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Science Centres: A Resource for School and Community

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We present a science centre established in Genoa on an agreement between Municipality of Genoa and Department of Physics of University of Genoa. The aim is to offer children, young people and community an opportunity to approach science in a playful way. The centre staffs guide the visitors through the exhibits, attracting their interests towards the most amusing aspects of the phenomena. According to the principles of constructivism, kids and children are encouraged to handle objects, play with geometrical shapes, observe materials collected from natural and human environment and make "discoveries", and students can take advantage of the visit and from the exhibits to study in depth a specific topic afterwards in their class, thus preventing the aridity of a purely formal presentation of the discipline, while a general public can realize how much science affects people's lives, enjoy its fun aspects and meet scientists during special events.

Keywords: science centers, children's education, playing and learning

Introduction

S & T (Science and Technology) play a key role in people's daily life and their impact will increase more and more; nonetheless the gap between research in such fields and society is increasing. Young people have a contradictory behaviour: On one side, they use many technical equipments easily, especially electronic ones such as mobile phone, IPOD, games, PC, etc.; on the other side, they often do not have any basic knowledge about scientific principles allowing them working and are not interested to do so, either, perceiving scientific and technical knowledge and distant and difficult things is totally aside from their life. The authors believe that the best way to increase students' interest in science-related subjects is by using teaching methods that solicit the curiosity and creativity that characterize all children.

Young people, beginning from early childhood, will be presented S & T in an appealing way and understand how their daily life is deeply influenced by S & T. It is needed to change children's/students' perception about S & T, letting them know they can have also fun with it. Only by welcoming S & T as a normal aspect of life, students may find it appealing to join related jobs in the future or simply to create a more educated society.

Role of Science Centres

Science exhibitions have been popular in Europe since the 19th century. However, science centres and museums began to spread in the 1970s. Today, there are hundreds, if not thousands, of them in the world

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attracting millions of visitors.

These popular institutions provide numerous interactive and "hands-on" installations and carry something of interest for visitors of all ages. The use of hands-on and inquiry-based activities develops team-working, critical thinking and problem-solving skills, and makes learning active and meaningful. In the references, the authors quote some science centres that have developed a sector for children according to the above point of view.

Science museums and edutainment centres enjoy a great deal of credibility and respect both with the public at large and within the scientific community. They not only inject an element of fun but also play an important role as science educators and public forums. It is their multiple roles as educational institutions, exhibitions for the state-of-the-art in science and public debating clubs that makes them an ideal channel for helping promote more societal participation.

In order to favour children friendly approaching to S & T in a pleasant environment, where they are free to express their feeling, curiosity and imagination, an agreement between Municipality of Genoa and Department of Physics of University of Genoa in 2001 has established the science centre "Idee e Materie in Gioco" (IMG)—playing with ideas and materials. Its activity is planned not to transfer specific scientific contents, nor to push-deliver of S & T to kids with the final goal of making them all become scientists or technicians, but to provide rich learning and amusing experiences in science and nature to young children. The centre is hosted in some premises of a kindergarten surrounded by a large green area. It is designed specifically to drive kids to explore, discover and imagine the world of science and playing with it, even if it offers many exhibits and opportunities for visit and enjoyment at any age level, with the main aims of: (1) favouring a friendly approach to science; (2) diffusion of a scientific culture; (3) development of a creative and critical thinking; (4) favouring contacts among people of different ages and roles (children, teachers and families/citizens) even organising special events (like "grandfathers and children"); (5) aiding children to express their thought in a playing environment; and (6) stimulating learning through "discovery" (Bruner, 1965).

In the centre, IMG facilitators and edutainment organisers are unique in their ability to ignite curiosity through science and nature and to enrich and engage children in scientific exploration.

Methodology

The child is by nature an attentive and insightful researcher, who investigates his/her reality of life trying to meet the need of the control of the world in which he/she is inserted, initially, as an egocentric subject. In order to pursue forms of equilibrium and quiet, the kid is ready to draw satisfying conclusions considered unique and winning. Deepened studies of developmental psychology (Piaget, 1977; Wallon, 1984; Butterworth & Harris, 1994; Bremner, 1994; Oates, Wood, & Grayson, 2005; Smith, Cowie, & Blades, 2003; Slater, 2006; Myers, 2008) have shown that, the kid overcomes the above-mentioned egocentric phase from the entry in the school of childhood, when, around the 4 years, he/she becomes a "fully social" subject. It is in fact from the attendance of the "group class" that, the child learns to be a member "in and of the world" to which belong other individuals who, like him/her, have ideas and answers considered univocal and universal to the phenomena. It is at this point that the teachers should become a mediator at the same level of the child, playing the role of a "curious pupil", should support a reflection about different opinions, in order to favour the construction of knowledge through the observation of the facts arising from the verification of different hypotheses. Moreover, children exploring together with their fellow classmates are stimulated to discuss, express their opinions and build their knowledge through a cooperative learning: Knowledge is a social

construction (Vygotsky, 1978; Glaserfeld, 1989; Jaworski, 1993; DeVries, et al., 2002).

