ACCADEMIA MEDICA DI ROMA

A HEALTH SCIENCE EDUCATION PROGRAMME IN PRIMARY SCHOOL: THE SCIESA PROJECT

THIRD YEAR

2015-2016

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INTRODUCTION

The third year of activity of the SCIESA project (SCIEnze della SAlute) was delivered in the Academic Year 2015-2016, as an initiative of the Accademia Medica di Roma, with the sponsorship of the Accademia Nazionale dei Lincei. The SCIESA project is an on-going experimental programme to teach health science over the five-year cycle of primary education. As in the previous two years, the project was delivered in two schools, in Via Asmara and Via Novara, both part of the Istituto Comprensivo Luigi Settembrini in Rome. This year the programme was taught to the same four classes already involved in the previous year's programme, and who were in their third year of primary school. The planning and supervision of the project was conducted by the SCIESA Working Group, composed of Mario Stefanini, Antonio Cappelli, Flavia Capozzi of the Sapienza University of Rome , Silvia Caravita of the IRPPS (CNR) Rome, and Gregorio Siracusa of the University of Rome - Tor Vergata. Mario Stefanini is also a member of the Accademia Nazionale dei Lincei. Gino Amiconi, of the University of Rome - Sapienza also joined the group during the year.

The programme was delivered by the same teachers of the four classes, Paola Cherubini, Roberta Corvi, Grazia Cossu, Elena Feliziani, Maria Eleonora Medici, Annarita Pierini, Grazia Zimbalatti, under the guidance of the School Director Massimo La Rocca and the two site coordinators, Angelo Matrone and Claudia Regazzini.

The numbers of children involved in the experiment was approximately 70. As in previous years, this present report detailing the activities conducted during the third

year of the project has been prepared in English and Italian, and can be consulted on the web site of the Accademia Medica di Roma at the following Link: http://www.accademiamedicadiroma.it/index.php?option=com_content&view=article&id=573&Itemid=106

We are deeply grateful to the Fondazione Terzo Pilastro Italia e Mediterraneo for financing the activities of the project related to its third year.

CHARACTERISTICS OF THE SCIESA PROJECT AND SUMMARY OF THE PREVIOUS ACTIVITIES

1. Preface

To understand of the activities conducted by the SCIESA project during the Academic Year 2015 - 2016, it is useful to summarise the fundamental characteristics of the project (motivation, objectives, and implementation), the activities undertaken in the preliminary phase as well as the teaching activities conducted during the previous two years.

2. Motivation, objectives and method of implementation of the SCIESA project

2.1. Motivation

The idea of conducting an experimental Health Sciences programme in a primary school (Istituto Comprensivo Luigi Settembrini di Roma) stems from the analysis of the epidemiology of the Italian population which is strongly characterised by the following:

- an ageing population with a consequential increase of chronic or degenerative illnesses associated with senility;
- the diffusion of a wide range of illnesses typical of an "affluent society" and knonw to be attributable to incorrect and risky health lifestyles (e.g. eating disorders, tobacco addiction, drug abuse, sedentary lifestyles, stress, etc.).

As a consequence of these phenomena, the overall demand for health care in Italy is increasing continually, incurring also greater costs for the National Health Service.

To offer an effective and efficient response to the increasing demand for health assistance and the consequential increase in costs, a strategy of systematic preventative measures aimed at reducing the entity or gravity of certain specific conditions, as well as the diffusion of the above mentioned pathologies, must be adopted.

In this context, preventive measures aimed at minimising the insurgence of these pathologies is fundamental, or at least measures to help combat their diffusion. In the compulsory education system, many important initiatives have been implemented for decades to this aim, primarily through a series of organised and systematic health education activities and informative initiatives.

Although acknowledging their validity, the results of these initiatives are subject to critical interpretation. Indeed, it is observed that the general effectiveness of

health education in the school system is rather limited and furthermore, delivered in a discontinuous fashion:

- many initiatives are generally delivered as occasional or sporadic events;
- in most cases, the learners lack any basic scientific training, even at an elementary level which is indispensable for long-lasting and effective learning;
- the information which is transmitted is thus perceived as an uncontested truth and not based on scientific evidence.

These are the critical issues that must underpin a new concept of health education which should be seen as a systematic activity to "promote health", and focused on the creation of "healthy and correct lifestyles". This new approach to health science education must be based on an understanding and awareness of the pupil's own body, its regulatory processes, and also the pathological mechanisms that should be avoided.

In this perspective, the first years of the compulsory education cycle represents the ideal opportunity for intervention for the following reasons:

- the fundamentals of knowledge are established in the formative years;
- obligatory schooling permits that entire age segments can benefit from such activities;
- the foundations for a healthy lifestyle in older age are cast in infancy.

2.2. Aims

With this premise in mind, the SCIESA project aims to verify the feasibility of a systematic educational programme in Health Sciences to be delivered to a target of primary school children with the objective of transmitting to these learners know-how and understanding on the conformation and functioning of the human body and a rational and scientific analysis of a lifestyle that can be considered appropriate to help prevent the onset of certain infectious or degenerative pathological conditions.

To this aim, the knowledge base to be transmitted, adequately translated to the learning level of primary school students, should include primarily the following:

- the general conformation and the main functions of the human body, with specific reference to its organs and apparatuses;
- the relationships with others, and in general with the external environment;
- the most important risk factors for health which can be manifested at a younger age, and which can have consequences throughout life;
- behaviour and lifestyles aimed at avoiding or contrasting those risk factors, or at least preventing the onset of illness which can be established both at a young age or during adulthood.

For this feasibility study, the project was formulated to be delivered to four classes of a primary school over the

entire duration of the five-year period starting from the first year of education.

2.3. Method of intervention

The educational strategy adopted to achieve the above objectives is based on two fundamental principles: an inductive method, and the active participation of learners during the delivery of the programme.

This strategy, aimed at enhancing the critical capacity of the children towards an evidence-based educational programme, also implies:

- identifying and attributing greater value to everyday activities of the children (family life, school activities, physical exercise, play, conditions of well-being or sickness, etc.) used to create the foundations for learning based on concrete, spontaneous or provoked experience;
- the direct participation in the learning process by the children through the systematic involvement of each individual in the group, and encouraging interaction between group members;
- the continual training of the teachers involved in the delivery of the proposed programme in the classroom;
- the collaboration of children's families, by means of periodic information sessions (letters to parents, meetings, etc.) during the delivery of the programme;
- adopting an inductive methodology during the planing and implementation of the progrmme, to enhance reflexions on the experience itself, and to

create solid foundations for effective learning, thus avoiding teaching based on the mere transmission of notions.

With these general premises in mind, the syllabus for each year of the programme was prepared according to the following plan:

a) Identification of "fundamental experiences"

Selection of specific basic experiences to be recalled to facilitate the delivery of the programme, was performed with the help of the teachers taking into consideration the age and social background of the participants.

b) Preparation of the teaching programme

The year-long programmes were prepared by the SCIESA Working Group together with the teachers, and were articulated into various Modules to be used by the same teachers as a teaching guide. The Modules focus on a series of topics pre-selected in consideration of the general guidelines of the project, but also on the indications and experiences gained from the activities of the previous years. A "flexible" teaching programme was considered more suitable for the effective delivery of an experimental programme with several innovative aspects.

Each module includes:

- indications of common everyday experiences which are referred to initially stimulate the interest of the children when focusing on the target topic;
- identification of specific learning objectives pertaining to the module;

- an analytical indication of the knowledge to be transferred;
- the methodologies, when possible inductive (experience and experimentation) to be applied when transfer the specified knowledge;
- a list of teaching support materials with indications on how these should be used.

c) Planning and production of the teaching support materials

The teaching support materials considered necessary for the delivery of each module (materials required for simple experiments, role plays, pictures/illustrations to be studied, etc.) were prepared or produced by the SCIESA Working Group, and ~~were~~ presented to and discussed with the teachers.

d) Workshops with teachers

Given that the programme is delivered by the regular school teachers, various meetings between the teachers and the SCIESA Working Group were held before and during the delivery of the programme. The aims of these meetings were:

- to illustrate and discuss the programme, and to make any adjustments when considered necessary;
- to give teachers the necessary indications, instruments and any other information (use of teaching support materials, etc.) necessary for the delivery of the module;
- to provide the teachers with a brief introduction to some notions of health science pertaining to the

teaching modules (background training for the teachers).

These meetings were conducted with a "teamwork" approach before the start of the teaching activity and also during the delivery of the programme.

e) Presentation of the activity to be delivered to the families of the children.

To encourage active collaboration with the children's families, before the start of the programme, a meeting was held with the families (in most cases, the parents) to present the final project and its objectives. The teachers involved in the delivery of the project, the school supervisors and members of the SCIESA Working Group were present. During the academic year, other periodic meetings were programmed with the children's families, to receive on-going feedback and comments regarding the activities conducted.

f) Implementation of the planned programme

To guarantee a certain "continuity" in the teaching activity (for a total of 40 academic hours in the academic year) delivery of the programme was entrusted to the regular class teachers who, however, received continual monitoring and technical assistance from members of the SCIESA Working Group.

g) Assessment of results

Evaluation of the achieved learning outcomes was conducted according to a project which included:

- evaluation of individual learning conducted by the teachers by means of appraisal tests or class activities;

- meta-analytic evaluation of the knowledge acquired by the children;
- meta-analytic evaluation regarding the children's capacity of inductive reasoning, their ability to explain their reasoning, and to draw logical and correct conclusions, through periodic documentation of conversations in the classroom;
- evaluation of the level of appreciation and critical observations by the teachers involved in the delivery of the programme, the school directors, and the children's families.

3. Articulation of the general teaching programme

As previously stated, the general teaching programme was conducted in a flexible manner, and was modified on critical analysis of the activities conducted in previous years.

The initial part of the programme was delivered in the first two years (Years 1 and 2 of primary school) and was dedicated to the environment and environmental problems, and to basic concepts of functional anatomy approached as "perceptible" anatomy, to make scholars to gain awareness of specific experiences of everyday life, as well as of their own body through simple classroom experiments based on the direct observation the human body. The titles of the modules can be found in part 4.2 of the present report. The details of each module have been published in previous reports which are available for consultation. In the present document the teaching syllabus for the third year of the programme is detailed.

For the fourth year, two modules are programmed to be delivered that are covering:

- revision and consolidation of the children's understanding of problems regarding the environment, and the concept of networks: (Module 8: “The brain and its networks: external with the environment, and internal with the rest of the body”);
- transmission of elementary, basic knowledge regarding the structure and function of the cell (Module 9. “Traveling through world that cannot be seen, from the organism to the cells and to the molecules”).

In the fifth and final year of the programme, the topics that will be addressed are: food as a source of energy and molecules, the defense mechanisms of our own body, the risk factors for health and the correct lifestyles to be adopted to counteract such risks.

4. Activities completed

4.1. Preliminary phase

In the preliminary phase of the project (2011 - 2012) the following activities were completed:

- elaboration of the general project for the Accademia Nazionale dei Lincei;
- presentation of the project for evaluation and discussion at a national (Accademia dei Lincei, Accademia Medica) and international level – the Executive Committee of the Inter Academy Medical Panel (IAMP). In co-financing with

Accademia Nazionale dei Lincei, the latter supported the programme during its second year;

- presentation of the SCIESA project to the Fondazione Roma – Terzo Settore that twice (for the first and third years of activities), co-financially supported with the Accademia Medica di Roma, the classroom delivery of the programme.
- definition of a protocol agreement with the Regional Education Authorities of Lazio for the implementation of the experimental project to be delivered in a school in Rome (Istituto Comprensivo Luigi Settembrini in Rome);
- definition of a protocol agreement with the Istituto Comprensivo Luigi Settembrini for the start of the activity for four first-year classes (in the Via Asmara and Via Novara centres) and the continuation of the programme for the entire five-year period.

4.2. Operative phase

The operative phase of the project consisted in elaboration of the detailed curriculum (teaching Modules) and the delivery and other related activities for the first and second classes of the selected primary schools.

The first year of activity involved delivery of the programme to two first-year primary school classes, and included the following modules:

- Module 1. *The Environment and Us* (Concept of environment and conditions of environmental well-being);

- Module 2. *The human body and movement* (general confirmation of the human body and perceptible human anatomy of the musculoskeletal apparatus);
- Module 3. *Relationship and exchange between the human body and the environment* (What goes in and what comes out).

The second year of activity involved delivery of the programme to two second-year primary school classes, and included the following modules:

- Module 4. *The heart and blood vessels* (functional and perceptible anatomy of the cardiovascular apparatus);
- Module 5. *The brain* (The journey of signals).

In order to provide adequate documentation regarding the activities undertaken, final reports were published and disseminated for the first two years of activity. Such reports are digitally available on the web site of the Accademia Medica di Roma: http://www.accademiamedicadiroma.it/index.php?option=com_content&view=article&id=573&Itemid=106

TEACHING CURRICULUM FOR YEAR 3 PRIMARY CLASS

The teaching curriculum for the Year 3 primary class (academic year 2015 – 2016) was prepared as a natural continuation of the activities performed during the previous year, and adopting the same didactic methodology.

Again, teachers were actively involved in the preparatory phases of the programme.

The proposed program for this year concerns the sensory functions and the executive mental functions. For what concerns the senses, the purpose was for pupils to understand in what way the signals coming from the external environment reach our organism, that decodes and integrates them. The study of mental functions followed the Module "The brain: the journey of the signals" held the previous year, and was aimed to understand how the brain gives rise to a set of skills that characterize the human species, such as memory, learning, coordination between thought and action, using signals from the outside and from inside the body.

The modules, covering about 40 hours of activities for each of the four classes concerned, were therefore as follows:

- Module 6: The senses
- Module 7: The journey in the knowledge. The executive mental functions.

The contents of the two modules is shown in detail in the sections that follow.

MODULE 6. THE SENSES

INTRODUCTION

The objective of this introductory module is to focus the attention of the children on the senses, to identify and understand everyday events, and experiences from their childhood.

Are you able to see what is around you if you are in the dark? (No, because there is no light). If you are in the open air in the daytime and close your eyes, can you see what is around you? (No, because visual images are transmitted through the eyes). Why do some people were glasses? (Because they cannot see well, and glasses help them see better). Why do older people tend to wear glasses more? (Because as we get older, our eyesight tends to get weaker, as do our other senses). If you want to see a film that frightens you, what do you do? (You close your eyes). And if you don't even want to hear it? (I block my ears). Can you hear the teacher talking if you put your fingers in your ears? (No, because sound reaches us through our ears). Do you know what fruit tastes like by touching it? (No). What do you have to do to taste an apple? (You have to put a piece in your mouth). To distinguish between salt or sugar, is it enough only to touch or look at it, or do you have to do something else? (No, you have to try it). When you go home, how do you know if your mother has cooked something that you like? (Because you can smell it in the air). Do you know what a snack smells like if you have a

cold and your nose is blocked? (No, because the smell reaches us through our nose). Do you know what a snack smells like when it is still in its wrapper? (No, because when its in the wrapper, the smell cannot reach our nose). Can you tell if a stone is hot or cold only by looking at it? (No). What you have to do to understand? (Touch it). If you want to know if the tyres of your bicycle are inflated, is it enough just to look at them or do you have to do something else? (Yes, feel the tyres with your fingers to check if they are hard or soft). If we have our eyes closed do you notice when a fly lands on your arm? (Yes, because it touches us).

GENERAL EXPECTED LEARNING OUTCOMES

On completion of this module, the children will be aware that our understanding of the external environment is due to our integrated perception of multiple signals visual, acoustic, gustatory, olfactory, tactile which reach our bodies through our sense organs.

- The signals that we sense around us are used to transmit information (e.g. road signs, billboards, warnings, advertisements, etc.). Similarly, visual signals (light), noise (sound), chemical (taste, smell), mechanical (pressure, vibration), thermal and pain (heat/cold, pain), reach specific *sense organs (sight, hearing, taste, smell, touch)* and are then sent to the brain which interprets them and attributes a meaning to help us understand more about the surrounding environment.

