: So what was new to you in this lesson?
Tolga: The new thing about it was how the eggs don't break. I'd never done an invention like this
Researcher: You've never done a lesson like that? What was different about this lesson?
Heri: The eggs.
Tolga: Exactly, there was eggs involved and messy stuff.

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UKEN_Int_Ice_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	1.1 Teachers should be able to pursue the social and affective objectives of children's science and mathematics learning, in synergy with the corresponding cognitive ones.
Factors linked with:	**AO: Affect;** **AO: Social**
Type of material (image – interview (int) – classroom extract (class):	Interview, classroom extract, photographs
Originating from:	
Country report :	D4.3 - UK England
Case:	Case 1
Episode:	Ice
Teacher:	Jenny
Age Group:	4-6
Selected episode present in D4.4 Appendix	No

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Encouraging children to work together and talk together

In the interview Jenny emphasised that she actively encouraged the children to work together as a learning strategy.

Jenny: And this week because we've just changed partners they're having a week where they're sticking with their partners and on Monday the supply teacher did lots of circle time games with just a bit of maths thrown in to work on bonding them as pairs. Because that will pay off in the weeks ahead. And so this week we've just stuck with pair things.
Researcher: You use talking partners a lot.
Jenny: Yes. I'm really trying to get away from hands-up. They just come in putting their hands-up don't they. And it's very hard. You just find yourself responding to it anyway, don't you? And just getting them to… We call it popcorning, where they shout out but try to shout out into the space so that everyone gets a go and everyone's engaged all the time.

This partner work was evident in the lessons observed.

Jenny gave an ice ball to each pair of children and challenged them to think of a way of preventing melting once out of the freezer. The children got to choose their own partners and then had to talk in small groups about their ideas. They then 'popcorned' their ideas (all called out their ideas but tried to take turns so they were speaking in a space).

Jenny: Any suggestions?

Children called out answers.

Jenny: That was rubbish popcorning because you all said 'outside'. Where outside? Talk to your partner.

The teacher asked for a response from each pair. She asked one child for the idea and then asked the other child in the pair to explain why they had chosen that.
*e.g. Child A1 '*in the field' *Child A2 '*because there was loads of snow there in the playground'

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Children talking in partners during the Ice episode.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.8 Teacher should be able to use a variety of scaffolding techniques to promote creativity in science and mathematics, from standing back in order to observe, listen and build from the children's interests, to intervening with appropriate questioning to support and extend inquiries.
Factors linked with:	**P:Scaff;** **P:Quest**
Type of material (image – interview (int) – classroom extract (class):	Image, Fnotes
Originating from:	
Country report :	D4.3 – report UK (Northern Ireland)
Case:	Case 9
Episode:	Gloop
Teacher:	Anita
Age Group:	3-4
Selected episode present in D4.4 Appendix	Yes

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Practitioners using different approaches to promote children's interest and creative activity in the preschool classroom

This activity involved mixing cornflour and water to make 'gloop'. The purpose was to provide a sensory activity, through which children might also develop language and descriptive skills, as well as sensory and motor skills.

Judicious intervention by the practitioner, Nina (the assistant to Anita in this episode), based on observation and previous knowledge of the child, coupled with the learning objectives for the lesson, enabled Nina to promote and further develop Juliet's understanding, questioning and creative exploration of the cornflour and water mix.

Juliet running the cornflour and water mix through her fingers

Questions and prompts from the practitioner:
"What do you think will happen if…?" (you add more flour, you roll it in your hands)
"See if you can make a ball"
"If you squeeze it, what happens?"

Encouragement from the practitioner:
"Wow, well done!"
"That's amazing!"

Nina working closely with Juliet, asking questions and giving prompts

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering a extending inquiry and creativity, by for example, prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events.
Factors linked with:	**P:Play;** **P:Quest;** **P:Scaff;** **M:Expl**
Type of material (image – interview (int) – classroom extract (class):	Classroom
Originating from:	
Country report :	D4.3 UK (Northern Ireland)
Case:	Case 15
Episode:	Outdoor sand
Teacher:	Maeve
Age Group:	3-5
Selected episode present in D4.4 Appendix	No

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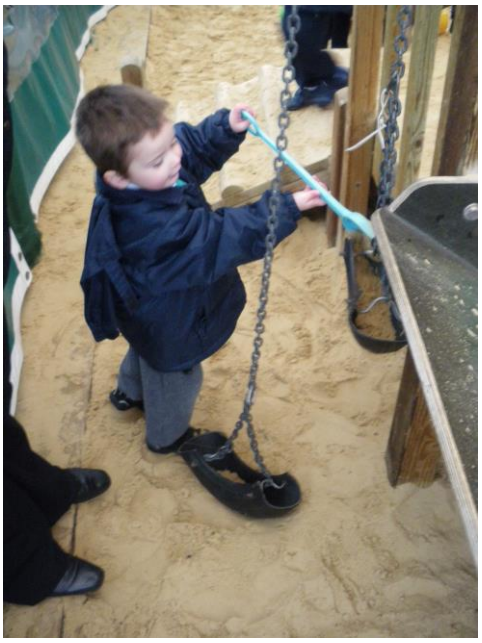
Supporting exploration for fostering inquiry and creativity

In this example, 'Paula' (the teaching assistant) can be seen just out of shot (bottom left) standing back and observing 'Patrick' as he explores the equipment. As he reaches the potential end of his activity, Paula asks some questions, based on her observation of his activity. This encourages him to continue and extend this activity further.



Patrick loading sand into one side of the pulley, and Paula asking extension questions

Extract from interview that used images (including the one above) as prompts for discussion

T: People think creativity is making things but it is that creative thought and for figuring things out and that is what we have been trying to develop as an ethos across everything
I: yes
T: you know, that it is that posing the question, but not asking those questions, children bombarding with questions, sometimes just watching, like you were saying, I mean sometimes I did that in that sand area, [teaching assistants] will say umm, 'how do we move it on?' yes there are buckets and spades and the pulley is there but how do you move it on? But sometimes children... they will just pull it, pull it and it goes the whole real connection and as the year goes on we can see, and it is lovely to see the children who actually do make a connection between when you put the sand in one will go up and up and down

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UKNI_Img_Bubbles_LEnvironm

Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE: LEnvironm**
Specific Teacher Outcome(s):	14.2 Teachers should be able to recognise and build on opportunities for informal learning in science and mathematics within the school environment, for example within day to day routines or child-initiated games and other activities in school classrooms or outdoor play areas.
Factors linked with:	**P: Affect;** **L: Informal;** **L:Indoors;** **M: Informal**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 UK (Northern Ireland)
Case:	Case 14
Episode:	Bubbles
Teacher:	Alice
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Providing children with informal opportunities to for science exploration

Here, Ryan is exploring a tube in which air bubbles rise up a spiral, through coloured liquid. He attempts to make them go faster by shaking it and spinning it. This is one of many science- and mathematics-based toys that are left around the classroom by Alice, which children are free to play with at any time. During this time, children were largely unsupervised. Practitioners would intermittently discuss and extend their learning.

Ryan observing the bubbles rising though the liquid

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UKNI_Img_FlowerDye_PractInvest

Teacher Education Design Principle + code:	2. Teacher education should provide teachers with skills and competences to carry out practical investigations of science and mathematics in the classroom. **TE: PractInvest**
Specific Teacher Outcome(s):	2.1 Teachers should be able to instigate and involve children in the design and conduct of practical investigations of science and mathematics in the classroom, as such activities can contribute to the development of children's creativity.
Factors linked with:	**LA:Plan;** **LA:Obsv**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 UK (Northern Ireland)
Case:	Case 17
Episode:	Flower Dye
Teacher:	Andrea
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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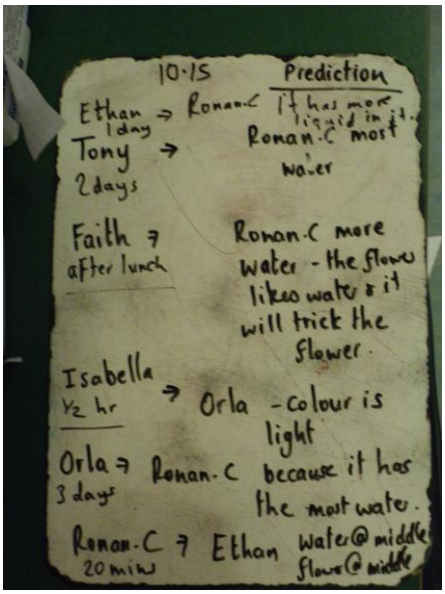
Investigation using food dye to show water transport in plants

This investigation involved placing flowers in cups of food dye to demonstrate water transport in plants. This was to consolidate knowledge learnt in lessons earlier in the term. Children worked with the teacher, Andrea, to plan the investigation.

Each child developed their own prediction about the length of time that it would take for the food dye to show up in the petals and drew their planned steps of the investigation. Andrea noted each child's prediction for what will happen and why, as noted in the picture below. Andrea encouraged the children to use and apply their existing knowledge of plants in order to do this. The children then carried out the practical part of the investigation individually.



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The flowers were left on the sideboard over the morning break time as the dye took, in some cases, over an hour to show in the petals. After the investigation, Andrea discussed the outcomes with the children, asking them to reflect on their predictions and if these matched the outcomes. Andrea asked the children to give possible reasons for the differences seen between the flowers based on their knowledge of plants.

