Hands-on Science

Growing with Science

Edited by:
Manuel Filipe P. C. Martins Costa
José Benito Vázquez Dorrío

The Hand-on Science Network

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Growing with Science

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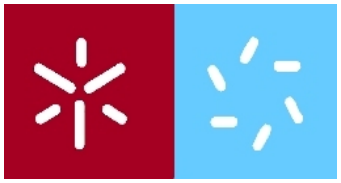
Manuel Filipe Pereira da Cunha Martins Costa, University of Minho, Portugal
José Benito Vázquez Dorrío, University of Vigo, Spain



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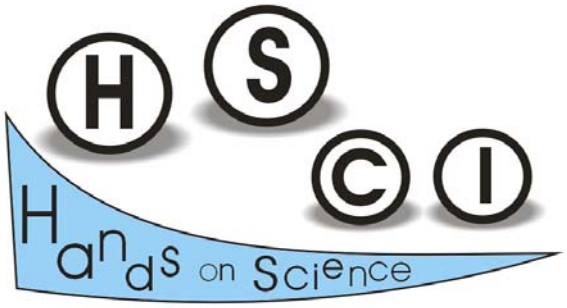

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Foreword

Growing with Science

Discovering the world that surround us, understanding the many "things" we feel, we sense, we perceive, we have and or want to interact with, is fundamental to our survival to our growth and to our wellbeing. Since the very first moments of our lives we begin this remarkable process full of difficulties full of rewards. And we do grow with all and every little pieces of new knowledge we, ourselves, manage to acquire.

As teachers and educators it is our job to support our youngsters in their everyday quest of unrevealing the "mysteries" of their world, "doing" Science.

Not only we teach, i.e. we use our knowledge (the common sense one as well as the specific scientific one we learned about) to help the students to learn, but we also should induce and facilitate, raise questions show problems reveal some of the wonders of nature to be explored discovered and understood by them, leading our learners in the amazing process of *Growing with Science*.

The book herein aims to contribute to an effective implementation of a sound widespread scientific literacy and effective Science Education in our schools and at all levels of society. Its chapters reunite works presented in this line of thought at the "14th International Conference on Hands-on Science. Growing with Science" held in Braga, Portugal, July 10 to 14, 2017. From pre-school science education to lifelong science learning and teacher training, the large diversified range of works that conforms this book surely renders it an important tool to schools and all involved in science education and on the promotion of scientific literacy.

Vila Verde, Portugal, June 19, 2017.

Manuel Filipe Pereira da Cunha Martins Costa
Editor in chief

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FOREWORD

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Hands-on Science. Growing with Science
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Overcoming 'Earth Science Blindness.' Earth Science in Action in Natural History Dioramas

SD Tunnicliffe
University College London, UK
s.tunnicliffe@ucl.ac.uk

Abstract. Children are born into this world into a place and environment, and immediately start developing a personal 'sense of place'. Through their gradual awareness of the immediate environment their knowledge and sense of this place extends. In the beginning, the 'place' is dependent on the earth science of our planet as has created the original environment in the area which is the child's place, real or conceptual.

Increasingly the deleterious effect on the environment, where own species has destroyed or otherwise changed the landscape, our place, has led to our era in our world being named the Anthropogenic [1].There is an imperative need in this time for we humans to understand how to interact with their surroundings evolved over time and became instinctive, people knew the seasons of the year, the changes in daylight hours, they understood cloud patterns and much more. Scientific Literacy, in terms of the understanding basic scientific processes and information, has become important for preserving what we have for our future.

Earth Science is as vital a subject today as it was necessary for survival in the past. The soil and the sky are two naturally occurring phenomena all around us, thus are part of a child's world, which they notice. I have coined the phrase 'earth science blindness", an extension of the phrase first proposed by Wandersee and Schussler [2]. Children have 'earth science experiences' when young but people possess an apparent ', earth science blindness' not noticing the environment which is determined by earth science. Earth science is the key to understanding our world and the living components, which create habitats, influenced by the substrate and the climate and thus inhabitants Biogeography depends on the Earth science phenomena. These factors are represented in natural history dioramas.

The recorded spontaneous conversations of visitors in natural history museums at dioramas reveal that few comments are made about earth science as well as other features and objects in natural history dioramas. Visitors focus on identifying the specimens and commenting on the attributes of the animals. The earth science elements, the substrate, the meteorology depicted and the flora and fauna which are all depended to the earth are largely ignored We suggest strategies to focus attention on earth science in these exhibits.

Keywords. Museum, science, diorama.

1. Introduction

As scientist specialising in education we are aware that learning in incremental and experiential. It involves skills, process communication and conceits. We can summarise as The How, the What. It also involves memory of observations and experiences from the past, which we use to make sense of that which we observe. Moreover, we also know increasingly recognise that young children are intuitive scientists [3] and have skills of investigating, recognising outcomes and considering evidence and interpreting it within their understanding [4] Moreover, it so also now recognised that children buddy up or contract their leaning, Piaget talked about accommodation. The translation of Vygiosyksy's work introduced the notion of constructivism which is now regarded as more effective when it is socially constructed. Driver wrote her seminal book Pupil as Scientist in 1983 which focused thinking on the traditional transmission of facts more leading to the development of theta inquiry approach and less dictation recipe following in practical work. It is important to recognise both science knowledge and the way of science discourse and how information is exchanged.

A diorama is a window on nature that invites the visitor to discover organism and habitus, frozen at a memento in time, often of an authentic recorded photographically and in field notes, and hence interlinked in the manner which they are in nature through listening to spontaneous out loud comments of visitors we can establish that which an individual or social notice and interpret from their knowledge and skills of perceiving within the diorama to satisfy them. Further interaction such as interviews or questionaries' can invite the visitor to provide

fighter insights which a researcher is able to probe their understanding further.

Do they comments and aspects of science in item widest sense including earth science? Or do they focus on the obvious or unusual and seek to identify, as they do at animals and plants in exhibits in zoos, botanic gardens and natural history museums [1,5,6]. The imagination of visitors is important in this interpretation too [7]. In the case of natural history dioramas drawing on their biological visitors also employ their environmental understanding as well as their biological [8].

Earth science is fundamental to understanding the surface of our planet. The biomes and ecosystems in which living organisms have evolved. Specific features have appeared and meteorological patterns are planet-derived adaptations of organisms which are all derived from the Earth. So what do visitors notice? How do they interpret the dioramas? What is the entry agenda and knowledge? We can find out by analysing the captured voice of the visitor.

2. Methodology

We had the permission of the museum to collect conversional anonymously. We sought permission of the school of the school groups or the parents of children in family groups or asked adult singletons to comment and the ensuing conversations are captured. Then they were transcribed, read, categories identified and then analysed.

We report here as an exemplar, a small pilot study Rowland Ward Dioramas which were in a special pavilion on the first floor of the Natural History Museum London were essential tools for the learning of science. They no longer exist there were three dioramas of African Scenes in the pavilion. The rain forest depicted was Ituri in the Congo where the Okapi was first identified in 1902. The other dioramas were depictions from Angola.

Visitors were asked, ”what is the story”, hence they were cued into looking. This approach was unlike in most of my research in which I am seeking baseline data with no cuing, in other words the visitors’ voice elicited through viewing the diorama and making sense of it from their personal knowledge.

3. Results

Firstly I will provide illustrations of the diorama and examples of the comments.

Figure 1. Angolian Desert

A five year old girl voiced the following at the diorama of the Angolian Desert (Figure 1): “It’s similar to that one but got different colours leaves on the trees I see deers and the antelope and really big kind of goat (Sable Antelope) and that mound type of thing.” (Termite mound)

A five year old bot looked intently and remarked, “A cow (bongo) and a goat and leaves and trees and that one (Water Chevrotain) and leaves and trees”.

A nine year old girl remarked, “It’s green and that animal horse thing (okapi) and that little thing (Water chevrotain) and a lot of those leaves and a kind of mushroom things and a mushroom with a white skirt and kind of a lot of sticks, just leaves and tree.”

Figure 2. The Rain forest diorama in situ

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Figure 3. The Waterhole

A Five year old boy said: “I can see a giraffe and some birds and a little giraffe and some monkeys. They’ve come to drink and eat. I can see some clouds and the sky and the grass.”

A 10 year old girl made these observations at this Waterhole diorama: “There’s rock, big giraffe, got its head down. There's a deer. It has birds on it and there’s a baby monkey with its hands up and some monkeys. Dirty water and ducks”.

The categories in this simple analysis from a read re-read iterative process in which they emerged were as follows: arranged in a hierarchy from the overarching category to the major living things group.

Superordinate:
- African Natural History dioramas

Ordinate categories
- Earth Science Biome
- Organisms Other

Subordinate categories
- Plant origin
- Animals
- Fungi

Mention was counted only once in each conversation, and not the number of instances of an exemplar in each. Had we been seeking to establish the variety of members of one subordinate category, for example animals we would have counted the instance of that name being used, but again only once because people often repeat a category when they notice that member again, as the girl does in the above conversation remarking several times about leaves, which were a predominate feature of that diorama, a rain forest. A total of fifty three conversations were collected on two separate afternoons. The majority from primary school aged children between: 5 yrs. And 11 years, several were lower teenagers.

The number of instances of Earth science categories observed and mentioned in the dioramas was twelve referred to an element categorized as earth sconce with twenty eight instances. All conversations mentioned an organism of which nine specifically mentioned fungi, which are displayed din the rain forest diorama. Organisms were the highest number of comments and were in the Organisms cattery Animal’s were mentioned in fifty two of the organism references and plants or plant origin such as twigs twenty eight times. The categories were not mutually exclusive. Children list as they notice things, the first observation being the type of biome when they did mention that.

The names used to refer to Constituents of Natural History Dioramas were as follows:

Earth Science
Water, rock, sand, dirt, clouds, footprint, stones, anthill, pond

Biomes
Rain forest, desert, savannah

Names used for living organisms

Plants
Hay, straw, logs, plants, Trees, leaves, grass

Animals
Deer thing, beetle antelope, little animal, bird, scorpion, Cleaning birds

Fungi

Mushroom

4. Discussion

Earth science comments were used for reference as locators for locating organisms, particularly animals. We maintain there is great potential in developing learning approaches and materials that could highlight the earth science inherent in Dioramas. First the earth science needs identifying. Secondly the voices of visitors need ascertaining. Hands on

materials can enhance the interpretation by visitors and provides a tangible item to hold and manipulate. Providing for a cue sheet through a laminated photographs or line drawing of the dioramas with a key to the identify of various elements. Stand alone interactive computers such as those in the National museum of Scotland at the dioramas presenting the evolution off the fauna and fauna of Scotland since the sat age examples of such.

Cueing strategies or prompts are crucial in my opinion. For example the view-workshop view again technique is effective if the museum has facilities for such where learners can handle specimens of rocks and learn characteristic features before returning to the galleries and re-looking at the diorama. Immediate activities such providing single isolated elements of the diorama, such as storm cloud, a cliff face, a boulder, sky colour, ground covering such as snow, cut out from a photograph of the diorama, to match with the actual representation in the diorama, Accompanying questions can be used, self administered or from an accompanying adult or museum facilitator. Interactive displays at a diorama with these activities can enhance this but low tech can be used in whatever setting and far less expensive.

Pre visit access to books, sheet, on line virtual tours can brief visitors as advanced organizer and are effective in similarities in promoting a richer, in terms of what is observed, observation capability during a visit to such dioramas. Additionally, planned mention of earth science in physics, geography and aspects of relevant science when taught in both primary and secondary schools might contribute to open the eyes of learners to the earth science manifest in our world. However, inherent curiosity and interest in the subject provides access to the story of a diorama which an individual brings to their visit

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Hands-on Interference in a Soap Thin Film: Nanoscience and Nanotechnology

B Vázquez Dorrío
University of de Vigo, Vigo, Spain
bvazquez@uvigo.es

Abstract. We have a lot of resources that can be employed to introduce the proposal to learn Physics by doing Physics in our classrooms. As an example, wave interference is presented in a hands-on methodology. Interference is a particular phenomenon for wave interaction than can be introduced in our classrooms with simple experiments with visible light. If we employ a soap thin film in a, for example, black cylindrical support we can explore properly constructive and destructive interference in a nanoscale hands-on activity by observation of different colour bands that depend on film thickness. This activity can be easily associated with concepts as visual perception, colour, wavelength, optical path difference, phase change, polarization, coherence, etc. Also obtained results can be related with metrology research in ultrasensitive interferometry, as recent gravitational wave detection.

Keywords. Physics, hands-on, waves, vision, colour, interference, resources, nanoscience, nanotechnology.

1. Introduction

Experimentation, whether it is structured or not, is a fundamental aspect of learning Physics, not only because of the role it plays in the scientific research itself that we must present to our students, but also because of its cognitive importance as it is linked to carrying out experiments to complement the usual use of references books. There have been many reports on education, learning, dissemination and vocation in Physics teaching/learning which point out that experiments and practical activities can inspire and help pupils to understand their related concepts, principles, laws or applications [1, 2,3]. One obstacle for their widespread use is the tendency of teachers to replicate in the classroom the teaching they received when they were students – centred at times on the theoretical basis and far removed on many occasions from an active, practical and experimental methodology.

The capacity to learn by doing – using activities that are hands-on / practical / experimental / materials-centred – should therefore be a possible objective in teacher training, which should offer possibilities for developing competences in this field [4]. There are currently countless resources that can be employed to make the most of students' creativity by introducing the proposal to learn Physics by doing Physics through the use, in or out of the classroom, of any material, object, instrument or experimental setup for learning a concept, principle, law or application in a suitable context [5].

Possibly the main way of acquiring new knowledge in this field is through direct or indirect connection with the work of colleagues who have opted to design and employ these tools [6]. In this way, it is common to gain information from them that we can make immediate use of or adapt in: a) books [7] that compile sets of activities suitably illustrated with instructions and explanations; b) specialised magazines [8] with articles periodically demonstrating new activities, proposals, suggestions and ideas that have been used successfully; c) events [9] that are occasional meeting points for teaching professionals in the broad sense who have a vocation to share their knowledge and experience; d) projects,[10] networks [11] or teachers' associations [12] that bring together people who are interested in improving the quality of teaching; e) websites [13] showing what others are doing in schools, colleges, universities, etc.; f) Media [14] (TV, radio, newspapers, magazines, etc.) demonstrating a fun and/or informative approach to what we teach; g) teaching materials companies [15] that supply our teaching labs with equipment, which can then be used beyond the usual structured practices, and that in many cases provide material for non-structured activities; h) interactive science museums [16] where the displays provide an opportunity to connect theoretical and practical concepts by means of some small-scale, personal, semi-guided research. All these, to a greater or lesser extent, are useful and necessary tools for our professional development [17] and work in the classroom in a model of learning Physics by doing Physics [18].

So there are a lot of hands-on information and resources that is waiting for us in order to construct amazing lectures for learning. In this context, an example of experimental for learning concepts related with waves and vision is presented.

2. A nanoscale hands-on activity

2.1. Nature of the light

The bands of colour that we can see in a soap bubble lit by white light are just one of the everyday examples of phenomena due to the wave nature of light and how our eyes work (Figure 1). They also demonstrate the fundamentals of science used in research labs to measure countless physical and chemical magnitudes. A set of simple experiments can be taken into the classroom in a coherent and structured way to help students learn important complex physical concepts. As for example, one of the key concepts in the understanding of this phenomenon is the spatial period of waves, their wavelength, which represents the distance between points in space that present the same disturbance. For light waves in the visible range, these distances are in the order of hundredths of nanometres with disturbances oscillating at frequencies in the order of 1014Hz – impossible for our eyes to appreciate. A model that can be used to understand these characteristics is a slinky [19], which can be made to oscillate, as a transversal wave, between two fixed points to generate a stationary visible wave with wavelengths in metres and frequencies in hertz (Figure 2).

Figure 1. A big soap bubble in classroom

2.2. Colour perception

At the same time, the retinas of our eyes have a series of photodetectors with maximums of detection at around 440nm, 540nm and 570nm – these are the so-called blue, green and red cones [20]. It is the combination of this process of photodetecting wavelengths in the retina and the complex workings of our brain that will eventually subjectively define the colour of an object in a process that depends on the illumination used.

Figure 2. Slinky at work

The persistence and latency of the retina's cones partly explain how the toy known as the magic ball works [21]. Inside, it contains three RGB LEDs that make white light and these create a sensation of having separate RGB colours when it is turned (Figure 3).

Figure 3. Mysterious Glowing Ball

A simpler version of persistence demonstration consists of observing the primary or secondary colours in a darkened

room for about 20 seconds before looking at a white screen – when the secondary or primary colours, respectively, will be observed during several seconds (Figure 4). Possibly, the simplest way to make this additive mix is with the extremely well-known Newton disc [22] that, when it spins, creates the sensation of the colour white by adding and mixing together the colours of the visible spectrum in the right quantities. In the same way, we can use spinning discs (with a CD and a ball, with a motor, with a fan, etc…) to obtain complementary colours (cyan, magenta, yellow) by combining two primary colours (red, green, blue), or, likewise, by removing the corresponding prime colour from the RGB combination (Figure 5).

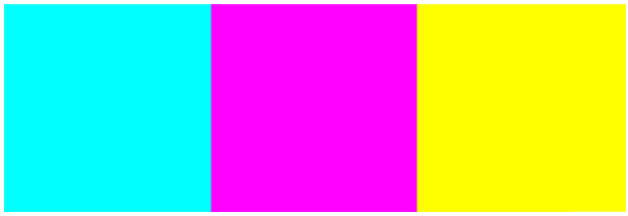

Figure 4. Staring for 20 seconds…

Figure 5. Mixing blue and green with a pc fan (see image.gif [23])

Finally, this process can be shown spectacularly in the classroom if an obstacle is illuminated by three RGB lamps and their shadow is seen on a far-off wall [24]. At the points where a primary colour is blocked, a shadow in a complementary colour will be seen (Figure 6). This additive mixing of colours is employed in the well-known RGB model of our screens, projectors, smartphones, … and it can be observed at work with a convergent lens on them or for a more spectacular demo with a USB microscope connected to our PC during a class (Figure 7).