The expected learning outcomes will be identified progressively for each sense.

The general content of this module is in many ways similar to an analogous module created by *Baylor College of Medicine* for primary school learners.

THE SENSE OF SIGHT
EXPECTED LEARNING OUTCOMES

On completion of this module, the children will be able to understand the following:

- Our sense of sight allows us to interpret information based on light;
- Light is essential for our sense of sight;
- Light signals are received by light-sensitive receptors which are found in the eye, and are transmitted to the brain by means of a long nerve;
- The brain processes information coming from the eyes, which are the "sense organs for light".

SUBJECT MATTER

The subject matter of each section of the module are hereby detailed (**in bold**, the concepts or notions to be

transferred, *in italics*, the experiences to be used in the inductive teaching methodology).

LIGHT AND THE EYE

The eyes are necessary for us to see objects.

- *Sit the children in a circle and place a coloured object, such as an apple or an orange, in front of them. Ask the children to describe in detail the object (ensure that they also mention the colour). Ask them how they are able to recognise so many details such as the colour, the form, and dimensions (because we can see the object, or rather we can see it with our eyes). Continue the discussion until they reach the conclusion that we need our eyes to see objects.*
- *Ask them to draw the object on the white sheet provided.*
- *Ask the children to close their eyes, and try and make the classroom as dark as possible. Ask them to open their eyes and look at the object once again. Ask the following: Does the object seem the same as before?; do you notice any differences?; in what way is it different? (the colour is perhaps less vivid, or if the classroom is very dark, perhaps the object is barely visible). Discuss with the children until they reach the conclusion that light is necessary for us to see, and that objects may be perceived differently if there is little light.*

- *Ask the children to explore the classroom with a kaleidoscope that they will have built (see teaching support materials). Ask the following: What can you see? (they will presumably refer to objects present in the classroom but reflected in the inner mirrors of the kaleidoscope). What happens if you place your hand in front of the kaleidoscope? Can you still see the same reflected images? (No). Why can't you see them? (Because the light cannot go through our hands). Ask the children to focus the kaleidoscope on a coloured drawing that they have made on a piece of white paper, and ask them to look at the drawing through the kaleidoscope. Ask the following: "What do you see?" (Nothing, because there is no light). Ask the children to lift the sheet of paper – always resting against the kaleidoscope – but with a light source behind the drawing. Ask*

the following: "What do you see?" (A reflection of the drawing in the kaleidoscope). Why? (Because now the light is now filtered through the paper). Discuss with the children how the eyes are able to receive light signals directly, or even reflected from a surface. Get then to put these drawings into their Science Workbook.

The eye can regulate the quantity of light that reaches it.

- *Divide the children into pairs and ask each of them to observe the eyes of their partner, and then draw it (without touching!) and discuss the differences that they notice (size, form, colour).*
- *Show the diagram of the eye from the front, and name the various parts (pupil, iris, sclera or white part of the eye, eyelids, eyelashes). Ask the children to look at the eyes of their partner and identify the various parts, paying attention to the iris and the pupil.*
- *Demonstrate how the iris can regulate the quantity of light that enters the pupil, by asking the children to examine their partner's eyes in turn under varying conditions of illumination. They will see that the pupil widens when there is little light, and it constricts when there is more light. Using a handheld torch for each pair, ask the children to see how the pupil of the partner contracts when it is illuminated.*
- *To reinforce this concept that the pupil regulates the quantity of light reaching the eye, carry out the following experiment: turn out the classroom*

lights and shine a torch which has been covered with black card with a small hole in the middle onto a sheet of white paper and ask the children to observe how much light passes through to the other side. Widen the hole and ask the children if there is any difference, and if so why is this so (The hole is like the pupil of the eye: the larger it is, the greater the quantity of light that can pass through).

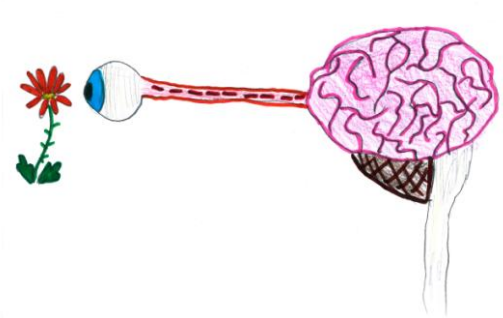
THE EYE AND THE BRAIN

Images that reach the eye are transformed by this organ into electrical signals which are sent to the brain.

- *Elicit from the children that signals travel from the body to the brain through the spinal cord. Ask them how they imagine that images perceived by*

the eye are transferred to the brain (they should be able to propose that there is an analogous mechanism interconnecting these two organs). Using a piece of wool, ask one of the children to connect the eye with the brain on the large cut-out figure of the human body hanging on the wall.

- *Ask the children if they think that a lot of time is needed for the signal to be transferred from the eye to the brain (No, this transfer is immediate). Help the children remember that information travels very quickly through the nervous system, and underline how this is very important for visual stimuli. Ask the children to write one or more phrases regarding vision in their Science Workbook.*



Images can evoke memories or can provoke emotions

- *Have you ever looked at something that frightens you? Have you ever looked at something that made you laugh? Or something that made you angry? Or even something that has made you feel bad? Discuss with the children how images can evoke emotions and memories. In what part of*

your body does this association between the image that you see and the emotion that you feel take place? In the eyes? (Wait for the children to answer: No, in the brain).

- *What is it that makes us run away when we see something that makes us feel in danger? Is it the image that our eye perceives, or is it what our brain tells us about that image? How does your brain understand what is dangerous in that image? (Memories of past experience, previous information received).*

In addition to activating our memory, visual signals can also produce reflex responses.

- *What happens if someone moves their hand quickly towards your eyes? (What usually happens is that we shut our eyes).*
- *What happens when we are hungry and we see some food that we like, e.g. a plate of our favourite pasta? (We could say that our mouth starts watering, or our stomach starts to rumble).*
- *Explain to the children that these are reflex mechanisms which start automatically, in the first case to protect our eyes, and in the second case to favour the process of digestion: when we receive these signals, our bodies get ready to receive food, even if the pasta is not eaten.*

That eye, rather like a camera, captures the image as it really exists. It is the brain, however, that can interpret it wrongly.

- *Distribute to the children a series of drawings showing optical illusions or that create a false sense of perception. Ask them to describe these and then make them aware of the error in judgement that is generated by the brain when interpreting these images. (Give the children rulers so that they can verify that these images are actually optical illusions).*

Ask the children to write one or two sentences in their Science Workbook regarding what they have learned from these experiments.

TEACHING SUPPORT MATERIALS

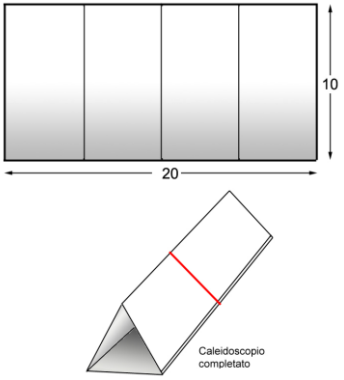
Required materials for each class

- One sheet of card with a mirrored side (50 x 70 cm), available in any art supplies store;
- Rubber bands (to close the kaleidoscope);
- 1 - 2 sheets of black card;
- an apple, orange or other highly coloured objects;
- a large diagram of the human body to be displayed on the classroom wall;
- paper rulers with indications of centimetres to be cut out (see diagram below);
- scissors;
- five copies of two figures of optical illusions, reproduced on card.

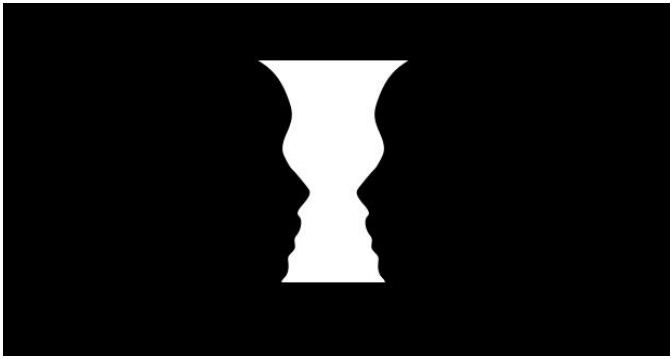
- **For each child**
- A sheet of white paper for each child for the coloured drawing;
- 1 rectangular piece of mirrored card 10 x 20 cm;
- 1 sheet of A4 white paper;
- transparent adhesive tape;
- marker pens or coloured pencils;
- handheld torch (one per pair);
- 1 copy of a reproduction of an optical illusion, that they will exchange with other pairs;
- Science Workbook (one for each child).

Preparation of the kaleidoscope

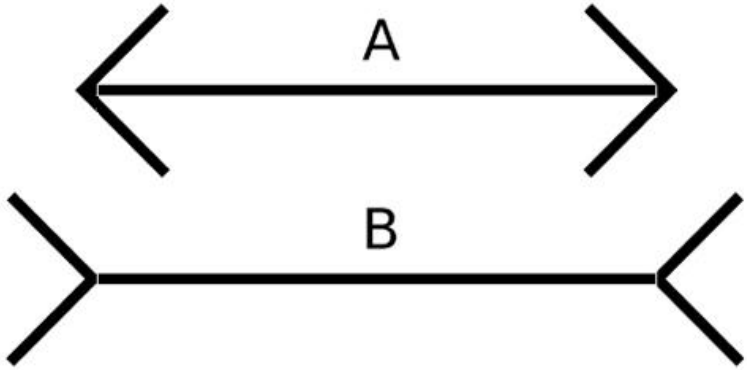
Cut the mirrored card into rectangles 10 x 20 cm. Cut out enough rectangles (one for each child). Prepare the cut-out so that it can be folded, scoring with a ballpoint pen and a ruler three parallel lines to make three rectangles 5 x 10 cm (see diagram). This will help to fold the card precisely. If the children are not able to do this alone then fold the card beforehand, but let them close it using an elastic band to make the triangular parallelepiped in the classroom. Punch a small hole into the black card.



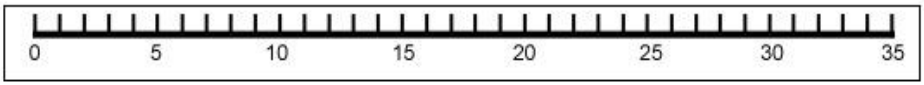
OPTICAL ILLUSIONS



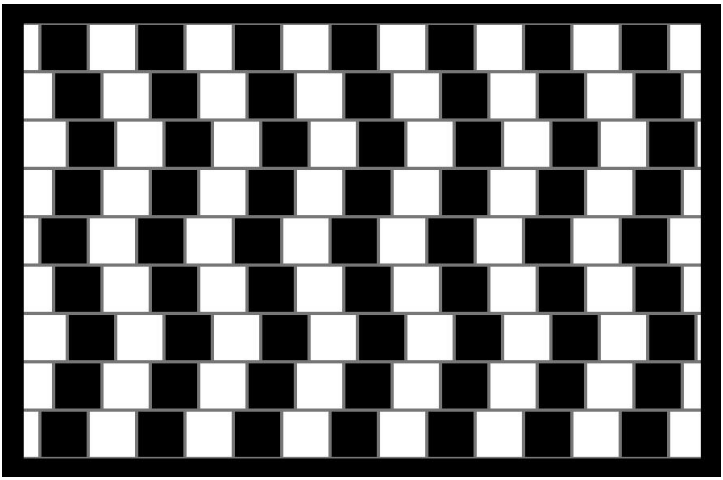
The Rubin vase: a white vase, or two black faces facing each other?



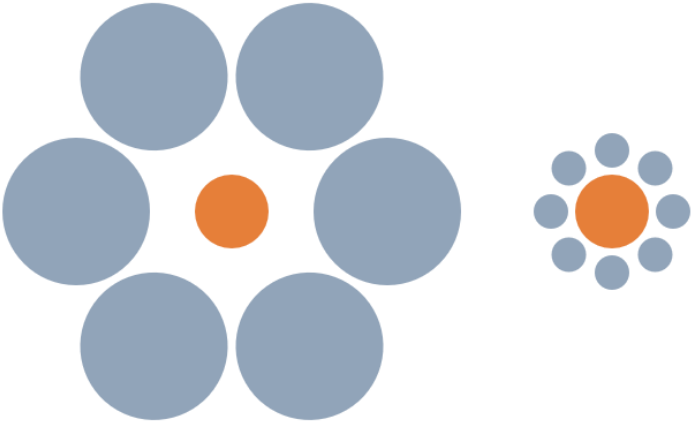
Segment A seems shorter than segment B, but in fact they are the same length (measure them to make sure!)



(distribute the cut-out rulers with indications of centimetres, and ask the children to use this to measure the segments)



The horizontal and vertical lines that delimit the squares in this board do not seem to be parallel (but indeed they are!)

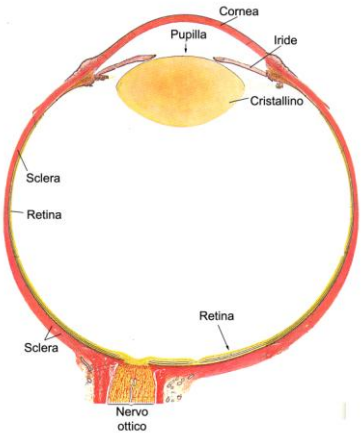


The two orange circles are the same size!

Background information for the teacher

Much of our knowledge of the surrounding environment come from our sense of sight, which transforms signals produced by light energy and which is perceived by the eye as form, colour, and movement. Our capacity to recognise a face, to identify an object under different conditions of light, or to interpret elements in a landscape are more complex processes and which take place in many parts of the cerebral hemispheres. Even computers and the most advanced software are still not able to emulate the processes that the brain activates when interpreting visual stimuli.

We know many aspects of the functioning of the sense of vision. Light enters the eye through the cornea and pupil. The cornea is an external transparent layer which makes the light rays converge on the pupil, which is the hole located in the centre of the eye. The pupil is surrounded by a coloured area known as the iris, which, by contracting or relaxing, can increase or diminish its diameter, thus regulating the amount of light entering the eye. Passing through the pupil the light is focused by the lens, which acts similarly to the lens of glasses, and is projected on the retina to activate special cells, *cones and rods*, which are light sensitive. These cells transform light into electrical signals which are then transmitted along the optic nerve to reach the visual cortex of the brain.



THE SENSE OF HEARING

EXPECTED LEARNING OUTCOMES

On completion of this module, the children will be able to understand the following:

- Sound is produced by vibrations;
- An object vibrates when it oscillates continually and rapidly in a regular fashion;
- Sound is gathered by receptors sensitive to sound waves which are found in the air, and which are transmitted to the brain through a nerve.

SUBJECT MATTER

- The subject matter of each section of the module are hereby detailed (**in bold**, the concepts or notions to be transferred, *in italics*, the experiences to be used in the inductive teaching methodology).

THE SENSE OF SOUND AND THE EAR

Sound is produced by vibrations

- *Ask the children to leave the classroom. Before getting them to come in again, connect your cell phone or the classroom computer to a web site that transmits the sound of a mechanical clock. Once this is completed, hide this from the children. See the following site: (https://www.youtube.com/watch?v=zHIVeWhCMU8) The sound of the clock is sufficient for this experiment. Increase the volume so that the*

ticking of the clock can be perceived by the children as an indistinct sound.