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UKNI_Img_Foam_CreatInqLA

Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**T: Ped;** **LA: Plan;** **P: Agency;** **A: Evid;** **M: Explor.;** **M:Cr.;** **M: Variet**
Type of material (image – interview (int) – classroom extract (class):	Image and Interview
Originating from:	
Country report :	D4.3 UK (Northern Ireland)
Case:	Case 14
Episode:	Foam
Teacher:	Alice
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Children exploring foam as an open-ended investigative activity in the early years

Children 'squeezing' foam from the water tray, developing sensory experiences and communication skills as they describe their experiences to one another and the practitioners

Two children playing with foam in the water tray

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Interview with Alice (lead practitioner in the nursery classroom) using pictures (including the ones above) as prompts.

T: Well the way I look at it is, it is an open ended activity, there's no closed in, there's no, you don't know where, you have an idea where it is going but you don't fully know where it is going and that's to me the value of it because so many things that they are used to doing aren't as sensory… children don't have those same experiences so these types of activities, and we either change them you know with the shaving foam… they are saying how materials change and we are trying to pose the questions and get them to pose questions to each other so it deepens that, you know it is like peeling the onion or someone mentioned to me once 'you are peeling he onion, just those layers of understanding' there could be a child who will get nothing more out of that activity than the sensory aspect but that in itself is good, especially as we have a few children in there who that sensory, like 'Rory', he loves anything sensory and there is obviously he hasn't, he needs that, umm whereas 'Ruby' here she'll be taking it at a much deeper level, understanding the science of what is going on, that is why we would do those types of activities…

T: I mean you are talking about temperature there *[in the foam activity]* because it is actually very cold and it is a funny feeling, so there is so much, the science of how it changes, also you are talking about the temperature, sensory aspect when you add the colour and then the children have added objects before, you know it is just that, just totally open ended… So 'Ruby' will understand the science whereas for others it will just be about the sensory.

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UKNI_Img_GingerbreadMan_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.5 Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games.
Factors linked with:	**P:Affect;** **M:Cr**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report UK (Northern Ireland)
Case:	Case 16
Episode:	Gingerbread Man Investigation
Teacher:	Siobhan
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

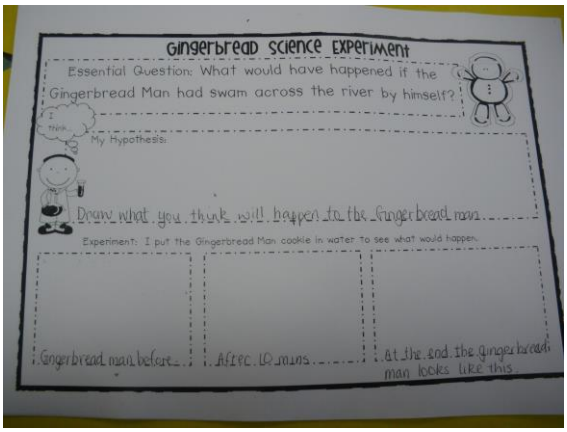
The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Using the Gingerbread Man Story as context for science learning.

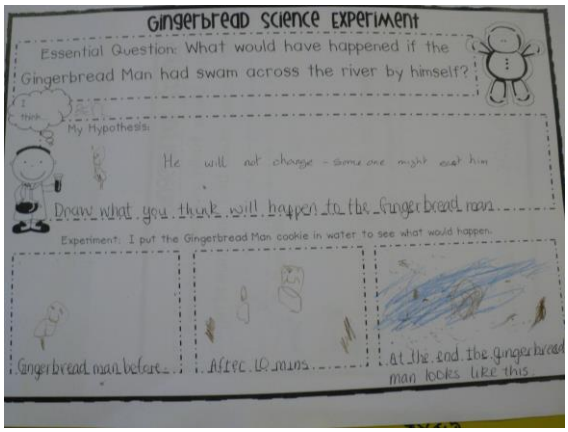
The story of the Gingerbread Man was being used across all areas of the curriculum, including literacy, PE, science and mathematics. Here, it can be seen as a way of developing children's investigative skills, such as hypothesising, observation and recording.

Each child was given a blank investigation sheet at the start of the session. The practitioner wrote their hypothesis for them. All hypotheses observed in this session were different.

Gingerbread Men were placed in a tray of water and observed at varying time intervals. Children recorded their observations.



A blank investigation sheet



Completed investigation sheet

Children observing changes to the Gingerbread man

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UKNI_Img_GingerbreadMan_IBSE

Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.1 Teachers should have knowledge of all essential features of inquiry and problem solving (questioning, designing or planning investigations, gathering evidence, making connections, explaining evidence, communicating and reflecting on explanations), their different purposes, degrees of structure and guidance (including open, guided and structured inquiries), and varied opportunities they offer for creativity.
Factors linked with:	**T: Ped** **T: Sci**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report UK (Nothern Ireland)
Case:	Case 16
Episode:	Gingerbread Man Investigation
Teacher:	Siobhan
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

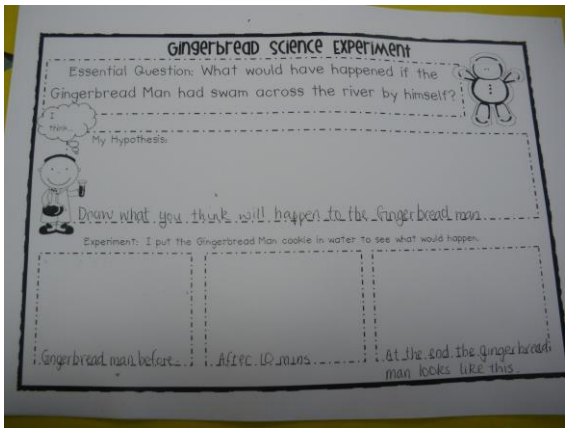
The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Using the Gingerbread Man Story as context for science learning.

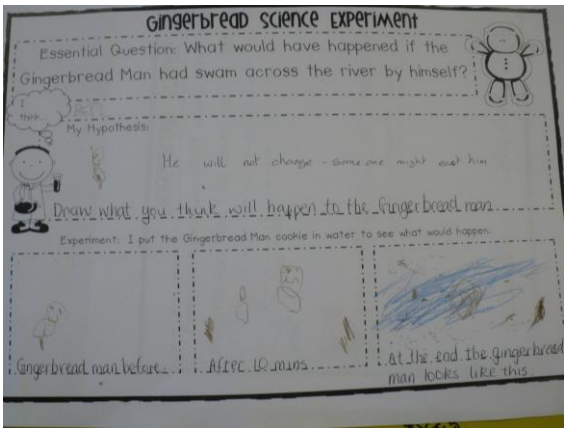
The story of the Gingerbread Man was being used across all areas of the curriculum, including literacy, PE, science and mathematics. Here, this is used as a means of introducing and developing children's investigative skills, by encouraging children to make hypotheses and predictions, carry out an experiment and record their observations through an 'investigation sheet'.

Each child was given a blank investigation sheet at the start of the session. Children were asked to make their own hypotheses, and the practitioner wrote their hypothesis for them. All hypotheses observed in this session were different.

Gingerbread Men were placed in a tray of water and observed at varying time intervals. Children recorded their observations. Again, children's recordings varied with Siobhan valuing children's individual responses more than a 'correct' response.



A blank investigation sheet



Completed invesigation sheet

Interestingly, in this case there was only discussion about why these changes occurred, (explanation of evidence, reflecting on evidence/explantations) rather than formal recording on the investigation sheet. It appears that this stage in the process may have been less valued by Siobhan than the first phases of investigation.

Children observing changes to the Gingerbread man

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UKNI_Img_Gloop_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	Teachers should be able to pursue the social and affective objectives of children's science and mathematics learning, in synergy with the corresponding cognitive ones.
Factors linked with:	**AO: Affect;** **AO: Social**
Type of material (image – interview (int) – classroom extract (class):	Image, Interview
Originating from:	
Country report :	D4.3 - UK (Northern Ireland)
Case:	Case 14
Episode:	Gloop
Teacher:	Alice
Age Group:	3-4
Selected episode present in D4.4 Appendix	Yes

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'Gloop' activity developing both cognitive and affective objectives.

'Ryan' showing focus and enjoyment working with the cornflour and water starch

This activity allows the children to develop motor skills, their ability to use tools as well as sensory development, such as observation through sight and touch. The affective aspect was most clearly shown through Ryan's enjoyment of the activity and his focus throughout.

Extract from interview with practitioner following activity, using pictures (including the two above) as a prompt:

Alice: and it is probably he is seeing it there, it is falling off the spatula and if he uses a different utensil what is going to happen and it is very hard to make patterns actually in gloop which fascinates them too, that is another stage you know, we would have a sand, we have a sand tray with combs and things, you can't really make patterns in the gloop because it all slides back into each other...

...

A: and language-wise and that is a fabulous opportunity for them to develop their language, and even just to listen, you don't necessarily need to put an adult in there, you can listen and grasp what they have achieved from that activity

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.6 Teachers should be able to gain insights into children's developing explorations and creativity based on their use of resources. 17.7 Teachers should be able to develop the school grounds and the outdoor classroom for use in science and mathematics education.
Factors linked with:	**A:Evid;** **P:Express;** **M:Outdoor**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report:	D4.3 UK (Northern Ireland)
Case:	Case 17
Episode:	Outdoor Measuring
Teacher:	Andrea
Age Group:	6-7
Selected episode present in D4.4 Appendix	No

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Using outdoor space for developing mathematics skills

As part of this session, children were experimenting with various forms of measuring tools, including metre-rulers and 'trundle wheels'. Their use was demonstrated by the teaching assistant before the children then used the equipment to measure things around the school ground, such as benches and the length of the school shed.