By offering a variety of materials and child-centred activities, the centre staff (composed of teachers, science education experts and edutainment organisers) nurture interest, stimulates imagination and desire to learn. Following the point of view of constructivism, the staff do not answer the questions posed by the children but solicit them to make hypotheses and observations/experiments, guiding kids/pupils/students to find the answer by themselves, so the answers are appropriate to the users' ages and as the children grow up, the answers to their questions become increasingly sophisticated and precise. In this way, the users learn to disentangle their thought and raise awareness of their reasoning. Hands-on materials encourage the development of creative, expressive, scientific, mathematical and literary skills in children. Situations are created each day to develop social skills, such as sharing, taking turns and respecting others.

The centre offers a variety of exhibits, activities, hands-on materials to introduce children to the many areas of interests within the realm of science. There children experience also the job of making things. The experiments are performed by the visitors themselves, by researching, performing and playing with the experiment, each visitor obtains first-hand knowledge and there is really no better way of learning. The centre does not substitute the teachers' activity in classroom, but it supports and empowers scientific learning in school.

Activity

The commitment of the centre is to engage children, parents, teachers and visitors in authentic science experiences and educational programs through hands-on materials and exhibits, stimulating awareness, understanding and interest in science and nature in all. For some years, it is a location of the Festival of Science, the most important Italian event popularising concerns of S & T. New games, shows and science paths are prepared for that annual event, gathering yearly a wide public. Taking as an example, the authors mention a play about the scientist Benjamin Franklin and his inventions, mainly acted by primary school children. The play has been prepared also with the collaboration of university students of Faculty of Education, which greatly appreciated such training "in the field", even if they had a hard work. In fact, they had to cooperate with persons of different background (researchers, teachers and edutainment experts) in order to present in a pleasant show a very creative mind and its discoveries, so facing unusual problems. The centre offers also opportunities and materials to develop graduation theses concerning S & T education, science communication, multimedia and society. It encourages research programs focused on investigation of mind conceptions and perceptions of children/students and of the public as well about scientific phenomena; issues can be used to produce materials and apply more effective methods in learning, communicating and playing with science.

Involvement of Educators

Teachers are a vital component in the development of scientifically literate citizens.

Through various modes of professional development, the center supports teachers in their lifelong learning of science content. Specific activities are planned for teachers' training. Training sessions will have the double aim of improving the incisiveness of educators in general, and enabling them to be an active part of the educational programme.

Examples of training courses are:

(1) Mastering spatial and temporal concepts is an important ability that children should develop by the end of primary school. Often, females have difficulties in reading and interpreting maps and in mathematical topics, especially in geometry, owing to an inadequate development of spatial concepts in the basic school. The authors

remark that, some mental disabled people have failures concerning space-time perception. So a training course has been carried out on those concepts aiming to stimulate kindergarten and elementary teachers to analyze and reflect on their own conceptions and the best way to build time and space concepts in children by playing.

The training course offered the teachers an opportunity to become aware about their own weak points and to be more attentive observers of the children's behaviors in order to prevent cognitive problems and help them in overcoming their difficulties.

(2) The increase in percentage of obesity is a characteristic phenomenon of the process of industrialization and is connected to several factors: the relative abundance of food, a diet rich in fat and sugar and a more sedentary lifestyle. In the last years, it has been observed an increase of obesity and overweight among children (in Italy, 30% of primary school children are overweight) and adolescents. Such a problem is common in all Europe and in many extra European countries, even in some developing ones; so it is evident that there is a great need of education in order to increase knowledge and awareness in educators, young people and families about the risks which the health runs because of bad habits concerning diet. For such a reason, it has been organized a training course on "Mediterranean diet", recently declared by UNESCO (United Nations Educational, Scientific and Cultural Organization) (2010) in 2008 "World Heritage", which should be diffused and protected. In fact, it is considered as the best diet to preserve health. It has been the first time that a lifestyle and not a monument or a natural site receives such an honorable mention.