- *Ask the children to come into the classroom and sit in a circle in silence and listen to the sounds of the classroom for one minute. Ask the following: Have you noticed any sound that is normally not present? Can you remember where you have already heard this? What sound is it? What you think is making the sound? What part of the room to think it is coming from?*
- *Leave the children to discuss these questions together. Show them the source of the sound and turn it off. Explain to them that we are now investigating the sense of hearing.*
- *Ask the following: How are sounds made? Let the children discuss this together. Hold a thick rubber band between two hands and ask one of the children to pluck it like a guitar string. Get them to listen carefully.*
-

- *Ask the following: What did they noticed? (That the rubber band oscillated back and forth, and produced a sound).*

- *Tell the children that this back-and-forth movement is called vibration.*
- *Show them a tuning fork and ask if anyone knows what it is. Let them discuss this together. Ask them to keep very quiet and listen carefully; make the tuning fork vibrate by hitting one of the prongs on a hard surface.*
- *Ask the following: What did you hear? (with a small tuning fork the might not be able to hear anything*). *Make the tuning fork vibrate again and hold it near the children's ears so that they can hear the sound.*
- *Ask the following: Did you see the tuning for vibrate? (No). Ask them to watch again when you place the vibrating tuning fork near a table tennis ball hanging from a thread. Ask the following: What happened? (The table tennis ball bounced every time it touched the tuning fork). Tell the children to bring out the tuning fork, after beating it, in a tank containing water. Ask: why the water splashes off? (The vibrations of the prongs of the tuning fork make water to move). Tell the children that even if vibrations are not always visible, sound is always generated by vibrations.*
- *Tell the children that they can also experiment using their own bodies to make vibrations to make sound. Get them to hum the letter "m" with*

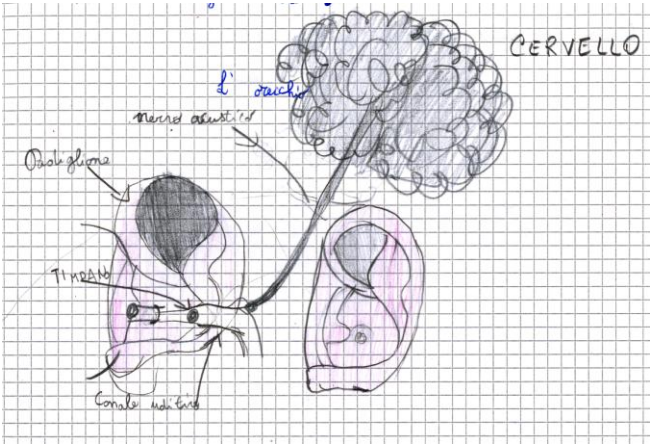
their mouths closed while holding two fingers to their throats.

- *Ask the following: Did you notice that when you make the sound, something was vibrating in your throat? Do you know what this was?*
- *Explain that there is a structure in the throat (the vocal cords) that vibrate with the passage of air to produce sound.*
- *Explain that every time a sound is made when we speak or sing, air from the lungs is forced through the vocal cords making them vibrate quickly back and forth.*
- *Check that the children have understood that sound is generated by vibrations, and that it can travel.*
- *Explain to the children that when an object vibrates, it exerts pressure on what surrounds it (air, water, etc.). If an object vibrates in the air, this creates waves which spread out just like the vibrating tuning fork which was able to move the table tennis ball.*
- *Sound waves that start from a vibrating object tend to spread, just like waves that are generated when we throw a stone into a puddle.*
- *Get the children to draw in their Science Workbooks the experiment of the vibrating tuning fork which, by generating a series of small waves, made the table tennis ball move.*

THE EAR AND THE BRAIN

Sound reaches the ear, and from here they are transmitted to the brain which decodes these signals and attributes a meaning to what we are hearing.

- *Ask the following: What part of your body allows you to hear? Ask the children to indicate where their auditory organs are (the ears).*
- *Remind them that they have already learned that all our senses are connected to the ....? Try to elicit the correct answer, the brain!*



- *Divide the children into pairs and ask each child to examine carefully the ear of their partner, and make a drawing of this in their workbook. Ask the following: Are your ears like those of other animals? For example, ask the following: What are rabbit ears like? How are they different from yours? Why do you ears have a different shape, and are they bigger than those of a rabbit?*

- *Explain that the visible ear is only the external portion of the auditory organ (the pinna or auricle). This is used to capture vibrations (sounds) and rather like a funnel, it channels these into the auditory tube.*
- *Get the children to make an "ear" with paper cups with the bottoms removed, to see if they can hear better when the place these against their ears like a funnel.*

- *Explain that at the end of the auditory tube there is a very delicate membrane which vibrates when sound reaches it. These sound vibrations are then transmitted by this membrane to a series of sensors which communicate with the brain.*
- *Using a piece of wool, get one of the children to connect the ear with the brain on the large diagram of the human body.*

The brain allows us to recognise and remember sounds, as well as establishing the direction from which these sounds come from.

- *In the previous experiment (the mechanical clock), the ears captured the sound and then the brain helped identify that this was the sound of a clock ticking, as well as where the sound came from.*
- *Divide the class into groups of 4 to 5 children, and give each group a photograph that evokes a certain situation involving sound. These images should represent scenes or places where many different sounds can be heard. Some examples can be found in the figures "Sound Scenes". Ask the children to act out the scenes, reproducing the sounds based on their personal experience and memory. Give them enough time to agree on which sounds have to be made. Ask each group to present their sounds to the class, without giving any indication on the specific scene that they are acting. After each presentation ask the other groups to try and guess what sounds they were listening to. Close this activity by showing the various images that inspired those sounds. Emphasise that the brain is able to remember sounds that have been heard.*
- *Using the same groups, try and get the children to recognise the voices of their classmates. The child that has to recognise the voices will be blindfolded, and the other children will repeat the same word in turn. This activity will allow the children to understand how a sound can be easily associated with a visual image, for example the face of the person that is speaking.*

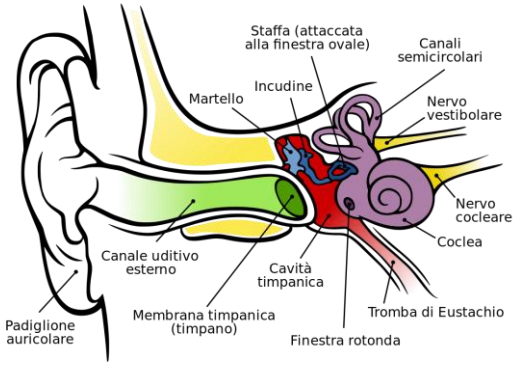
- *Ask the children to write one or two sentences in their Science Workbook regarding what they have learned from these experiments.*

Sounds can evoke memories and provoke emotions.

- *Like other senses, sound can also evoke memories and emotions (the fright caused by a sudden loud noise, the pleasure listening to nice music, the voice of a loved one, the angry voice of someone telling you off). Discuss with the children the following: In what part of your body does this association between the sound that you hear and the emotion that you feel take place? The ear? (wait for the children to answer: in the brain).*
- *Are there some sounds that help protect us from danger? (The noise of a car coming close, the sound of people arguing, the noise of a gunshot, the noise of a snake, the cracking of a branch that is about to break).*

Background Information for the teacher

Sound is produced by object that vibrates in the air (or in another medium such as water), producing a series of compressions and rarefactions which are known as sound waves. Even if sound waves contain very little energy, our ears and brain are able to identify their intensity and frequency, and also to locate their source. The human ear is constructed in such a way as to gather sound waves, and identify small changes in their intensity. The external ear consists of a *pinna* or *auricle*, and a short canal known as the *external auditory canal*. The bottom of the external auditory canal is closed by a membrane known as the *tympanum*. The *tympanum* vibrates (moving in and out) due to the change in pressure caused by sound waves. Three small interconnected bones present in the middle ear transmit these vibrations to a second membrane which separates the middle- from the inner-ear. The inner ear is a complex labyrinth of interconnected chambers and canals filled with fluid. The superior group of canals have an important function in the sense of balance. The inferior group of canals has a spiral form rather like the shell of a snail. This structure, known as the *cochlea*, transforms these waves of compression and rarefaction (the sound waves) into impulses which are transmitted via nerves to the auditory centres of the brain.



Rappresentazione schematica dell'orecchio presa dal web

TEACHING SUPPORT MATERIALS

Materials necessary for each class

- mobile phone (teacher)
- personal computer or interactive whiteboard (school)
- a large rubber band
- table tennis ball
- a meter of cotton thread and adhesive tape (see module: "The Sense of Sight")
- tuning fork
- scissors (see module: "The Sense of Sight")
- a set of "*Sound Scenes"* printed on card

For each child

- plastic cup
- copy of the page "What sound is it?"
- Science Workbook for each child

Preparation

Attach 30 cm long piece of thread to a table tennis ball.

Download to a cell phone or personal computer the ticking sound of a mechanical clock, for example see the following web site: *https://www.youtube.com/watch?v=zHIVeWhCMU8*, and adjust the volume so as it can be heard slightly.

Download from the web or copy from books five images of "sonic landscapes" characterized by easily regognizable specific sounds, such as the zoo, a football game, the playground, the band, the time, a race car (see example attached).

Images of "sonic landscapes" downloaded from the web




THE SENSE OF TASTE

EXPECTED LEARNING OUTCOMES

On completion of this module, the children will be able to understand the following:

- One of our senses is taste;
- The sense of taste is perceived by the gustatory system made up of receptors sensitive to taste;
- The tongue is covered in taste buds which contain gustatory receptors;
- The taste receptors on the tongue communicate with the brain which determines the taste that we perceive;
- The gustatory receptors identify various tastes and are stimulated by *sweet, bitter, sour, salty* and (less known) umami (savoury).

SUBJECT MATTER

The subject matter of each section of the module are hereby detailed (**in bold**, the concepts or notions to be transferred, *in italics*, the experiences to be used in the inductive teaching methodology).

THE TONGUE AND THE SENSE OF TASTE

The tongue is covered by taste buds which contain specific gustatory receptors.

- *Ask the children what their favourite taste is. They will probably name some foodstuffs that are sweet, salty or sour, or they may describe some complex combinations of tastes.*
- *Explain to them that with this information you will draw a table on the board indicating the four*

main tastes (at this stage do not mention umami, which is little known in Italy). Ask the children to place in each column the food that corresponds to each taste.

- *Ask the following: Where does the sense of taste happen? Probably the children will indicate the tongue.*
- *Have you ever thought that your tongue is connected to your brain? Think about this! Discuss with the children that information regarding taste is transmitted to the brain (the various receptors on the tongue are activated when they "feel" different chemical substances, and they send signals to the brain which interprets these as tastes).*
- *Divide the children into pairs and ask them to examine the tongue of their partner using a light source. Ask them if they notice any small protuberances on the tongue (the easiest ones to notice are those that form an upturned V shape, at the base of the tongue). It could be useful to write the number 10,000 on the board, and explain to the children that this is the number of taste buds normally found on a tongue!*
- *Get the children to make a coloured drawing of the tongue in their Science Workbook.*
- *Tell them that now we will start to conduct a study using our sense of taste. Emphasise the fact that when at school we don't usually taste chemical substances, but in this case we will do so. Tell them not to worry because the substances*

that we will taste are very safe. Get the children to wash their hands before and after this activity.

- *Divide the children into groups of five, and give each group a tray. Show them how to divide this into four quadrants using a marker pen. Tell them to number these quadrants from 1 to 4. Give to each group the paper cups numbered from 1 to 4 which contain the mysterious substances.*

- *Give each child 4 cotton buds. Tell each child that they have to dip the cotton bud <u>only once</u> into paper cup number 1, and then touch their tongue with it. Show them how this is done and get them to repeat the action. Ask the following: What does it taste like? Tell the children not to exchange cotton buds with others. Let them discuss between themselves and listen to the answers. Tell them to throw away this cotton bud, and use a new one to do the same activity but with cup number 2.*
- *Ask the following: What does it taste like? Again, get them to exchange their observations, this time also between groups.*

- *Ask and now to do the same with cups number 3 and 4, paying attention to use clean cotton bud for each test. Again, get them to exchange their observations, this time also between groups. At the end of each trial, make sure the children throw away the used cotton buds. (The substances contained in the cups are: water, sugar, salt, lemon juice).*

THE TONGUE AND THE BRAIN

The gustatory receptors communicate with the brain which decodes and attributes taste to the various signals that it receives.

- *Ask the children: How were you able to identify the contents of each of the 4 cups? Ask the following: What taste did cup number 1 have? And number 2? (and so on). What part of the body lets you recognise the different tastes (The brain).*
- *Ask the children to attach a piece of coloured wool to indicate the pathway that connects the tongue with the brain on the large diagram of the human body on the classroom wall.*
- *Give each child a transparent plastic cup full of water and a plastic teaspoon, and another cup containing a little sugar. Tell them that they will now do another experiment on our sense of taste. Ask the following: What taste does lemon juice have without sugar? (bitter or sour). Why do people add sugar to lemon juice? (to make it sweeter). Do you prefer things that are very sweet*

or just a little sweet? Ask each of the children to put a teaspoonful of lemon juice and a teaspoonful of sugar into their cup, and stir carefully to dissolve the sugar. Check that the children have only used one teaspoonful of sugar and one of lemon juice. Ask them to sip the liquid. Ask the following: Is your lemon drink sweet enough? Is it still sour (or bitter)? Have you tasted other things that are sweet and sour at the same time? Ask the children to add another teaspoon of sugar, stir carefully and then taste again. Ask the following: Now do you like the lemon drink more or less than before? Discuss with the children about individual tastes, I like/I don't like, and how this information comes from their brains. Highlight the fact that likes (or oppositely, dislikes) for a certain food can change over time, and are different from person to person.

- *Ask the children what their favourite food is, and write down the answers. Draw a bar chart on the board with the information on the children's favourite foods, dividing them into the four fundamental tastes (sweet, bitter, sour, and salty).*

Tastes can evoke memories and provoke emotions.

- *What sensations can taste evoke? (pleasure, disgust). Can it make you remember something that tasted good? And something that didn't taste good? In what part of your body does this association between what you taste and the emotion that you feel take place? On the tongue?*

(in the brain). Can you remember any horrible tastes? Can you give any examples? (sour milk, food which is rancid or that has gone bad). Can you imagine why these tastes are not interpreted by our brain is being good? Give the children time to think about this (the brain helps us defend ourselves from the external environment, and so creating a sense of disgust with certain foodstuffs that may harm us). Therefore, everything that tastes good is good for us? (no, because there are some things that can be dangerous for our health that may taste good or have no taste at all, e.g. poison with no taste, poisonous mushrooms which may even smell like tasty mushrooms), or there may be some foods that we like but are not good for our health.

Ask the children to write one or two sentences in their Science Workbook regarding what they have learned from these experiments.

Background Information for the teacher

Our sense of taste opens a window to the entire chemical environment that surrounds us. It adds pleasure to our lives, and also protects us from danger. We "taste" food with a series of chemical receptors which cover the surface of our tongue. The tongue is covered by thousands of small protuberances called taste buds; about 10,000 of these are found on a normal tongue.

Taste buds contain taste receptors which interact with chemical substances that enter our mouths and send signals to the brain. These are combined with other olfactory signals from the nose and create what we identify as taste.

We recognise four fundamental tastes: *sweet*, *bitter*, *salty*, *sour*, and another recently added taste *umami* (savoury) which is derived from

the presence of monosodium glutamate in food. Foodstuffs such as bacon, mushrooms and fermented food such as cheese or soy sauce are rich in umami.

The tongue does not only identify taste, but similar to the skin, it also detects pressure, temperature and pain. The thermal receptors of the tongue are also sensitive to spiciness, or even the cold sensation of mint.

Additional notes
Our sense of taste is already active before birth. It is thought that a child in the womb is already exposed to the foods that the mother eats. Perhaps this is what influences our preferences for certain foods later in life.