Ronan and Diedre (teaching assistant) measuring a bench

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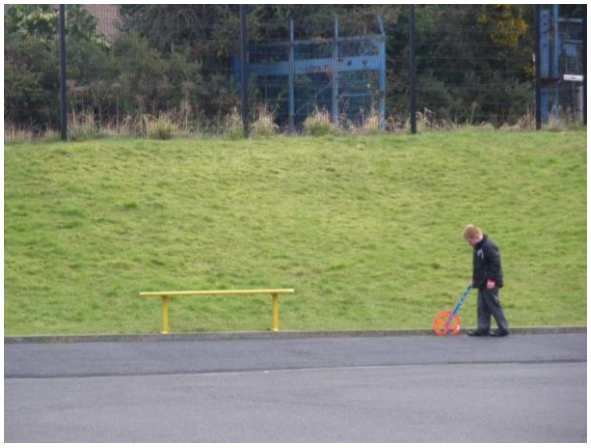
Children's creative use of mathematical classroom equipment

Ronan measuring a pole

In this case, Ronan then used the trundle wheel in innovative ways to measure different things not specified by the teaching assistant; the height of a post, the width of a door, the length of a windowsill.

Ronan then was extending the activity past the initial task set by the teaching assistant. This provided an excellent opportunity for the practitioners to gain insights into Ronan's explorations.

Afterwards Ronan announced that he wanted to measure the perimeter of the playground. The other children either went back inside or found other things to measure, such as the width of the door using the metre ruler.



Ronan measuring the perimeter of the playground using a trundle-wheel

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.1 Teachers should be able to organize and use materials (including everyday materials), resources (including ICT and natural resources) and equipment (including digital equipment and simple laboratory instruments) in the classroom, school and wider environment, both indoors and out, to support independent inquiry and creativity 17.4 Teachers should be able to evaluate provision for free flow play in their school settings.
Factors linked with:	**M:Expl;** **M:Cr;** **M:Outd;** **M:Inf;** **M:Variet;** **L:Outdoor;** **P: Agency;** **P:Play**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 UK (Northern Ireland)
Case:	Case 8
Episode:	Outdoor sounds
Teacher:	Linda
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Outdoor provocation for children to explore sounds.

'Sound Investigation Station' in the covered playground area

The Sounds Station includes a variety of musical instruments and materials for the children to use. In addition, there are a number of prompts and questions that might start children's investigations. In this particular episode, children were able to use the sound station after they had completed their set investigation, however the Sound Station is set up all day, meaning the children can use this resource during free play time.

Close ups of activities on the 'Sound Investigation Station':

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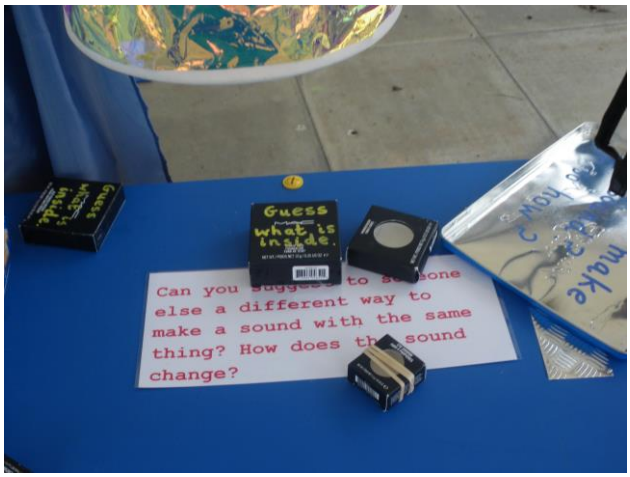
More activities on the ‘Sound Investigations Station’.



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UKNI_Img_Shapes_IBSE

Teacher Education Design Principle + code:	6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education. **TE: IBSE**
Specific Teacher Outcome(s):	6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.
Factors linked with:	**P: Agency;** **P: Ques;** **P: R and R;** **LA: Ques;** **LA: Plan;** **LA: Obs;** **LA: Equip;** **LA: Connect**
Type of material (image – interview (int) – classroom extract (class):	Image
Originating from:	
Country report :	D4.3 – report UK (Northern Ireland)
Case:	Case 15
Episode:	Shapes
Teacher:	Maeve
Age Group:	3-4
Selected episode present in D4.4 Appendix	Yes

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Exploration and using mathematics activities

In this activity, 'Amy' finds that the wooden triangles from another activity on the mathematics table are the same size as in her puzzle. She removes the pieces from the puzzle and reassembles it using the new pieces.

Her exploration work leads her to making connections between concepts (triangles/shapes), making patterns and trying new approaches.

This was possible due to the rich resources provided by the teacher and the freedom and autonomy that the children are given in using them.

Amy notices the similar sizes of the equilateral triangles by comparing them side by side

Amy reassembles the puzzle using the pink triangles from a different mathematics activity

Amy making patterns with the pink triangles

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Teacher Education Design Principle + code:	8. Teacher education should enable teachers to design and assess creativity-enabling inquiry-based activities which are child-friendly and include both guided and open inquiries. **TE: CreatInqLA**
Specific Teacher Outcome(s):	8.1 Teachers should be able to design and assess open-ended learning activities.
Factors linked with:	**T: Ped;** **LA: Plan;** **P: Agency;** **A: Evid;** **M: Explor.;** **M:Cr.;** **M: Variet**
Type of material (image – interview (int) – classroom extract (class):	Image and Interview
Originating from:	
Country report :	D4.3 UK (Northern Ireland)
Case:	Case 14
Episode:	Foam
Teacher:	Alice
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Children exploring foam as an open-ended investigative activity in the early years

Children 'squeezing' foam from the water tray, developing sensory experiences and communication skills as they describe their experiences to one another and the practitioners

Two children playing with foam in the water tray

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Interview with Alice (lead practitioner in the nursery classroom) using pictures (including the ones above) as prompts.

T: Well the way I look at it is, it is an open ended activity, there's no closed in, there's no, you don't know where, you have an idea where it is going but you don't fully know where it is going and that's to me the value of it because so many things that they are used to doing aren't as sensory… children don't have those same experiences so these types of activities, and we either change them you know with the shaving foam… they are saying how materials change and we are trying to pose the questions and get them to pose questions to each other so it deepens that, you know it is like peeling the onion or someone mentioned to me once 'you are peeling he onion, just those layers of understanding' there could be a child who will get nothing more out of that activity than the sensory aspect but that in itself is good, especially as we have a few children in there who that sensory, like 'Rory', he loves anything sensory and there is obviously he hasn't, he needs that, umm whereas 'Ruby' here she'll be taking it at a much deeper level, understanding the science of what is going on, that is why we would do those types of activities…

T: I mean you are talking about temperature there *[in the foam activity]* because it is actually very cold and it is a funny feeling, so there is so much, the science of how it changes, also you are talking about the temperature, sensory aspect when you add the colour and then the children have added objects before, you know it is just that, just totally open ended… So 'Ruby' will understand the science whereas for others it will just be about the sensory.

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UKNI_Int_Gloop_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	Teachers should be able to pursue the social and affective objectives of children's science and mathematics learning, in synergy with the corresponding cognitive ones.
Factors linked with:	**AO: Affect;** **AO: Social**
Type of material (image – interview (int) – classroom extract (class):	Image, Interview
Originating from:	
Country report :	D4.3 - UK (Northern Ireland)
Case:	Case 14
Episode:	Gloop
Teacher:	Alice
Age Group:	3-4
Selected episode present in D4.4 Appendix	Yes

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'Gloop' activity developing both cognitive and affective objectives.

'Ryan' showing focus and enjoyment working with the cornflour and water starch

This activity allows the children to develop motor skills, their ability to use tools as well as sensory development, such as observation through sight and touch. The affective aspect was most clearly shown through Ryan's enjoyment of the activity and his focus throughout.

Extract from interview with practitioner following activity, using pictures (including the two above) as a prompt:

Alice: and it is probably he is seeing it there, it is falling off the spatula and if he uses a different utensil what is going to happen and it is very hard to make patterns actually in gloop which fascinates them too, that is another stage you know, we would have a sand, we have a sand tray with combs and things, you can't really make patterns in the gloop because it all slides back into each other...

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A: and language-wise and that is a fabulous opportunity for them to develop their language, and even just to listen, you don't necessarily need to put an adult in there, you can listen and grasp what they have achieved from that activity

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UKSC_Class_Baking_SocialAffectAims

Teacher Education Design Principle + code:	1. Teacher education should provide content knowledge about science and mathematics, including interesting and current topics, to be used in activities linked with everyday life. **TE: SocialAffectAims**
Specific Teacher Outcome(s):	1.2 Teachers should be able to make children aware of connections between science and mathematics learning and their everyday lives, in order to engage their motivation, interest and enjoyment in science and mathematics and foster curiosity and creativity.
Factors linked with:	**P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 20
Episode:	Baking
Teacher:	Sarah
Age Group:	3-5
Selected episode present in D4.4 Appendix	No

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Baking as a daily routine in the life of the Centre
Resources organised to promote independence

In this children's centre bread making takes place each day. It begins at 8.00am as children are beginning to arrive. A laminated booklet provides information to support children's bread making with words and symbols to indicate the ingredients needed and each stage in the process.

Ingredients from the booklet on Baking Bread.

Ingredients and equipment are set out on a table in the kitchen area. A variety of additional resources such as rolling pins, baking trays and name labels are accessible nearby for children to collect as needed. The children share the bread they make at snack time. The extract below involves a child Amelie and Lara the Deputy Head.