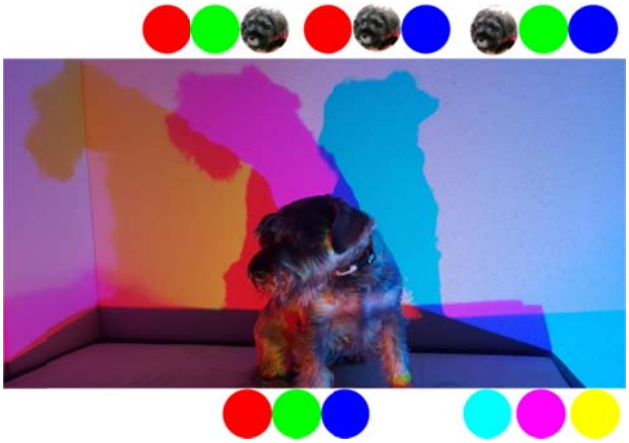

Figure 6. Coloured shadows with RGB led lamps

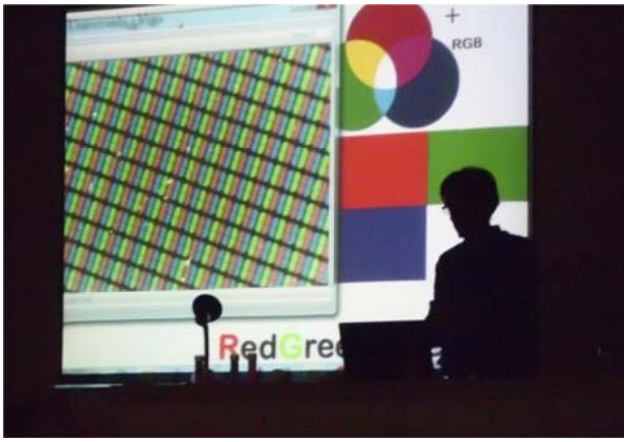

Figure 7. RGB in a monitor with a USB microscope

2.3. Colours in a thin film

Once the basic workings of the eye, in terms of colour definition, is understood, the next step is to understand the colour bands in the soap bubble that appear from the overlapping in space and time of the light waves that have been reflected and transmitted at the air-soapy water-air separation surfaces and are observed by our eyes. In the soapy water, which is in principle colourless, if the thickness of the bubble is sufficiently small, then the similarity of the waves that overlap produces the well-known phenomenon of interference in the form of easy-to-see bright colours associated with the concepts of phase difference, polarization, coherence, phase shift, etc.

To make it easier to do in the classroom, a thin film of soapy water – with just the right amount of glycerine to reduce evaporation –

can be placed vertically, initially with a parallel plane configuration for the liquid layer, on a circular or rectangular frame that is preferably dark on the inside (to absorb the transmitted light) (Figure 8). The support can be made from opaque, semi-rigid plastic or from a piece of cane, medical tubing, a cup, the cover from an old photographic film, etc [25]. The liquid can be made, for example, by mixing suitable amounts of washing up liquid, water and glycerine [26] or acquiring a ready-made mix for use in commercial bubble makers. The third item needed is the container for the soapy water, where the frame will be soaked to successfully create a thin film before being placed with its section vertical with respect to the support surface. This can be used to explore, in a naïve model, the constructive and destructive interference by analysing the different bands of colour formed, which depend essentially on the thickness of the film, its refraction index and the angle of incidence/observation.

Figure 8. Thin film with a mug cup

With the thin film placed vertically, its initial parallel plane configuration becomes wedge shaped over time due to the effect of gravity and evaporation. A film like this will last up to 2-3 minutes and what can essentially be observed are cyan, magenta and yellow bands, which indicate that in some way the corresponding primary colours, red, green and blue, have disappeared. These lines of colour will descend as the water drains away due to gravity to gradually. The period of the repeated colour band decreases towards the bottom. That is where the layer is much wider and the bands are not visible for thicknesses of the order of several microns, whereas at the thinner part near the top a transparent band of very little thickness is formed where all the colours interfere destructively. At the top a transparent film at the top formed, that is called Newton black film with a thickness less than 7nm [27]. Just before the bubble pops, the thickness at the top is of the order of 1-2nm [28]. In this top part, where no light appears reflected, the light that is reflected first and the light coming from the second soap-air separation surface are interfering destructively. This indicates that, in a simple interference model, with linearly polarized light, the second wave suffers a phase shift of 180º.

Figure 9. Thin film in a piece of cane

When the thickness is not practically zero, both waves interfere on the way out to give rise to a resulting wave of a different colour, but if the thickness of the thin film is precisely 150nm (half the wavelength of blue in water), the blue disappears and a yellow band can be seen. The same thing happens for thicknesses of 200nm and 250nm (half the wavelength of green and red in water, respectively), where green and red disappear and we can see bands of magenta and cyan, respectively. This layout of colours is repeated over the area for multiple semi-whole thicknesses of the corresponding wavelength in our medium (approximately 300-400-500nm; 450-600-750nm; etc) and so shows the periodical character of the interference phenomenon (Figure 9).

Each colour line (fringe) is a phase isoline with the same value of thickness, since the constructive or destructive interference condition differs on half the wavelength of each colour in water, these lines/fringes can be understood, for each colour, as the intersection between the first surface of the thin film and

planes parallel to the second surface and separated by half the wavelength in water. So, these colour lines are therefore a live topographic map of the microscopic differences in the thickness of the thin film of soapy water!

3. A simple interferometer

This simple experimental setup can in fact be considered as a double beam interferometer (rejecting the contribution of the light with more than one reflection) by division of amplitude at the air-soapy water-air separation surfaces (that act as a beam splitter) [29].

It is perhaps one of the simplest and most versatile interferometers that can be assembled using everyday materials in order to carry out nano-experiments in the classroom. It enables direct measurement of the thickness of the thin film of the soapy-water, recognising the fact that the different colours observed correspond partly to the cancellation by destructive interference of their complementary colours due to the various thicknesses of the thin film (Figure 10).

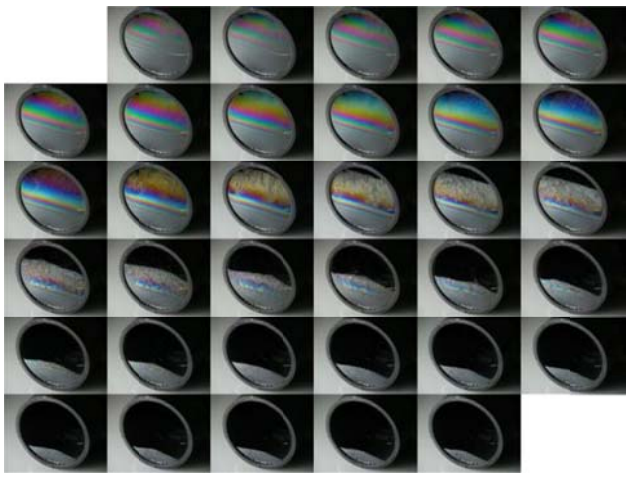

Figure 10. Evolution of the thin film in a piece of cane during 2 minutes (see image.gif [23])

Since any magnitude able to modify the phase difference of the interfering beams can be measured with an interferometer, we can use our simple interferometer to check its high sensitivity to environmental variations of pressure, temperature and so on by observing processes of capillarity, convection, turbulence, vortices, etc.

We are replicating in the classroom an experiment in nanotechnology and nanoscience that is easy to reproduce, that remains stable for long enough to make observations in detail with no need for excessive environmental control, and that makes it possible to relate curriculum contents with the wave nature of light and the colour perception process in our eyes.

4. Conclusions

A set of hands-on activities related with thin film interpretation in a soap bubble has been presented with a simple model (non absorbing media, homogenous and isotropic media, normal incidence, linear polarization, two-beam interference, RGB perception …). This hands-on model provides valuable conceptual knowledge about colours in a soap bubble, since a reduction of the foundations of everyday interference to an elemental level helps in the understanding of many applications in ultra-accurate measurement processes (from the determination of temperature, pressure, chemical concentration, etc, right up to the recent detection of gravitational waves). It also aids understanding of the workings of diverse technological applications (such as reflective and anti-reflective coatings) or various natural phenomena (such as iridescence in coins, molluscs, insects, etc.). Also it can go further if “monocromatiic” illumination is employed [30], complementary transmitted pattern is observed [31], etc. There's plenty of information at the outside. During the 2016-2017 academic year, there have been 25 talks with these contents to around 1200 students and 100 teachers in Galicia-Spain [6-32].It is an example that what we can do in our classrooms…

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The Role of Creativity in the Teaching and Learning of Science and Mathematics

M Marques, P Machado, MFM Costa
Universidade do Minho, Braga, Portugal
mfcosta@fisica.uminho.pt

Abstract. The purpose of this paper is to identify and characterize what creativity is evidenced in early science and mathematics. As a consequence, this qualitative study sought to produce a description and map of lived experience in a primary school classroom, explores how creativity can enhance learning and examines some relationships and synergies between science and mathematics education and creativity. In this paper we discuss the concept of creativity in the context of science and mathematics education. Then we recommend an activity and strategies that encourage creativity, and more specifically imaginative/creative thinking. The episode herein reported was drawn from selected observations and supported by information gathered through several types of data and offers many examples of children's dynamism and rising abilities to collaborate in deciding what to do in carrying out investigations.

Keywords. Creativity, primary school, science education, mathematics.

1. Introduction

There is a rising recognition that scientific literacy plays a progressively important role not just for individuals but also for 21st century society as a whole [1]. Developing scientific and mathematical literacy in individuals then becomes an important part of the development of the child and the citizen. Looking at the world from a scientific perspective enriches the understanding and interaction with phenomena in nature and technology, enables students (and consequently future adults) to take part in social discussions and decision-making processes, and gives them an additional element from which to form interests and attitudes [2]. High quality scientific thinking [3] is one of the key goals in contemporary schooling, especially when facing vast quantity of information and in using new technologies.

As the need for more innovative thinkers increases, so the need to improve attitudes, and the importance of scientific reasoning skills arguably become more important. Indeed, in order to compete globally as future scientists, it is further important that individuals develop the skills and confidence to apply their knowledge in innovative ways. In Europe then, scientific literacy is viewed as a dimension of "democratic citizenship", as an informed citizen can better contribute to the decisions of the community to which he/she belongs [4].

It is important to develop socially aware and responsible citizens. Education must therefore strive to achieve this aim in the development of the child. In order to avoid a simplistic view of science and mathematics as the acquisition of factual information and conventional explanations of natural phenomena and to move understanding towards a view of science and mathematics as a range of widely applicable skills and competencies, researchers have argued a primary objective of science and mathematics education should be to increase motivation and foster positive attitudes [5]. Young people's attitudes towards science and their motivation are increasingly recognised as crucial.

Science, mathematics and creativity are all altered by rapid advances in digital technologies which are shaping new literacies. Digital technologies enable children's creativity, in connecting with others and, in particular content generation in [6]. Creativity needs to be encouraged in primary school classes. Creativity involves more than making something new or creating something, and can be applied to sciences [7]. It also involves thinking and problem solving [8, 9], as well as discovery [10] and innovation.

Creative science teaching and learning is active and child-centred, involving problem solving and exploration [11]. Allowing children to solve problems for themselves is also a creative way to achieve learning goals. These can range from simple challenges, whilst children are playing or exploring, to more refined problem-solving activities.

The challenge for teachers is to achieve equilibrium between structure and freedom in early years educational settings, adopting a more dialogical pedagogical model in which the teacher coordinates standing back with

collaborative intervention in science and mathematics classroom.

The episode herein reported illustrates an example of creativity in mathematics in the early years. It was drawn from selected observations and supported by information gathered through several types of data.

The notes taken included a timeline along which we recorded the development of the activity: the teacher's actions and speech, the children's interventions and comments, the actions taken and the events happened. The latter processing of these field notes from different observers, together with the pictures taken, enabled to better identify and to characterize the episode.

The findings of this episode aim to reveal the potential for creativity and the role of inquiry in the classroom reality of primary science and mathematics education. Seeking to find children creativity in maths at this level, a primary school class was challenged to solve a task.

2. Instruments and methodology

The fieldwork involved the use of sequential digital images capturing detailed interactions, with field notes supplemented by audio recording later transcribed and an overall timeline. The fieldwork instruments were: observation with field notes and a timeline [12], sequential digital images taken during the observations [13], audio recordings (with relevant sections transcribed), a map of the space, individual interviews with the teacher [14] and a group interviews with children [15].

The objective of the observation during this activity was to illustrate an episode of children creativity [16]. The notes taken included a timeline along which the observer recorded the development of the activity: the teacher's actions and speech, the children's interventions and comments, the actions taken and the events happened. The latter processing of these field notes from different observers, together with the pictures taken, enabled to better identify and to characterize the creativity episode. The interviews included the observation by the teacher and the children of a sequence of pictures relative to one or more moments identified as having creativity.

3. Characterization of the class

The school, placed in Braga, in northern Portugal, is a private education educational catholic institution covering four levels of education: preschool, primary school, 2nd and 3rd level of basic education, the students in a total of 600, are aged between three to fifteen years old. The class in this case has twenty-seven students (seventeen boys and ten girls), with average age of 8 years old.

4. The wolf, sheep and cabbage problem

The aim of the problem was to move the wolf, sheep and cabbage to the opposite shore of the river. It got more difficult though because when the man was not around the wolf would eat the sheep, the sheep would also do the same when alone with the cabbage. This involves the use of knowledge of food chains to solve the problem – analysing possibilities and predicting if there is more than one solution.

The teacher introduced the well-known problem 'Wolf, Sheep and Cabbage' on the blackboard, and explained the rules of the game to the children. The children had to carry the wolf, sheep and cabbage on a boat from one side of the river to the other, one by one. The conditions were that 1) if the wolf is left alone with the sheep, it will eat the sheep, 2) if the sheep is left alone with the cabbage, it will eat the cabbage, and 3) the wolf will not eat the sheep and the sheep will not eat the cabbage if the farmer, who is sitting in the boat, is right nearby to side of the river that they are on.

Using the paper cut-out models of the wolf, sheep and cabbage that the children had made and painted previously, and an origami boat that they created at the start of the game, they were encouraged to work in groups to solve the problem.

Throughout the activity, the children collaborated with their peers to think of different possibilities, to try out the different potential solutions, and to give reasons why certain ideas would not work.

The whole class reached conclusions and solved the problem presented in the beginning, and had the opportunity to verify their solutions against the online version of the game, which is available freely on several websites. The uses of ICT allowed the children to experience and

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represent the same problem in different ways.

4.1. Opportunities for creativity

The context of the game provoked children's imagination and the informal and fun nature of the task motivated the children to become engaged in the problem. Working in groups encouraged children to articulate their ideas and reasoning. Children collaborated in sharing and discussing different ways to solve the problem.

Children's problem solving skills were fostered as they suggested and modelled different potential solutions and gave reasons why certain ideas work or would not work.

Children used and developed science skills such as predicting, observing, analysing and describing, demonstrating scientific or mathematical creativity in generating alternative ideas and strategies and reasoning critically between them. They also had to make connections between the combinatorial / mathematical aspect of the task and their knowledge of food chains.

4.2. Illustrative extracts from data

Figure 1. The informal and fun nature of the task helped in engaging children

Child 1: "The sheep eats the cabbage."
Child 2: "The sheep has to go first because the wolf doesn't eat the cabbage."

Child 2: "If we took the sheep first, then the cabbage, then the sheep will eat the cabbage."
Child 2: "So we have to leave the sheep and bring the cabbage back."
Child 2: "If we took the cabbage in first place, the wolf will eat the sheep. (…)"

Figure 2. An example of children collaborating and giving reasons

Figure 3. Examples of children explaining why certain ideas would work and would not work

Figure 4. The integration of ICT for children to verify their solution

Child 3: "First we take the sheep across, then we go back and get the cabbage, then we take

the sheep back and take the wolf across, then we take the sheep across."

4.3. Reflecting on learning

Child 4: "With this activity we learned that to solve a problem we have to make relationship between what we are 'analysing'."

5. Conclusions

Creativity is an attribute that we can all develop. Creativity in early science involves children in solving problems. We need to support children in being creative in science and for this to happen we need creative teachers, who think flexibly and provide motivating experiences for the children.

The episode showed creativity through the encouragement of problem-solving and children's agency.

The teacher initiated activities promoting the interest and curiosity of students, presenting problematic situations and discussing with students initially.

During the activities, the teacher was always careful to guide students in their learning and guiding them to a way forward, not invalidating the trials and errors of students in order to solve the problem. She fosters reflection and reasoning, encouraging students.

Teacher prepares her activity depending on students' interests, not forgetting the national curriculum and student achievement, looking to find activities that promote students' interest in mathematics and science and creativity.

Teaching approaches appear to provide children with a "starting point" from which they can ask questions, experiment, observe phenomenon and so on, mainly teacher provides guidance so the students can achieve the purpose of the proposed activities and building their network of knowledge. As noted, teacher has the ability to foster creativity. Opportunities for the generation of ideas, for example, were fostered by rich motivating contexts for play and exploration.

The potential of sensitive teacher scaffolding to extend inquiry was emphasized, particularly in relation to when to mediate and when to stand back in order to listen to and build upon children's creative engagement and the development of their ideas and questions.

Across the episode there were many examples of children observing and making connections.

In the interview the teacher made reference to the importance of encouraging and supporting children's engagement in early years' science and mathematics as an important starting point for learning. Also emphasized the need to foster motivation and collaboration and provide a rich environment with space and time for exploration and problem-based learning, underlining key role for teacher in encouraging reflection and making connections to promote children's conceptual understanding and the application of ideas.

As the teacher referred in the interview: "creativity is important, because how more creative students are, more motivated they feel", because she considers the fact that they can discover multiple paths to get to the result, gives them a great joy and takes them to get excited fostering the interest in these disciplines (maths and sciences). Teacher finds this relation between creativity, mathematics and science very important.

Dialogue and collaboration, promoted by widespread use of group work and teacher questioning, played important roles in encouraging the processes of reflection and explanation related with the evaluation of ideas and strategies.