TEACHING SUPPORT MATERIALS

First experiment

Required materials for each class

- bottle of lemon juice, 500 ml (teacher)
- sugar (teacher)
- salt (teacher)
- Large diagram of the body (the previous year's model can be used)
- marker pen

For each child

- marker pens or coloured pencils
- 4 cotton buds
- plastic spoons
- Science Workbook for each child

For each group of 5 children

- cardboard or plastic tray

- 4 plastic cups, each containing a small quantity of salt, sugar, water, lemon juice

Second experiment

Required materials for each classis

- bottle of lemon juice, 500 ml (teacher)

For each child

- plastic spoon
- transparent plastic cup half filled with water
- small plastic coffee cup with a little sugar

Preparation

For the first experiment get the children to work in groups of four. For each group prepare a tray and a set of 4 plastic cups numbered from 1 to 4. Put in each plastic cup a small quantity of each of the substances (1: lemon juice, 2: sugar, 3: water, 4: salt). For each child, prepare 4 cotton buds.

For the second experiment, prepare a plastic cup half full of water for each child. Place on the tray (one for each child), the cup with water, the cup with sugar, a half cup of lemon juice, and a plastic spoon.

THE SENSE OF SMELL

EXPECTED LEARNING OUTCOMES

On completion of this module, the children will be able to understand the following:

- The sense of smell is one of our senses;
- The nose detects (smells) the presence of odours in the air;
- Odours are caused by the presence of tiny odorous particles (molecules) in the air;
- These odorous particles activate olfactory receptors that are found in the nose;
- Signals gathered by the olfactory receptors sense by the nose along the nerve to the brain which decodes these signals, allowing us to recognise odours.

SUBJECT MATTER

The subject matter of each section of the module are hereby detailed (**in bold**, the concepts or notions to be transferred, *in italics*, the experiences to be used in the inductive teaching methodology.)

THE NOSE AND THE SENSE OF SMELL

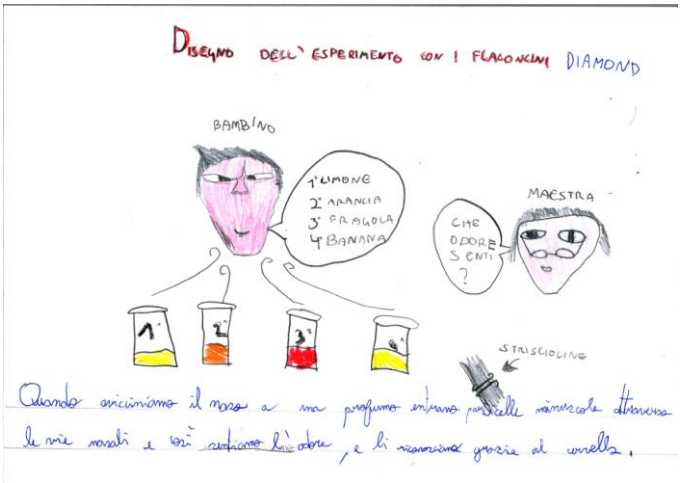
The nose allows us to identify odours.

- *Ask the children to identify their noses by pointing their fingers. Ask the following: What is the nose used for? Discuss the answers that the children give.*
- *Ask the children if they have ever examined their noses carefully. Divide the children into pairs and ask each child to examine carefully the nose of his/her partner. Get them to note that the nose has*

two openings, the nostrils, which allow air to enter the nasal canals. Underlined that the nose is important for respiration. Get the children to breathe in and out slowly so that they realise that air passes through the nose, together with odours.

- *Get the children to draw their own noses in their Science Workbook.*
- *Divide the children into groups of five and give each group a set of 4 fruity odours contained in four numbered jars (which they should not open until told), and some strips of paper (4 for each child, which they will number using a pencil from number 1 to 4).*
- *Ask the children to smell the jars without opening them. If the jar has not been contaminated with the contents, then the children should not be able to smell anything. Why weren't you able to smell the content of the jar? Get the children to share their ideas on this fact.*
- *Demonstrate what they have to do: Open the jars carefully to make sure they don't spill the contents, dip the piece of paper into the liquid and then smell it. (For any aromas in alcoholic solution, get the children to wave the piece of paper a little so that the alcohol will evaporate; to avoid any contamination between jars, children should only use the piece of paper with the number corresponding to that on the jar).*
- *Now get them to open the jars and smell the contents to try and identify them, making sure that each child has the opportunity to smell each of the four jars.*

- *Ask the following: Were you able to recognise the smell? Have you already smelt something similar? If they were not able to recognise the odours, then tell them that they were orange, lemon, strawberry, and banana.*
- *Tell the children that smells are made of tiny little chemical particles (molecules) which are dispersed in and travel through the air. When these tiny particles enter our nasal canals, they are recognised by nerve terminations (olfactory receptors) located in the nose.*



- *To demonstrate the dispersion of these odorous particles (molecules), get each group of children to dampen 2 cotton wool balls in one of the odorous liquids. One of these dampened cotton wool balls will be placed in a closed jar and the other one will be left in the open air next to the closed jar. The following day, ask each child to*

smell both cotton wool balls and ask them what differences they notice. (the cotton wool ball left in the open air will have lost most or all of its smell). Ask them why this is. (Explain that the smell disappeared as the chemical substances that produce it were dispersed into the environment). Is the sense of smell the same in all animals? You could get them to discuss the fact that dogs are able to find hidden food in the house only by using the sense of smell.

- *Close the jars with the odorous liquids.*

THE NOSE AND THE BRAIN

The olfactory receptors communicate with the brain which decodes and attributes a smell to the signals which are captured by the nose.

- *Ask the children: How are you able to recognise the smells contained in each of the four jars? (because we already knew those smells and we remember them). What part of the body allowed you to recognise these different smells (the brain).*
- *Discuss with the children the concept that the substances that they smelled were identified thanks to messages sent from the nose to the brain by means of a nerve.*
- *Ask the children to attach a piece of coloured wool to indicate the pathway that connects the nose with the brain on the large diagram of the human body on the classroom wall.*

Smells evoke memories and provoke emotions

- *Have you ever smelled something that made you think of a favourite food? How did this make you*

feel? Did you feel disgusted? Did you feel happy? In what part of your body does this association between the odour that you smell and the emotion that you feel take place? In the nose? (wait for the children to answer: in the brain).

- *Do you know any horrible or disgusting smells? Can you give any examples? (gas from the stove, sour milk, food that has gone bad, cigarette or cigar smoke, dog faeces which have been trodden on). Can you imagine why these smells are not interpreted by our brain as being good? Give the children time to think about this (the brain helps us defend ourselves from the external environment, and so creating a sense of disgust for things that may harm us). Therefore, everything that smells good is good for us? (no, because there are some things that can be dangerous for our health that may smell good or have no smell at all, e.g. an inodorous poison, poisonous mushrooms which may even smell like tasty mushrooms).*

As well as activating our memory, olfactory stimuli – often together with gustatory stimuli – can also produce reflex responses.

- *What happens when you're hungry and you smell something that you like, e.g. pizza? (we could say that our mouth starts watering, or stomach starts to rumble). Explain that this is an example of a*

reflex mechanism which is started automatically to favour the digestive process: when we receive these signals, our bodies get ready to receive food, even if the pizza is not eaten.

- *What happens when we smell pepper? (we sneeze). Why? (to expel the odorous pepper molecules from our nose).*

Ask the children to write one or two sentences in their Science Workbook regarding what they have learned from these experiments.

TEACHING SUPPORT MATERIALS

Required materials for each class

The large diagram of the human body used previously.

For each group of 5 children

- 4 screw top jars, numbered from 1 to 4, each containing one of the four selected odours: lemon, orange, strawberry, banana (be careful not to contaminate the outside of the jar: the content should not be perceived when the jar is closed)

For each child

- 4 strips of paper to smell the odours, numbered from 1 to 4 (for a total of 80)
- Science Workbook

PREPARATION

Divide the class into groups of 5. Each group will have four screw top jars, each containing a different fruit odour (orange, lemon, strawberry, banana).

SAFETY

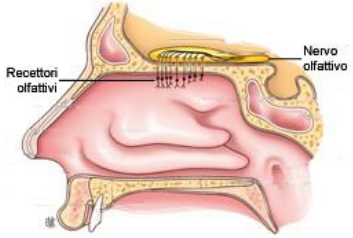
Get the children to wash their hands before and after this activity.

Background information for the teacher

Just like the sense of taste, the sense of smell allows us to identify chemical substances present in the environment. Indeed, often these two senses work together to gather information about the environment that surrounds us. Molecules reach are nose and nasal canals through the air that we breathe, and make contact with a surface tissue known as the olfactory epithelium. This tissue hosts a series of olfactory receptors (which are specialised in neurones) which link to specific molecules and respond by sending signals to the olfactory bulbs in the brain, and from here to the olfactory cortex. Neurones present in the olfactory cortex interpret the signals and transmit information regarding the perceived odours to the thinking part of the brain.

The olfactory system allows us to identify thousands of odours which can be roughly divided into about 10 primary groups (primary odours). An example of such classification (there are many possible classifications): fragrant, floral, resinous wood, sweet, non-citrus fruit, lemon, popcorn, pungent, putrid.

The sense of smell is also closely linked to memory. Have you ever noticed a smell that has evoked a memory of your childhood, a specific place or specific circumstance? It is thought that this is due to the many connections that the olfactory cortex has with the *amygdala* and the *hippocampus*: this first organ is responsible for emotive memory, whereas the *hippocampus* regulates what is known as working memory and short-term memory.



Rappresentazione schematica di una cavità nasale presa dal web

THE SENSE OF TOUCH

EXPECTED LEARNING OUTCOMES

On completion of this module, the children will be able to understand the following:

- Another of our senses is that of touch;
- The sense of touch includes various sensations such as pressure, temperature, and pain;
- The sense of touch varies in different parts of the body;
- The sense of touch is perceived by touch receptors which are found on the surface of our bodies and which send signals to the brain to be analysed, thus allowing us to perceive and distinguish between different touch sensations.

SUBJECT MATTER

The subject matter of each section of the Module are hereby detailed (**in bold**, the concepts or notions to be transferred, *in italics*, the experiences to be used in the inductive teaching methodology).

THE SURFACE OF THE BODY AND THE SENSE OF TOUCH

The touch sense varies in different parts of the body.

- *Give each child a cotton wool ball. Ask them to touch it, then ask the following: What consistency does it have? Let them discuss their answers. Ask the following: Isn't it rather like a teddy bear? Ask the following: What did your fingers tell you?*

Ask the children to describe the texture of the cotton wool ball.

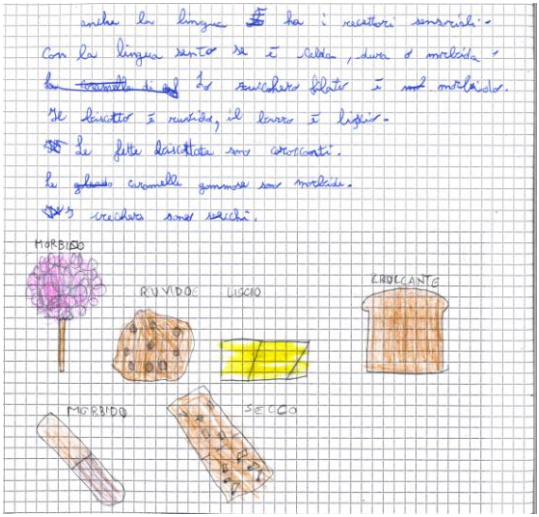
- *If they don't understand the term "texture", explain to them that this means what they feel when they touch an object. Ask the children to think of some examples of words that describe texture (e.g. smooth, rough, hard, soft, uneven, spiny, grainy, etc.).*
- *Remind the children that they have already learned much about the sense of sight, hearing, taste and smell. Each of these senses is based on sensory receptors which are situated in specific organs, and which gather information from the environment and transmit signals to the brain.*
- *Ask the following: Where do you think touch receptors are located? Most children will probably answer "on our fingers". Ask the following: Can you feel things with your elbows? Get them to touch the cotton wool balls with their elbows. Did your elbow feel the cotton wool ball? Check that the children have understood that the entire surface of our bodies is covered by touch receptors.*
- *Divide the class into pairs and give each couple one of the numbered bags each containing two similar but different objects. Demonstrate the activity to the children. Blindfold one of the children in each couple (the "subject") and tell the child also to keep his/her eyes closed. Tell the other child (the "researcher") to take the two objects from the bag and run these lightly one at a time along the forearm of the other child; the*

researcher will then ask the subject: Can you tell me the difference between these two objects? Do you know what they are? Then the researcher will place the two objects in the hands of the subject (still blindfolded) and will ask him/her to identify them.

- *Exchange the bags between the pairs, making sure that in the end each couple can experiment with the content of the various bags. Get the children to exchange roles and repeat the process in the time available.*
- *Discuss the activity and the results with the children. Ask the following: Was it the same when you felt the object with your arm and with your fingers? What differences did you feel? Why do you think this was? Explain to the children that the entire body is covered in receptors that can "feel", but some parts of the body have more receptors than others. Those areas that have more touch receptors are more sensitive.*
- *To underline the varying distribution of touch receptors in our bodies, conduct the following activity: get a child to close his/her eyes and touch the palm lightly with either one or two fingers slightly separated, and ask how many fingers are felt. Repeat this operation varying each time the number of fingers. The child will probably always reply correctly. Repeat the same experiments but now touching any part of the back: each time the child will most likely reply that only one finger is felt (this is due to the fact that the sense of touch and the ability to*

distinguish between two adjacent points is much greater on the hands than on the rest of the body).

- *Ask the following: does the tongue have touch receptors? Listen to their answers and try and lead them to the conclusion that the tongue has touch receptors which give information on the consistency of food (hard/soft, smooth/rough, chewy/crunchy, dry/moist) and that our sense of taste is also connected to the tactile sense of the tongue.*



THE SENSE OF TOUCH AND THE BRAIN

Touch receptors communicate with the brain which decodes and attributes a significance to the signals it receives.

- *Ask the children: How did you manage to identify the various objects just by touch? (because you*

already knew those sensations). What part of the body did allow you to recognise different textures and shapes? (the brain).

- *Ask the following: What else can our brain tell us when stimulated by our touch receptors, apart from giving us information about shape, size and texture of objects? (cold, hot, pain). If we touch something that has just been taken out of the freezer, what sensation do we get? And if someone touches you with a pin? Discuss with the children that the sense of touch can also give us information concerning the temperature of an object, and also any pain that this might generate.*
- *Ask the children to attach strings of coloured wool on the large drawing of the human body to indicate the connections between various parts of the skin with the brain.*

Touch stimuli evoke memories and provoke emotions

- *Ask the following: Can touch stimuli provoke emotions? Get the children to discuss this between themselves (possible discussions: hugs or kisses from mom, a comfort blanket, a teddy bear, the feeling of a warm house on a winter day, the pleasure of taking off shoes – especially if they're tight, scratching a mosquito bite, etc.). In what part of your body does this association between all these sensations and the pleasure or the memories that you feel take place? On your skin? (we would expect the children to answer: in the brain).*

Touch stimuli can produce reflex responses

- *What happens if we touch something very hot like a frying pan? (our hand retracts very quickly and automatically). Explain that this is an example of a reflex mechanism which is started automatically to protect ourselves.*

Ask the children to write one or two sentences in their Science Workbook regarding what they have learned from these experiments.

TEACHING SUPPORT MATERIALS

Required materials for each classis

- The large drawing of the human body used previously.
- Paper bags numbered progressively, one for each pair.
- Pairs of similar objects that can be recognised by touch (two for each bag). Suggestions: piece of paper and paper handkerchiefs, cotton fabric and wool fabric, coarse and fine sandpaper (each approximately 3x3 cm), pieces of string and wool, piece of electric wire and a rubber band, button and coin (of similar sizes), smooth stone and rough stone, glass ball and plastic ball, kiwi and mandarin, walnut and almonds.

For each child

- Cotton wool balls

PREPARATION

Before the children enter the class prepare the numbered bags, each containing two similar objects. Divide the

group into pairs and give to the researcher of each pair one of the closed bags.

SAFETY

Get the children to wash their hands before and after this activity.