Dialogue sustains interest and engagement

At the start of the bread making Amelie began measuring out the flour, spooning it into the balance tray and watching its changing position.

Amelie: Do I need all of this?
Lara: Think we might do - Keep an eye on it – see if it balances.
Amelie: If does not balance will we have to pour it into the bowl?
Lara: What do you think – maybe we might wait?
[...]
Lara: Let's have a look - are they balanced yet?
Amelie: No – I think we should put some more.

Once balanced Amelie poured the flour into the mixing bowl. A similar process followed in weighing the margarine:

Lara: What's the next bit? *[Referring to the recipe]*
Amelie: *[Turning over the page]* Points.

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Lara: Now need 25g margarine *[turning over the page]* – So we don't need all of these weights – we just need a 20 and a 5 – that's a 20 and there's a 5. You watch out for the balancing.
Amelie: Balance! *[She pours the margarine into the mixture.]*

Amelie adding the flour

Amelie adding the yeast

This was followed by mixing together the flour and the margarine and adding the yeast.

Lara: What's the picture telling us here?
Amelie: Mix with your hands. *[She starts putting in some of the extra flour that has spilled out.]*
Lara: If you add all the extra flour what will it do to the recipe? We can use this later when we are kneading. What does our book show us?
[...]
Amelie: I am going to do that I can do both of them. *[She cuts the top off the yeast packet.]* Then I just mix it with my hands. I'm going to mix it. I think it will turn into bread. If we pour the water in we have to put our hands in after and into the oven.

Then finally the water was added:

Lara: What's our next part? – Check *[pointing to the recipe booklet].*
Amelie: We put the water in, now you mix it - put a wee bit in then a wee bit in and then you put more water in. *[She puts more in mixing with a spoon.]* Put all the water in.

Amelie fetched a rolling pin to roll out her dough and placed it on a baking tray ready to go into the oven.

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Amelie's developing an understanding of the importance of measuring

Amelie chose to engage in baking bread or cakes on each day we visited. In an interview with her about her baking experiences she highlighted her growing understanding of the processes of measuring and their importance.

Amelie: I'm putting in the flour - The scales weigh the flour – When you need how much - Then you put in the bowl. It balances when it goes like that *(demonstrating with her arms and hands, showing them at the same level)*. You know it's enough. Then it goes in the bowl. Then you have a big jar full hot water - tells you how much – pour it all in the big bowl. It matters how much, it tells you how much."

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UKSC_Class_DayandNight_CreatInqPed

Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE:CreatInqPed**
Specific Teacher Outcome(s):	*7.5* Teachers should be able to use a range of creative contexts and approaches for provoking children's interest, motivation and enjoyment in science and mathematics, such as stories, poems, songs, drama, puppets, games. 7.6 Teachers should be able to use strategies for making and building on science and mathematics real life connections and applications for engaging creatively young children in science and mathematics learning
Factors linked with:	**P: Affect**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 19
Episode:	Day and Night
Teacher:	Mary
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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Context for the extract

Petra explained that they would be learning about what is happening to make day and night time. To help demonstrate the concept, she showed a globe to the children and a little picture of a person placed on the globe where the school is located. Petra incorporated **role play** into her teaching, inviting Gideon to be the sun. He was given a sun hat and a torch to hold and shine at the globe. Children were then asked to indicate whether the little person was experiencing daytime or night time as the globe was turned.

The use of role play to engage children

Teacher: Gideon, you are going to be the sun so I want you to wear the sun hat – do you think you could wear that on your head? You are going to be the sun. (…) I'm going to give Gideon the torch. Why do you think we would give Gideon the torch if he is the sun?
Lewis: Because the Moon – because the Sun is bright.

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Making connections with children's daily experiences

Teacher: How often do you think the world turns all the way around? (…)how much time do you think has passed between daytime once and getting dark and daytime?
Child1: Quite short
Child 2: About two weeks?
Child 3: I think it's a day.

To address these ideas, Petra linked the turning of the globe to the children's daily experiences.

Teacher: So it is daytime just now and when you go home have your dinner it is going to be night-time. Then, you are going to sleep all night and get up in the morning again it's going to be …?
Children: Daytime!
Teacher: So the world or the Earth rotates once a day can you see that?

Independently Gabriel, who had taken the role of the Sun, during the modelling of day and night, made his own drawing of the solar system.

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UKSC_Class_DayandNight_Multimodal

Teacher Education Design Principle + code:	9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity. **TE: Multimodal**
Specific Teacher Outcome(s):	9.1 Teachers should be able to recognize and value children's various forms of expression and representation of their ideas and learning in science and mathematics. 9.2 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development.
Factors linked with:	**P: Express;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 19
Episode:	Day and Night
Teacher:	Mary
Age Group:	5-6
Selected episode present in D4.4 Appendix	Yes

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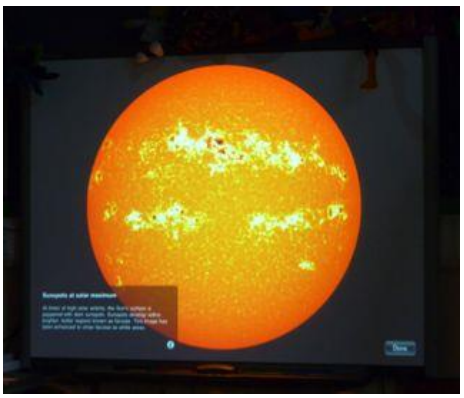
Context for the extract

This episode took place as part of a planned topic on Day and Night, with the following overarching learning intention: 'children will learn about the earth, moon, sun and stars. They will observe the sun and moon at different times and relate their findings to the concept of time' as shown in the school planning document.

Petra employed a variety of approaches to introduce ideas and promote engagement during the session including a classroom story to prompt discussion about why it gets dark and role play using a globe and a torch to model day and night as the Earth turns on its axis. Petra also integrated ICT in her teaching by introducing her new Space app on her iPad to show high quality images of the sun , moon, Earth and other planets. These prompted much excitement, comment and sharing of new ideas and enthusiasm between the teacher and the children as they read the captions from the different images together. Petra then showed an animation of the solar system. This also provoked interest and enabled the class to revisit ideas about the Earth turning on its axis.

Children then worked in mixed-ability groups on one of the following activities: 1) drawing pictures of how we get day and night using colouring pencils; 2) sorting photographs of animals into those that come out in the day and those that come out in the night; 3) sorting activities according to whether they take place at daytime or night time; and 4) making models of the Moon and Sun using plasticine. These activities employed a wide variety of materials and offered opportunities for children to express and reflect on their ideas in different ways.. Children's representations reflected the inspiration from their experiences in the earlier part of the lesson.

The integration of ICT through the use of high quality images and animation of the solar system



Teacher: I have brought in my iPad again today and (…) I've got a really interesting app on the iPad that shows the Earth turning. (…) There are also some really nice pictures of the sun taken with really powerful telescopes and it shows you that it does not really look like that – round and yellow. (…)
Lewis: You can see the fire and it's burning. (Children all very captivated)

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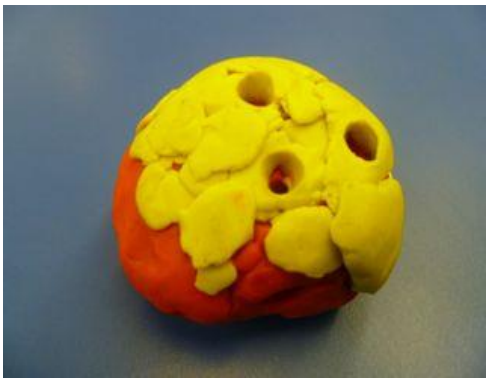
Examples of children's work – Ronald's drawing of the Sun (left) and Donald's model of the Sun (right)



Ronald: There's lots of solar flares Earth is so far away you can never reach that… got explosions – that's the light shining at the Earth. This shows all the planets are – going round and round. That was Jupiter and one next to Jupiter – and Saturn – closest to the sun. The blue bits are the sea and the green bits are the land.
Donald: That's fire coming and they're the holes and that's all the lava ... the sun is boiling hot fire.

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UKSC_Class_ForestSchool_ChildIdeas

Teacher Education Design Principle + code:	10. Teacher education should enable teachers to recognize and build on children's ideas, theories and interests for the teaching of science and mathematics. **TE:ChildIdeas**
Specific Teacher Outcome(s):	10.1 Teachers should be able to use a range of strategies for picking up on children's ideas, theories and interests 10.2 Teachers should be able to build flexibility into planning to take advantage of unexpected events, children's interests and questions
Factors linked with:	**T: Ped;** **AO: Affect;** **LA: Quest;** **A: Strat;** **A: Form.**
Type of material (image – interview (int) – classroom extract (class):	**Classroom extract and interview**
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 20
Episode:	Forest School
Teacher:	Sarah
Age Group:	3-5
Selected episode present in D4.4 Appendix	Yes

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Identifying and capitalising on children's interests

The setting for the episode was a protected wildlife area in the city walking distance away from the preschool centre. It has open areas of vegetation, woodland and a pond.

This episode follows the explorations of Ian that illustrate the opportunities provided for children to follow their own interests and make connections to their previous experiences at the site. His immediate focus was the pond. He poked the ice with a spade. He observed holes in the ice and collected some water in his spade to look at it more closely. Sarah, the teacher built on his interest drawing attention to the differences in the pond compared to the previous week and suggesting that he might look at the water more closely with a magnifier. After some considerable time Ian was still at the pond. This time he was poking at the ice with a litter picker. Marta the Nursery Nurse asked him about what he was noticing, encouraging him to explain what he was doing.