6. Acknowledgements

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Growing Scientific Thinking with Fictional Picture Books: Questioning and Imagination in Early Years

SD Tunnicliffe[1], *C Bruguière*[2]
[1]*University College London, UK*
[2]*Université Lyon 1, Lyon, France*
s.tunnicliffe@ucl.ac.uk
catherine.bruguiere@univ-lyon1.fr

Abstract. Reading fictional picture books is a feature of early childhoods, with an adult or they look alone. In preschool and early years education such highly coloured illustrations are a feature of the story. These stories, such as The Very Hungry Caterpillar, Fish is fish, or Tadpole' promise, were not written and illustrated by their authors-illustrators / and authors and illustrators to inform about science but to tell an engaging story. However, they do introduce information related to the authentic science but inaccurate, and such are remembered by these early learners. Our innovatory work is about taking a more integrated science teaching approach with literature by using fictional storybooks in science classroom. We are exploring for the cultural trend of how primary curriculae can evolve with a development of a real scientific literacy through reading such books. The issue in scientific literacy is to ensure that the pupils acquire more than knowledge about the basic concepts in science but also a vision of how such knowledge relates to other events, why it is important and how this particular view of the world came to be. Scientific literacy involves a meaningful understanding of knowledge about the nature of science, scientific inquiry such as hypothesising and the major conceptual themes. It also enhances cognitive abilities, critical thinking to understand the big ideas of science and to be able to inform and persuade the others about these ideas The essence of such an approach is in the form of the teaching, how the books are used and the contribution (or intervention) by the adult and their own knowledge of the science portrayed. We consider the way in which the science information is elaborated from the point of view of the method being used to transmit such. The modes of language (reading, writing, talking) used in this process are also crucial. The potential that reading in an interactive manner of these colourfully illustrated fictional texts, with young pupils can offer in their scientific literacy development. While information books are often used in the science classrooms of older pupils, this is less the case with young pupils. However, the use of fictional texts and the reading of them is a feature. We are interested to ascertain in what conditions reading specific fictional storybooks that we called 'realistic fiction' storybooks might stimulate young children to engage in a scientific thinking manner of observations, evidence hypothesising as well as learning the form and usage of books. To what extend the teacher interventions during the reading allow the pupils to think for themselves about science aspects underlying these stories? How are the pupils able to put the sense of the story into their own words? How do their interpretation and their prediction about the story allow them to develop scientific thinking and imagination? We consider how we can attribute an epistemic aim to the reading of these 'realistic fiction'. We show examples of a realistic fiction picture book Fish is Fish that reading with young children (4 - 5 years old) at nursery school. We present a taxonomy of the interventions of the teacher related with the development of children thinking. The issue is to allow the teachers to read realistic fiction storybooks with young children in order to develop a real scientific literacy and not only a merry image of the science (often inaccurate).

Keywords. Picture books: questioning, imagination, early years.

1. Introduction

Conversational analysis has a history [1,2,3] verbalised what a number of primary teachers had been advocating [4] of developing dialogue with learners, cuing them into thinking for themselves and problem solving, rather than doggedly following instructions in repeating a science investigations, referred to as 'experiments', for which the expected outcome was known, and often given at the start of the exercise. In effect this type of science work in school was a practising of skills and the ability to follow a recipe. What has become called Inquiry or Enquiry science advocated such an approach.

The reading of stories, pictorial fiction for very early learners and mostly text for older

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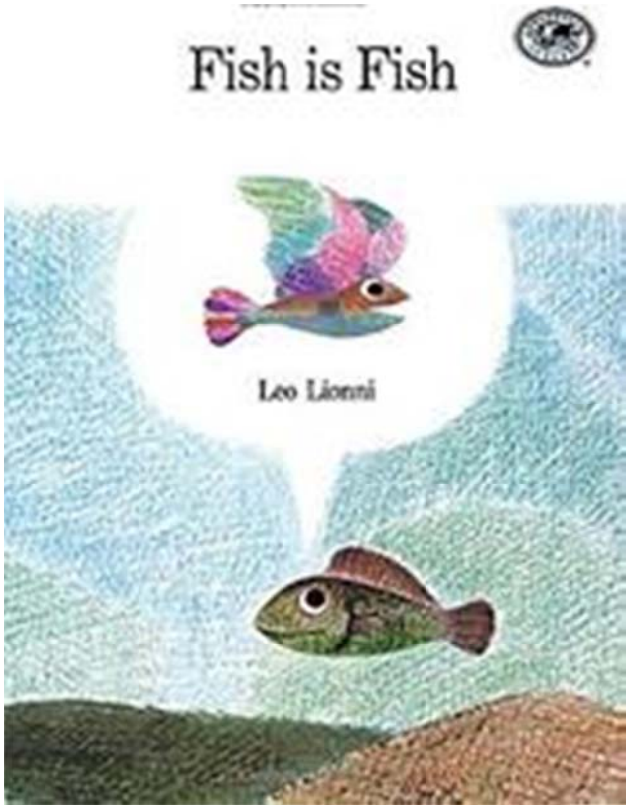
children is a feature of early years and primary school life, hitherto the role of such narrative telling has not been related to the learning of science.



We are referring to effectively illustrated children's stories that were not probably written to convey science information but it is embedded in the story, not always accurately. Such as Fish is Fish [5] and not like for example, Robert Well's book How to Lift A lion which sets out to help children investigate pulleys [6]. Nor in the work we report here are we disusing the use of stories specifically in a science focused classes The use of fictional stories in the learning of science in the preschool and early years has been advocated and employed as a start of some investigations such as the reading of a fairy story such as Jack and the Beanstalk [7]. We propose that such stories should be used with the children to critically evaluated based on their first hand observations, the outcomes after they have investigated for themselves a similar issue so the first hand knowledge can feed into their critique.

A characteristic of these popular books read by parents and others with young children as well as early years teachers and other staff with children are brightly coloured illustrations illustrating the text. Another key feature is that anthropomorphism of the characters, in for example the popular, The Very Hungry Caterpillar, and the caterpillar eats cakes, food familiar to the readers. Frequently characters talk and act as humans do. The animals are frequently portrayed in an anthropomorphic manner with their natural facial characterises modified to resemble more human features. The minnow (small fish) for example in Fish is fish had human eyes and mouth, not resembling a real fish it a very great extent except the basic body shape.

Characters are sometimes endowed with understanding of human characteristics, which in the real world they would be unlikely to know. The minnow for example in Fish is Fish when imagining humans walking on land envisages, according to the illustrations a fish upright, as frog has told him, but also one fish wearing a bowler hat, a tie and carrying a brief case, information not provided in the text. He appears to understand the position and action of wings. An aspect of the reading of this genre of stories is the science concepts, which are being introduced or reinforced by the text. Such may be new to children or have some familiarity. It is the skill of the reader and the response of the child. Which varies and can contribute to the concept development of the individual and possibly other children listening although we did not seek to establish such in this study. The understanding of an individual, indeed adult and child, depends on the mental models held by the build of the issue being told. It is preferable for a child's development of science concepts and the nature if science that the reader is familiar with activities with which the child has been involved so they can refer to shared or knows experiences.

We are biologists. We are exploring the role of fictional storybooks in the very early stages of the learning of science. The way in which the adult uses the book is, we consider, of extreme importance in this foundation of learning. Our rationale was to establish the comprehension of the listeners through drawings and nothing their out loud commends or their responses to a question form the adult.

2. Methodology

We had no intervention ourselves with children, we were observers. However, we had

permission off the heads of the schools and had given then the disclosure certificates that confirm that we had no criminal record. The unit we are considering various but there is always one reader and from one to a larger number of listeners, the children. An adult and child is one unit for such reading, particularly in a family or in a nursery or other formal educational setting with a dedicated adult. More often in a class one adult reads to a group of children.

We report here the results of having observed teachers reading such pictorial fiction books to young children and identified the manner in which they do this. We recorded the dialogues and transcribed the recording. We focus in this paper on the use of the story Fish is fish (1970). We read and re read the raw data and categories of action emerged. From these observations we propose a categorisation of the way narrative are used to identify which narrative category(ies) foster(s) science children thinking.

3. Results

The taxonomy identified from our observations and initial reading transcripts is:

1) Story just read, (R)
2) Read and Show, (RS): story read but illustrations shown as appropriate intervals.
3) Read Stop Draw, (RSD): story read to a point and children asked to draw their interpretation of a description for so that their mental model stimulated by the text but also their revise experiences may be revealed
4) Read and a break, (RB): narrative interpreted by teacher why translates the text into everyday words for the reader if the language/terminology is unfamiliar
5) Read and Break, (RBA): adult interrupts and explains relating to a shared memory within the group such as a relevant class/family activity.
6) Read and Break, (RBC): child interrupts. Adult and others listen to a child comments and suggestions exploring the relation to the story
7) Read, Break, Invite (RBI): adult invites the children's suggestions, predictions as to what the outcome of a situation may be and why or why something has already occurred.
8) Break at Childs comment and Explore, (RCE): using a child's out loud comments to explore issues relevant to the story e.g. in Fish is Fish a girl says' crabs because crabs like in water too', whereas her out loud comment 'shark' reflects the child connecting in her mental model of fish like animals that live in water.

We identified exemplars of these categories in the transcripts, which we show below to illustrate our analysis. In the work reported here there was introduction of read break and draw. Such is reported elsewhere [8]. The next stage was to illustrate examples of such in a transcript. Not all reading occasions contained all the categories, particularly for example, the READ BERA KDRA.

An example of one of the categories is shown in Table 1. The full table can be sent on application. The emailed here is of Read Stop and Draw, RSD. The story is read to a point when stopped and the children asked to daw their interpretation of the image which they have formed (a mental model) which aches been simulate by hearing the text. Their previous experience may be revealed in the exemplars.

T: 'In the week that followed the tadpole grew two front legs'/ so now he's got how many legs he's got now E: two T: two in the back and two at the front. E: that is that is his hands. T: it's like his hands you are right the front/	The teacher Conversation strategy : extension, recasting Science learning/ teaching: - identify two pairs of legs - match front leg/ hand

Table 1. RSD

The above examples show that by employing one of the techniques children can be actively involved in the group listening to a story. A practising teacher of 5year olds in England recognised or analysis in her work.

"The children were directing the conversation (focused on a pictorial fiction book she was reading with them) rather than me, so it was much more of a child led interaction with them making the comparisons and myself only coming in to support and extend the

discussions" [9].

4. Discussion and conclusion

Allowing children to break the reading of a story reveals their interest, how they can relate theses effectively second hand instances, accessed through the words and illustrations provided by the book which are given to them by adults, teacher or parent who are reading the book and the author who created the story amplified by the artist illustrating the author's text. Moreover, the spontaneous words of children stimulated by the story (word or pictures) provides access to the way in which children make concretions from the fiction to their own world, their actual experiences and indeed being able to relate this fiction to related stories. Furthermore, through listening, capturing and then analysing such comments their understanding of the science presented is accessed. They are thinking as emergent scientists by recognising salient features which define a class member. Key instances presented in a story, in this story the two different environments, air on land and water in the pond, such was differing habitats, associated animals that live in such, and understanding that physiological needs shared by all animals such as need for oxygen are provided by systems appropriate to the habitats and its features in which an animal lives and such are not the same for all.

Fleer [10] reminds us that constructivism places importance on determining the learners existing ideas. Interactive experiences have a value in the construction and consolidation of an individual's learning. Indeed, Inhelder et al. [11] observed that the more activities in which a leaner is involved the more they learn [12] that these young children have the skills of evaluation, which the reading of pictorial fiction books can enhance their application of these skills. This approach is mind-on science as well as enhancing the skills of reading, essential for developing hands on science

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How Kids Can Learn Sustainability through Hands-On Activities - a City under Construction

MA Forjaz, MJ Almeida, C Almeida-Aguiar
University of Minho, Braga, Portugal
scientia.com.pt@bio.uminho.pt

Abstract. Sustainable development, defined by the World Commission on Environment and Development as the ‘‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’’, is in worldwide agendas. Education for sustainable development is particularly important to guarantee that everyone has the values, the behaviors and the lifestyle necessary to transform our society and to build a sustainable future. Considering that environmental and scientific education in general should be promoted from early childhood the project Scientia.com.pt has been implementing hands-on activities for children on a regular basis. The present work will present the project “Ciência p´ra que te quero" conceived under the 2030 Agenda for Sustainable Development, the different activities promoted and some of the results of its implementation.

Keywords. Hands-on activities, formal and informal education, science with and for society, sustainable cities, sustainable development goals.

1. Introduction

The call for sustainable development echoes all around the world. This new concept, advised by the World Commission on Environment and Development was defined as the ‘‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’’ [1]. As in all major actual themes, a sustainable development involves science and its applications. It is also desirable that any citizen could understand the major questions raised by our contemporary world. Therefore, in order to contribute to this sustainable development and also to a more committed and aware society we have to stimulate in the younger generations the pleasure of discovery, the love of learning and the joy of imagination. New generations must feed the need to change, must think scientifically, should make informed decisions, needed to take risks to transform things. The experimental teaching of science is a considerable contribution to this objective, encouraging and stimulating a systematic attitude of openness towards the world and the other human beings” [2]

1.1. Sustainability and the new ONU 2030 Agenda

A key element in the above sustainable development definition is the unity of environment and development that cannot and should not be distinguished as separate entities. Considering that environment encompasses all living and non-living things occurring naturally, we can sustain that it does not exist as an isolated domain from human actions, ambitions, and needs. On the other side, due to the great economic and political power, many of the decisions regarding development taken by the majority of countries have a profound effect upon the ability of all people to sustain human progress for generations to come. So, it is not difficult to accept that the two entities are inseparable: "environment" is where we all live and “development" is what we all do in attempting to improve our lot within that abode [1].

Figure 1. ONU 2030 Agenda: 17 goals for sustainable development

As the sustainable development is not a fixed state of harmony but rather a process of change, in September 2015, the United Nations General Assembly formally adopted the "universal, integrated and transformative" 2030 Agenda for Sustainable Development [3]. The proposal, which contains 17 goals (Fig. 1) with 169 targets, considers the three dimensions economic, social and environmental to improve

people's lives and protect the planet for future generations.

Covering a broad range of sustainable development issues, the interconnected and integrated nature of the goals are of crucial importance and highlight five areas of intervention: people, planet, prosperity, peace and global partnership. If it is true that all the governments and stakeholders should be busy working to achieve the goals, it is also important that private sectors, local authorities, civil society organizations and ordinary people can help and collaborate to accelerate the achievement and lead to a sustainable lifestyle.

1.2. Education for Sustainable Development

The terms "sustainability", "sustainable behaviours", "sustainable cities", or others in the same scope, have become daily frequent in all media. Nevertheless, many individuals still do not know exactly what they are, whereas others do know their meaning but do not act accordingly. Wals & Jickling [4] refer that there are multiple perspectives on sustainability, education for sustainable development, and education for sustainability and multiple perspectives on the way educators should interpret these ideas. Sustainability potentially brings together different groups in society searching for a common language to discuss environmental issues. The vision of education for sustainable development is a world where everyone has the opportunity to benefit from quality education and learn the values, behavior and lifestyles required for a sustainable future and for positive societal transformation [5].

Environmental education should thus be promoted from early childhood. Central to quality in early childhood education and care is recognition that early experiences must be stimulating and involve positive interactions with adults in appropriate learning environments [6]. Malone & Tranter [7] raise a question: "What is the role of school grounds as sites for teaching and learning"? We know that all children have a right to play. Play is not only inherently valuable as an enjoyable activity, it is also a process through which children learn. Play enhances problem solving and promotes opportunities to experiment with creative thought. The best play environments for children are those which are developed on the basis of children's natural play needs, taking into account the play behavior engaged in at different developmental periods, including the social, physical and cognitive forms of play [7]. Learning outdoors, outside the classroom, provides another context in which to pursue the 'normal' content-based learning and simultaneously a 'special' space for children to develop broader range understandings, skills and attributes [8].

1.3. "Ciência p´ra que te quero" and the "sustainable city"

Scientia.com.pt is a University of Minho science communication and outreach project that has a more experimental-oriented section: "Experiment@Ciência". Over the last three years and upon the hospitality of the "Biblioteca Lúcio Craveiro da Silva" (BLCS) library, in Braga, Portugal, Experiment@Ciência has been carrying out "Ciência p´ra que te quero", a project that includes hands-on interdisciplinary science activities for children from 6 to 10 years allowing them to be scientists for two hours [9]. From February to November 2017, seven monthly sessions were designed under the motto of the 17 goals for sustainable development [3] (Fig. 1). The proposed experimental activities highlighted the need to respect ecological norms in human needs, without undermining the development of future generations and aiming to: (i) realize that natural resources are limited and should therefore be used in an appropriate manner, (ii) draw attention to the natural changes caused by the presence of pollutants from domestic, commercial or industrial use, (iii) emphasize that wastewater is returned to the environment and may compromise the water quality of rivers, fauna and flora, fisheries, navigation or energy generation, and treatment is expected to avoid damage to the environment and living beings.

One good reason for implementing "Ciência p´ra que te quero" activities is the one referred by Bonnett [10]: "For authentic human being the attitude of sustainability is not a bolt on option but a necessity." "… In an educational context, aspirations to promote sustainability as a frame of mind must necessarily be located in a practical way of life. … This has clear implications for aspects of education which fall outside the formal taught curriculum …".

Another good reason is that education for sustainability is a quest for effective learning outcomes of values, attitudes and behaviors, as referred by Shephard [11]. Each of the sessions is based in a different theme, with several experimental activities, but sharing a specific hands-on activity related to a main and big transversal project "the sustainable city".

Scientia@sustentabilidade	**Goal 7- Affordable and Clean Energy** **Goal 9 – Industry, Innovation and Infrastructure** **Goal 11 - Sustainable Cities Communities**
Água - valoriza a gota!	**Goal 3 - Clean Water and Sanitation** **Goal 14 - Life Below Water,**
Terra à vista!	**Goal 13 - Climate Action** **Goal 15 - Life on Land**
Semear e plantar, tudo está no começar!	**Goal 2 - Zero Hunger**
Experiment@Ciência.com.Férias	**Goal 3 - Good Health and Well-Being** **Goal 4 – Quality Education**
Quantos Rs ECOntas?	**Goal 12 – Responsible Consumption and Production** **Goal 13 - Climate action**
Ciência & Cientistas	**Goal 8 – Decent Work and Economic Growth.**

Table 1. The seven sessions and the 17 sustainability developments goals

Education in sustainable development is not just a matter of instructing children about sustainable development, but also of preparing them to be active members of a society where sustainable development occurs. How can we explore our non-formal and informal education to facilitate the attainment of the goals of sustainable development? How can we integrate environmental experiences to help children learn and care for the environment? We know that children's interest in the environment is clearly strong and we believe that engagement with the environment, which starts early in life, is decisive for the individual as well as for society's commitment to care for the environment.

The idea of a having a big global project that could be developed under the sustainable development goals was on the table. So, from the very beginning, children were invited to embrace the project of creating a sustainable city. We strongly believe that if we look at the children as really citizens and let them have active participation it will have various and good implications in our future, our society, ours cities. An actual subject matter is "In the future the triumph is of the cities" [12]. Every week, three million people around the world move to cities, billion homes will be needed by 2025 to accommodate the 50 million new residents who move to cities each year. In 2016, four thousand million people will live in cities, being more than half of the world's population. By 2050 they will live two thirds! But for many of them this new reality does not mean quality of life. Cities are getting bigger, especially in developing countries, but that does not make them better. The lack of housing, poverty and marginalization, gigantic traffic jams and inefficient transport, energy consumption or garbage accumulated in overwhelming quantities, risks of malnutrition, infection and diseases, pollution, high temperature and insufficient potable water are some of the big problems that can dramatically increase during the coming decades.