Background information for the teacher

The sense of touch is often described as a single sense, however, the capacity to distinguish between a pinprick and a feather requires many different types of receptors to be present our skin. Indeed, the sense of touch consists of a variety of senses which are fairly distinct: the skin and the underlying tissue are capable of identifying pressure, vibration, temperature, and pain. Receptors for the different types of touch are not distributed equally over the surface of the body. For example, some areas of the body are more sensitive to pain whereas others may be more sensitive to pressure. In addition, some areas of the body have much higher concentrations of touch receptors than other areas. For example, the tip of the tongue and the fingertips contain many more touch receptors than other parts of the body. One of the activities in this section will allow the children to compare the relative sensitivity of the skin in different parts of the body (fingertips and forearm). Trying to compare the differences between the two similar objects but with slightly different shape, the children will appreciate that some areas of our bodies are more sensitive than others. This is because some parts of the body have more touch receptors than others.

MODULE 7
A JOURNEY INTO THE KNOWLEDGE
The executive mental functions

1. INTRODUCTION

To deliver this module effectively, the following preliminary steps should be taken:

Verify the level of retention by the children's of their knowledge acquired the previous year about the brain, what are its functions, what are the connections with our sense organs, paying particular attention to the following notions:

— the brain and its extention, the spinal cord, are soft organs and as such, they are protected by hard skeletal structures (the cranium for the brain, and the spinal column for the spinal cord);

— the brain and the spinal cord are formed by billions of cells (neurones), which are interconnected between themselves by long extensions which creates a widespread and dense network (through which electrical signals are transmitted);

— the brain and the spinal cord are connected to all parts of the body through nerve fibres which originate in the neurones and exit the cranium and the spinal column to reach the tissues and organs of the body, transmitting commands from the brain to these parts of the body. Other fibres running in the

opposite direction take signals from these parts of the body to the brain;

— due to the high number and dense network of neurones, the brain is able to: 1. recognise, compare, select, and integrate signals that arrive from the external environment (through our sense organs) and from within our bodies (through receptors); 2. send to the entire body "command" signals to carry out voluntary and involuntary actions.

Elicit the children's retention of the subject matter studied in the first year of the programme regarding the concept of the environment. In particular, it is important to confirm the following:

— and "all-encompassing" concept of the environment which, depending on the circumstances or context, does not only include the physical environment, but also humans, animals, and plants;

— the concept of continual "interrelation" and more importantly of "exchange" (exchange of substances, of information, of relationships, etc.) between all components belonging to this environment.

In this context it is useful to ask the children to comment on images of different environments, and get them to describe those which are most familiar (the home, school, familiar play areas, etc.) and to identify different types of exchanges that occur between the various components of these environments (material exchanges between the resources of the physical environment and those using it, and immaterial exchange such as actions, knowledge,

experience, sentiments, emotions, etc., between the people within these different environments).

Prepare a poster to record the various functions of the brain which will be examined by the children during delivery of this module ***(poster "brain/mind").***

This poster will have an image of the brain at the centre, and a series of arrows radiating from it will be progressively added indicating the various functions that will be examined (memory, learning, etc.), to be named by the children in their own words. This poster will be compared with a similar one which was prepared the year before, showing the brain connected to the rest of the body by wool threads to illustrate the two brain functions that were being studied, acquiring and elaborating incoming signals; sending out various command signals to govern the different activities of the body.

To maintain a certain consistency of reasoning – which aims to highlight how behaviour is the result of integration between the brain, the rest of the body and environment – it is appropriate during the preparation of this poster to refer to the concepts studied in the previous year regarding the various cerebral activities (voluntary actions, reflex actions, involuntary actions).

During the delivery of this module it will also be useful to encourage the children to manifest any queries regarding the brain and its functions, noting down any of their more significant questions.

On completion of the module it will be useful to summarise what is represented on the "brain/mind" poster, pointing out that the connections that exist between the various areas of the brain allow it to carry out its complex functions (perception of external and internal signals, the sending of "command signals", memory, learning, coordination between thought and action, emotions). Invite the children to indicate any other functions that they may think attributable to the brain (feelings, fantasy, creativity, etc.).

2. EXPECTED LEARNING OUTCOMES

This module aims to create awareness in the children that the brain is the primary organ which allows the person to maintain a continual relationship and constant exchange with the external environment understood in its wider context, as well as the internal environment of one's own body. To achieve this aim, some functions – namely the "executive mental functions" – are particularly developed in the human brain, due to a series of functional connections within the neural network. These functions, greatly conditioning the character and behaviour of all human beings, are represented by complex mental processes which permit thought, attention, accumulation of memories, planned actions, and to carry out other sophisticated activities (e.g. speech, reading, writing, inventing, fantasising, etc.).

One completion of this module the children will be aware of the following:

— Most animals, humans included, have a highly organised nervous system, a part of which, the brain, is responsible for the central coordination of all complex activities of the organism;
— In humans and in many animals, the brain is the primary organ which allows us to be connected (see: Module: *"The Brain: The journey of knowledge"* completed the previous year), and is capable of exchanging signals both with the external environment and with the rest of our bodies;
— The human brain is a very efficient and complex organ. It is not only capable of receiving and sending signals, but is also able to elaborate information due to the functional interaction that exists between neurones; thus, the signals it receives can generate a series of functions which characterise humans and which are defined as "executive mental functions";
— These "executive mental functions" allow the human to carry out very important functions such as thought, speech, memory, the planning of actions, to feel emotions and sentiments, etc. These functions are indispensable to maintain contact with both the external environment and the rest of our bodies, and also for us to learn and to "grow up";
— One of the most important executive mental functions is that of *memory*, which allows us to accumulate and interpret signals, to make comparison between these, and also to undertake all normal activities of daily life;

— The *coordination between thought and action* is an executive mental function which allows the human to undertake complex voluntary actions and, as such, conditioned by the thought process;
— *Learning* is an executive mental function because it allows the humans, starting from birth, to continue to enrich and widen their knowledge base.

3. SUBJECT MATTER

The subject matter of each section of the module are hereby detailed (**in bold**, the concepts or notions to be developed using an inductive teaching methodology; *in italics*, the experiences to be used).

MEMORY

Memory, or the capacity to remember, is one of the principal capacities of the brain: to be able to conserve in our mind the history of our lives, and therefore to remember past experiences (events, readings, lessons and conversations, images, sounds, emotions, ideas, affection, fantasies, etc.). Refer to the *Play Activity* concerning *The Memory.*

— *Verbal presentation of the task, ask the children if and when they think of their memories, and if they enjoy remembering;*
— *Ask the children to give written answers to the following three questions: What does "to remember" mean? Where are your memories? What are memories used for?*
— *Ask the children to make a drawing of a beautiful memory and one of bad/sad memory, and prepare a*

poster for their drawings divided into two sections: beautiful memories, and bad/sad memories;

— *Discuss the written answers and also the poster with the drawings together with the children, to answer the following questions: do you like thinking about your memories? Do we only remember facts, people, things, or we also remember fantasies and emotions? Are memories useful only to give us information about the past, or are they also useful for the present? Can you live without memories? Can you sing a song without being able to remember it? Can you go back home from school without remembering the streets that you have to take?*

All human beings can remember and therefore have memories, and – if we think about it – we realize we can recall these memories.

— *Homework: a short interview asking one family member (parent, grandfather, brother, sister) to tell you about the happiest and the worst memory that*

they have. To simplify the review of this work in class, this task could be assigned as follows: some children can be assigned to interview their parents, others their grandparents and others their siblings. Once the interviews are finished, the children will have to write or draw about the story. The conversation in class to review the written texts can be animated by questions such as the following: What events regarding our lives are remembered the most? What emotions are connected to these memories? How do these memories change with age? Why are these events not cancelled from our memory? Is it easier to remember things that we personally have been doing (listening, seeing, touching, etc.), or things that have been told to us?

— *Get the children to speak freely about memory, giving input such as the following: can someone live without memories? Does your father, mother, brothers, the teacher all have memories? Do we realize that we remember?*

Memory consists not only in storing information that reaches the brain, but also in the elaboration and integration of this information, and analysing it with other information that has already been elaborated and is present in our memory.

— *Show the children a series of images (people, cityscapes) and ask them if they recognise the places or the people: how do you recognise things people? (see Teaching Support Materials);*

— *Ask the children: how do you recognise your own mother amongst all of the women waiting for the children after school? (by comparing the images of all the women with that of one's mother which is registered in our memory). How do you recognise your own house from other houses? (by comparing the images of different houses with that of your own house which is registered in your own memory).*

Why don't you eat food that you don't like? (because you compare the food that is on your plate with the sight and flavour registered in your memory of the same food that you have tried in the past and didn't like). Why do you like going to the park to play? (because your memory can associate the park with fun times you had there.

— **During our lives billions of signals reach us from the external environment and from our own bodies. Of all of these signals, only those that draw our attention, or that seem interesting or important, are registered in our memory.**
— *Propose some games to stimulate the attention of the children based on some visual cues (the classroom, the teacher, the furniture, etc.) or sound (the noise of traffic, the sound of a classroom of children, etc.) that are taking place at that moment and which are normally not recorded in our memory;*
— *Reason together with the children how remarkable events that have really occurred are permanently stored in our memory (e.g. meeting a famous football player or singer).*
— **Not everything that is registered in our memory remains there for a long time. Less important experiences are often very quickly cancelled or forgotten (short-term memory).**
— *Ask the children some questions about some memories that have probably been forgotten or at least recalled only partially (e.g., what did you have for lunch three days ago? A song or a poem*

that you used to know but now you cannot remember?);

— *Memory Game: The ability to remember 5 -10 everyday objects observed one minute (observation skills and short-term memory). (See Play Activity and Teaching Support Materials: Kim's Game, Memory Game).*

More important experiences, however, tend to remain in our memory longer or sometimes for our entire lives (long-term memory).

— *Ask the children (noting down any significant answers) if there is anyone that believes to have a memory that will last their entire lives;*

— *Ask the children if they have any vivid memories of a long past experience.*

Even animals are able to remember.

— *Ask the children if they can give any examples of the memory of pets; if they recognise the people that live in the house; do they remember where their food is, etc.);*

— *Tell about famous animal stories in which memory plays a fundamental part, e.g. dogs that are able to return home; carrier pigeons; swallows that return to the same place every year to nest; police dogs that use the sense of smell to find things. Show the video of elephants that can remember situations that had occurred many years previously ("to have the memory of an elephant"). Show the video of the surprising working memory of a chimpanzee (see teaching support materials). Discuss with the*

children the advantages of having such a short-term memory for animals that have to move rapidly in complex environments such as the jungle, in which chimpanzees have to jump from one branch to another.

Our memory is influenced by our emotional state and by the quality of these memories.

— *Refer to the poster with the drawings of happy and bad/sad memories, and also the interviews with family members and how we tend to remember happy memories of long desired events (a school trip, a present, a sign of friendship) and how we tend to forget any traumatic or sad experiences (an accident) or information that doesn't interest us (the lesson, a report card). Use the material "Mandala of Emotions" or the Flower Game (see teaching support materials).*

Add to the "brain/mind" poster the additional information acquired in this section

COORDINATION BETWEEN THOUGHT AND ACTION

Some of our bodily functions are involuntary but, in general, they are voluntary which means that they are guided by our thoughts.

— *Give some examples of in involuntary actions (heartbeat, yawning, sneezing) and voluntary actions (walking, running, reading, writing, etc.).*

To carry out a voluntary action we have first to think about it, and then apply both attention and memory and then send command signals to activate the various parts of our bodies in a coordinated manner.

— *Ask the children to carry out some everyday activity, and analyse these together (tying shoelaces, walking towards the door, moving an object, etc.);*

— *Ask the children now to carry out some more complex actions and try to analyse the progressive adjustments of the body (e.g., walking on a piece of string on the floor as if it were a tightrope, throwing a table tennis ball into a wastepaper basket) (see teaching support materials); visual evaluation of the nature of different objects, such as their weight and shape) (see teaching support materials, "objects with unexpected weights").*

— *Ask one of the children (or even a pair) to teach the other children a simple group game by writing on a poster (with the help of the teacher) the instructions of the game. The purpose is to verify if the game when carried out is a true reflection of the written*

instructions, and if all necessary information such as the sequence of actions to be carried out, etc. were correct.

To achieve a group objective, we have to be able to coordinate our actions with those of others.

— *Organise some improvised activity common to the classroom (singing in chorus, dance, movement activity), underlying the concept of coordination between different individuals;*

— *Comment on some images of group activities (a football match, an orchestra playing music, a tug-of-war, etc.).*

When we want to carry out an activity that we've never done before, very often we make mistakes.

— *Give examples using photographs showing the training that is needed to carry out complex activities (playing an instrument, learning to recite a poem, being good at football, etc.);*

— *Get the children to undertake some complex activities (make a paper aeroplane, fold paper to make a little box, etc.) for which they will need the teachers help (see teaching support materials).*

Animals also have a good capacity to plan and memorise so they can carry out complex activities, such as storing food, hunting, looking for a mate, building a nest, an anthill, a dyke, a beehive. These are all extraordinary activities which require great skill.

— Show the children videos of complex activities of crows and octopuses (see teaching support materials). Visit to the Zoological Museum (with models of an anthill, beehive, spider's web).

Add to the "brain/mind" poster the additional information acquired in this section

LEARNING

Learning is an important skill of the brain which allows us to acquire new knowledge and therefore to generate new behaviours and ideas.

— *Ask the children what they think they have learnt at home (how to undertake the normal physiological needs correctly, to dress themselves, to wash themselves, to have good relationships with others, etc.);*

— *Ask the children what they think they have learnt at school (reading, writing, to have good relationships with others and the teacher, etc.);*

— *Gather all of these answers in a poster divided into two parts: learning at home, and learning at school.*

At birth we have no memories, but very soon we start to recognise our surrounding environment, under the protection and with the help of our parents.

— *The teacher could perhaps show the children some photographs of when they were very young, and possibly other pictures, chosen to discuss how the way we dress has changed in time; how our toys, our everyday objects, and also our environment have changed, but – at the same time – how the attitude of adults towards children does not change through time nor in different cultures;*

— *Written assignment: Which is your first memory of when you were younger? Put these in a folder and ask the children to continue to add more information (during the delivery of this module) regarding memories of their lives such as photographs, drawings, etc.). This collection of material "As We Were", should be left available for the children to look at when they want to.*

In the early months of our lives we start to recognise some people, and manifest certain sentiments towards them. This means that we are able to recognise experiences and attribute either positive or negative significance to these based on our memory.

— *Ask the children if they have any younger siblings, cousins or friends so that they can tell the class their own observations: when was the first time that they understood that their little brother/sister recognised them? How di you notice that he had learned something new? (because he started eating by himself, using the spoon, smiling to mom etc.).*

In any cultural or environmental context children in the first year of life show very similar behaviour, and they tend to start standing and walking at a very similar age.

— *Show the video of infants from different cultures. (See teaching support materials, video "Babies 2010 excerpts"). Stimulate discussion by asking questions such as: What do babies have to learn at a very young age? How do they learn? Do they learn only with the brain? Does the environment in*

which baby grows make any difference? And if yes, in what way?

When human beings or animals grow, they need more and more information and knowledge: learn how to eat, how to avoid danger, how to relate with others, how to have fun, how to establish relationships with the environment, etc. We human beings have to learn how to speak, to get to know ourselves, to get to know the people we love, and also people that we don't like.

— *Show the video of the Capuchin monkeys in which we can see the young monkeys watching the mother and imitating her gestures when she cracks nuts with a stone, or chooses ripe fruit to eat. (see teaching support materials, and possibly the complete DVD on Capuchin monkeys). (What does the mother do? What do the babies do? What difficulties do they have to overcome?);*

— *Games to be conducted in class: a puzzle, a test for the children, situations/problems to be resolved (problem of the shepherd, the goat, the cabbage, and the wolf), and reflection on the actions and thoughts that take place during the game.*

As we grow our learning abilities increase (learning how to read and write, learning a profession or trade, becoming good at a sport, etc.).