Later Ian took the researcher round the site to photograph the different fungi he had noticed, another developing area of interest over time. In a conversation with the researcher about this visit to Forest School later in the afternoon, Ian highlighted these two activities (breaking ice and photographing fungi), making connections with previous experiences at Forest School. The photographs taken by Ian were included with his reflections in his profile.

Using questioning to encourage communication of ideas and interests

Nursery Nurse: What can you see?
Ian: Bubbles.
Nursery Nurse: Where do you think they are coming from?
Ian: Animals – may be frogs? Maybe air coming up?
Nursery Nurse: You're doing a good job – the animals will be really pleased. Can you see the bubbles moving around?
Ian: Putting more air for the animals. (...)
Ian splashed round the edge of the pond, breaking up the ice.
Ian: Can see big bubbles – when you hit the bubbles it makes much more.
Nursery Nurse: Why are you rescuing the animals?
Ian: So they can breathe – whole pond nearly dug up now – saw breathing.

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Reflection on experiences provides insights into Ian's interests and ideas

Ian: When I went to Forest School it was brilliant. I liked the most taking pictures *(of fungi*) and that was the best thing I did there.
Researcher: So the best thing was taking pictures?
Ian: And lots of smashing ice on the pond.
(...)

Researcher: What were you doing in smashing the ice (..)?
Ian: So the animals could breathe under the ice?
Researcher: Have you been there another time? Have you seen any animals?
Ian: I think I been there a long time ago.
Researcher: What did you see?
Ian: I think I saw frogs in the summer – and before I saw frogspawn.
Researcher: That sounds exciting what was it like?
Ian: It was sort of jelly – and tadpoles inside the ball of jelly.
Researcher: Wow!
Ian: Not the kind of jelly from what you eat and got tadpoles inside it.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.2 Teacher should be able to use a range of strategies both formal and informal for supporting children's extended engagement with an area of study and progression in learning in science and mathematics. 7.3 Teachers should be able to recognize and exploit the value of play and exploration in science and mathematics for fostering and extending inquiry and creativity, by for example prompting questions, eliciting ideas, providing opportunities for consideration of alternative strategies during children's familiarisation with phenomena and events.
Factors linked with:	**P: Play;** **P: Scaff;** **L: Formal/Informal;** **M: Inf.** **M: Expl**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 18
Episode:	Melting and Freezing
Teacher:	Martha
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Opportunities for learning over time building on children's interests and responses

In days prior to this episode children had spent time outside observing snow and ice in the nursery garden and had noticed animal footprints. Indoors they had put snow and ice in the water tray and watched it melt. These activities provoked discussion about how animals might survive outside in these wintry conditions and whether it would be possible to turn the water back into ice. On this day Martha had designed two activities to capitalise on these experiences, *Bird Cake*, making bird cake to leave outside for the birds in the garden and *Ice Balloons*, observing yoghurt pots and balloons filled with water and left in the freezer overnight. Both these activities provided children with opportunities to explore the reversible processes of melting and freezing as a result of heating and cooling in different contexts. The activities were adult planned, but built on children's prior experiences and ideas. Examples of children's developing ideas recorded by staff on a class record sheet were used to inform the planning of these activities.

Exploring ice balloons.
Opportunities for observation, questioning and suggesting ideas for investigation

At the start of the day adults and children went to collect the balloons full of water and yoghurt pots that had been left in the freezer overnight.

Martha: I was remembering – do you remember we put some things to freeze? What do you think's going to happen to the water we put in the freezer?
Alara: Cold freeze
Martha: Let's have a look. Let's get a tray.
Alara: It's going to melt because it's warm.

They placed the ice balloons in a tray near the water tray for the children to explore freely. Salt in a pot, pipettes and balance scales were set out nearby. Adults visited the table from time to ask about how children were getting on. Two children, Robert and Alara in took ownership of the ice at the start of the day. They spent time across the day observing the ice, showing other children and taking the tray round the classroom for people to see what the ice looked like and the changes taking place.

Robert and Alara observing the ice balloons

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Robert: Mine is a ball of ice! Wow! Ice is so sticky what happens? *[screaming]*
Alara: And it's sticky and cold – there's snow inside *[on the rough surface]* crystals inside.
[...]
Alara: Ice this is what I was looking for [holding it up]. Do you think it's glass?
Robert: It feels like glass.
Alara: You can see inside it – if you shake it what will happen? It's moving a wee bit. I feel the ice there.
Robert: I've got a bigger one than yours that's why.
Alara: Let's try and get the ice out of it – let's see what happens if you do that *[puts salt].*
Robert: *[He puts it in the dent at the top of the ice balloon]* Keep it in there – see what happens.
Alara: I'll try on mine now.
Robert: Remember when the ice cracked? I heard it crack and then.
Alara: Mine's gone now *[salt].*
Robert: *[Calling to a friend]* Come and look at this. Look at that it's ice.

The children observed that the ice began to melt for example:

Robert: Watch it – see what it does – melting.
Alara: Getting like water. I can see through. You look after them and see what happens – and I'll see if anyone wants to do it. *[She took a tray with her ice balloon round the classroom to show.]*

Interactions between adults and children took place from time to time, expressing interest and excitement in the shared experience of the balloons as they were taken round the classroom. In the afternoon in response to questions about whether the water could be turned back into ice and where it would need to go to freeze, Vera (one of the nursery officers) brought out a thermometer that had a scale from red (hot) to blue (cold) and with the children set out mapping the cold and hot places indoors and out to help decide where to leave the melting ice to freeze again.

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Teacher Education Design Principle + code:	14. Teacher education should equip teachers with knowledge and skills to use a range of formal, non-formal and informal learning environments, including the outdoor environment, both the school grounds and the wider environment beyond the school, in their teaching of science and mathematics. **TE:LEnvironm**
Specific Teacher Outcome(s):	14.1 Teachers should be able to make use of varied settings for science and mathematics learning, including flexible use of the environment both indoors and out. 14.4 Teachers should be able to manage visits with children to the outdoor and wider environment beyond the school, addressing issues of health and safety, liaison with parents, building progression in experience inside the classroom.
Factors linked with:	**L: Outdoors;** **L: Informal/Non-formal** **M:Explor.;** **M: Outd.;** **M: Inf.**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 20
Episode:	Scout Camp
Teacher:	Sarah
Age Group:	3-5
Selected episode present in D4.4 Appendix	No

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Aims and organisation of visits to Scout camp

This extract is set in a 26 acre wild space at a scout centre just at the edge of a city. The site includes a variety of features including open grassland, wooded hillsides and a river. Children from the Centre visit on a regular basis in a minibus. Children choose whether they wish to go in collaboration with parents and staff. Photographs of visits to the site feature frequently in children's profile records and informal conversations. The site provides opportunities for adventurous and challenging physical activities and for close observation and study of the natural world. The place of visits to the site within planned Centre activities also reflects the priority given to prompting the holistic development of each individual child based on their interests and fostering citizenship and environmental awareness.

The Base Camp

Routines associated with the careful organisation of appropriate **materials**, including suitable clothing, blankets, mats, food and drink are essential to keep visits safe and comfortable at all times of year. There is an enclosed base camp area with a yurt to allow a sheltered space to collect and eat in winter. The camp also includes a fire pit and a barbeque area. During their visits adults and children set off in a group to explore different areas within the site. There are clear structures to ensure safety with set stopping points for everyone to collect together and assess possible risks ahead. There is a strong emphasis on the involvement of children in the evaluation of risk. Snacks and drinks are shared too at regular intervals. This provides time to rest, get warm and plan ahead. Activities undertaken at the site are led by children's observations and ideas as they explore different parts of the site during the day.

Children's explorations and observations during the day

At the base camp, following a snack in the yurt, Ian followed by Vanessa started rubbing twigs against the metal structure over the fire pit, trying to get the bark off '*to see if there are any beasties*'. Later children began running up and down the mounds of chipping in the enclosed base camp area. Mark noticed '*it's easy if you go down and then up*'.

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Running up & down the mounds

Vanessa trying to find 'beasties'

Amelie collected fir cones to take back to the Centre. Beth and Karla picked up twigs and waved them around as they walked. Beth made comparisons between their sticks '*I've got a bendy stick – mine's a fishing rod – yours is a straight one'*. Vanessa noticed a big hole in a tree and stopped to stare up and questioned '*maybe someone inside?'* She was lifted up to look.

Following a return to base camp and snacks, the group set off to higher ground and a stopping point in another part of the site. Towards the top of the hill there was a grass sledge run. Children spent time climbing up and then running down, mirroring their actions with the smaller slopes at base camp.

The grass sledge run

Ava pulling Vanessa on the rope swing

The next stopping point was even higher up. Here some children explored the roots of an upturned tree. Ian commented '*looking to see if I can find any beasties'*. Linda and a group of children went to set up a swing using ropes slung over a fallen tree. Linda encouraged the children to show her how to tie the ropes to the tree. Children took turns to sit in the rope swing and be pulled. Vanessa sat on the swing with Ava pulling her backwards and forwards. It was hard work and Ava was pulled down the hill as she released the rope each time. Linda suggested '*pulling gently Ava*' so she could keep her footing. On the way back down to base camp there were further opportunities for exploration and observation for example to find sticks with pine cones, smell the sticky resin from a pine tree or make a den inside a clump of rhododendrons.