The participants to the training course had the opportunity to observe in the garden of the centre an area reserved for growing sweet herbs. The purpose of the area is to stimulate children to approach by smell and touch such savory sweet herbs, learning that they are typical of Mediterranean dishes. The use of sweet herbs makes meals tasty so contributing to reduce the amount of salt, responsible of hypertension in the adults. Experts (like a physiologist) were invited for seminars and for answering doubts and questions posed by the trainees.

Involvement of a General Public

Similarly, a general public, including children's families, is directly involved. This is done at two levels: Firstly, people are invited to the presentation of new exhibits and/or school works. Secondly, some activities are planned and addressed to the community. A successful activity (a series of seminars by experts) has been carried out during the "International Year of Physics", during which many aspects of physics have been discussed, its link with other disciplines and its role in daily life. For instance, advanced researches in physics have been applied in medicine and surgery: Sophisticated equipments and imaging techniques as well are used in diagnostics or to treat many diseases or to operate. Physics is used to investigate, in a not invasive way, a work of art or in meteorology, weather forecasting, and so on. Issues of researches have been presented and explained to a general public.

In that way, the centre provides the opportunity to focus on the importance of S & T in the educational process and in the society, to stimulate a positive feeling and support towards science. By enjoying the visit to the centre and participating to seminars, lectures and debates, people understand that science contributes to solve problems and improve the quality of life. Another interesting side-effect is to help parents themselves get closer to those activities different and complementary to those belonging to the school system and S & T disciplines in particular. Furthermore, some sessions are dedicated to young people with special needs.

Organization. Exhibits may be permanent or temporary. Permanent exhibits, even if they could be removed or replaced by other exhibits on the basis of request of the public or valuation of the scientific

committee of the centre, are conceived to allow a fun, educational and stimulating path on a specific topic. Taking as an example, students practicing experiences along the path "light and colours" under the guide of the centre staff can study and carry out other investigations at school in order to learn more about light and its interaction with matter. Usually, the teachers visit the centre, choose a path and reach an agreement with the staff about the following visit with their pupils and the development on the topic that they would like to achieve. So a class can visit the centre more times in the school-year to better investigate a specific topic or to follow other paths. Along the year, the same pupils, visiting the centre, can receive different stimulations according to their cognitive development and scientific knowledge mastered.

Temporary exhibits are organised for special events and are not conceived to allow deep investigations for the students. They are thought to arise curiosity and recall attention of the public on the thematic focused at.

The centre has carried out in the years different projects on specific matters; among them the authors mention the table game "Discover!", consisting of cards and squares related to scientific experiments to do and touch; it has also been built a giant version of it with big platforms on which children can trample.

The last productions are the "scientific suitcases": Three suitcases addressed to different age level contain materials allowing in a micro context some of the experiences hosted in the centre.

Exhibits. The centre born after many experiences of temporary science exhibitions addressed to schools like "Imparagiocando" (Learning by playing), "Il gioco dalla scuola" (The game from the school), mainly conceived by a university professor, Mario De Paz, involved in science education for children.

In the centre, the "Magic of learning and playing with science" occurs everyday.

As mentioned above, some exhibits are permanent while other ones are set up only for special events, like those promoted within the Semep Project of UNESCO, concerning environmental education or the Festival of Science.

Among the permanent ones designed by researchers and experts: (1) light and colours; (2) sound; (3) geometrical shapes; (4) space and matter; (5) environment and nature; (6) sky; (7) optical illusions; (8) the "corridor of physics"; (9) biology; and (10) equilibrium and motion, the authors shortly present the following ones.

Geometrical shapes. Geometry is fun (see Figure 1)!

Figure 1. Children playing with geometrical shapes.

Many coloured geometrical shapes made of plastic are available for compositions. Children may also use squared or rectangular frames which should be filled, at the best, using shapes of different geometry, size and colour. So they may develop their intuition (which shapes are more suitable for the best filling of the frame) and creativity in matching colours and spatial skills.

The younger children are invited to select shapes and put them properly in a frame where different geometrical shapes are prepared: In this way, they are solicited to handle and recognize each geometrical shape they choose.

Environment and nature. Various materials (shells, sand, pebbles, pieces of bark, leaves, etc.) are collected from different environments in the country and in other countries. Children observe and handle them, make hypothesis about the place of their origin and make drawings (see Figures 2 and 3).

Figure 2. Placing organisms in their environment—Studying mimicry.