— *Written homework: Now that you're old enough, what would you like to learn to do? Do you think you will succeed? What you need to do this?*

— *Encourage the children to prepare a second container with the title "What we will be". This*

container should contain material (drawings and photographs) and some writings regarding their ideas and aspirations for the future, and what they think they will have to do to achieve these goals.

Also animals are able to learn, but this is usually limited to satisfying their primary needs.

— *Ask the children if they can remember and describe any experience of pets having learnt something (e.g. remembering favourite food and how to obtain it, signs of danger, recognising people, everyday places, how some dogs help hunters look for the prey, how cats meow for food, use a litter tray for their needs; etc.);*

— *Comment on some photographs of animals carrying out trained activities (horses jumping over obstacles, dog offering a paw, cats standing on two legs, a falcon sitting on the shoulder of the falconer, etc.).*

The difficulty or ease with which we learn new things depends on the environment, on our level of interest, and also on our emotional state.

— *Encourage the children to describe environments, situations or people with which they feel at ease and can easily learn things;*

— *Get them to remember some experiences in which they learnt something difficult (a game, some dance steps, arithmetical division, skating) because they really wanted to do it, or because their parents, a friend, or their teacher wanted it;*

— *Get them to describe a difficult moment in which they thought they ~~weren't able~~ wouldn't make it to learn a new activity. How can one overcome these difficult moments? Asking parents, the teacher, or friends for help? Triyng to do it on your own, pretend the difficulty doesn't exist, or even ignore the problem?*

Add to the "brain/mind" poster the additional information acquired in this section

4. PLAY ACTIVITY

MEMORY

Memory, or the ability to remember, is one of the fundamental skills of the brain.

The Forgetfulness Game

Start the story by imagining that one of the children in the class has lost his/her memory.

We could tell the children the following:

- School has finished and the bell has rung, but Giovanni can't even remember his own name. What will happen? The children will now have to imagine. He doesn't know how to get out of school, so what will he do? When he gets out of school, he doesn't recognise his mother and so he will probably start walking alone. What risks will he face as he doesn't know where to go? Giovanni could perhaps do what his classmates tell him to do.

Games to demonstrate how not everything is remembered in the same way.

- Memorise a sentence in Italian. Propose to memorise the same sentence in a foreign language. This last task would probably be more difficult.
- Propose some phrases: (e.g. "I will come to your house if you invite me to dinner") and then the same sentence but the words in the wrong order ("come I house if to you invite your will me dinner to"). This nonsensical sentence will be more difficult to memorise.

Mandala of Emotions (Flower Game) (from the book by Erickson, p. 61-62, modified)

Materials

- A copy of the drawing of the flower for each group
- A large-scale copy of the same drawing.

Procedure

- The teacher explains that the drawing of the flower that will be given to the children will help them to concentrate on their own positive emotions. Divide the class into groups of 3 to 4 children and give one copy of the drawing to each group asking them to write on the smaller petals the names of *positive emotions* and on the big petals the situations or experiences that generated these emotions. On completion of this task the children can colour in the petals.
- The teacher will collect the completed drawings. On the enlarged photocopy attached to the wall

the teacher will note down all of the positive emotions that were shared amongst the groups, and also the associated situations that generated these. Get the children to discuss any differences or similarities in the situations, and also the different colours used. Ask the children if they can remember any pleasurable situation that made them feel good when they were actually feeling sad.

- Get them to repeat the same drawing at home and hang it on their bedroom wall to help them remember past pleasurable moments when they're feeling sad.

Kim's Game

Place from 5 to 7 everyday objects on a table and ask the children to observe them for one minute. Cover these objects and then ask the children to write down their own list of the objects that they can remember.

Memory Game

This is played with a deck of cards with double cards (e.g. cards used to play the children's game of Snap). The cards are spread out face down on a table. Each child in turn will raise two cards: if these form a pair he can collect them and can raise two more cards; if not, the cards are placed back on the table, face down, back on their original position, and the hand passes to the next child. The aim is to memorise the position of the various cards on the table, so as to be able to

match them in pairs when it comes to his/her turn again. Wins who collects more cards.

Restaurant Game

Groups of 3 - 4 children make a food order to a "waiter" child, who brings the orders to another child in the virtual kitchen. The latter has to return with the virtual food that the "customer" children have ordered.

Not everything that is registered in our memory stays there for long.

Short-term Memory Game

Write on the board a sequence of five 2-digit numbers. Tell the children to memorise them, without making any notes. Cancel these after three minutes. After an hour, ask the children to write the sequence of numbers on a piece of paper, which is consigned to the teacher. Many children will probably be able to reproduce the numerical sequence correctly. Without telling the children, ask them to write the same sequence of numbers after a period of one week. This time the proportion of children that are able to respond correctly will be very low.

Long-term Memory Game

Ask one of the children what was his/her most favourite food (getting them to refer to a distant period in time). Ask then what they had for dinner three days previously. Discuss with the children

why they tend to remember some events better than others.

Short- and Long-term Memory Game

With a torch and pieces of differently coloured tissue paper, coloured lights can be projected in a dark environment in succession (e.g. red, green, blue, etc.). Ask the children to remember, but without writing any notes, the progression of colours immediately after the projection, then after one hour, after four hours, and then after three days.

COORDINATION THOUGHT-ACTION

Motor Sequence Games

A child, *one at a time*, verbally instructed by the teacher and by imitating her for a series of movements – or, in alternative, following the teacher's verbal indications only – instructs the other children to perform those motor sequences. Initially these instructions will be for single movements, but progressively more complex instructions will be given. Examples: Clap your hands twice, turnaround 360°, squat, stamp your feet twice, jump with both feet together, make a salute, raise one arm, look up to the ceiling, down to the floor, etc.

Blindfold one of the children in turn and get him/her to try and identify classmates only by touching their hands or face.

5. TEACHING SUPPORT MATERIALS

for each class

- Model for the child's interview of a family member (teacher).
- A *USB Pen drive* containing: i) video showing animal memory (elephant and chimpanzee) and intelligence (octopus, crow, Capuchin monkey); ii) photographs of people and external and internal environments with recognisable functions; iii) the early years of an infant in different sociocultural environments. (See below "Short summary of the videos")
- DVD "*The Bearded Capuchin Monkeys of the Fazienda Boa Vista*" (one copy for each school)
- The *Memory Game* (one set of cards for every group of 6 children)
- Balls of different sizes, shapes and weights to be used to throw into the wastepaper basket
- Objects with deceptive weights (an empty aluminium can, one filled with heavy weighted substance)
- A block of white paper 50 x 70 cm
- A copy of the book: M. by Pietro and M. Dacomo – *Giochi e attività sulle emozioni. Nuovi materiali per l'educazione razionale-emotiva.* Erickson (2015)
- Coloured square sheets of origami paper to make a box, with instructions
- 50 sheets of paper to make paper aeroplanes, with instructions

- A large size photocopy of the *Mandala delle Emozioni* (flower drawing on pag. 62 of the book "Giochi e attività sulle emozioni").

6. SHORT SUMMARY OF THE VIDEOS

Babies 2010 (excerpts) (duration: 37' 53")
This is an excerpt from the documentary (*Babies 2010*)
(https://www.youtube.com/watch?v=gZa04bRS8FQ)
A selection of scenes which demonstrate the growth of infants in their first year of life in different sociocultural environments (USA and Mongolia). The aim of this video is to demonstrate how some steps in the development of infants are innate and follow the same timeframe independently from external conditions (e.g., being able to stand on 2 legs).

EthoCebus Project [correggere anche in italiano](duration: 18' 48")
https://www.youtube.com/watch?v=bWK8bxOQQ6k
This video, subtitled in Italian, shows various aspects of the life, socialisation and the use of instruments or colony of tree-living Capuchin monkeys in the Brazilian forest.

Octopus Escapes Jar (duration: 1' 38")
https://www.youtube.com/watch?v=IvvjcQIJnLg
The octopus understands that to get out of the jar in which it has been closed, it has to remove the lid by unscrewing it.

Use of tools in the New Caledonian Crow (duration: 50")
https://www.youtube.com/watch?v=lcvbgq2SSyc

Realising that with a piece of metal wire it cannot access the piece of food which has been placed in a small bucket at the bottom of a glass container, the crow bends the piece of wire to then pull the bucket up by the handle.

A very intelligent crow 2 (duration: 2' 13")
https://www.youtube.com/watch?v=BwpeKgyNgE0
A crow wants to eat a piece of food at the bottom of a thin glass tube but cannot reach it with its beak. It chooses one first stick but it realises it is too short. It then uses this stick to get a longer one which it uses to reach the piece of food which is then eaten.

Elephant in the desert remembers years later were to find water (duration: 4' 02")
https://www.youtube.com/watch?v=vpOdJyLwku0
A group of elephants is looking for water in the Namibian desert in a period of drought. Followed by two researchers, these elephants are able to find water by excavating in a precise spot where they had found water 30 or 40 years previously. The small elephants look and memorise this information which might be useful in the future.

Chimpanzees have an exceptional working memory
https://www.youtube.com/watch?v=zsXP8qeFF6A
Before this experiment, a chimpanzee was taught to recognise the correct number sequence from 1 to 9. In the experiment, numbers from 1 to 9 appear on a touchscreen, in a random order. The chimpanzee must touch each number in the correct order but when the number 1 is touched, all of the other numbers are hidden by a circle. The chimpanzee could look at the numbers as long as was necessary for him to remember their

position. Due to its remarkable working memory, when the task started the chimpanzee was able to touch all of the numbers in rapid succession without any mistakes. When the human researcher tried to repeat the same experiment, the results were disastrous. The score for this memory game between the chimpanzee and the human was 1 – 0!

WORKSHOPS WITH TEACHERS

The teachers involved in the project were highly qualified and were able to adopt a pedagogical approach based on active learning rather than on simple transmission of knowledge. The experience and skills acquired by the teachers during the first two years of the SCIESA project made them fully aware of the expected learning outcomes and fully capable of implementing the inductive methodology which characterises the project.

The teachers actively participated in meetings of the SCIESA group and also contributed in the elaboration of the teaching modules. These meetings were mainly focused on contents (knowledge to be transmitted), and the practical approach to be adopted to achieve these goals (organisation of the subject matter, timeframe for delivery of concepts, teaching materials to be used).

On occasions, following specific requests by the teachers, this "working together" methodology was implemented by the presence in class of one or two members of the group of experts. This also helped to standardise different ways of interacting with pupils when carrying out the practical activities and during class discussions. The

contribution of teachers was also important in gathering documentation (recording of the children's discussions, observations, photographs, digital acquisition of the children's works).

On occasions, following specific requests by the teachers, this "working together" methodology was implemented by the presence in class of one or two members of the group of experts. This also helped to standardise different ways of interacting with pupils when carrying out the practical activities and during class discussions; to collect documentation on the abilities shown by the children, such as to remember and properly connect experiences, to ask relevant and reasoned questions, to explain and justify statements, to use counter-factual arguments, to express personal views. In this collection of documents, the contribution of teachers was also important in gathering documentation (the verbalization of children's discussions, observations, photographs, and the digital acquisition of children's works).

In the working group experience the teaching methodology adopted is producing quite acceptable results, since the teachers have responded well to the group work approach, and have been able to give contributions concerning both contents and methodology.

One critical issue that came out, not easy to be solved, was the barely sufficient time the could be assigned to this type of activity. Indeed the teachers' teaching loads are substantial and very little space is left for innovative and complex type of activities such as that proposed by the SCIESA project.

ASSESSMENT OF RESULTS

1. PREMISE

In line with the methodologies used in the previous two years, the assessment of the results achieved during the delivery of the programme for the third year of activity was carried out by the entire SCIESA group (teachers, researchers, children, parents):

In particular:

all teachers kept a log book in which observations were noted, including any critical or positive elements (difficulties in the classroom, level of participation of children, feasibility of activities, etc.) encountered during delivery of the programme;

the researchers analysed the materials produced by the children (texts, drawings, posters) and the transcipts of their conversations during their periodic visits to the class or those prepared by the same teachers during the activities;

the children expressed themselves through various means of communication such as verbal, written, and drawing to help the retention of the various activities and to reflect on what they learned from these;

the parents prepared a series of comments, requests and observations during the regular meetings with the researchers.

This form of evaluation was devised specifically to assess the following:

suitability of the subject content of the modules with respect to the level of comprehension of the children;

feasibility of the proposed activities or experiments;

efficacy of the inductive methodology which was primarily used in the delivery of the module;

the level of interest and participation of the children in the various activities;

the role of the various components which were part of the whole process of construction of knowledge, awareness and learning capacity of the children.

The results that were collated are reported below, and also contain information regarding the following:

some excerpts from the log books, to illustrate how this tool was used by the teachers during the delivery of the module;

a summary of significant critical or positive elements, and the conclusive observations registered in the teachers' log books, and specifically those regarding evaluation of the efficacy of the experimental activity;

the interpretation of possible evolutions of the learning capacity of the children, of their reaction to the proposed didactic activities (even emotive), and based on excerpts of recorded class conversations and on written texts in the children's workbooks;

analysis of the materials produced by the children in reply to the assessment at the end of the third year: the "question boxes" and elaboration of posters by the part of teachers and children of other classes in the school and the level of curiosity generated by the SCIESA project.

2 LOG BOOKS: SOME EXAMPLES

The log books compiled together with the teachers involved programme contained a series of information regarding the context and climate created in the classroom during the activities, the reaction of the children and any eventual integrations made by the teachers to create additional stimuli. In many cases excerpts were recorded regarding single and particularly significant interventions which document the children's reasoning regarding various phenomena. Analysis of the observations registered in the log books is the ideal opportunity to review and revise the entire teaching experience that was developed together with the children. For example, the following observations were recorded regarding to modules ("The Senses" and "A Journey into our Conscience").

2.1 General observations on the module "The Senses"

The critical observations observed regarded the cognitive or emotional difficulties encountered by the children during delivery of this module. Specifically, in the case of the sense of hearing: *"The children were aware that sound is recognised because it has already been memorised by the brain. The sound–emotion association was less evident".* For the sense of smell: *"The children had difficulty in evoking smells that recalled previous experiences"; "Noticeable difficulty was encountered in identifying the various odours, with a tendency to give the same answer (smells like chewing gum)". More generally, it was observed that "The children when discussing positive emotions had difficulty in recognising emotions that they were experiencing"*.

Sometimes problems were encountered that regarded the level of interest (e.g., *"Minimum level of interest demonstrated for activity 2"*) or other difficulties related to time or school organisation *("This part of the activity was not conducted")* or the low level of cooperation by the children's families *("Unfortunately, a low level of cooperation at home was encountered. The written assignments were scarce. The children limited themselves to writing the memories without any additional or specific details").*

Overall, positive comments tended to be more frequent. These primarily regarded the children's level of interest for certain activities, and of the new knowledge that these same activities generated. Some of these comments more significant: *"This section generated a high-level of curiosity in the children, who were able to understand how the eye reacts to light"; "The construction of the kaleidoscope was a truly interesting activity for the children All participants spoke about it and compared their observations"; "The videos generated a high level of interest, also because they made the participants reflect on the necessity of interrelations with the environment, and that this is a required condition for effective learning"; "By reasoning they were able to understand the distribution of the receptors".*

The tuning fork and table tennis activity received very positive feedback. The vibration of the tuning fork partially immersed in water was found to demonstrate the formation of waves better than the table tennis ball. The association of vibration and sound was a novelty for the greater part of the children.