Considering this world, from the very beginning children were invited to embrace the project of how to create a sustainable city. They were challenged to plan, develop and build a "sustainable city" through the gradual construction of a model of that city. Ideally, a sustainable city, or an eco-city, must be designed considering the environmental impact, inhabited by people dedicated towards minimization of required inputs of energy, water

and food, and waste output of heat, air pollution and water pollution to create an enduring way of life across the four domains of ecology, economics, politics and culture. Aspects like urban strategic planning, architecture, walk able urbanism, diversity in modes of transportation, urban farming, energy, water, renewable resources among others, were considered together with the children engaged in the activities. On behalf of these purposes, the seven sessions were named: (1) Scientia@sustentabilidade, (2) Água - valoriza a gota! (3) Terra à vista! (4) Semear e plantar, tudo está no começar! (5) Experiment@Ciência.com.Férias, (6) Quantos Rs ECOntas? (7) Ciência & Cientistas. The purpose of matching each of these sessions to the 17 sustainable development goals [3] was achieved according to what can be seen in Table 1.

Not every goal for the development defined by the United Nations [3] was included in our activities. This is not a matter of minor importance, but rather because these objectives are both wide and difficult to achieve within the scope of the "Ciência p´ra que te quero" activities, or the nature of their essence. Anyway, being these goals the basis of this project, they are always included in the activities, in the dialogue with the children, and whenever possible.

It is also relevant to refer that in terms of gender, the responsible of this project are women and the majority of monitors are frequently women too. In order to reduce inequalities among children interested in this kind of activities, their participation is totally free.

2. Learning sustainability through hands on activities

All "Ciência p´ra que te quero" sessions begin with a short presentation – 15-20 minutes of a more theoretical introduction - always in dialogue with the kids about the aspects of the hands-on activities of that day. This way, children know what they are going to do, becoming familiar with some terms and definitions, and understand the reasons for doing the practical activities. Participants are then invited to organize in small groups, each one starting and choosing a different hands-on activity. For two hours, all the groups pass through all the different activities, allowing each child to perform all the proposed tasks. At each activity one or two university students, "the monitors", guide the kids while performing the protocols. The number of activities per each monthly session is variable, but never less than five. At the end, all the activities are evaluated by children and by the monitors, filling in a questionnaire.

Figure 2. "Scientia@Sustentabilidade." A- Children defining and deciding the most relevant zones in their "sustainable" city, B - Kids constructing a dam, C - Children trying to construct some wind generators, D – The "sustainable" city model

To get a picture of how these Saturday mornings run at BLCS let us have a look at some of the activities. In the first one – "Scientia@sustentabilidade" - children were challenged to get familiar with the concepts of sustainability and sustainable city, taking into account the 17 objectives of sustainable development [3]. Goals numbers 7, 8 and 11 which demand many of the infrastructures in the plan of an eco-city were highlighted. Kids decided how to design the "sustainable city", defining the relevant spaces in a cork base (Fig. 2.A). In the other stations included in this session kids constructed 3D models for clean energies, infrastructures and means of transport, which were later placed in the suitable places of the model [Fig. 2. B and 2. C]. Figure 2.D shows the "sustainable city" at the end of the first activity.

In the Session "Água - valoriza a gota" children became aware of the importance that water has in the earth and for all of us, not only for our survival but also for all the other species. What attitudes we must take to prevent water from becoming increasingly

polluted and get the required clean /potable water were debated. This session included, among others, special hands-on experimental activities related with the properties of water, water footprint (Fig. 3). It was very interesting to see that some parents enjoyed helping children in some activities. Simultaneously, the participants were invited to find some answers to questions that were posed by visiting the exhibition "Água p'ra que te quero" with pieces created by first year students of the Biology and Geology degree program at the University of Minho (Fig. 3). This exhibition was supported by the author's pieces and the kids participating could also suggest ideas to the authors.

Figure 3. "Água – Valoriza a gota!" A and B - Water properties, C - Children seeing a 3D piece, which shows the relation between the amount of drinking and polluted water at different places on the earth, D – Children trying to understand some results to answer a quiz, E - A student author of a 3D piece explaining how a river gets polluted, F - A child´s father showing how to place a clip to float

In April, children were invited to visit BLCS in order to explore some ideas about earth and other planets of the Solar System (Fig. 4). At the same time, they learn how to estimate a year-light, very useful for calculating distances between planets, as well as some concepts about spherical geometry, a non-Euclidean geometry. It was also interesting to see their curiosity and interest in natural disaster simulations (hurricanes and volcanoes), as well as in food chains and food webs. From this point children evaluated the relevance of climate action for life on land, and of course, the problems for the sustainable city "model" under construction.

Figure 4. "Terra à vista!" A - After a small theoretical introduction about earth and other planets, children are ready for hands-on activities, B and C - Kids defining orbits of planets and understanding the spherical geometry, D - The simulation of a volcanic eruption, E and F - Kids playing a game about food chains and food webs G – Inquiring what is missing in the "sustainable" city, H - The sun, source of life

"Semear e plantar tudo está no começar" was the name given to the activity that took place in May. At this season, children easily see activities like sowing and planting, but not all of them have the possibility to experience them. We want children to learn how to plant and sow, creating gardens and/ or vertical gardens (Fig. 5) in order to promote "Zero Hunger", goal number 2. In the sense of realizing that plants, like all the living beings, may belong to different species, the concept of DNA has been introduced. Because the participants are still in the "age of the real things", we tried that through experience they could visualize portions of banana DNA.

Other activities were associated with the use of plants for an increased number of purposes (soap, for instance). Thinking about the "sustainable city" model, the children decided that it needed some green spaces, and so they decided to create some green zones, and several gardens (Fig. 5). In order to have beautiful fences between spaces they created friezes through symmetries (translations, rotations, reflections and glide reflections) and using regular polygons. At the end of the session they put the constructed gardens in the spaces of the "sustainable city" they considered more appropriate (Fig. 6).

Figure 5. "Semear e plantar tudo está no começar" A - The material used in the construction of vertical green gardens, B and C - Sowing and constructing a vertical garden, D and E - Following the experimental protocol for DNA, F – Showing the obtained DNA, G - Making herbal soap, H - Children preparing the trees and gardens for the "sustainable" city, I and J - Constructing fences

Figure 6. General aspect of the "sustainable city"

3. Results and evaluation

As already said, at the end of each monthly session, kids fill out a questionnaire (Fig. 7) allowing to know their preferences and to evaluate each activity individually.

Figure 7. Answering the final questionnaire

A total of 4 out of 7 "Ciência p´ra que te quero" sessions were already animated in 2017, engaging 47 children. Ages ranged from 5 to 11 years old and 64% were girls. All the children said to have enjoyed the activities and would like to engage in other activities of the

same kind, although 42.5% of the kids never had enrolled in nothing similar. More experimental activities and particularly the ones related with the sustainable city got children´s preferences. The great majority (43 kids) think that their friends would also like to participate, essentially because they had fun and they learnt new things. As some of the children participated in all the sessions, we could realize that the hands-on science learning activities can enhance children' s learning effectiveness in scientific thinking and attitudes thus promoting science education and scientific literacy.

Regarding the 21 monitors that supervised children´s activities, 62% females and 38% males, some experienced this initiative for the first time (7), others are more or less regular helpers as monitors in hands-on activities promoted by the project Scientia.com.pt. In any case, students are almost unanimous in considering these sessions both an asset and an opportunity, in the way they feel the challenge of communicating science to a different public and of different ages. All, without exception, said that the initiative stimulated their interest in participating in other activities of the same type.

4. Still 23 years to 2030 Agenda. Final remarks

All nations all over the world, through the General Assembly of United Nations unanimously adopted the resolution of "Transforming our world" trough the 2030 Agenda for Sustainable Development in order to underline the importance of concerted action to ensure that patterns of sustainable development offer a high quality of life to all, both to present and future generations. Independently from all possible interpretations about the concept of sustainable development there are no doubts that the human element is the kernel. Sustainable development is essentially about relationships between people, and between people and the environment. Therefore education for sustainable development is an integral part of a strategy of sustainable development and must promote interdisciplinary and holistic learning experiences not only in formal education but also, and not less important, in non-formal and informal education. “Scientia.com.pt” believes that the project “Ciência p´ra que te quero", which promotes hands-on activities to early childhood, this year in particular under the motto of the 17 goals to a sustainable development, is a good example that can be replicated.

5. Acknowledgments

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The Use of Educational Games in the Teaching of Social Sciences in First and Second Degree Studies

K Stolarek
Pedagogical University of Cracow, Cracow,Poland
Kamil.Stolarek@gmail.com

Abstract. The author's aim is to present various educational games that can be used in the education of students in all fields of social sciences. Educational games, both traditional, in the form of board games, and modern in the form of mobile applications, greatly facilitate the process of acquiring knowledge. An example of this is a group of students who have broadened their knowledge of the history of European integration based on the "Star Express" board game. The use of this game has increased student interest in this course and has facilitated the acquisition of basic knowledge about the history of the European Union. Another board game is Eurobusiness, also known as Monopoly, which is useful for courses in Macro and Microeconomics, so that students use logical thinking and learn the laws of economics based on fun, and not just by reading books and memorizing theories. In addition, mobile games are increasingly used in classrooms. The argument is that the growing of new generation of "Smartphones" or "Facebook" need not be seen only from the negative sides. For example, taking a free time, addicting from mobilephone, deficit of reality relationships, with other people. Thus, the use of new methods in education, for example in the form of board and mobile games, has its advantages. Therefore, it was built the argument of learning through fun. According to the author, this is an adaptation of new methods to the present social reality evolving towards digitization and mobility.

Keywords. Educational games, education, social sciences, students.

1. Introduction

The modern times and thus the first decades of the 21st century are moments of various transformations, not only of a political-economic but also socio-cultural nature. It is also a period in which technological development in the form of mobility and digitization contributes significantly to the development of modern teaching methods in education and, consequently, the use of various kinds of educational games in the teaching process at every level of teaching. So if we talk about games in education, then we can ask the question, what does it mean - educational games?

Every game, whether it's a board game or a sport, a strategic game, contains a few distinct elements: a well defined goal (victory), rules of the game, voluntarity, or feedback system [1]. Therefore, in order to achieve the goal in a given game, it is essential to follow the defined rules well and to make a voluntary effort to achieve this goal by overcoming various obstacles. If I want to win, I have to overcome a number of difficulties, but the desire to receive a reward (motivation) motivates me to voluntarily take this effort [2].

2. Games in Education

In the case of educational games, it can be observed that players have more opportunity to participate in the teaching process than those who use traditional teaching methods. The problems are becoming clearer, and the experience gained in the virtual world raise the skills of such people in the real world. In addition, the essence of educational games has three essential functions [3]:

1) Motivation: educational games motivate players, making them a more attractive background for the whole teaching process. This function plays an important role especially among younger pupils, who at their stage of development have a stronger emotional connection with games instead with education only.

2) Functionality: games reflect real situations, and so teach the players experience and provide many skills that apply in reality, and thus in practical terms. For example, they show that we have to respect the rules and act fair-play against others.

3) Explanatory function: games often help to understand complex problems.

It is important to emphasize that learning process while taking a part of game is a side

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effect and teaches the habits in a given situation. Consequently, education games are connected more with the Aristotle's conception which is based on habits, instead than Socrates conception that is connected with the making of reflections [3]. Taking into account the aforementioned functions, and also eliminating significant simplifications, we can take the statement that the educational games are an original and important didactic aid. Nevertheless, by their application, one must keep in mind the fundamental principle. The knowledge of the participants of the game has to be adequate to the issue. As well as participating in card games, they players are obliged to understand the basic conceptions and rules in order to play poker, bridge or chess game, so students must learn the basic rules to be able to play in the educational game.

3. "Star Express" Game

The educational game used by the author is "Star Express" (Fig. 1-3), published by the European Information Network "Europe Direct" (Fig. 4) [4]. This game, according to the author, can be an important didactic aid in the teaching of social sciences students, especially those whose discipline concerns European studies, international relations or political science. The aim of this game is to learn general knowledge about the history and functioning of the European Union. The game on the one hand helps students to refresh the information they have learned during lectures and, on the other hand, allows for easier processing of that information.

"Star Express" is a board game that consists of players becoming players in the European continent. Each of the six players has one pawn. Players one by one throw a dice with numbers from 1 to 6. Players move their pawns in as many boxes on the board as they would throw the dice.

However, cards with questions are an important impediment (Fig. 2). Depending on the degree of difficulty, you can choose a green card (grade I), yellow (grade II) or red (grade III). Players to move their pawn by the number of squares corresponding to the number of meshes, but at first they have to answer to the question on card. If they do not answer, they have to wait one turn.

Figure 1. "Star Express"

Figure 2. "Star Express" – box with question cards

Question cards cover a wide range of subjects related to the European Union, from the history of its origins to the current principles of its functioning. The author conducted research among students of first and second degree in international relations, subject: History of European integration.

Both first and second grade students were divided for two exercise classes. In some groups, the author applied traditional teaching methods (multimedia presentations, conversational lectures, source texts) but in other groups modified the part of the classes by introducing an educational game called "Star Express". As

a result of this, there were differences in student assessment scores. Students in both groups had a test with the same questions ahead and wrote it at the same time. However, higher scores have been obtained by students who have used educational games in the classroom, so they had the opportunity to reproduce and use the knowledge they have already gained, both from lectures and from source texts.

Figure 3. "Star Express" – the board with pawns

Figure 4. The logo of "Europe Direct" - Cracow

4. "Monopoly" Game

A similar situation took place in the course of the subject of Fundamentals Economics, where some of the students took part in the famous game "Monopoly" (Fig. 5-6). Taking on the role of bankers, merchants and businessmen, the students easily absorbed knowledge in micro and macroeconomics. On the one hand, they learned the rules of supply and demand, and on the other hand the important roles of financial risk

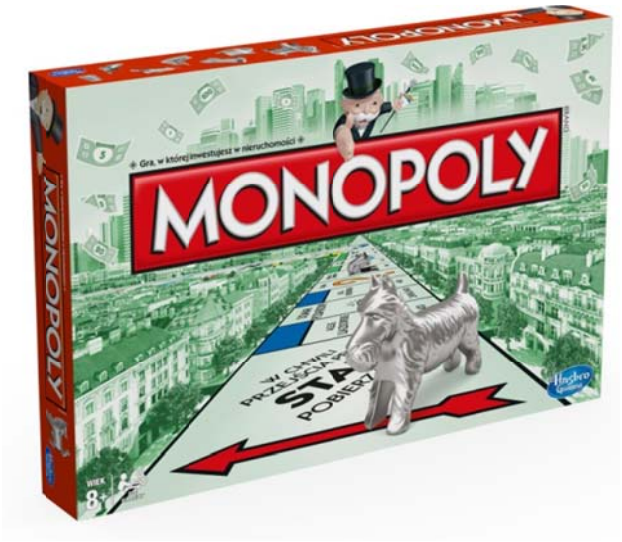

Figure 5. "Monopoly" game

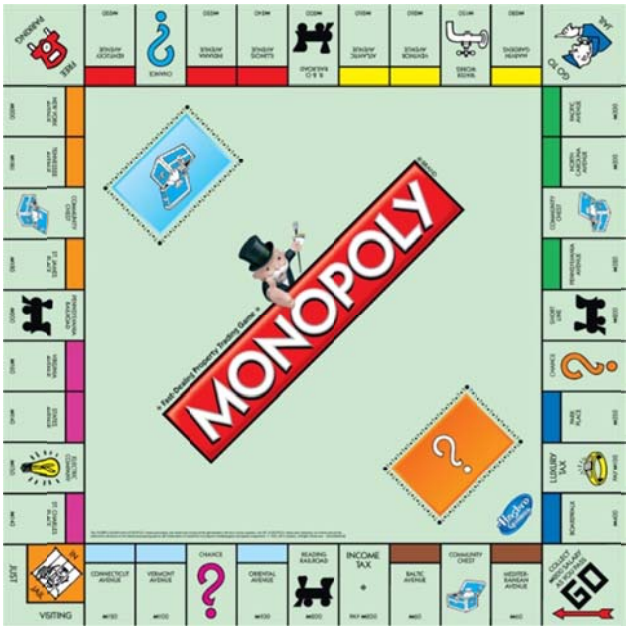

Figure 6. "Monopoly" – the board

The use of the above games was, according to the author, a significant contribution to the increased effectiveness of the didactic process, as confirmed by the students' statements:

1) International relations, 2nd degree, 1st year, European Union Law: "I first played Star Express. To be honest, I had no

idea that such a game exists. It is very easy to gain general knowledge of the European Union. I got the impression that all my knowledge gained during these studies was used in this game. Some questions were really difficult, but I'm glad that I knew the answer for most of them. Now I'm more confident, the more that soon exam" [5].

2) International Relations, 1st grade, 2nd year, History of European Integration: "The game is unbelievable. I think if I had been playing with my friends for the whole semester, I would have learned more quickly than reading these thick books. The bottom line is that in this game you can play at any time and repeat yourself a lot of information. With the book is getting worse - harder to focus and harder to remember" [5].
3) International Relations, 1st Grade, 1st Year, Fundamentals of Economics: "If every teacher would have used the Monopoly game in class and then will translate all these complex concepts on an example of this game, economics would never be a frightening for students. Before I started this course, I was frightened of numbers and graphs. I have never imagined in my life that I would play in Monopoly game " [5].

5. Conclusions

Nevertheless, it should be noted that educational games play a significant role in the didactic process. On the one hand they motivate to acquire knowledge through voluntary participation in the play, also scientifically. Thus, science has ceased to be associated only with books and encyclopaedic knowledge at the moment. On the other hand, they provide a break up for participants in the didactic process and a springboard from traditional teaching, because they give rise to innovation. Therefore, the essential question that the author asks readers is the future of educational games and their role in the teaching process. So can educational games largely replace textbooks? Should the contemporary teaching model be oriented towards educational and fun games or traditional methods? According to the author, these questions cannot be unequivocally answered as there are many different views on this topic. However, according to the author, the use of both innovative and modern teaching methods as well as traditional ones, and thus their combination, significantly contributes to the effectiveness of the teaching process.

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Use of Mobile Applications in Outdoor Lesson

A Michniewska
Pedagogical University of Cracow,
Cracow,Poland
anna.michniewska@gmail.com

Abstract. Field activities provide opportunities for many of the goals set out in the curriculum. One of the basic tasks facing biology teachers is: arouse natural interests and develop cognitive activity [1]. Due to the wide range of mobile applications that can support children's and young people's environmental education the author will give suggestions for using mobile applications in nature lessons with youth. The author will present scenarios of activities that were conducted with students of the gymnasium school during outdoor education in the field of nature education.