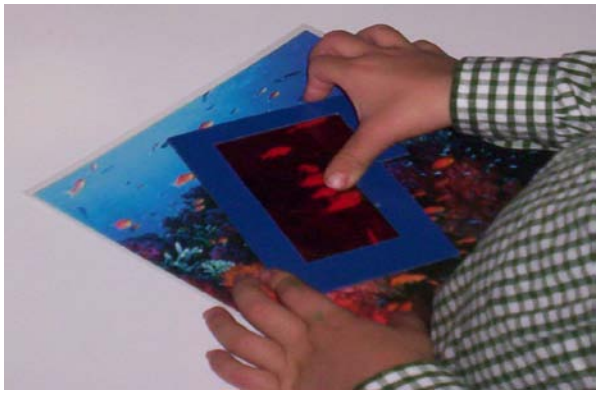

Figure 3. Studying mimicry.

In the natural environment, many organisms use a protective mimicry to escape their predators (see Figures 4, 5 and 6). A well-known organism is an insect, the walking stick, family Bacillidae, order phasmida (from the old Greek "Φαντασμα", meaning invisible creature, ghost, for its feature).

Figure 4. Amazonian stick insect, by courtesy of Dr. Brigitte Gavio—Universidàd Nacional de Colombia-sede Caribe.

Figure 5. Observing shells.

Figure 6. Drawing leaves.

Colour laboratory. A path on light and colours allows many experiences.

Did you know that colour and light are inseparable? Explore the workings of the eye, create cool colour experiments including spotlights for colour mixing, enjoying playing with coloured shadows, and observe the rainbow.

Experience reflection and refraction, admire the shining fountain: What it appears like to?

The shining fountain is very exciting for children, who compare the brilliant water drops to crystals or stars in the night and remember some tales.

Learn all about the inner workings of kaleidoscopes! Discover how they work and use common items to create a kaleidoscope, even at home.

With a microscope, it is possible to see small, invisible but real things that surround people every day; with this tool, the authors offer the opportunity to discover the small world of nature, or to see the activation and propagation of some simple chemical reactions on a big screen.

Here are some paths that make use of the microscope (see Figures 7, 8, 9 and 10). For example, the natural path is structured in two parts.

In the first part, the visitors can collect materials in the garden (flowers, leaves, sand, etc.) and seek similarities and differences with unaided eye. It is spectacular to see how the kids have fun, and at the same time, they learn by themselves by thinking and trying. In the second part, using the microscope, the pupils learn and discover what it is, without any explanation.

Figure 7. The rainbow.

Figure 8. Colored shadows.

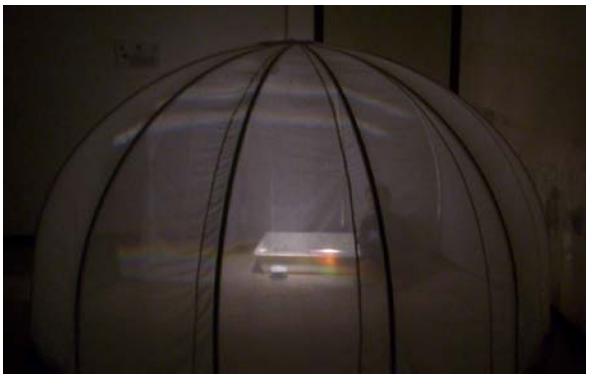

Figure 9. Playing with light.

Figure 10. Superimposing colored shadows.

Another example is special sea sand (see Figure 11). The children observe it with unaided eye and look very colorful. With the microscope, the children discover many microscopic shells between the grains of sand. Many questions arise: “What are the shells? Who does build the shells? How does it do?”. Beside the microscope, there is a table where various types of shells are arranged. Children are guided to distinguish the shape of the various shells and the organisms living there.

Figure 11. Observing objects using a microscope.

Another laboratory that the authors present in the centre IMG is “DNA extraction”. It is a path for junior school students. It is possible to see DNA’s cloud using fruits, for example, banana or strawberry, learning biology step by step. A poster with a plant cell helps remember its structure. The cell wall and cell membrane are a good protection for the cell. The pupils act on the cellular structure and demolish them to extract the DNA. As

a game, they press a piece of banana and then start the actual experiment. Sodium chloride, soap, distilled water and pineapple juice are simple but effective ingredients to demolish the structure and digest cellular proteins.

All materials present in the "Centro IMG" are safe and they are used by children without any problem.

In the last part of the laboratory, with the help of the scientific explainer, ethanol is added. In a few minutes, the young visitors see the formation of gas bubbles and a transparent substance.

Here is the DNA! DNA from water-soluble phase becomes visible when immersed in ethanol.

Conclusion

Science centers are poly-functional places where: (1) Scholars can play with science; (2) Teachers can implement their professional development and update their science knowledge with special programs; and (3) The community can have opportunities to meet scientists and debate with them about issues of advanced researches and their follow up on society. Such meetings increase people's awareness and favour a responsible and active citizenship based on a scientific literacy.

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