Quite interesting are the comments that highlighted how some activities had created a prolonged level of motivation: *"The children demonstrated high level of interest and presented the materials to their families"; "The fact that the children ate at school let them reflect on their personal tastes, and also that they don't try certain food that they remember they dislike"; "The videos were highly appreciated, and were the topic of conversation and stimulus for many spontaneous drawings of what they liked the most".*

It was also important that some children perceive the connection between the various activities in the programme, and also between the experiments/activities conducted in class and their daily lives: *"They demonstrate to be able to make correct assumptions"; "Many children were able to understand the connection between some class activities and experience or information acquired at home".*

2.2 General observations on the module "A Journey into our knowledge"

The conclusive observation in the log books regarding the Module "A Journey into our knowledge" demonstrated different levels of understanding between the classes.

IIIA: *The children were very surprised by the abilities of some animals. The referred that they had never imagined that a crow would have known how to use a stick to get food, or an octopus could unscrew a lid, or chimpanzee was able to perform better than a human in a memory game. Some children also added that animals were more intelligent than humans.*

IIIB: *The children found some initial difficulties when presented with the Module; later they showed interest and participation increased when they played an active part in the learning process.*

IIIC: *The module received positive feedback from the children as they enjoyed remembering their previous experiences. The memory game involved all participants, and the video that was projected in class stimulated reflection and a very positive debate.*

IIID: *The module on learning was delivered but was not consolidated, due to lack of time available. All activities carried out by the children were undertaken with great interest and participation. The wide range of topics ideally should have been delivered over a longer period of time.*

3. CONVERSATIONS IN CLASS: SOME EXCERPTS

In each of the four classes, the delivery of all modules was characterised by verbal interaction between the children, and between the children and teachers who accompanied them in the learning process. Of the two Modules delivered during the year, the numerous and varied activities proposed by the module on the five senses was undoubtedly of greater interest to the children; in the discussions, they expressed their own ways of interpreting or understanding the various phenomena and were able to reason as a group. Also the Module "A Journey into our knowledge" generated a high level of participation, as the children were able to

express, discuss and reflect on their personal experiences and emotions.

Some of these comments more significant. *In response to the teachers' question regarding what humans are able to remember that animals cannot, the children replied regarding happy memories, food, emotions, and affirmed that animals do not have the same emotions as humans, e.g. joy, happiness, disgust. Gi: spoke of exclusion, which triggered a short debate between the teacher and the children. Teacher: "Is the feeling of exclusion an emotion?" Gi: "Yes. When someone excludes you from a team". Teacher: "What do you feel?" Giovanni: "Sadness, distress". Airon: "Fear". Giovanni "You're afraid that that they tell you no". Airon: "This also happened to me. I was afraid that they weren't going to let me play, but then they let me stay. After that I felt really happy". Gi "When they let you play, they are friendly, but when they don't they are not friendly any more".*

The analysis of these answers gives insight into the increasing expressive skills of the children which is partly related to age, but also stimulated by the issues under discussion. Regarding this point, we cite some excerpts of the children's answers, with the understanding that their significance may be lost when extrapolated from the context. We have highlighted in bold the terms that demonstrate a certain linguistic and metacognitive evolution in the children.

Va: You had to take 8 cups (4 of cold water, and 4 of hot water) and put into them various substances (sugar, salt, coffee, lemon) and we had to say which one was the

strongest. Ma: According to me, with the hot water we could taste the bitter and salty testes the most.
Teacher: "Can you consider what we are doing now as being an experiment? Some children said no, but were not able to multiply their opinion. Ri: however said yes, and tried to motivate his answer: because we are making observations on what we are doing ... ***We have to evaluate.*** *We have a great deal of memories..... so we have to evaluate because children have lots and lots of memories. Fl: it is an experiment because* ***you can understand*** *things.*

*Teacher: "How do we understand tastes?" Ig: "There is a nerve that goes to the brain, and the brain understands because it already knows this taste", "****a young baby doesn't know this*** *and the first thing it does is to put something in its mouth".*

*Teacher: "But do all of these senses work a little bit together or not… ?" El: "they work together because there's a lot of connections". And another child adds: "****the body is connected!"***

Teacher: "And why was the flow diagram useful?" Ma: "Because for every action there is a lot of different movements." Teacher: "Were you surprised?" "A little, ***I never thought about it*** *... well,* ***I had thought about it, but I didn't realise it.***

Lo: "I can see in the dark because I've ***memorised*** *the room". Teacher: "What did you use instead of your sense of sight?" "Memory… the sense of touch… of smell".*

Cr: remembered that the Capuchin monkeys were able to break the hard nuts using a stone. Di : They chose the stone, but before they have to ***try and choose the most suitable one.***

*Teacher: "What does to remember mean?" Ivan: "it means to think about something that you already experienced". Di: "****Thinking*** *about things that have happened to you".*

Teacher: "Where are your memories?" Iv:: and the others say that they are in the brain, in the mind.

Teacher: "Are the brain and the mind the same thing?" The children replied yes.

*Teacher: "Then why do we use two different names to indicate the same thing? What we do with our mind?" A child replies: "****We think****". Another child replies: "You can see the brain, but you can see the mind, sort of like when you can see a muscle, but you can see the force [trans. note. that it generates]". Giovanni: "You can see the table that the carpenter has made, but you can see all of the work that generated it".*

Teacher: "What you call the activity of the mind?" The children: ***Thinking, imagining, inventing, constructing, making up a story or a fantasy****".*

Experimentation in class allowed the children to "become aware" of something that they already knew in their daily lives, but had not consciously been aware of ("I had never thought about it"). It made is also feel happy about learning things , because "**When we are able to understand something, it becomes a game and**

we're more sure about things": this last affirmation was a wonderful auspice for the future.

One can start to detect signs confirming that the children were gaining some understanding regarding the organism, and the single components of which it is composed.

4. SCIESA PROJECT WORKBOOKS: ANALYSIS OF WRITTEN MATERIALS

Children has specific *Workbooks* dedicated either to Science studies, or to the SCIESA Project and which contained the following: written texts accompanied by drawings regarding the various activities completed, assigned written work, answers to assessment questions, drawings regarding specific contents pertaining to the teaching modules (e.g. my nicest/worst memory). In some cases the written assignments were completed as a group activity; in other cases, written work was completed by each child. Although these tend to contain indications shared by the class, these texts were highly individual, particularly when these referred to drawings.

It is interesting to describe the process adopted to when preparing joint written materials: at the end of a class conversation regarding the activity undertaken, the teacher asked the children to formulate a series of written phrases which can summarise the salient points of the recent discussion. These phrases are then corrected in form, but not in content through discussion between the children, and under the supervision of the teacher. The phrases that are shared are written on the board. These phrases are used to reconstruct the sequence of actions,

and the appropriate names given (e.g., organs, phenomena, tools, etc.) and expressions such as "we imagined", *"we understood", "we ask ourselves"* are used, to highlight the reflective aspect of the learning process. Contributions from single children are also included in this process.

Some examples:

"Today we used our sense of touch to recognise different objects, and we were able to perceive the consistency of different materials: the roughness of sandpaper, the softness of cotton wool, the smoothness of a handkerchief, the hardness of a coin. We were able to recognise the difference in consistency between wet handkerchief and a dry one."

From these activities we were able to understand that the tactile receptors are found on our skin, but there are many more on our fingertips and on our lips. Tactile receptors transmit sensations to the brain, which recognises them.

The sensations that we perceive through touch can also evoke memories and emotions. Ni: said that the roughness of sandpaper reminded him of his cat when it scratches: it was an unpleasant/disagreeable sensation. Ni: added that the softness of cotton wool made her think of her mother's caresses. it was a pleasant/enjoyable sensation. Ma said that the sandpaper made her think of her cat's tongue when it licks her: it was a pleasant/enjoyable sensation".

The following is an example of an individual text with corrections by the teacher:

Today we drew a flow diagram and from this diagram I understood that the brain makes the body carry out actions very quickly without noticing (corr.: without us noticing). When we play, we carry out a series of connected actions. When you don't know the rules (corr.: of a game) you make mistakes and these are understood by the mind (corr.: our mind helps us not to make mistakes)".

For each class, the objective is that the texts regarding the activities undertaken indicate the learning objective of that same activity, and the conclusions that were reached. We also encountered expressions such as: we understood that… or I understood that… When dealing with practical activities, the general format of the text is organised to include the following points: materials necessary, procedure, observation, conclusions. Some children also indicated things said or done by their classmates. The conclusions of some children are often more personal and original than those of others.

Some examples of conclusions:

"We did these experiments to understand what the teacher G. explained to us, but also to see if the things that we can feel can also make us remember events".

"We saw the video to understand that animals also have different stages of growing up, and they learn by imitating their parents, monkeys make their lives easier by using objects around them, and by making things".

"The eye see different things such as optical illusions, because the brain receives wrong information from them. The eyes don't see like a microscope or telescope. The

brain receives information from the eyes through signals communicated by the nerves. Neurones are not only found in the brain but also in other parts of the body. Optical illusions are used to trick the brain".

Naturally, not all children showed the same level of precision and articulation of their written work, but all of them demonstrated to have participated actively, to have understood the sense of the activity, and to have learnt something from it.

5. END OF YEAR ACTIVITY

The range of questions formulated by the children and their level of inquisitiveness was sufficient reason to propose some activities for the end of the year to create some form of assessment of the level of knowledge acquisition, of the children's degree of appreciation of the project, and their level of interest and curiosity regardless of the specific issues dealt with within the modules. To this aim, the following two activities were programmed and implemented: The Question Boxes and the "Wall Poster".

5.1 The Question Boxes

Each of the four classes involved in the SCIESA project was given a cardboard box with a slot in the lid to collect the children's questions over a period of one week. The children were invited to prepare one or more written questions on a series of topics of interest and not necessarily directly connected with the SCIESA project. The children were free to consign the questions also anonymously (PHASE 1). These boxes were then exchanged between the two classes of each centre to give

the entire group the opportunity of reading all the questions and propose any eventual answers (PHASE 2). The 117 questions that were collected were analysed by the research team and subdivided according to a series of subgroups:

a) Questions regarding the structure of the body (37 questions): e.g. Why do we have two lungs instead of one? Why does the heart beat? Why is the iris coloured? What is inside the cerebellum?

b) Questions regarding biological and mental functions (23 questions): e.g. Why are we not able to stop our heart from beating? Why are emotions useful? How is the brain able to remember?

c) Questions regarding the mechanisms underlying biological and mental functions (17 questions): e.g. How are our five senses able to work together? How are we able to remember things that happened a long time ago? How are people able to grow up without realising it?

d) Questions regarding experiences (17 questions): e.g. Why do we cry when someone hurts our feelings? Why are we all different? Are nice/good memories remembered better than sad/bad ones?

e) Conceptual questions (4 questions): e.g. What is the difference between the mind and thought? Is there any difference between sensations and emotions? What do we mean by instinct?

f) Questions regarding comparison with other animals or plants (7 questions): e.g. Why do insects not have bones? Do plants have hearts? Do two different animals have the same memory?

g) Questions regarding natural phenomena (7 questions): e.g. Why is wind invisible? How are Black Holes created? How are tornadoes created?

Questions regarding anatomical structure and functions were the more frequent, but questions regarding on how these functions are produced, and the hidden processes underlying them were also numerous. If some of these questions could be attributed to the customary behaviour of children when interrogating adults, the greater part of the questions revealed the children's desire to analyse or interpret the target activities conducted in the classroom and other everyday experiences at home. This authentic and "non-scholastic" approach towards learning is a necessary premise to develop critical and reasoning skills, and represents an element that may be underlined as a positive result of the project.

The list of questions produced by each class was given to the teachers. The children therefore had the opportunity to hear not only their own questions but also those of other classes. In one of the two centres, the two classes met to exchange questions and answers. In the other centre with much more numerous classes, the questions were read rather than letting the children meet. The teacher invited the children to answer those questions that they thought they were able to, and underlined to the children the importance that their answer be based on real facts or information. They encouraged the children to discuss when they believed that answers were not fully convincing. During the course of these discussions, the children were also informed that in many cases, more than one factor could be involved in determining the event. In some cases it was found that the children did

not have sufficient information to formulate an adequate or appropriate answer.

Some excerpts of these discussions are given below as an example of the type of discussions that were held.

Why do we remember some things for a long time, and other things only for a short time? Va: we remember nice things for a long time, and the bad things only for a short time. Fr: No, it's not like that because sometimes we don't realise it but then memories come back.

How are Black Holes created? Mi: It happens when a star dies. The start is made of material, and when it dies it becomes Black Hole. My dad told me so. Da: I don't believe it.

What is our memory for? Br: Our memory helps us remember who we are.

Do two different animals have the same memory? The children: The have the same memory but they use it in different ways; in the way that best suits them. Va: for me they are different, because the elephant is bigger and it has a bigger memory, and it remembers differently. Mi: **I agree**. Song: it's not always that a bigger animal has a bigger brain. Il: it doesn't depend on its dimensions.

Why do insects not have bones? Because they can defend themselves. Cr: when I squash them, they make a noise. Fr: that's the bones or the wings. Ivan: the carapace breaks. Ai: I don't know why. Va: We can make an X-ray. Mi: What's that? Br: Is a piece of paper that shows you the bones. Da: It's like a photograph.

Is anxiety a good or a bad emotion? Il: It depends! Because if you have to do something bad soon, then it's bad, while, if you are going to do something good, then

it's good. Gi: ...a lot of anxiety in swimming competitions. Fr: .... or when mum or dad are sick. Ad: ... but it's a nice feeling like when you go to a party. Il. speaks about the anxiety that is felt when one is sick, and has to take antibiotics. Ch: anxiety is bad when you do athletics, and you think you're always going to come last. Va. remembers a bad case of anxiety when he was at the dentist for a dental appliance, and when he was waiting outside he fainted. Mi. speaks about anxiety when he is the goalkeeper when playing football. So: I get anxious when I'm on the bus because I'm afraid of being sick. Ma: I get anxious when we have tests at school but it's a nice feeling when my mum tells the something nice, like when we're going on holiday. Gio: when I get a bad mark at school, or when the teacher writes something on my report card.

Are nice/good memories remembered better than sad/bad ones? We remember bad memories better because these are usually only events, and if they present themselves once again, you remember them and they won't happen again. **For me** you remember nice memories better, because when you are sad, these can cheer you up. No, you remember bad memories better because if the teacher gives you a bad mark, you want to forget it but you can't.

Do we remember all of our experiences? No, **for me** only those ones that we like most. No, because there are too many experiences.

Why do red blood cells go everywhere? Red blood cells go everywhere because they have to take oxygen everywhere.

5.2 The Wall Poster

The children of the four classes were asked by the teachers involved in the SCIESA project to collaborate in the preparation of Posters to be exhibited in the school corridors to inform other teachers and children about the project, and giving a series of interesting information regarding the functioning of the human body and how to safeguard our health.

This work was carried out at the end of the academic year and the results were a series of posters full of drawings and texts. In September each class was asked to summarise all of the preliminary work into a single poster for the class that could be reproduced and a series of instructions were given according to a specific typographical layout. The children in each of the four classes worked in groups to select some of the drawings or create new ones and coupled with a series of phrases used as "advertising slogans" to illustrate synthetically and effectively the methodology and the objectives of the project. The following paragraph gives a brief illustration of the final work for each class, remembering that these are the result of a previous selection, and therefore may result less spontaneous or significant than the previous posters prepared in June to evaluate the didactic outcomes of the project.

IIIA "The SCIESA project: observe and reflect"

Due to the low number of children in this class (7), each of the sectors is a result of the work of a single child. The drawing in each of the sectors are accompanied by a written comment, e.g. "and here is the human body", "a

young scientist at work", "we were part of the SCIESA Project. Why don't you participate and learn about how our senses, the body, the emotions, the heart, the digestive system and the brain all work". The drawings illustrate either the entire human body or parts of it, and sometimes objects used during the activity work are also shown. There is also one large diagram of the eye with arrows indicating the different parts. C. drew a diagram of the human body with indications of only some of the organs (bones, heart) labelled with arrows and captions explaining the functions of the various organs. The captions followed the same formula: "the …….. is used for……". In the lower left-hand corner was a text: "You will be able to do a lot of experiments. Bye!"