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Links between experiences at Scout Camp and the outdoor area at the Centre

The interview with Sarah, a teacher, indicated ways in which children's experiences have brought new ideas and materials back to the Centre and influenced the development of resources in their outdoor area. For example the swing has been replaced at present by a hammock. Loose branches have been added in parts of the outdoor area site and a water pump installed to give the sounds of moving water. There are plans for a dry riverbed in progress.

"They brought back ideas for things like water here – they wanted water to be here – we already had the little pond but that's when we got the pump and they wanted that to be moving water because the sound lends itself – we hadn't had the sounds – that has led on to now wanting a dry riverbed which we have sort of started to do…. bringing their ideas of we need to have something to swing on here so that's why we've got the – we had a swing which was made by children with Dan and that has been replaced by the hammock at the moment. Even the things like having the loose branches – this has influenced us and we have brought branches from Scout Camp."

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.4 Teacher should be able both to build in new and to make the most of existing opportunities for child-initiated play, recognising and capitalising on the potential of children's explorations beyond the teacher's original intentions.
Factors linked with:	**P: Play;** **P:Agency;** **M: Expl;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Classroom extract (class)
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 18
Episode:	Water Play
Teacher:	Martha
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Rich physical environment for exploration
Material organised to support independence and improvisation

In the nursery provision is made each day for the exploration of materials including water, sand and malleable materials. Adults vary the resources provided in the water tray over time based on their observations of children's interests and wider events in the life of the nursery. Children also have free access to trays of resources nearby to extend their observations. The organisation of space allows easy access for groups of children.

The setting for the water tray

On this occasion a wide variety of resources had been set out at the start of the day to support children's explorations including measuring jugs of various sizes, boats, whisks and spoons. To these children had added plastic pipes and syringes taken from the trays of resources behind the water tray. Staff had placed balance scales and pipettes on a table right next to the water tray intended to support the exploration of ice balloons. These resources too were incorporated by children into their water play. Children were mostly left to explore on their own or in collaboration with others throughout the morning. Adults interacted occasionally to show interest or ask questions in response to the direction of children's activities.

The episode reported here concerns the sustained and focused explorations of one child, Anna. Across the episode she engaged in a series of repeated activities, showing focused attention throughout.

In the first phase of her explorations she repeatedly poured water into the bucket on one side of the balance and then the other – gradually filling each side to the top and making the two sides balance.

Anna noticed connections between the level of the water in the bucket and whether it was heavier or lighter, '*heavier when it's higher'.*

Noticing the children had moved the balance scales into the water tray Vera, one of the nursery officers, came over to see what was happening and suggest ideas.

Anna: Too much water *(on one side, commenting on balance tipping)*
Vera: Will you put some on the other side as well?
Anna: Need to put some here.

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Vera: Good idea.

Anna pouring water into buckets on the balance scales

Anna then started filling the bucket with the syringe. Following this her focus of attention shifted to the pipette. She tried various ways of filling the pipette, first trying to fill it with the measuring jug and then by attaching the pipette to the syringe, but she could not manage to attach it securely. Eventually she asked the researcher what the pipette was and was shown how to fill it.

Filling the bucket with a syringe.

Trying to fill the pipette with the syringe

Next she used the whisk to create bubbles in the water – singing away as she did so *'swish, swish, swish'* and watching closely the bubbles produced. She returned to the whisk on several occasions during her time at the water tray.

A further activity that gained her close attention was using one of the balance scale buckets to fill a measuring jug. She filled the jug very slowly and carefully until no more water could be added saying '*careful, careful and pour' 'put one here put one there' 'all of the water in there'* feeling the rounded surface of the water in the jug. She repeated this several times.

A final focus of activity that provoked Anna's attention and commentary was watching the water flow through holes, through the bottom of a bucket with holes and through the holes in a plank that ran across the water tray. She articulated her observations for example *'Going through the holes - – shhhhh''* (pouring water through the hole in the middle of the plank). She made connections

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between her actions and the water flow for example *'If you pull this up it comes out the bottom'* (the bucket with holes).

Recognising and capitalising on the potential of children's explorations

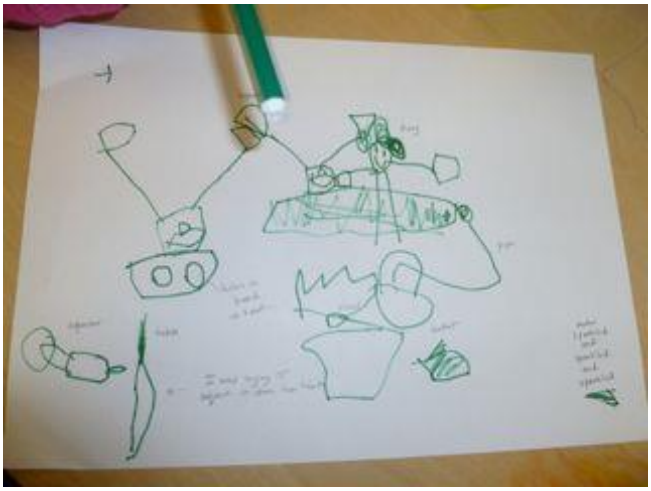
Dialogue with Anna prompted by photographs of her explorations and her drawing of her experiences provided opportunities for reflection and gave further insights into her explorations and thinking. For example in discussing photographs of her activities with the researcher Anna explained

> *'I was putting the water in to see which one was the heaviest (balancing activity)'*
> *'I was squirting – yeh something happened and it squirted in my face (syringe).'*
> *'I was it put through the little 'tuber' and it didn't work' … 'it kept slipping off, slip, slip, slip (trying to fix the pipette on to the syringe.'*

When asked what she found most interesting she quickly referred to '*the tuber*'. When asked what she thought was new or special she commented on her observations of water flow – the sound it made and its appearance:

> *'Well the special thing was the water goes woo, woo, woo'…. 'the water glows a wee bit.'*

Key equipment and events also featured in her reflective recording of the activity with annotations dictated to the researcher. The drawing highlights the balance scales, the holes in the board, the incident with the syringe and the pipette *'I was trying to squirt it down the tube'* and her observations of moving water '*water sparkled and sparkled and sparkled*.



Anna's drawing of her experiences in the water tray

The photographs, drawing and dialogue were recorded in Anna's profile, providing valuable evidence to support staff and parents in recognising and building on Anna's interests and capabilities.

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Teacher Education Design Principle + code:	7. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.10 Teachers should value and be able to make use of varied forms of assessment evidence (including children's portfolios, individual or group records of activities), both to promote creative learning, through reflection and discussion in science and mathematics, and explicitly to inform teaching and longer term planning.
Factors linked with:	**A: Evid.;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Images
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 20
Episode:	No episode – general photographs of children's portfolios
Teacher:	Sarah
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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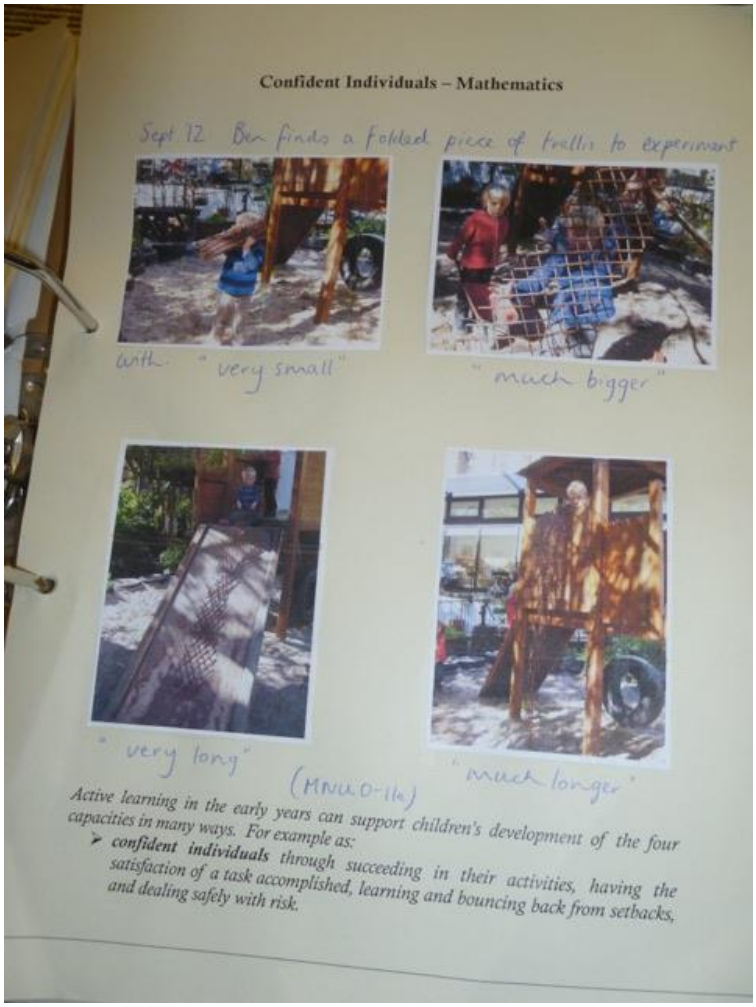
Activities and experiences at the Centre are based on the needs of each individual child. Children's on-going interests and ideas are recorded in individual Learning Folders, drawing together photographs of significant events, staff observations and children's reflections on their experiences. These are used to inform provision at the Centre. They also provide a focus for dialogue with parents about their children's learning.

The folders are readily accessible and children often spend time reading and sharing their portfolios.