Keywords. Mobile application, outdoor education, science lesson.

1. Digital natives

Prensky [2] points out that digital natives are people born in the digital age, for whom New Media is a natural environment of existence. They are more likely to prefer hypertext, graphic, image on a computer or other multimedia device than a written word [2]. They use multiple multimedia devices simultaneously or on one multifunction device, such as a smartphone. They can use the same device at the same time to surf the web, listen to music, send messages or watch movies. The peculiarities of learning digital natives are that if they cannot understand or find something, they are not looking for printed books but are turning on the Internet and looking for the information they need. This kind of activity confirms that digital natives are so-called. Always on - always connected. They cannot imagine life without a smartphone or the Internet. Current teens are digital natives, who are eager to discover all the functions of their devices, invent new applications, treat new technologies creatively and confidently [3].

2. Mobile applications

"A mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer. Mobile applications frequently serve to provide users with similar services to those who are on PCs. Apps are generally small, individual software units with limited functions. This use of software has been popularized by Apple Inc. And its App Store, which sells thousands of applications for iPhone, iPad and iPod Touch" [4].

3. Outdoor education

The use of mobile applications for teaching purposes, including learning is becoming increasingly popular. The mobile application market is developing very dynamically, so teachers and students have an ever-expanding database of ready-made products. Mobile applications can be used by teachers and pupils during school lessons as well as during outdoor education.

Strategies and techniques for learning in the field do not differ significantly from those that teachers regularly use for years. More emphasis, perhaps, is on getting information from the student based on his inquiry and challenging problems-solving situations, rather than merely providing information about empty content. An additional advantage is the student's acquisition of concrete experience. Students are encouraged to conduct their own observations and formulate their own conclusions [5]. This can contribute to the development of creativity, critical skills, openness and active participation in situations related to knowledge and experience in the field of life sciences.

Diverse learning environments, such as field research in the field, laboratory experiments and trips to museums and scientific centres, will expand the opportunities for education in the natural sciences and will stimulate curiosity, reflectivity and fascination.

In this area, the objectives of the classes are to enable students to:

a) ask questions, talk and reflect on experiences in nature and the place of man in nature;
b) use of the senses to get to know the world in the local environment;

c) describe, illustrate about your own experiences and experience in nature;
d) use natural science concepts to describe and present your own observations in various ways,
e) use of measuring instruments, systematic data, evaluation of whether the results appear to be correct or not,
f) write reports and descriptions [6].

Methods of conducting field activities are conditioned by access to the natural environment. First and foremost, it is important to continue to learn new skills in the field and to refer to your previous experience. It is important to find the right solution by acting independently, for example: when students learn the different elements of the terrain, they observe and skilfully formulate and ask questions themselves.

4 Examples of mobile applications that can be used during field activities

4.1. Pl@ntNet

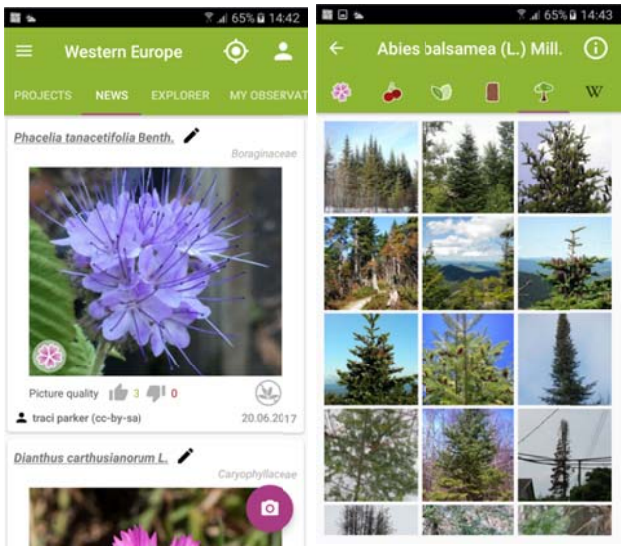

Figure 1. Pl@nt Net

This program was developed by researchers from four French research organizations (CIRAD, INRA, INRIA and IRD), and the Tela Botanica network, with financial support from Agropolis foundation, has supported an application that facilitates the identification of plant species by comparing them with photographs. The number of species and the number of images used by the application evolve through users. Application users may use publicly available resources by creating their own observations and descriptions. The application is available in English. Some of the described plant species have references to the descriptions on Wikipedia.com (Fig. 1) [7].

4.2. What's Those Flowers?

The application has a wide base of plants that are grouped by colour, their habitat, and then the number of flakes. Each plant has a detailed description, however, it has not been translated into Polish and only the English version is available.

There are several possibilities of using mobile applications during field activities: Atlas applications / plant identification key (Plant Atlas, What is Plant?, Pl@nt Net Plant Identification, Whose leaf is it?)

The application allows for:

- Search for plants based on morphological characteristics and occurrence (Fig. 1, left)
- Identification of species based on hand-made photographs (Fig. 2, left);
- Search for plants based on their names or photos / drawings (Fig. 2, right);
- Creation of descriptions and maps of the occurrence of plant species;
- Add new plant photos and share them with site users (Fig. 3);
- Create e-herbarium.

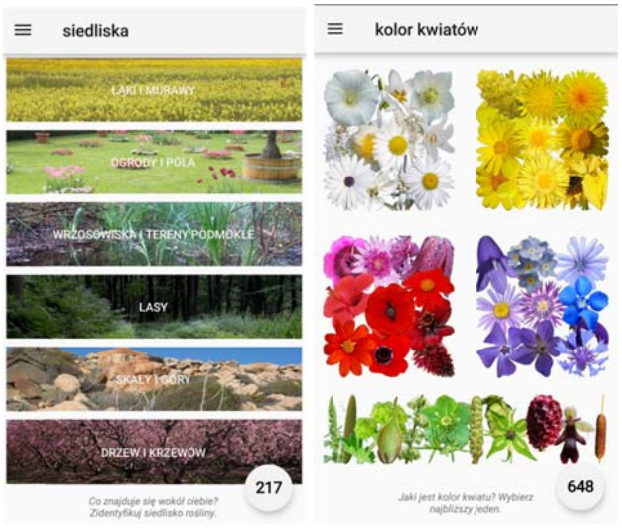

Figure 2. What's Those Flowers?

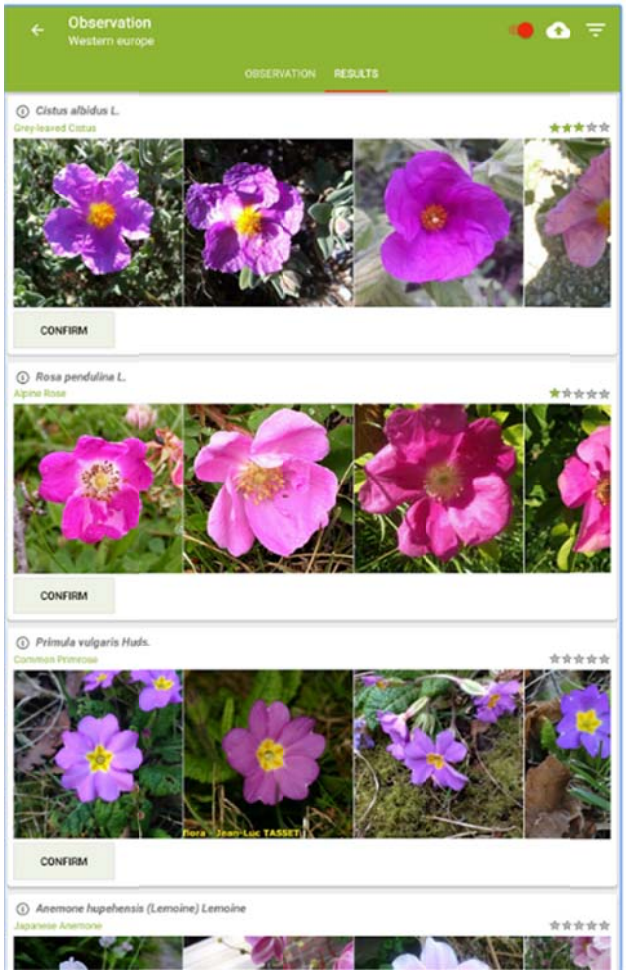

Figure 3. User image database

5. Conclusion

Using mobile applications in life science can help shape and improve many skills. Depending on the type of mobile application, they can be used both in biology, nature, as well as in student work, homework, projects or self-study. The prospects for the development of teaching and learning supported by the use of new technologies including mobile devices appear to be an interesting alternative to traditional teaching using printed materials.

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Online Science Classroom. Growing with Science

V Belaga[1,3], *K Klygina*[1,2], *A Komarova*[2], *N Sidorov*[1,2], *Y Panebrattsev*[1,2], *E Potrebenikova*[1, 2]
[1]*JINR, Dubna, Russia*
[2]*InterGraphics LLC, Dubna, Russia*
[3]*Dubna University, Dubna, Russia*
belaga@jnr.ru

Abstract. The article is devoted to popular science resources developed by InterGraphics LLC and JINR for people of all ages: school and university students, their parents and grandparents.

Keywords. Multimedia educational resource, online-lesson, science popularization.

1. Introduction

Modern world is a world of high technologies and amazing science discoveries. To give young people an opportunity to learn about modern worldview, complex technical equipment and prepare the most talented ones to future science and engineer career is task not only for schools and universities but for science laboratories as well. That's why two largest cross-disciplinary science centers – Brookhaven National Laboratory (Upton, USA) and Joint Institute for Nuclear Research (Dubna, Russia) – came up with collaborative project "Online Science Classroom".

The project is designed for school students, who are interested in physics, biology, ecology, chemistry and nanotechnologies. By now we have Internet version of the project, portable exhibition and stationary exhibition in the Enlightenment Center named after academician Alexey Sisakian. Some of educational materials about science are also built on mobile platforms.

For teachers, students and young researchers is important to learn knowledge from the front edge of modern science. In this report we will observe two educational multimedia resources.

First is online-lesson that tells how scientists study the processes occurred immediately after the Big Bang happened about 13.7 billion years ago. Studies are carried out at collider experiments in which accelerating nuclei collide almost at the speed of light.

Second is interactive exposition of Main Facilities of Joint Institute for Nuclear Research (JINR, Dubna, Russia). We will talk about movie that tells how scientists synthesize superheavy elements and fill new cells of the Periodic Table.

There is not much time given for studies of weak interactions in the school physics program. But these interactions occur in the stars. Mysterious neutrino particles coming to Earth from outer space are born exactly in these interactions. In this exposition there is also a story that tells how scientists record neutrinos in deep water experiments on Lake Baikal.

2. Formation of the scientific picture of the world

People of all ages take a great interest in our interactive resources about microcosm and macrocosm, history of the Universe (Fig. 1).

Figure 1. Visitors watching Microcosm and Sagan Calendar applications at the Open Days in BNL

In our work we strive to use the latest technologies, for example, model of an electron microscope via augmented reality technology, "My first collider" game based on collective modeling environment (Fig. 2).

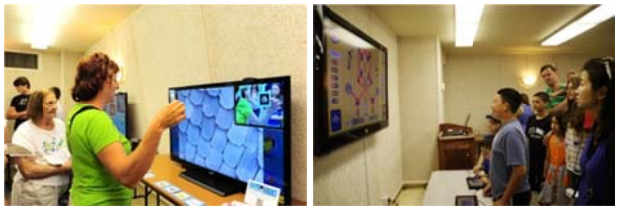

Figure 2. Visitors playing with the model of an electron microscope and "My first collider" game at the Open Days in BNL

3. Implementation of the modern science achievements in the educational process

The implementation of international modern research projects makes an invaluable contribution into such the fundamentally important problem as the raise of educational and cultural awareness of people. Educational support of such projects is aimed at attracting public attention (school and university students, science teachers and generally interested audience) to the scientific achievements. The use of modern multimedia and communication technologies for the development of projects related to the science popularization opens up wide opportunities for explaining complicated things in a clear and understandable form.

Modern scientific findings and technological solutions should be accompanied by educational, popular-science and outreach projects intended for a wider audience, including school students. In the future, it will allow us to overcome a serious social problem — decline in young people's interest in scientific research and engineering professions.

Nowadays, according to the modern theoretical models, matter can exist in several states: hadron matter, quark-gluon plasma and a transition process, so called “mixed phase”. High-density baryonic matter is virtually unexplored. For its experimental study, it is necessary to create baryonic matter in the extreme conditions of heavy ion collisions at high energies. With this purpose in 2008 a project NICA (Nuclotron-based Ion Collider fAcility) was started.

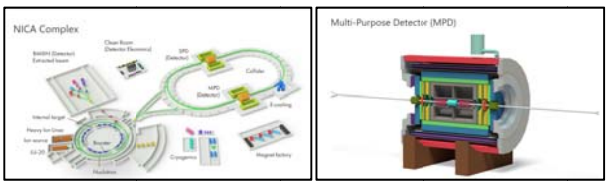

Figure 3. Multimedia educational resource about NICA Complex

In this year there has been made the online-lesson for school students on the topic: “NICA – Universe in the Lab”. In this video, Academician Grigory Trubnikov speaks about the research that scientists from different countries will carry out at the NICA accelerator complex. This is an education material for school students and science teachers, which we tried to do interesting for all ages. It’s a popular science movie, where we talk about the role of science in our life, how our Universe was created, about phase transitions of matter and quark-gluon plasma etc. We explain why we need particle accelerators and colliders and how they work.

Our experience of public presentations and workshops shows that teachers and school students take great interest in our multimedia presentations.

Figure 4. Presentation of the open online-lesson “NICA – Universe in the Lab” in the Petrozavodsk State University

All results of this work are in the public domain and can be used in the educational process. We also have developed the attractive interactive exposition that explains the principles of operation of Main Facilities of JINR.

4. Super Heavy Elements (SHE) Factory

The Laboratory of Nuclear Reactions is world-known for the discoveries in the synthesis of superheavy elements. Element 105 in the Periodic Table is named “Dubnium” after the Russian town Dubna where this element was first synthesized. Element 114 was named “Flerovium” after the lab founder Georgi Flerov. At the end of 2016 two more elements obtained in Dubna were officially included into the Periodic Table. The first of them is the element 115 — Moscovium. It was named after the Moscow Region where the Joint Institute for Nuclear Research is located. The second — the element 118 — Oganesson is named after the academician Yuri Oganessian who still works at the Joint Institute for Nuclear Research in Dubna. One of the key projects of JINR is the construction of the factory of superheavy elements (SHE Factory) in the Flerov Laboratory of Nuclear Reactions. SHE Factory is created on the basis of the new, the most powerful in the given region, accelerator of heavy ions DRIBs-III (Dubna Radioactive Ion Beams) with the intensity

exceeding the world analogs 10 times. This will allow solving the problem of synthesizing of new elements with atomic numbers 119, and 120, and beyond.

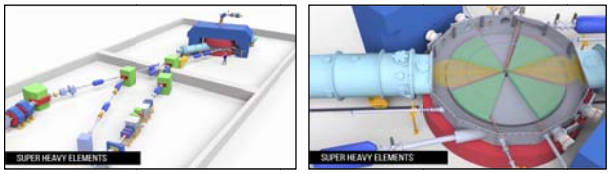

Figure 5. Multimedia educational resource about SHE Factory

5. Baikal Neutrino Telescope

One of the main directions of JINR research activities is the development of methods for deep underwater elementary particles detection and construction of detectors using vast bulks of water of natural reservoirs as target and working substances. At the Baikal Neutrino Station an unique large telescope NT-200 is now being constructed for deep underwater neutrino research with an effective detection area 2–11 thousand square meters (for atmospheric muons) and controlled water bulk of about 200 thousand cubic meters. The construction of this multipurpose setup will allow to search for new elementary particles and rare processes, and fulfil a large-scale experimental research program in the field of high-energy cosmic ray physics.

Figure 6. Multimedia educational resource about Baikal Neutrino Telescope

Figure 7. Multimedia educational resource about IBR-2 Reactor

6. IBR-2 Reactor

IBR-2 is a fast neutron pulse reactor. Its main distinctive feature is the mechanical modulation of reactivity with a movable reflector. The reactor is located in the Laboratory of Neutron Physics and intended for studying the properties of condensed matter and nanostructures using neutron scattering.

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Game of Genomes: Didactic adaptation of the Nature's Dice Kit (NCBE)

T Ribeiro, M Paz, S Pereira
University of Porto, Porto, Portugal
tiago.ribeiro@fc.up.pt

Abstract. The purpose of this work is to approach laboratory techniques in biology and genetics, in a simple but rigorous way, making it possible to be replicated in a school, with students of the 12th year of Secondary Education. To achieve this goal, we outlined this activity to respect the following main points: use of a case familiar to most students to arouse their interest and motivation; adaptation of laboratory techniques to the school context; simplification of the techniques and materials used enabling (methodologically and economically) their replication in the school, but respecting the scientific accuracy; encompassing several subjects included in the Biology curriculum of the 12th year of schooling.

Given the nature of science, it is natural that learning science should involve seeing, handling and manipulating objects and materials. The scientific knowledge cannot be built only on a theoretical basis. It is essential to promote the critical spirit and the investigative capacity, integrating the theoretical knowledge with the practice, understanding that these two domains are complementary in learning and teaching sciences.

The school science curriculum in most countries has two distinct purposes. First, it is a 'scientific literacy' aim, providing every young student with adequate understanding of science to participate assertively and effectively in the current world. Second, the attempt to encounter the labor needs of advanced societies, preparing students for jobs that require more scientific and specialized knowledge [1].

In this sense, this work results from the adaptation of the National Center for Biotechnology Education (NCBE) teaching kit - "Nature's Dice" (simulation of genetic screening), to the context of a popular fictional series - Game of Thrones (HBO). What is intended is to set up an experience that is challenging for students, stimulates their skills and fits into the school program. The experimental design must consider not only the theoretical field, but also all the techniques. Our aim was to use some of this kit materials and main strategy, but replacing some of the materials and procedures, making it simpler and faster, intelligible and economical.

The major focus of this work is the learning of DNA manipulation techniques, Mendelian genetics, character transmission and genetic screening (including ethical discussion).

The techniques used were the preparation of agarose gel, DNA restriction through endonucleases, DNA electrophoresis and its coloration and interpreting the obtained DNA profiles. In conceptual terms, we resorted to the construction of a genealogical tree based on the pathologies such as colour blindness and Huntington's disease.

Colour blindness is a genetic condition related to the X chromosome, being a heterosomic recessive disease. The Huntington's disease is a rare neurological disease and is autosomal dominant, expressing itself both in homozygosity and in heterozygosity.