IIIB "A great discovery"

This poster contains a series of diagrams of organs copied from books (heart, lungs, brain, stomach" and then a series of small boxes which contain phrases regarding the SCIESA project and other small drawings representing the organs targeted during the class activities. Under these boxes are his phrases such as: "This project helps us to know our body better, and to take care of it", "Do you want to see the heart. Well, with the SCIESA project, you have the chance to do this, to hold it and to touch it", "By chance, do you know what the brain is made of? Do you want to know? Would you like to know more about your body? Do you know about the cerebral cortex and neurons? Okay, if you don't know, then with the SCIESA project you can walk into a world of curiosity and fun with our incredible experiments. Come in and sign up for the SCIESA

Project". The drawing above this text is a two-scene comic strip, the first showing children asking questions, and the second shows a child in a type of space capsule travelling along the neural network.

IIIC "Building and experiment is a good deal indeed"

This poster contains one large box with the title "Listen, observe, understand, construct, reproduce", and describes sequentially and in detail the process of construction of paper aeroplanes. There are also many drawings illustrating the experiences conducted during the year, some inspired by the videos of animals (crow sourcing food using a stick, the octopus opening the lid of a jar) or growth in different nations/cultures (comparison Mongolia vs. USA). There are also some of the children's comments written in the form of slogans, such as: "Fun learning can waken your mind", "Only by doing can you learn".

IIID "All together for SCIESA. Brain energy doesn't cost anything"

This poster contained few drawings and many slogans. One of the drawings shows an athlete representing SCIESA "the science of health" ready to participate in a track race. Another drawing shows the brain as a cartoon saying "Help, help, I need air" and then another cartoon showing the lungs which reply "We're coming!". These quotes may appear a little naïve but they do show great creativity by the children and their efforts to synthesise and communicate to their peers and adults about their experiences. For example: "If you do the SCIESA Project and think, your brain will start training and ideas will come", "If you've got a brain, then don't be a donkey",

"SCIESA will give you wings", "SCIESA: the science that isn't heavy".

6 NOTES REGARDING DIDACTIC INTERVENTIONS DURING CLASS CONVERSATIONS

For all four classes, the content and activities pertaining to the teaching modules were discussed in advanced with the teachers. Obviously, it is understood that teachers have their own pedagogical approach and style. In general, all teachers were able to stimulate and maintain the interest of the children, as well as encouraging their desire to interact in the various tasks. The children were stimulated with many questions, sometimes provocative, to increase their observation skills and open up new interrogatives. Some examples:

Teacher: "So, does the brain always understand everything?" El: "The brain doesn't understand straight away, and perhaps it understands when someone explains or communicates to it". Gi:" Images are transferred immediately to the brain, but the brain doesn't always understand".

Teacher: "What is it that helps the brain understand?" The children elaborate progressively this concept: "by the sense of sight, by smell, by memory, by experience, by study". Teacher: "Have you ever put your head under water when you were at the beach? Can you hear sounds?" Chi: "No, when I'm under water I cannot hear anything." "Teacher: "but why?" Mat: "because water gets in your ears". Ma: "because there is water instead of air". Teacher: "And what about smells?" Mat: "No,

because water gets in your eyes and nose, and what you need is air". Francesco: "even your sense of touch is less". Ch: "I can smell the salt".

Teacher: "what vibrates?" Ivan: "the rubber band". Mark: "the vibration is so fast that you can see it". Da: "If there's vibration then there's always sound". Teacher: "what else did we make vibrate apart from the rubber band?" Br: "The tuning fork in the water, the water splashed and the table tennis ball bounced". Cr: "You can see it when it stops". Di: "The vocal cords vibrate because air passes through them, and oxygen".

From the observations in class and the transcripts of these conversations, we can understand the nature of the interventions by the teachers, which were effective in eliciting and organising the children's thoughts. The level of trust of the children shown by their response to these questions, even those children who seemed to have difficulty in concentration, was a critical factor in determining their answers. This same level of trust was also reflected in the overall approach adopted by the teachers and was functional in determining their communication style when addressing the children, by stimulating them to use and express knowledge to anticipate any observations that they make in order to reason based on facts *(First let's think and then we'll try! According to you, how long/much will it take...? What happens when... ? According to you, what is made of....?)*

Not anticipating the children in describing or explaining phenomena but waiting for their impressions allows the teacher to understand the children's thinking processes better, and also gives them a useful methodology in

formulating successive interventions. We have grouped a series of interventions by the teachers taken from transcripts of class conversations to highlight the teaching objectives and how these interventions were functional in organising the process of knowledge acquisition.

a) Questions eliciting memories, to reconstruct sequences, sharing the memory of experiences, to connect activities, such as: *What did we notice? What would have happened if...? What do we have to do to... ? What was needed..? Which? Why? And how? Now perhaps you know how to explain why...*

Examples: *Teacher: ... it this needed for something that we did little time ago... Teacher: but was it before or after?*

b) Questions that encourage going beyond the obvious, to seek explanations regarding the mechanisms underlying the manifestations of an event, such as: *How did you understand that…? How was it able to happen...? Does it always happen in the same way? Why was it that.....? How is it that all these things can happen? What does it mean by...?*

Examples: *Teacher: How do we understand the taste of something? Vi: With the brain. Teacher: But how is it done? Ig: there is a nerve*

Teacher: Right, but this is the signal, but what about the brain? Teacher: the brain understands because it has already tried it ... a young baby doesn't know it, and so the first thing it does is to put something in its mouth. Teacher: try and think … Teacher:and you think it is…?

c) Repetition or reformulation of a previous question by one child by the teacher to reinforce or consolidate the on-going discussion:

Examples: *Teacher: Francesca said: ..... Have you also had that experience?*

d) Questions that draw the attention to the form of language used (requests to explain the significance of a term that has been used, stimuli to reflect on the relationship between language, idea and thought), which are also opportunities to consolidate the children's vocabulary.

Examples: *Teacher: What does the term optical illusion mean? Teacher: What is the difference between the brain and the mind? Why do we use two different terms? Teacher: What do you think smells are like? (the children find various terms to define the quality of odours/smells); Teacher: we found the correct adjective ... what did you say?... instantaneous; Teacher: if they are there, then that's good ... - when they are there [here the teacher is drawing attention to the difference in meaning between a sentence starting with "if" and one that starts with "when"]..*

e) Questions regarding the significance of the activities that have been completed, to elicit conclusions (examples: ...why did we do it)?

Examples: Teacher: after having seen all of these things, we tried to reorganise them, and how did we do that? Teacher: we identified some key words in the two systems. Teacher: so what have we understood?

Teacher: so try and make some conclusions … from what you have understood. Teacher: yes, but why is that useful?

Teacher: (…) because if we don't make conclusions, we haven't finished our work and it's left hanging...

f) Requests to add evidence and to qualify what is being affirmed, (examples: how can I understand that…? What is it...? What difference is there between....? Let's try and say that better. Why do you think oppositely than I.?)

Examples: *Teacher: How can you say...? Teacher: is it true that the brain understands immediately and well? Let's hear the reasons for saying yes, and those for saying no. Teacher: Did that surprise you? Ma. - a little, I never thought about it … I had thought about it, but I didn't realise it.*

g) Questions that stimulate reflection on the methodology

Examples: *Teacher: according to you, do you consider what we were doing as an experiment?*
Ri: Yes, because what we are doing is making observations… - because we had to understand why children have different memories; Gi: because you understand. Teacher: why are the observations? Ad: we can understand environments, and the world around us. Teacher: why can you say that this is an experiment? Fl: because we understand things

h) The teacher uses terms that express mental functions, and therefore offering cognitive and metacognitive models of behaviour

Examples: *Teacher: I was thinking about what you all said … Teacher: and so how do we know this? How can we be sure that this is so? Teacher:– let's go over that last thought and see if we can think of any other ones.*

In some occasions the teacher was more interested in transmitting information rather than animating their discussion or reasoning. In these cases the questions aimed at the children were more notional, and sometimes very direct which leaves no space for dialogue nor generated interest from the children, who were more interested in trying to guess the answer expected by the teacher.

This notion-biased teaching approach may over time influence the children's desire and pleasure in learning, as well as having a negative effect on the children's trust in their own reasoning skills.

7 NOTES ON MEETINGS WITH PARENTS

Meetings with parents were organised with more than one objective: to present the books that were published on the Accademia Medica di Roma website, to summarise the results of the previous year's work, to illustrate the teaching programme for the upcoming year, to explain the overall objectives of the SCIESA project, to solicit the collaboration of the families in achieving these objectives, to verify if the children speak of the various activities pertaining to the project at home, if there was any evidence of a greater observation, experimental and interrogational skills in the children's everyday behaviour. These meetings were held every three months and the parents of both classes in each

centre met jointly. Some difficulty was encountered by the parents in being able to attend in the early afternoon and therefore participation was limited. Greater participation was shown by mothers rather than fathers, who tended to interact little in the discussions. Greater participation was shown by the parents of the Via Asmara school than the Via Novara centre. We noticed with pleasure the continued presence of a group of mothers of non-Italian children.

Over time a relationship of trust was built between the research team and the parents, who then felt free to ask questions or receive explanations, even though this type of interaction was limited to a small part of the entire group.

Being able to see the books which contain drawings or written materials by their own children had a very positive effect on the parents, who began to feel part of the project. Many parents manifested their appreciation for the SCIESA project teaching objectives, and were primarily interested in understanding how the project would help their children comprehend how to take care of their bodies, and even asked how they could contribute in the role as parents.

Generally they were interested in understanding what the programme entailed, but were more interested in hearing from other people and the teachers if the children followed, if the class completed the "set syllabus" like other classes, if the SCIESA project substituted the customary Science programme, and if there was going to be any final assessment.

A great deal of variation was found in the motivation of the children to speak to the parents regarding the class

activities: some parents referred to the difficulty in receiving a response to the question "what did you do at school?", whereas another parent of a child who entered the programme this year said the following: "s/he talks to us a lot, s/he talks about of the experiments. S/he want to bring his/her own science toys to add to the activity regarding sounds etc.", "My son Pietro who entered the class this year is enthusiastic!". Other comments were as follows: "my child asked me if s/he could try a lemon" or "we repeated the experiment with an egg"; "R. repeated the experiment at home for his/her brother", "V. wanted to answer the question regarding the body or the senses". "I realised that the level of curiosity increased", said one mother, and another said "my child is learning in a much more "natural" way: If we ask what she did at school, sometimes she would even reply nothing, but then in other situations she remembers things that she heard, and is able to connect these to everyday events or occurrences".

The children considered the practical/experimental activities on the senses as being more interesting, whereas those regarding reflection on mental function as being less so. The parents also asked if they could help preparing materials for the class, or even with the experiments.

One mother commented positively on the continuity of the project which was something important and rather rare in public education.

In some cases the parents made requests and/or proposals. For example, one parent asked if we could help gain permission so the children could bring their toothbrushes to school to brush their teeth (which seems

not allowed by school policy). They asked specifically regarding the module “A Journey into our Conscience”, as this created perplexity due to a misunderstanding of the name. One parent thought that the model regarded the technique of Yoga, aimed at teaching the children how to control their emotions, whereas she herself was educating her daughter to “let her emotions flow”. The opportunity that yoga be introduced into the school system was discussed between the parents present at the meeting, but without the involvement of the group of researchers.

Some parents also suggested to focus not only on diet (“in that children have to eat what is prepared at home, and thus, is of little relevance”), but on other issues such as sleep, fear, hygiene, controlling one's own behaviour, being able to organise oneself. One mother raised the problematic issue of how to regulate the time spent using computers, smartphones and television..... in relation to the activity of the brain, and the importance of alternating physical and mental activity.

In conclusion, we found that discussing with the children’s families of the various themes dealt with in the programme represents an invaluable factor to the implementation and success of the project.

GENERAL EVALUATION OF THE METHODOLOGY

In the process of evaluating and assessing the results, a great quantity of material was gathered, consisting primarily in the teachers' logbooks, as well as works produced by the children. Careful examination of this material integrates and amplifies the information given in the previous chapter, and has permitted us to make some interesting considerations regarding the development of the project with reference to some methodological issues which are considered fundamental.

The first and perhaps the most important element is the evaluation of the level of interest and capacity to comprehend of such young learners for topics related to health sciences. Indeed, the subject matter of this project are highly innovative when compared to the customary syllabus taught in the first years of the primary school cycle.

Teacher's observations noted in the logbooks confirm precisely what was already identified in the first two years of the project regarding the children's adequate capacity to comprehend the subject matter of the modules. Furthermore, both the children and their families appreciated the programme, commenting repeatedly and favourably on the topics developed in the syllabus. This has permitted us to state with certainty that, after three years of experience, the teaching of health sciences can be delivered – paying obvious attention to the appropriate teaching methodology – to children in the first years of the primary education cycle.

A second and very important methodological observation is the assessment of the efficacy of teaching based on an inductive approach which can be adopted, even at an elementary level, to teach scientific disciplines.

From this consolidated experience in class, and the feedback and reports given by the teachers, we can confirm the following:

— the inductive methodology, based on evidence gained from experimentation or rational interpretation of experiences, is a useful tool in health education and appears to be most effective in the transmission of knowledge, which tends to be retained over time.

Given that experimentation is the key concept and the driver of an inductive teaching methodology, the technical instrumental feasibility of experimental procedures must necessarily be verified before being implemented. To this regard, the experience gained from the previous two years which was confirmed in the third year has allowed us to make an encouraging contribution to the project. During the preparation and elaboration of the teaching modules, a great quantity of specialised literature and on-line informative materials were identified regarding scientific experimentation and specifically for health science teaching for elementary learners. The careful selection of this material was invaluable in preparing an experimental programme to achieve the learning objectives of the modules in a simple but rigorous fashion. The positive results of this preliminary work were constantly confirmed by the comments made by teachers in the logbooks, and allows

us to confirm that a significant level of experimentation is perfectly feasible for the teaching of health science to young learners.

In the case of complex experiments or demonstrations, we find no objection for the occasional involvement of external experts in the delivery of the programme in the classroom. Another factor very much appreciated by the children were study visits to various structures specifically destined to promote scientific education for schoolchildren.

The active participation of the schoolchild is of fundamental importance, and must be considered a key factor in addition to other critical issues previously indicated. Indeed, during the delivery of the programme, general interest and attention for some topics developed in the syllabus were not sufficient to guarantee the successful transfer of knowledge. The decisive element that characterises effective "participation" is the direct involvement of learners in the conduction of some of the experiments or activities.To implement this involves the preparation of specific teaching material and adequate classroom time available to conduct the activities.

Aside from these positive elements identified in the evaluation phase, we must underline a problem regarding the time available for the implementation of the project. The teachers involved in the project were unanimous in stating that there was not enough time to complete the programmed activities in an optimal fashion. For future programmes, the experimental syllabus should be aligned with the traditional science teaching syllabus, while maintaining as much of the experimental syllabus to

privilege those specific topics which are considered essential and not to be forgone.

LOGBOOK

As previously noticed, the evaluation of teaching Modules carried out in class has been performed by the teachers. They have been asked to write down, during the course of each section of the Modules, an evaluation of the didactic efficacy shown by the experimental items proposed (experiments or experience). To this end, the teachers were provided with a "logbook" in which they were to record, for each experimental item, whether it was fully realized in class (yes, no, partially), the degree of efficacy (rated on a 1 to 10 scale), and possible additional notes.

An example of the logbook that was used for the Sight section of Module 6, The senses, is given below.

Personal experiences or experiments	Realization			Efficacy (1-10)	Additional notes
	yes	part.	no		
Observation and description of objects (the eyes are essential for sight)					
Observation and description of objects in darkness (the light is necessary for sight)					
Making a kaleidoscope and looking at the class with it (the eyes are capable to see direct and reflected light)					
GENERAL COMMENTS					