Examples of children's portfolios recording experiences in mathematics and science



Comments in the portfolio:

Brian finds a folded piece of trellice to experiment.
Photo 1 "very small"
Photo 2 "much bigger"
Photo 3 "very long"
Photo 4 " much longer"

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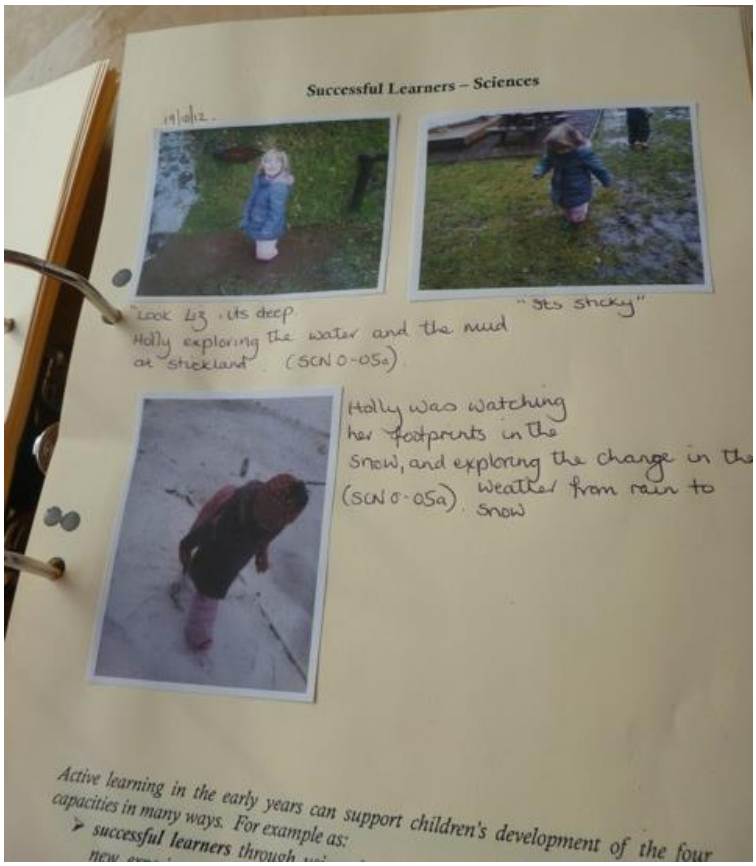

Comments in the portfolio:

Photo 1 " Look Linda – it's deep"
Photo 2 "It's sticky"
Harriet exploring the water and the mud at Scout Camp.
Photo 3 Harriet was watching her footprints in the snow, and exploring the change in the weather from rain to snow (SCN 0- 05a)

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Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations. 17.4 Teachers should be able to evaluate provision for free flow play in their school settings. 17.6 Teachers should be able to gain insights into children's developing explorations and creativity based on their use of resources.
Factors linked with:	**M: Expl;** **M: Cr.;** **P: Agency;** **P:Play;** **P: Express;** **A: Evid.**
Type of material (image – interview (int) – classroom extract (class):	**Images**
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 20
Episode:	No episode – general photographs of construction
Teacher:	Sarah
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Photographs of construction activities in the nursery

There is a strong emphasis throughout the nursery on the importance of the processes of learning and learning through play. This is illustrated in the range of booklets for staff and parents that spell out the rationale and learning potential of various aspects of play provision including for example block play, malleable play, baking, small world play or modelling and gluing, with links identified to the Curriculum for Excellence (www.curriculumforexcellenceScotland.gov.uk).

Activities and experiences at the Centre are based on the needs of each individual child. Children's on-going interests and ideas are recorded in individual learning folders, drawing together photographs of significant events, staff observations and children's reflections on their experiences. These are used to inform provision at the Centre. They also provide a focus for dialogue with parents about their children's learning.

As illustrated in the photographs below, a range of different construction materials are provided that offer opportunities for the development of inquiry processes and knowledge and understanding in mathematics and science.

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Teacher Education Design Principle + code:	7. Teacher education should familiarise teachers with a range of formal and informal inquiry- and creativity-based learning, teaching and assessment approaches and strategies and their use in relation to authentic problems within the areas of science and mathematics. **TE: CreatInqPed**
Specific Teacher Outcome(s):	7.9 Teachers should be able to use different assessment approaches and strategies and in particular those that involve children in the assessment processes, such as peer and self assessment, dialogue and feedback on progress, in the early years science and mathematics classroom. 7.10 Teachers should value and be able to make use of varied forms of assessment evidence (including children's portfolios, individual or group records of activities), both to promote creative learning, through reflection and discussion in science and mathematics, and explicitly to inform teaching and longer term planning.
Factors linked with:	**P: Dialog;** **A: Strat;** **A: Peer/Self;** **A: Evid.;** **A: Form**
Type of material (image – interview (int) – classroom extract (class):	Interview
Originating from:	
Country report :	D4.3 UK (Scotland)
Case:	Case 19
Episode:	Counting Money
Teacher:	Mary
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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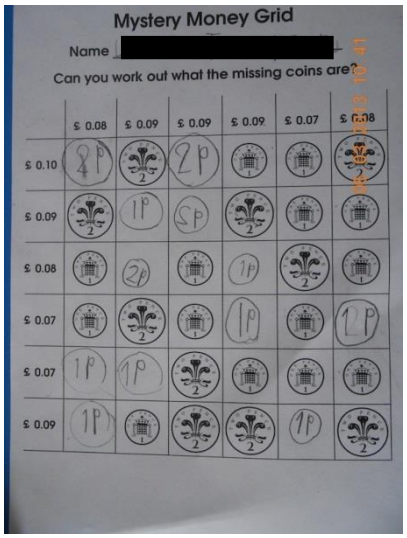
Two children Murray and Corey were working, largely independently, on a worksheet-based problem-solving task, called the 'Mystery Money Grid', whereby they had to work out the missing coins in each row and column. There were meant to be six coins in each row as well as in each collumn. The children were supplied with a number line and small pots of plastic coins they could use to help them explore and solve the problems on the worksheet.

In this extract opportunities for assessment are provided through the observation of Murray's talk and action in completing the Mystery Money Grid and during an interview following the activity. This provided insights into his developing thinking and prompted self evaluation.



The worksheet for the 'Mystery Money Grid'

Observation of Murray's talk and actions indicated the strategies he was using to solve the problem

Murray was found counting coins on his worksheet using the 'pairing' counting strategy whereby he was using two fingers to count and add the value of two more coins at a time. For example, the third row was comprised of 1p, 2p, 1p, 1p, 2p and 1p coins – in that particular order. He started counting backwards by pointing two fingers at the last 2p and 1p coins and said 'three'. He then moved his two fingers to the two 1p coins in the middle, and said 'two'. Then, he started from the end of the row again. Still pointing his two fingers at the last two coins, he said 'three' *[adding the last 1p and 2p coins]* … 'five' *[after adding the two 1p coins in the middle]* … 'and eight' *[after adding the remaining 1p and 2p coins from the beginning of the row]*.

In the fourth row of six coins with the total value of 7p, it comprised of a 1p coin, a 2p coin, a 1p coin, a missing coin, a 1p coin, a missing coin. Murray was counting backwards from the end of the row using just one finger this time: *'1p, 2p, 3p, 4p, 5p, 6p.' [Incorrectly thinking that one coin, regardless of its value, represents 1p]* He later said: *'It needs to be 7p, so one of them has to be a 2p. I'm gonna go with a 2p at the start [i.e. at the end of the row].'*

Murray was drawing a 2p coin at the end of the row, and then a 1p coin in the middle of the row. His row now looked as follows: 1p, 2p, 1p, 1p, 1p, and 2p. When Murray was asked how much money he had in the row, Murray he was once again employing employed his pairing strategy to work out the

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total value of the six coins. Pointing his two fingers at the first 1p and 2p coins, he said '3p'. Then, pointing his two fingers at the two 1p coins in the middle, he said '5p' *[having already mentally added the 2p to the previous 3p].* Pointing his two fingers at the last 1p and 2p coins, he said '8p'.

When Murray was asked how many pence he had too much, given the total target for that row was only 7p, Murray was immediately seen checking his calculation using his pairing counting strategy again. He did this by very quickly moving his two fingers along the row from the beginning to the end of the row, covering two coins at a time. Pointing at the last 2p coin, he said, *'So we'll need to make that one a 1p'.*

Murray's counting strategy

There was also a degree of collaboration during this activity, for example, when Corey spotting spotted Murray counting his row of coins using his fingers, Corey said: *'You don't need to use your fingers. There you go, Murray'*, whilst pointing at the number line, to which Murray responded *'I don't need one. You have it.'*

In addition to the number line, children were also supplied with small pots of plastic coins where they could use to help them explore and solve the problems on the worksheet. At one point, Murray and Corey were seen comparing two long rows of coins.

Murray and Corey conducting their own investigation

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Reflective discussion as a context for assessment and for child self evaluation and learning

In the interview after the activity the researcher asked them to explain what they were doing. Corey said they were trying *'To see which one chained the most'*. And when asked whether they were doing it to help them with their work on the worksheet, they said no as according to Murray – *'counting money is more interesting'*.