This work is, in some aspects, based on the original kit, namely in the use of plasmids (DNA) and the restriction enzyme BamHI, but the scenario is different and some materials too. The scenario adopted is the story of Game of Thrones that unfolds around the paternity of Jon Snow, allowing to obtain a family tree simpler and intelligible to interpret by the students. This allows the saving materials, and it is possible to repeat the procedure more often.

We also replaced the Kit's electrophoresis buffer by the SB (Sodium Borate) buffer, which is more economical and equally effective. [2] The use of non-toxic fluorescent DNA stains such the Roti-GelStain or GelRed dye allows the use of 4 times less DNA (compared to the dye of the original kit) making the activity cheaper.

It should be noted that this activity is not a way of diagnosing the above-mentioned pathologies. This kit only provides a reproduction of genetic screening. It gives an ideal occasion to arouse discussion about genetic counselling, privacy of genetic

information and other ethical anxieties.

Keywords. Agarose gel electrophoresis, DNA profiling, genetic testing, laboratory practice in teaching.

1. Introduction

The deoxyribonucleic acid (DNA) is one of the most important and also most complex of all biological macromolecules. Until the middle of the last century, this represented serious problems in the separation of specific fragments of chromosomes. The discovery of endonucleases enabled a new analysis of the structure and function of DNA, revolutionizing molecular biology [3].

The endonucleases are enzymes that cleave the phosphodiester linkage of a polynucleotide chain, generally consisting of specific sequences [4]. The recognized nucleotide sequence for cleavage by a restriction enzyme generally corresponds to a palindromic sequence, about four to six nucleotides in length. Most endonucleases cleave the DNA chain distinctly, leaving complementary single strand ends. These ends may be re-coupled and are referred to as cohesive ends. Following the pairing of two complementary sequences, the phosphodiester bonds of their fragments can be further ligated by the action of the DNA ligase enzyme [4].

There are hundreds of endonucleases, each with specific restriction sites. In addition, DNA fragments cleaved by the same restriction enzyme may be attached to a complementary DNA strand of distinct origin, the final product being called recombinant DNA [4].

The discovery of these enzymes allowed the fragmentation of the DNA in certain places, allowing the development of DNA electrophoresis and with it several genetic screening tests.

Electrophoresis is a biochemical technique widely used in laboratory practice of biology, introduced by Tiselius in 1937, which was initially performed in a liquid medium [5]. Electrophoresis consists on the migration of polar molecules, according to their electrical charges and molecular weights along an electric field, conducted in a solution with density gradient or in different media, such as filter paper, agarose gel, starch or polyacrylamide, among others. The medium must be chemically and physically inert, not interfering with the mobility of molecules [5].

In this work, a simulation of genetic screening based on the pathologies such as colour blindness and Huntington's disease is proposed. This choice results from the inclusion of diseases in the 12th year biology program.

1.1. Colour blindness

Colour blindness is a genetic condition related to the X chromosome, being a heterosomic recessive disease [6]. This disease manifests itself in the inability to distinguish certain colours due to changes in the retina. The retina is composed of two main types of cells: the cones and the rods [7]. The cells responsible for detecting colours are the cones. There are 3 different cone types that can identify red, green and blue colours. When a type of cones responsible for determining a colour is missing, vision is affected [6].

Genetically this pathology is characterized by mutations in the OPN1LW and OPN1MW genes on the X chromosome (Xq28). Proteins encoded from these genes play essential roles in colour vision. These genes are responsible for the synthesis of three opsine pigments in the cones [8].

One means by which we can detect some of the forms of colour blindness is through the enzymatic digestion of the TEX28 gene from exon 5 by the BamHI endonuclease and electrophoresis of the resulting fragments as described in Oda, Ueyama, Nishida, Tanabe, and Yamade [9].

Being a heterosomic recessive disease, it manifests in male individuals of genotype (d -) and in female individuals in recessive homozygosity (dd). Women may still be carriers of the gene and do not manifest the disease when heterozygous (Dd).

1.2. Huntington's disease

Huntington's disease is a rare neurological disease that affects one in 10000 individuals, caused by a mutation of the DNA sequence of the gene known as HTT [10]. This mutation is expressed by the abnormal replication of the CAG trinucleotide sequence on the short arm of chromosome 4 (4p 16.3) [11].

In a healthy individual, there is expression of the Htt protein (normal huntingtin), since the trinucleotide sequence of the gene is repeated less than 26 times. When this number is higher than 40, there is a complete penetrance phenotype expression [12,13], leading to the production of mutant huntingtin protein (mHtt) complexes in the brain responsible for accelerating death of the cells [12].

The huntingtin gene has 350 kDa and 67 exons. The mutation causing the disease is located in exon 1 of this gene [14,15].

Usually the genetic screening of this pathology is done by polymerase chain reaction (PCR) using repeated sequence flanking (CAG) primers. However, we can perform genetic screening through electrophoresis using the restriction enzyme type III EcoP15I as described in Buchner et al. [14].

This disease is autosomal dominant, expressed either in homozygosity (DD) or in heterozygosity (Dd). The symptoms of the disease usually appear between 30 and 50 years old [10].

In spite of the two described ways of diagnosing the aforementioned pathologies, with teaching objectives we will adapt the NCBE Nature's Dice Kit [16] and procedures to a simulation of genetic screening in order to simplify the understanding of the techniques and their execution in schools.

2. Material and Methods

Restriction of the NCBE DNA plasmids was carried out with the *Bam*HI enzyme of the Nature's Dice kit. Subsequently, two electrophoreses were performed, corresponding to the detection of each of the mentioned diseases. Each obtained genetic profile allows to determine the fatherhood of John Snow - character of the fictional series of Game of Thrones (chosen scene).

2.1. DNA samples

Each DNA sample provided for the students is not of human origin but consists of different mixtures of three plasmids, obtained from NCBE, with different sizes, respectively, 2600, 4000 and 6500 bp.

2.2. Enzymatic digestion of the DNA

The BamHI enzyme (Bacillus amyloliquefaciens origin) used in this work cleaves the DNA only in the sequence G ↓ GATCC. Each plasmid has a unique BamHI restriction site so that treatment with this enzyme will cut the circular DNA producing a linear fragment that will be visible as a single band after electrophoresis. The three plasmids are thus used to prepare three different plasmid mixtures that will be used as individual family DNA samples that will give one, two or three bands on gel electrophoresis. The mixtures of plasmids are obtained from NCBE:

- MIX 1 - a solution of one plasmid of 6500 bp (simulates the dominant allelle);
- MIX 2 - a solution of two plasmids with respectively 2600 and 4000 bp (simulates the recessive allele);
- MIX 3 - a solution of the 3 plasmids with respectively, 2600, 4000 and 6500 bp (simulates heterozigoty, the dominant plus recessive allelle).

The result of the digestion, in terms of the number of bands in relation to the genotype, is the following:

- DD (homozygous dominant) - 1 band with 6500 base pairs (bp);
- dd (homozygous recessive) - 2 bands with 2500 bp and 4000 bp;
- Dd (heterozygous) - 3 bands with 6500 bp, 4000 bp and 2500 bp.

In order to perform this laboratorial work, we needed to use 3 tubes with dehydrated BamHI enzyme and to each of them 20 uL of original plasmid DNA mixture was added. One tube of cut DNA will provide 4 individual samples. Digestion of the plasmid DNA contained in all three tubes occurred for 45 minutes in a 37°C bath.

2.3. Preparation of Electrophoresis Gel

The gel used was 0.8% (w/v) agarose, respecting the protocol of the original kit. However, the electrophoresis buffer was replaced by SB (Sodium Borate) buffer [2] just as the DNA stain was non-mutagenic fluorescent Roti-GelStain used directly on the gel.

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2.4. Electrophoresis

Before loading onto the gel, 2 µL of sample buffer (bromophenol blue) was added to each 20 µL restriction tube. For each of the electrophoreses, a DNA marker (ruler) was used in the first well and loaded with 2 µL.

The remaining wells, corresponding to the samples, were loaded with 5 µL of DNA, subject to digestion with loading dye, according to the profile of electrophoresis bands that we intended to obtain (according to the following scheme – Figure 1).

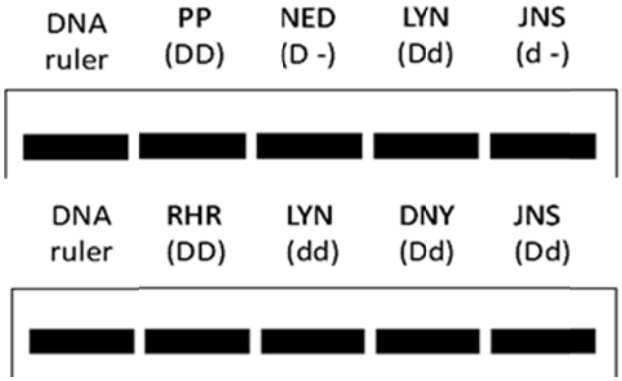

Figure 1. Scheme of the electrophoresis gel wells according to the experimental design

Each individual sample corresponds to one of the DNA of 6 different characters of the fictional series Game of Thrones, with the following correspondence:

- PP - Possible progenitor of John Snow;
- NED - Ned Stark;
- LYN - Lyanna Stark;
- JNS - John Snow;
- RHR - Rhaegar Targaryen;
- DNY - Daenerys Targaryen.

The gel was run at 200 volts (instead of 36 volts from the original kit) for about 15 minutes (as opposed to 90 minutes from the original kit), and then visualized using a transiluminador. In the first electrophoresis, we intend to reproduce an alleged genetic screening for the disease of colour blindness, whereas in the second electrophoresis the disease hypothetically traced is Huntington's disease.

3. Results

After the electrophoresis, the following DNA profiles were obtained. In the first electrophoresis, the veracity of the following genealogical tree was tested – Figure 2 – by means of the colour-blindness examination, obtaining the DNA profile of Figure 3.

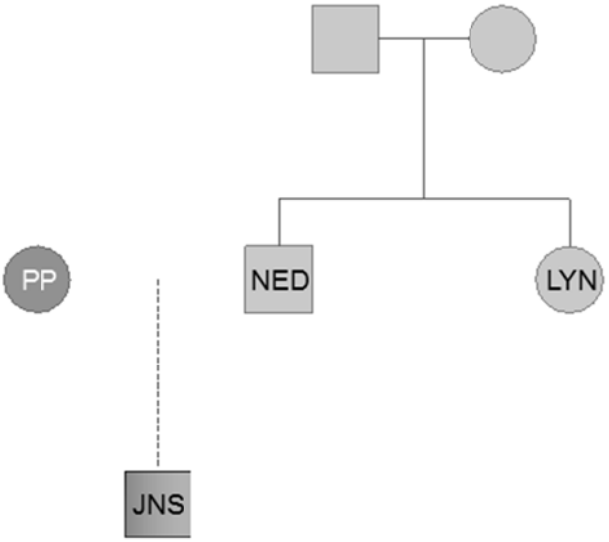

Figure 2. Theoretical genealogical tree for the paternity of John Snow

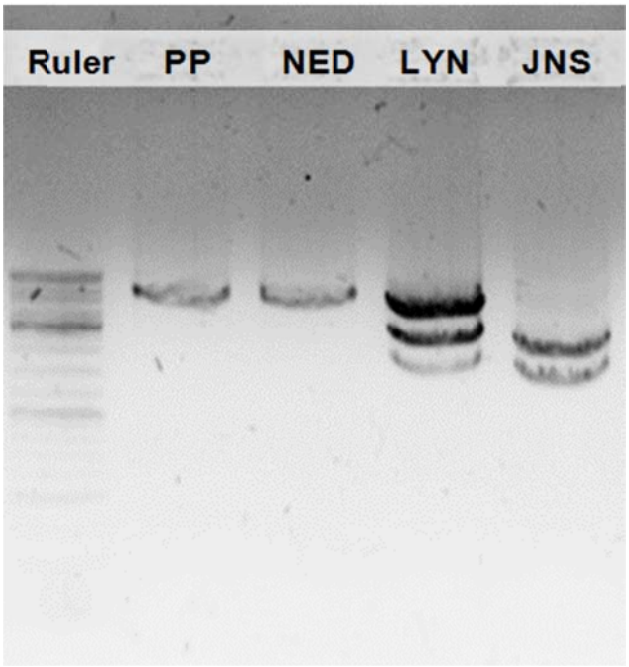

Figure 3. DNA profile obtained through the first electrophoresis, which corresponds to the genetic examination of the colour-blindness

In the second electrophoresis, the truth of the possibility of Snow's father being Rhaegar (family known as the "madmen") – Figure 4 – was tested by the detection of Huntington's Disease, obtaining the DNA profile of Figure 5.

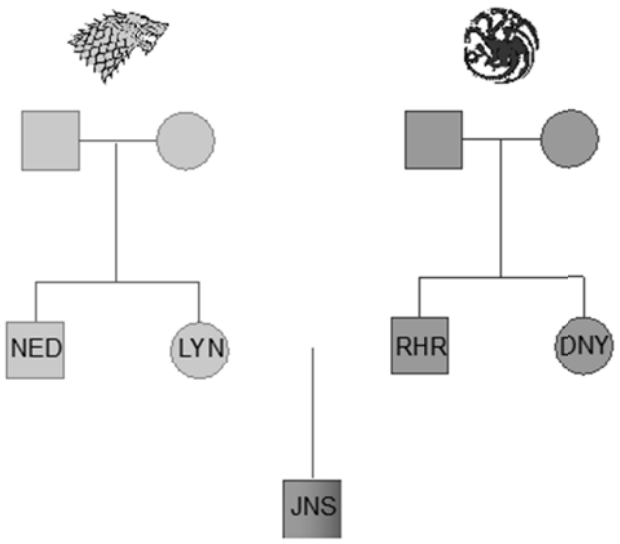

Figure 4. Genealogy of the real paternity of John Snow

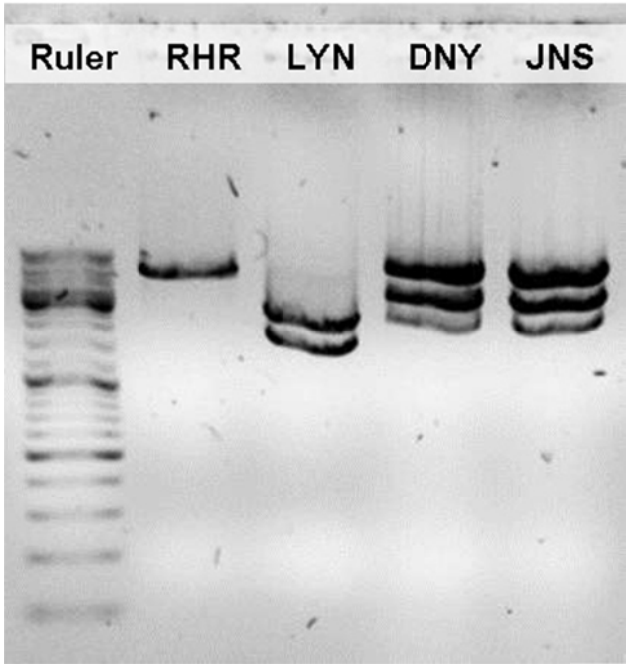

Figure 5. DNA profile obtained through the second electrophoresis, which corresponds to the genetic screening of Huntington's Disease

4. Discussion

In relation to the first electrophoresis (Figure 3), we can verify that the character John Snow (JNS) cannot be the son of the woman who was named as his mother (PP), nor of the man who was named as his father NED, since both are homozygous dominant for colour blindness (they have only one visible band on the gel), while John Snow turns out to be colour-blind (homozygous recessive, has two bands visible on the gel), so he must have received the gene from another Progenitor. In this case, it can only be Lyanna (LYN), which is shown to be heterozygous for the gene for colour blindness (with three bands visible on the gel) and is therefore a carrier of the condition (a heterosomally recessive X, Males receive the gene that confers the disease exclusively through the maternal route).

Concerning the second electrophoresis (Figure 5), we can infer that JNS, such as Daenerys (DNY), are both heterozygous for Huntington's Disease, presenting three evident bands in the gel. Being this autosomal dominant, both will manifest it. The mother of JNS, LYN, does not carry the gene (homozygous recessive, two bands are observed in the gel). His father will be Rhaegar Targaryen (RHR), which proved to be homozygous for this condition, having only one band visible on the gel.

Thus, based on two electrophoreses that are quite simple to perform and resorting to two hypothetical genetic tests, to detect colour-blindness and Huntington's disease, it turns out that the paternity of the character John Snow is not one that history, at least in this phase of plot, tries to show.

Following the run of the two electrophoresis and the visualization of its result using a transiluminador, we noticed that the option for the SB buffer and the Roti-GelStain dye proved to be a good bet. SB buffer is more economical and equally effective than that used in the original kit [2]. The use of non-toxic fluorescent DNA dyes, such as Roti-GelStain or Gel Red dye, in addition to ensuring safer handling, allows the use of 4 times less DNA (compared to the original kit, 5 µL instead of 20 µL), making the activity much cheaper and allowing it to be carried out faster (since Azure A kit proposals, or more recently Toluene Blue O, require gel staining after the run, being less practical and more time-consuming). On the other hand, the simplification of the genealogical tree seems to us a more sensible choice, since the core of this type of laboratory work in the schools is the learning of the techniques and the associated contents, being that large number of individuals/samples is a factor of distraction and adds unnecessary complexity to the activity. Moreover, the optimization of the running time of electrophoresis makes our proposal more

easily practicable within the time constraints of school activity.

5. Conclusion

The discoveries and innovations in the area of genetic testing have been enormous. At the same time, the applications and implications of these discoveries and new technologies linked to human health and diseases have not ceased to question us and raise imminently ethical and human rights issues [17].

In Portugal there is legislation on the Protection and Confidentiality of Genetic Information [18], which stipulates that it must take into account the principles "arising from the Convention for the Protection of Human Rights and Dignity of the Human Being in relation to the applications of Biology and Medicine, those of human dignity and autonomy of the person, from which information and consent are derived, as well as confidentiality and privacy" and regulates the prohibition of direct sale to the public of tests. Genetic testing should be carried out exclusively within the health system, with appropriate medical prescription, and with genetic counselling if any hereditary disease or presence of a pathogenic mutation passable of transmission to the offspring is confirmed.

However, since some of these tests are accessible via the internet, it is clear that these principles can easily be called into question. And since the potential effects of genetic test results can be significant not only in a person's life, but also in that of other family members, issues of imprecision, interpretation, and risk-benefit analysis require a careful approach.

When diseases for which there are no preventive measures or available treatments (such as Huntington Disease) at stake, information about the existence of a mutation in a gene that will provoke a condition for which there is no cure may affect the personal, family, social and professional life of this individual [19]. In this scenario, ethical, legal and social concerns increase.

On the contrary, when the consequences of the specific disorder in question are treatable, most people may agree that genetic testing makes sense [19]. Genetic testing does not only have inherently negative aspects, the identification of diseases and genetic conditions at an early stage, when intervention is possible, is clearly a great benefit to those who resort to them.

However, even in these cases, most citizens may not have the knowledge or the ability to obtain the appropriate information in order to properly understand the results of genetic testing if it is not properly followed and advised by a specialist.

The execution of this laboratory work can be used by teachers to discuss these bioethical issues with the group / class, creating conditions to increase students' critical spirit and their ability to argue and position themselves in relation to such current and challenging issues in a democratic society.

In order to increase students interest and motivation for curricular content, it becomes necessary to re-think teaching strategies, in the sense that they promote an intense involvement of the student (intellectual and emotional), necessary for the articulation between theoretical and conceptual knowledge and practical-procedural aspects, and to the establishment, and understanding, of relationships between activities in which students engage in science classes and subjects of their daily lives [20].

The constructivist perspectives of science education should value and foster meaningful learning [21]. According to these currents, laboratory work should be designed and implemented with a view to contribute to stimulate and promote them.

Thus, the use of teaching strategies that are pedagogically attractive, experimental and relational seems to be of great importance, making use of pedagogical resources that promote the stimulation of students' critical thinking, in order to foster their scientific literacy, thus making them citizens who are more aware and able to participate actively, assertively and jointly in society.

Scientific literacy can not only be built on a theoretical basis, it is essential to integrate theoretical knowledge with practice. In this way, this work intends to be a contribution for teachers, making the connection between biology curriculum of the 12th year and daily life

of the students, in order to potentiate not only their theoretical-conceptual learning in relation to subjects of sometimes difficult Understanding, such as DNA manipulation techniques, Mendelian genetics, transmission of hereditary characters, DNA profiles and genetic tests, but also to promote, through the execution of laboratory work, the acquisition of skills in molecular biology techniques, such as the use of Micropipettes, restriction of plasmid DNA, preparation of agarose gels, their inoculation and electrophoretic run.

The practical work we have conceived seems to be more advantageous than the original kit, not only for saving time and material (lower cost), but also because we work with fewer samples, making genealogical trees easier to understand by the students. In addition, the fact that we perform two electrophoreses, allows us to approach, with the same laboratory activity, two different forms of transmission of hereditary characteristics (a heterosomic recessive and another autosomal dominant), being therefore the patterns of bands obtained after the race of the two electrophoreses, necessarily a differentiated interpretation by the students, thus integrating with the same practical work, several different theoretical concepts.

Being aware that only innovating is possible to do better, we have in us the certainty that, by working with students, not only theoretical concepts but also experimental activities / processes, we can bring together and link curricular science and everyday life, creating therefore classrooms where real and meaningful learning in science takes place).

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Design and Develop an Effective Teaching Aid for Buoyancy

Y Chang, L Horng
National Changhua University of Education, Changhua City, Taiwan
phlhorng@cc.ncue.edu.tw

Abstract. In order to improve the natural science remedial teaching and to develop the necessary teaching courses, the implementation of new teaching strategies and different teaching aids are carried out in our country. This study is aimed at the 8th graders of Changhua County Tianwei Junior High School. With the purpose to stimulate students' motivation, turn passive learners into active learners, to enhance students' self-values and achievements senses, and cultivate their self-confidence, concentration and desire for learning, the students are trained to be hosts of science activities.

The new teaching aid is designed for buoyancy. The topic "buoyancy" has been a teaching class that is not easy to learn at 8th grade in junior high schools in Taiwan, especially to determine whether the object is a body or a float (or when the object will submerge or float), and finding the relationship between the density of liquid and the strength of buoyancy. Therefore, the teaching aid is designed for this situation. The teaching aids were divided into two parts. A transparent cylindrical container that was filled with a gradient of salt solution along the height of the cylinder from high to low concentration, and several transparent glass bottles were chosen as the test mass units to float or submerge in the liquid. The students can control the degree of floating in the salt solution by adjusting the average density of the transparent glass bottles. It was a very effective teaching via this intuitive way to make the students learn to determine whether the object will be a submerge body or a float and find the relationship between density and buoyancy. This type of teaching aid has the advantages of low cost, beautiful, full of fun, easy to operate and suitable for all types of students of different aptitude.

During the teaching process, students were very fond of setting up the unit and engaged in the class by giving their own positive suggestions or responses about how to make the set-up more better. The teaching aids is strongly recommended to the teachers who like to demonstrate some teaching aids and let the students do some really effective hands-on experience during the class.

Keywords. Science education, breakout activities, hands-on experience, innovative teaching aids, effective teaching.

1. Introduction

The topic "buoyancy" in Taiwan's junior high schools has not been a go-easy teaching class for both the students and teachers at 8th grade and that is what led us to develop a better user friendly teaching aid by which we can clearly demonstrate to the students the determining conditions of a body whether it will float or sink in a particular liquid medium and find out the relationship between the body and buoyancy of the liquid. We have seen, students have "concepts of myth" when we randomly ask them to guess whether a body in a liquid will float or sink [1,2]. So the author hopes to design an effective teaching aid so that the students through their hands-on activities and the teachers with some vivid examples with easy explanations can determine and demonstrate respectively the intricate relationship between floating or sink bodies and the liquids under test.

2. Teaching aids

The teaching aids begin with a reference of the Galileo Thermometer [3], hoping to design simple, intuitive, beautiful and effective teaching aids where the teaching aids will certainly help students to learn how to determine if the object will be float or sink.

The composition of the teaching aids consists of several small glass bottles with varying volume of 5 to 10 ml, a measuring cylinder with volume of 300 or 500 ml, eating salt, clean water and edible pigments (Fig. 1).

2.1 Instructions of teaching aids

First of all, we have to prepare a cup of about 500 ml of saturated saline solution, used as our base solution. Then, we distribute the saline solution in to 3 to 5 cups with different amounts to prepare a variety of different concentrations of saline solution in the cups. For example, we can prepare three cups of

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different concentrations of saline solution where the first cup is fully filled with the saturated salt water, the second cup contains half saturated salt water and half clean water and the third cup filled with clean water only. After the completion of the modulation, we add appropriate edible pigments for coloring (Fig. 2).

Figure 1. All making stuff of the teaching aid including several of cups, eating salt, edible pigments, small glass bottles, and one cylinder

Figure 2. Using the edible pigments to color the different concentration saline solution

Now, we slowly fill up the measuring cylinder with the solutions of the three cups which have three different concentrations. Here, precaution must be taken not to mix the three solutions completely in the cylinder but instead make a smoothly varying concentration of resulting liquid column in the cylinder along its height (Fig. 3, 4, 5, 6). At this step, the teaching aid is half complete.

Then we have to start making our floating (or sink) glass bottles. We fill small glass bottles with the right amount of water or any liquid or any kind of filler as shown in Fig. 7.

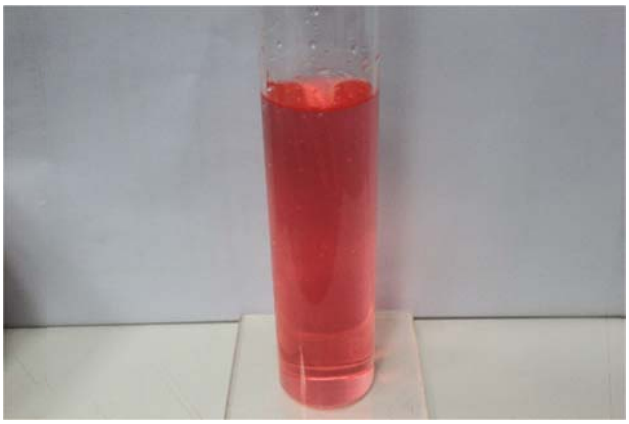

Figure 3. The bottom layer fills the red liquid, which is saturated salt water

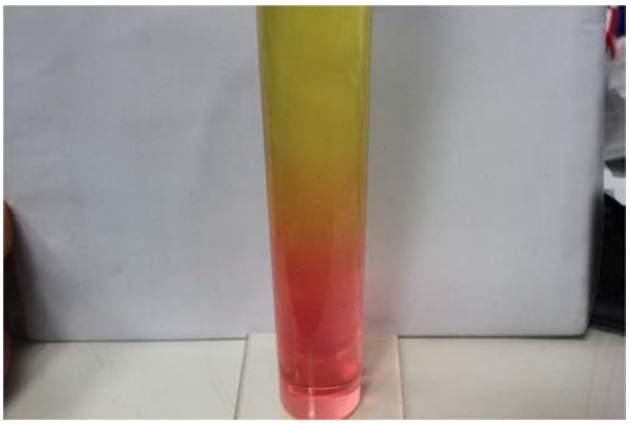

Figure 4. The second layer fills yellow liquid, which contains half saturated salt water and half clean water

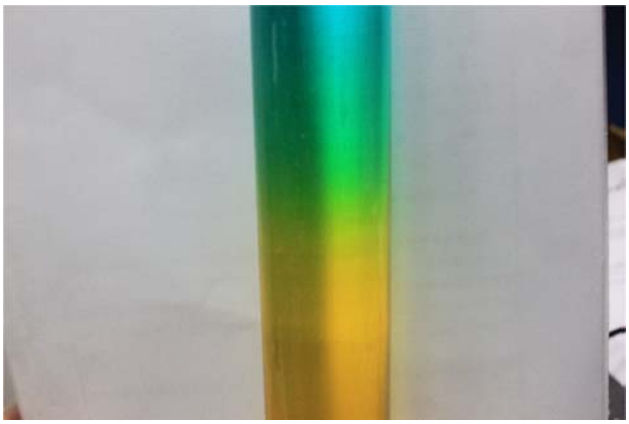

Figure 5. The top layer fills blue liquid, which is clean water only

Finally, we slowly put the small glass bottles in the measuring cylinder one by one and observe the location of the glass bottles in the cylinder. The making of our teaching aid is therefore finished (see Fig. 8)

Figure 6. That is the whole view of this teaching aid, when teacher or students finish

Figure 7. These glass bottles can be filled anything you want

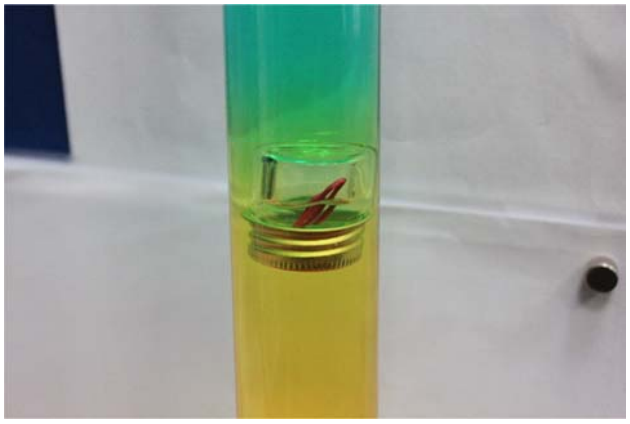

Figure 8. Put the glass bottle into the cylinder and observe the location

3. Teaching strategy

Teachers who prefer teaching by demonstration can achieve certain results through simple operation and appropriate teaching strategies (such as POE) through this teaching aid. The following is a brief presentation of the teaching steps:

1) Before the teaching activities, simply introduce the constituent parts of the teaching aid to the students.
2) Ask students to discuss among themselves in groups where the various bottles will be expected to stay in the cylinder and record the basis of the forecast.
3) The teacher conducts the demonstration activity by putting the pre-prepared small glass bottles in to the measuring cylinder and, assists students in comparing with their forecast.
4) Guide students to discuss the similarities and differences between the results of the forecast and the results observed in the demonstration. The teacher then ask each group for their best possible explanation of the demonstration and summarizes all the respective answers.

If the teacher finds it is suitable for hands-on activity of the classroom and students, then he/she can explore some convenient ways to help students to carry out activities by the repeating the process and observed results to explore the concept of buoyancy. The following are the steps that I provides for the hands-on activities for inquiry teaching:

1) Distribute the teaching aids to each student (group) and introduce the teaching aids and the activities to be carried out.
2) To help the students in setting up the teaching aids and set the goal, the teacher can ask the students to design at least two or three glass bottles with different concentrations of salt water and then they can start the activity.
3) In progress, the teacher is recommended to help all the students to record how they control the glass bottles so that they can stay in the locations where they want them to stay and, help the students as further needed.
4) Guide students to complete the activity objectives to organize the activity records and summarize their findings. Therefore, ask them to publish the conclusions they have obtained so far, particularly the factors that affect or control the floating or sinking of the glass bottles and the relationship they have

found in this way between buoyancy and solution density.

5) Finally the teacher is recommended to make a summary.

In case, the students like it very much, we can also design the final set-up in a way that can be handy to allow students to take home as a gift. For example by using of different shapes of glass containers to replace the measuring cylinder. Moreover, one can use two different immiscible solvents instead of using a solution (mixture of solute and solvent for e.g., salt and water respectively), and put in small glass bottles in a way so that they can float at the interface of the two solvents. The teacher can suggest the students some ways of beautification for the teaching aid that helps them to complete the gift and let them take home as a scientific souvenir.

4. Result and discussion

When the author started the lesson in Changhua County Tianwei Junior High School, the students had no prerequisite knowledge of buoyancy. So the students only depended on the life experience or imagination to guess what will happen in the following demonstration. Because of that situation, the teachers could use students' conceptual conflict to easily lead the students fix their own concepts of misunderstanding. After the demonstration, the teachers could lead the students start the hands-on activity of inquiry learning. In this activity, the students could immediately use their acquired knowledge from teacher's demonstration to control the bottles, and let the bottles stay any position inside the cylinder where they want the bottles to stay. Through the activity, the students could truly feel how they control the bottles and how buoyancy influence the floating or sinking of the mass units.

After the whole lesson (demonstration and activities), the students were all doing great. Most of the students could control at least two bottles to let them stay anywhere inside the cylinder and some of them also wanted to challenge the controlling of more bottles. Even more, some of the students were curious about the differences between this teaching aids and a typical submarine.

So we have enough reasons to believe that this teaching aid can help the teachers and the students to teach and learn more easily the concepts of buoyancy.

5. Conclusion

The idea of this teaching aid was to help the teachers experience a more easy way of teaching and the students experience a more easy way to learn the concepts of buoyancy. So from the beginning, I wanted to build an effective teaching aid with the advantages like, easy to find the making stuffs of the teaching aid, easy to use, easy and clearly to do the demonstration and more directly feel the underline physical concepts of buoyancy. After I designed this teaching aid and taught with it, I received the feedbacks from the students with their shining eyes out of their excitements, and I understood that they were enjoying the pleasure of learning science. The author understood it more clearly specially when the students really focus on setting up the bottles and challenging to go further. According to the teaching experience of the author, it is needless to mention here that I faced students with different learning aptitudes at the beginning of the class, for example, some students had already been very positive intrinsic motivation and some students almost rejected to learn science. But, at the end of the demonstration and all the hands-on activities most of them were doing great. So the author recommends strongly this teaching aid for all the students and the teachers who will need to learn and teach the topic of “buoyancy”, respectively.

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Visualization of Recombinant Proteins in Agarose Gels. An Example with Fluorescent mCherry and GFP

A Séneca, S Pereira
Universidade do Porto, Porto, Portugal
aseneca@fc.up.pt

Abstract. Bacteria are able to incorporate foreign DNA in a process called transformation. Manipulation of this uptake allows the regulated production of proteins through the selection and cultivation of transformed bacteria, in an experimental process generally designated as molecular cloning. Escherichia coli DH5 α is an E.coli cloning strain that is non pathogenic, is easy to cultivate and transforms with high efficiency, which makes it most frequently used host strain for routine cloning applications. Here we develop an easy method for separating and visualize recombinant fluorescent proteins mCherry and GFP (Green Fluorescent protein) overproduced in E. coli. Protein electrophoresis in agarose gels is an alternative approach to the more common polyacrylamide gels and provides several benefits namely, no toxic components are used in the preparation of the gel and the use of horizontal gels do not require the use of a stacking gel.

GFP and mCherry retain their fluorescent properties when cloned and expressed in E. coli, and when isolated from E. coli and separated on agarose gels, provided that samples are not heated.

Fluorescent proteins can be identified as a single band and the gel can be stained with Coomassie Blue or other non-toxic stain for all proteins visualization.

Keywords. Agarose gel electrophoresis of proteins, fluorescent proteins, overexpression in *E. coli.*

1. Introduction

Biotechnology has an increasing social impact in daily lives requiring citizens to be able to understand its main concepts and make informed decisions regarding its applications. The booming field of biotechnology relies heavily on the development of complex molecular techniques, including those related to genetic engineering, as a process of manipulating the DNA of an organism often including DNA from a foreign organism.

Through genetic engineering it is possible to add, alter, replace, augment or silence genes or their expression in an organism.

Bacteria can acquire altered genetic characteristics from a different source, in a process known as bacterial transformation. Generally, a vector such a plasmid or a virus is used as a vehicle for DNA transport into the bacterial cell.

By manipulating gene expression in an organism in such a way that it expresses large amounts of a recombinant gene it is possible to produce large amounts of specific proteins in a biotechnological process known as protein production. A very well-known example of a biotechnological application of genetic transformation in the context of genetic engineering is the production of biopharma-ceuticals like insulin.

Protein production systems also referred to as “expression systems” are used in the life sciences, biotechnology, and medicine.

For most proteins bacteria are an excellent expression system because of their relative simplicity, lower media costs and shorter process times. The most commonly used bacterium for recombinant protein production is Escherichia coli, an enteric bacterium safe for use in laboratories and industry, well characterized physiologically and metabolically, with many molecular biology tools available. Molecular biologists use E. coli to express recombinant proteins, the goal being usually to “overexpress” the protein of interest so that it can be easily identified and purified. Usually the production of the protein of interest involves an initial electrophoresis, which separates the mixture of all cell proteins and allows the identification of the protein of interest as a prominent band on the gel, followed by. protein purification which can be used in downstream applications.

The activity here proposed relies on a preceding process of bacterial transformation, gene cloning, induction and examination of expression. Afterwards, in the work here described, colonies are allowed to multiply in liquid nutrient media and bacterial cells are

then broken open (lysed) to release proteins into the media. The entire repertoire of proteins expressed in E. coli are separated by gel electrophoresis and the protein of interested identified in the gel. Bacteria used in this activity were transformed with two different plasmids. Bio-Rad's pGLO plasmid which contains the jellyfish gene that codes for Green Fluorescent Protein (GFP) and another recombinant plasmid produced in our lab by inserting the gene coding for the red fluorescent protein mCherry [1] in a cloning vector.