In the middle of the interview, Murray abruptly asked the researcher if he could do something quickly. He said '*I'm going to count my money*'. With two 50p coins and six £1 coins, he started putting them in a straight row: *'50 [50p coin] … adds one [£1 coin] is 51 adds one [£1 coin] is 52 … adds one [£1 coin] is 53 … adds one [£1 coin] is 54 … add one [£1 coin] is 55 … add one [£1 coin] is 56 … add one 50 [50p coin] is … […] Is it 106? I know what I can do!'*

Murray decided to count a new set of coins, putting each of the following coins in a straight row: 50p, 50p *('100')*, 50p *('150')*, £2 *('152')*, £1 *('153')*, £1 *('154')*, £1 *('155')*, £1 *('156')*, £1 *('157')*, £1 *('158')*, £1 *('159')*, £1 *('140')*, £1 *('141')*, £1 *('142')*, £1 *('143')*, £1 *('144')*, £1 *('145')*, £1 *('146')*, 20p *('What's 146 plus 20? 166')*, 1p ('167'), 20p *('187. What's 187 adds 20 …. is 220'*). While it was not apparent from his arrangement of the coins whether Murray necessarily associated bigger size with bigger value, it was clear that he did not make any distinction between the pound and pence units.

Murray's first attempt at counting how much money he had by putting both pence and pound coins in the same row

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Self-evaluation prompted by the invitation to check his answer

However later when asked by the researcher how he could check the answer, he exclaimed: *'I'm not right. I'm not right. They are pound coins!'*, whilst pointing at the £2 and £1 coins and rearranging all the coins. This time he was grouping and counting only the pence coins first, then counting the pound coins later. For the pence coins, he had three 50p coins, four 20p coins, and one 1p coin, totalling *'231p'*.

Murray whispered to Corey: 'Let's count all the pounds and pences altogether and see how much it makes! […] We just put all the pounds altogether and all the pences altogether. I need to count my pounds first though.' With one £2 coin and fifteen £1 coins, Murray correctly worked out the total sum of '£17'.

Murray's second attempt at counting how much money he had by sorting pence and pound coins into two groups

When asked why he changed his technique, Murray said *'Because it makes sense'.*

When asked to add up the two amounts (i.e. 231p and £17), Murray said *'I have to start with the highest number. 231 adds 17 will be 248!'* When asked whether the total would be in pence or pound, he said *'pences and pounds? […] I don't get it'.*

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Teacher Education Design Principle + code:	11. Teacher education should enable teachers to use questioning effectively and encourage children's questions in order to foster creativity and inquiry **TE: Question**
Specific Teacher Outcome(s):	11.1 Teacher should be able to use different forms of questioning at appropriate points to scaffold creative learning outcomes in science and mathematics, and in particular to encourage children's reflections and explanations, foster their independence and extend their inquiry.
Factors linked with:	**P:Ques;** **P:Scaff;** **P:RandR;** **AO:Creative**
Type of material (image – interview (int) – classroom extract (class):	**Classroom extract**
Originating from:	
Country report :	D4.3 UK Wales
Case:	Case 22
Episode:	Flapjack
Teacher:	Joanne
Age Group:	5-6
Selected episode present in D4.4 Appendix	No

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Questioning to support understanding and encourage discussion of the changing state of materials

The teacher capitalised on a baking activity to develop an understanding of the changing states of materials using questioning to encourage discussion and support understanding

T led group task.

T: And we will be looking at what 'state' they're in…A liquid, a solid, and gas….
Child: You could call it steam.

T gets out oats.

T:Is this a liquid or a solid?
Children *respond:* solid
T:Are oats liquid or solid?
T: It's dry not wet, it's a solid not a liquid.
Child: pours like a liquid.
Child: glitter.
T: Touch them. Talk about them. How do they feel?

She gives each child a pile of oats in front of them.

T: How do they feel?
T: Sugar *(repeats in Welsh)*: Is this a liquid or a solid?
T: looks little tiny bits, like glitter
T: Is it a liquid? Would it make a puddle? It looks like we are pouring it but it's teeeny tiny pieces

Each child gets sugar on pile.

Child: What's the next thing were getting?
T: What is happening as you touch?
Child: Raisins are dried grapes, they look old.
T: They are a solid, grapes are juicy. The sunshine dries them out, applies heat to them and they become raisins.
Child: Syrup, too much syrup is not healthy for you.

Children looking, watching, listening.

T: Butter, is it a liquid or a solid?

T gives out a little bit of butter to each child.

Child: Cheese is full of calcium.
T: Sugar, raisins, butter, oats… How many solid things do we have now? What is happening? Liquid, syrup is a liquid.

T gives out 'liquid' syrup. Children mix in on table as T mixes in bowl, children take turns with stirring bowl.

T: What's happening to your butter?
Child: Melting
T: melting because we have warm hands

T melts butter on stove.

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T: I'm going to give it some heat. It just goes inside. Dissolves sugar into liquid butter
T: Look now
Child: Germs
T: Yours is for experimenting with. Creating, exploring.
Child: Look at my butter!
Child: It's melting.
Child: The butter sticks it together.
T *showing melting butter on stove*: What's happening now? It's getting smaller and smaller.
T *counts spoonsful of sugar*: 1 2 3 ..
Add to liquid: It's dissolved.
T : Think
Children together: It's changing.
Children: Changing colour.
T: Can you see it? The liquid is the hot butter.
T: Temperature.
T: What's happened to the butter now?
T: I'm stirring it and stirring it.
T: add 2 spoonfuls of syrup.
Child: messy
T: Add the dried out grapes, raisins.
T *Counts out*: 1 2 3 *T counts and children join in.*

The children stir as they add the hot liquid.

T: Think now… What's going to happen to the raisins?
T: Stirring... need muscles to stir this
Child: Its messy isn't it
Child: Look at this…

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UKWA_Class_Jelly_PractInvest

Teacher Education Design Principle + code:	2. Teacher education should provide teachers with skills and competences to carry out practical investigations of science and mathematics in the classroom. **TE: PractInvest**
Specific Teacher Outcome(s):	2.1 Teachers should be able to instigate and involve children in the design and conduct of practical investigations of science and mathematics in the classroom, as such activities can contribute to the development of children's creativity.
Factors linked with:	**LA: Plan**
Type of material (image – interview (int) – classroom extract (class):	Classroom Extract
Originating from:	
Country report :	D4.3 UK (Wales)
Case:	Case 22
Episode:	Jelly
Teacher:	Joanne
Age Group:	3-4
Selected episode present in D4.4 Appendix	No

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Making Jelly

This was a follow up activity to making jelly the previous day – the teacher used the opportunity to take something which the children had experience of into a scientific inquiry.

T constantly used key vocabulary as she recalls the process of making the jelly yesterday.
T: How was this jelly made?
T: Do you make jelly at home?
T: presents clear focus on PROCESS of making jelly solid.

T models the use of scientific language. Hot liquid dissolving solid jelly making it liquid before it becomes solid jelly again.

Predictive talk was encouraged:
T: What will happen if I try to put this jelly on a flat plate?
Child: it will fall out
Child2: it will wobble
T: What will happen if I drop this knife on the jelly?
Child: it will bounce off
T: What will happen if I cut the jelly with a knife?
Child: its better with a spoon Mrs J…cos we can eat it then but we mustn't put knives in our mouths …that's dangerous.

The activity was followed by the pupils conducting their own investigation using 'Flubber', a material with similar properties to jelly

Child 1: Let's put some water with this… shall we?
Child 2: It will make it sticky
Child 1: Yeah sticky-icky
Child 2: But the water won't make it into a liquid will it…?
Child 1: No…It will still be a sticky solid
Child 2: It's good for making stuff…look I'm making a dinosaur
Child 1: …I'm making nothing I'm making cake
Child 2: We could make a flap jack but it won't be nice to eat
Child 1: Let's put some glitter in it
Child 2: That won't taste nice…
Child 2: I like glitter…you can pour it out…and make sprinkles and shake it like this …

Pot of glitter emptied into modelling material.
Children rush to feel it and mix it into flubber.
Children continue to knead and squeeze flubber.

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UKWA_Class_Makingmusicalinstrument_Resources

Teacher Education Design Principle + code:	17. Teacher education should address with teachers issues in ensuring rich provision, planning and use of resources (including digital resources) in and out of the classroom to support children's inquiry and creativity. **TE: Resources**
Specific Teacher Outcome(s):	17.2 Teachers should be able to recognize the nature and potential of different materials and resources both to constrain and extend children's explorations. 17.4 Teachers should be able to evaluate provision for free flow play in their school settings.
Factors linked with:	**M:Expl;** **M:Cr;** **P: Agency;** **P:Play**
Type of material (image – interview (int) – classroom extract (class):	Classroom Extract
Originating from:	
Country report :	D4.3 UK (Wales)
Case:	Case 24
Episode:	Makingmusicalinstruments
Teacher:	Brenda
Age Group:	4-5
Selected episode present in D4.4 Appendix	No

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Investigating sound through instrument making

As part of a cross curricular activity on musical instruments children had the opportunity to make their own instruments facilitated by a range of 'sound making' materials including dried peas, elastic bands and plastic bottles.

All the children pick up items from the table and explore them, investigate.
Children explore the dried peas, by touching them, rolling them around the big plastic bowl. Making a noise with them rolling round.

Child 'look at me' *as they explore the rolling dried peas.*

Other children join in, with the 'music making'
Exploring the sounds by banging the empty plastic bottle on the table.

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Another child takes some dried peas and puts them inside their chosen tub, and then starts to shake the tub about.
Another child then bangs on top of a margarine tub using it like a drum.
One child then puts elastic bands over his tub lid and 'strums' and shakes at the same time.

One girl calmly, carefully and in a very considered way is putting dried peas one by one into her pot. Every time she adds a pea she shakes the pot, considers the noise and adds one more. She continues for some time.

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