Colonies of E. coli can be qualitatively examined for either green or red fluorescence, which suggests that the genes for GFP and mCherry are being expressed. The proteins from the bacterial protein extracts containing either the foreign GFP or mCherry proteins expressed in E. coli, are separated by gel electrophoresis and the fluorescent GFP and mCherry can be visualized and identified in the gel allowing to directly link gene expression to identification of a protein responsible for the specific observable trait.

Usually proteins are separated by SDS polyacrylamide gel electrophoresis (SDS-PAGE) but agarose gels have been used for protein separation for many decades [2]. These are particularly used for separation of large proteins and protein complexes, since they lack sufficient resolution to analyze small proteins and peptides. However, they have the great advantage that no toxic components are used in the preparation of the gel.

Here we describe a technique for separating bacterial proteins by agarose gel electrophoresis and identify overexpressed fluorescent proteins expressed in bacteria. The procedure of obtaining a lysate from a bacterial culture, performing electrophoresis and identifying the fluorescent proteins in the gel can be completed in 2 hours.

2. Methods

2.1. Recombinant plasmids used in transformation

Bacteria used in this activity were transformed with two different plasmids: (1) Bio-Rad's pGLO plasmid (Bio-Rad Laboratories #166-0003-EDU) which contains the jellyfish gene that codes for Green Fluorescent Protein (GFP) in the presence of the sugar arabinose and a gene that confers resistance to the antibiotic ampicillin; (2) the pCherry recombinant plasmid has been previously built at our Biology Department, by inserting the gene coding for the red fluorescent protein mCherry [1] in the cloning vector pBluescript II SK under the control of the lac promoter sequence.

2.2. *Escherichia coli* DH5α cultures

Single colony liquid cultures of E. coli DH5α expressing GFP and mCherry proteins were allowed to grow overnight at 37 °C with permanent agitation. The liquid culture medium was 5 mL of Luria Bertani medium to which arabinose was added for cultures of E. coli expressing GFP, to a final concentration of 3 mg/ mL. Ampicillin was added to both media to a concentration of 100 ug/mL to prevent growth of non-transformed E. coli DH5α. The culture medium was prepared and sterilized in a microwave, a procedure known to be as efficient as a normal autoclave [3]. Sterile conditions during media preparation and bacterial manipulations were achieved by a lit flame, which was used to flame tools and to create an updraft that pushes airborne contaminants away from the close working area.

2.3. Cell free extract of recombinant GFP and mCherry proteins

From the overnight grown liquid cultures 2 mL were dispensed to two Eppendorf tubes and centrifuged at 12000 rpm for 5 min. The sediment can be observed at the UV light box to check for the presence of the grown transformed cells expressing these proteins.

Supernatant was discarded and the sediment suspended in 150 µL of TE buffer (10 mM Tris-HCl pH 8, 1 mM EDTA). Following the addition of 15 µL of a lysozyme solution 15mg/mL, the tubes were incubated for 10 minutes at room temperature. The lysozyme is a glycoside hydrolase that hydrolases the peptidoglycan, which is a major component of the cell wall of Gram positive bacteria. This is the first step of the process of disruption of the bacterial cell wall in order to obtain a solution with free recombinant proteins.

The tubes were next frozen for 15 minutes at -20^0 C in order to further break the cell wall and disrupt the cell membrane, and then centrifuged at 12000 rpm for 5 minutes. The sediment is mostly composed to cell debris and an observation with UV light should show most of the fluorescent recombinant proteins solubilized in the supernatant.

2.4. Electrophoretic separation of proteins

Visualization of the protein extracts was done on a 4% (m/v) agarose gel prepared in TG buffer (25 mM Tris-Cl, pH 8.3, 250 mM glycine). To load the samples in the gel 10 µL of lysate was mixed with 10 µL of 2 X Laemmli sample buffer with SDS (4% SDS, 20% glycerol and Tris HCL buffer, pH 6.8 120 mM) to confer a negative charge to the proteins and ensure a partial denaturation since no heating of the samples was performed. Alongside 20 µL of a pre-stained protein marker (Thermo Scientific Page Ruler TM Plus Prestained Protein Ladder) was also loaded. The gel was run at 200 V until the marker shows well separated colored bands. The gel was observed under UV light and additionally stained with Coomassie Blue.

3. Results

The centrifugation of the overnight cultured recombinant E. coli DH5α separates the cells from the culture medium producing colored sediments under UV light according to the proteins that were expressed (Fig.1-A). Re-suspending these sediments in TE buffer followed by cell wall and cell membrane disruption solubilized the cell protein content in the supernatant, after a new centrifugation step. Fig. 1-B shows the sediment mainly composed of cell debris and the protein solution colored pink and green, as a great part of this content are the expressed mCherry and GFP proteins.

Agarose electrophoresis of the partially denaturated non-stained protein extracts under natural light (Fig. 2-A) revealed only a faint pink band that corresponds to the mCherry protein.

Both mCherry and GFP proteins became visible under UV light. (Fig.2-B). Whole protein content staining with Coomassie Blue shows the two recombinant proteins with an apparent mass of 150-200 kDa. The rest of the protein content accumulates at the bottom of the gel since even an agarose concentration of 4% is not enough to separate most of the different proteins according to their mass (Fig. 2-C).

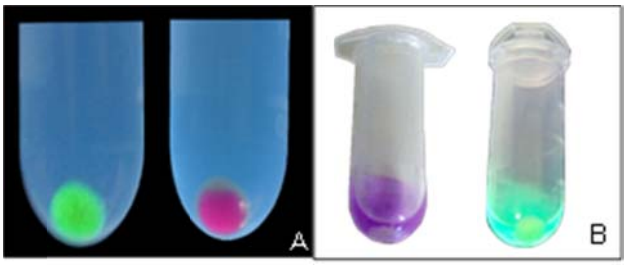

Figure 1. Steps in obtaining a cell free protein extract: A – sediments of recombinant E. coli DH5α cells expressing GFP (left) and mCherry (right) proteins observed under UV light; B – mCheery (left) and GFP (right) in the supernatant solution after disruption of the bacteria wall and cell membrane. GFP observed under UV light

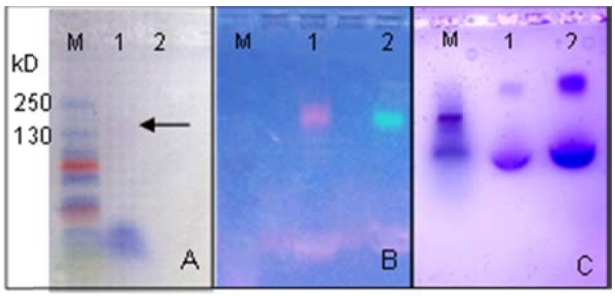

Figure 2. Slides of Picture Book

4. Discussion

The practical activity here described introduces the processes of genetic engineering and transformation and describes the protocol for recombinant protein production, separation in agarose gel electrophoresis and identification of the protein of interest.

Genetically transformed bacteria with either plasmid, pGLO or pCherry, are allowed to grow in liquid culture, cells are harvested and subsequently lysed to obtain a cell free extract containing all soluble proteins that can be separated by electrophoresis.

Plasmid pGLO encodes green fluorescent protein GFP and pCherry encodes the red fluorescent protein mCherry. Expression of GFP is under the control of pBAD promoter and is inducible by arabinose. Expression of mCherry is under the control of the lac promoter of pBluescript II SK vector and when expressed in DH5-alpha strain of E. coli does

not need an inducer (IPTG) since this specific bacterial strain does not produce sufficient amount of LacI repressor protein to repress expression controlled by the lac promoter.

The use of these fluorescent proteins allows monitoring all the intermediate steps of the procedure, tracking the fluorescent proteins by their color. Firstly, bacterial cells are separated from the liquid growth media by centrifugation. The pellet of concentrated bacteria at the bottom of the tube will glow when exposed to UV light. It is noteworthy that due to specific spectral characteristics of both proteins, GFP green fluorescence will only be observable under UV light but the pink reddish color of bacteria expressing mCherry is observable under ambient light.

After discarding the supernatant, the bacterial pellet is resuspended in TE and lysozyme added to degrade (or lyse) the bacterial cell wall. Complete disruption or "lysis" releases soluble components, including GFP or mCherry into the media and further centrifugation separates the cellular debris of lysed bacteria (such as the cell membrane and walls) that are pelleted in the bottom of the microcentrifuge tube from the supernatant. At this stage, the supernatant will fluoresce either bright green or pink upon exposure to UV light.

Separation of proteins from a cell extract can be usually performed by sodium dodecylsulfate -polyacrylamide gel electrophoresis (SDS-PAGE). Since the detergent SDS confers a negative charge to the proteins it drives electrophorectic separation according to protein size. SDS also partially disrupts the quaternary, tertiary, and secondary structure. Before proteins can be separated in an electric field, they are disrupted in a sample buffer such as the most common Laemmli sample buffer which can contain besides SDS, reducing agents such as dithiothreitol (DTT) that reduces the disulfide bonds in proteins breaking the bonds and disrupting protein structure. A heating step of the mixture to 95°C for 5 minutes, completes the denaturation.

GFP and mCherry, only partially denature in the presence of SDS and DTT. The partially denatured proteins remain very fluorescent and can be visualized during electrophoresis. However, heat denaturation fully denatures the protein and fluorescence is quenched. Thus, during electrophoresis visualization of GFP and mCherry fluorescence on the gel will be apparent only in the unheated samples.

Although SDS-PAGE (sodium dodecyl sulphate-polyacrylamide gel electrophoresis) is commonly used for the separation of proteins based on their molecular weight, agarose gels have been used for protein separation for many decades particularly for separation of large proteins and protein complexes, since they lack sufficient resolution to analyze small proteins and peptides. However, protein electrophoresis in agarose gels as an alternative approach to using polyacrylamide gels presents several benefits namely no toxic components are used in the preparation of the gel. Gels can be run using a horizontal system and use of a stacking gel is not necessary for horizontal submarine electrophoresis.

Fluorescent GFP and mCherry bands were both very easily identified in the gel under UV light. Although the predicted molecular weight from the aminoacid composition is approx. 27 kDa and 29 kDa for GFP and mCherry respectively, the bands migrate to an apparent molecular apparent mass of 150-200 kDa, since they are not completely denatured and migration is affected not by size but by the three-dimensional conformation of the proteins. This is advantageous for demonstrations purposes since a 4% agarose gel lacks sufficient resolution to analyze small proteins and peptides.

After the gel is stained with Coomassie blue, all proteins are visualized.

In conclusion, in the proposed activity, recombinant fluorescent proteins GFP and mCherry are overexpressed in E. coli and an agarose – gel electrophoresis technique is described that allows to separate and identify the proteins on the gel.

The procedure does not involve toxic acrylamide and the all the process from obtaining a lysate from a bacterial culture, performing electrophoresis and identifying the fluorescent proteins in the gel can be completed in 2 hours.

Besides involving the students in a simple but sound technical procedure this allows to establish a conceptual link between the genetic

engineering and transformation and between gene expression and identification of a protein responsible for the specific observable trait.

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Augmented Reality in Learning Contexts

E Fernandes
University of Madeira, Funchal, Portugal
elsa@uma.pt

Abstract. Augmented reality (AR) is an environment that includes both virtual reality and real-world elements. By using technological mobile devices such as smartphone, tablet or smart glasses, we can see the real world, as well as computer-generated images projected on top of that world.

In this communication I am going to discuss the potentialities of Augmented Reality for growing with science and present how we are using augmented reality in multidisciplinary learning contexts, in pre-service and in-service teacher training.

Keywords. Learning, augmented reality, in-service, pre-service, teacher training, interactive technologies.

1. Introduction

"A good analogy to better understand an AR environment is to imagine living in the magical world of Harry Potter, where the school hallways are lined with paintings that are alive and interactive. As in the movies, AR allows us to stablish an interaction between virtual objects and the real world" ([1], p. 241).

To transform an environment in an augmented reality requires three components: a physical element, a virtual content (image, video, text, etc.), and the technology that makes possible the visualization and interaction with that content.

Augmented reality is invading our society and our lives through catalogues of furniture, clothing, etc, is also a strong presence in museums, and in games. According to Azuma [2] at least six classes of potential AR applications that have been explored: medical visualization, maintenance and repair, annotation, robot path planning, entertainment, and military aircraft navigation and targeting. As referred by Azuma, one of the contributions of AR´s use is that the virtual objects display information that the user cannot directly detect with his own senses and the information conveyed by the virtual objects helps the user to perform real-world tasks.

What can we say about the presence of augmented reality in learning contexts?

The Horizon Reports, and other important Educational Reports, predict that the use of simple augmented reality in education will be widespread within two to three years [3, 4]. A variety of software for creating augmented reality is now available, as well as a huge amount of applications that allows its visualization.

In this communication I am going to discuss the potentialities of Augmented Reality for growing with science and present how we are using augmented reality in multidisciplinary learning contexts, in pre-service and in-service teacher training.

2. The way we look at learning

Whatever the theory adopted to think about learning, it always has underlying a way of looking at the person, to the social world and to the relationship between the person and the world.

We see learning as participation in the social world [5]. People need a purpose to participate and this usually stems from motives that lead people to participate in a certain practice, even if the practices in which people participate have not been organized to meet those motives. However, the way people participate in social practices have a strong relationship with the motives and dispositions (that end up being the resources of the intentions-to-learning [6].

When these dispositions from the agent do make that his acting in a certain practice denotes a reflexive action we can talk about acting in a competent way. Consequently, it is not possible to think about competence disconnected from experience. The tension between experience and competence promotes learning. Learning transforms people who learn and the practices where they participate.

To talk about participation implies also to talk about reification. Wenger [7] uses the term reification, more generally, to talk about the process of shaping our experience by producing objects that congeal this experience into 'thingness'. By doing that we create points

of focus around which the negotiation of meaning becomes organized. Writing down a law or producing a tool it is a similar process. A certain understanding is given form. “This form than becomes a focus for the negotiation of meaning, as people use the law to argue a point, use the procedure to know what to do, or use the tool to perform an action. The reification process is central in any practice. In any practice are produced abstractions, tools, symbols, stories, terms and concepts that reify something of this practice in a congealed form ([7], p. 59).

With the term reification, Wenger [7] intends to cover a wide variety of processes that include making, designing, representing, naming, encoding, and describing, as well as perceiving, interpreting, using, reusing, decoding and recasting.

Reification shapes our experience. Having a tool to perform an activity changes the nature of the activity. The word processor reify our view of the activity of writing, but also changes the way we position ourselves in relation to writing, in the sense that we pay attention to different aspects of those who pay attention when we write by hand.

Learning transforms people who learn and also the practice in which they participate.

But participation in much more than making things. Making things is not enough. Participation involves what Resnick and Rosenbaum [8] describe as tinkering. “The tinkering approach is characterized by a playful, experimental, iterative style of engagement, in which makers are continually reassessing their goals, exploring new paths, and imagining new possibilities”. ([8], p.164) And it is “(…) what exactly what is needed to help young people prepare for life in today’s society” ([8], p.165).

We see tinkering as a valid and valuable style of working, characterized by a playful, exploratory, iterative style of engaging with a problem or project. When people are tinkering, they are constantly trying out ideas, making adjustments and refinements, then experimenting with new possibilities, over and over and over. But how to design for learning to tinkerability emerge? It seems that to design for learning with Augmented Reality can help to bring

3. Why to Use Augmented Reality in Learning Contexts?

Learning implies create, develop, interact, investigate, present and it occurs in different contexts which could be more formal or more informal. Learning can happen online, in museums, in libraries, in school and also in classrooms. Augmented reality has the potential to bring "magic" into the learning contexts. Who of us when reading a book, had never imagined that the characters will become alive and will get out of the book? Moreover, who never imagined being one of the characters in the story that is reading? Augmented reality can make these dreams come true. Having this possibility at our disposal is something that, as teachers, as parents, as educators, we cannot surely waste it.

But beyond the above argument that would be worth by itself, augmented reality also allows to make teaching more individualized and personalized. Some students by interacting with a virtual object only once, can capture the essentials of that object to learn what they need to learn, others need to interact more times with the virtual object to learn something. With augmented reality and with BYOD (Bring your own device) this aspect is ensured.

With AR applications and using their own devices learners can interact with virtual elements related with different educational fields. One more advantage of AR is that students can create their own elements of augmented reality. They can, for example, make some mathematical concepts come to life, creating an element of augmented reality that shows, for example, the practical application of this concept. Or they can read in the science book the explanation of the water cycle and through an augmented reality element see the water cycle.

4. Augmented Reality in Teacher Education

Since 2014 that University of Madeira become Associate Partner of a big European Project – ITEC ((Innovative Technologies for an Engaging Classroom) – Designing the Future Classroom. To become an Associate Partner of the Project iTEC had implied to be committed to disseminating both in pre- service as well as

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at in-service teacher training, the innovative technologies as well as the methodologies of work in the classroom used in iTEC.

4.1. Pre-service teacher training

Figure 1

In 2015, in a Mathematics discipline of the last year of an undergraduate degree in Basic Education, in which I had to work on the Pythagorean Theorem, I proposed to the students to create an interactive exhibition on the Pythagoras, using Augmented Reality. In this exhibition they would have to talk about who was the Pythagoras, what is his best known theorem and would have to choose the demonstration of this theorem that was more meaningful for the group. Students had to create their own elements of augmented reality. For that they had to search about Pythagoras, about his theorem, look for the demonstrations of Pythagoras' theorem and choose the one they better understand.

After that, in their master degree, these students have been using this idea in other disciplines of the master and in their students in the internship.

4.2. In-service teacher training

In January 2015 we started a teacher training project to disseminate among teachears of STEM areas, in University of Madeira, the innovatives technologies and methodologies conveyed by the project iTEC.

We have been creating, with the teachers, different learning scenarios with robots, Scratch, Toondoo, Augmented Reality, among other innovatives technologies. We will present and analyse some of them that included augmented reality.

1) Anatomy 4D “puts every detail of the most complex human body systems into a free app that is easy to use, accessible, and truly engaging. Learners explore bodily systems in depth through DAQRI’s 4D experience, which provides the opportunity to understand their interrelationships spatially – a learning experience previously only accessible in a gross anatomy lab” [1]. We have been creating multidisciplinary work proposals that included the Daqri –Anatomy 4D - images that allows to go to the ‘inside heart’ to see how it work, what composes it and then using mathematics they have to find the heart volume. The inclusion of elements of augmented reality in the work proposal allows that teachers /students with their own device can see the ‘inside heart’ as many times as they need to understand and solve the task which is one way to personalise ways of working in the classroom. All of

them as to solve the question but with their own rhythm.

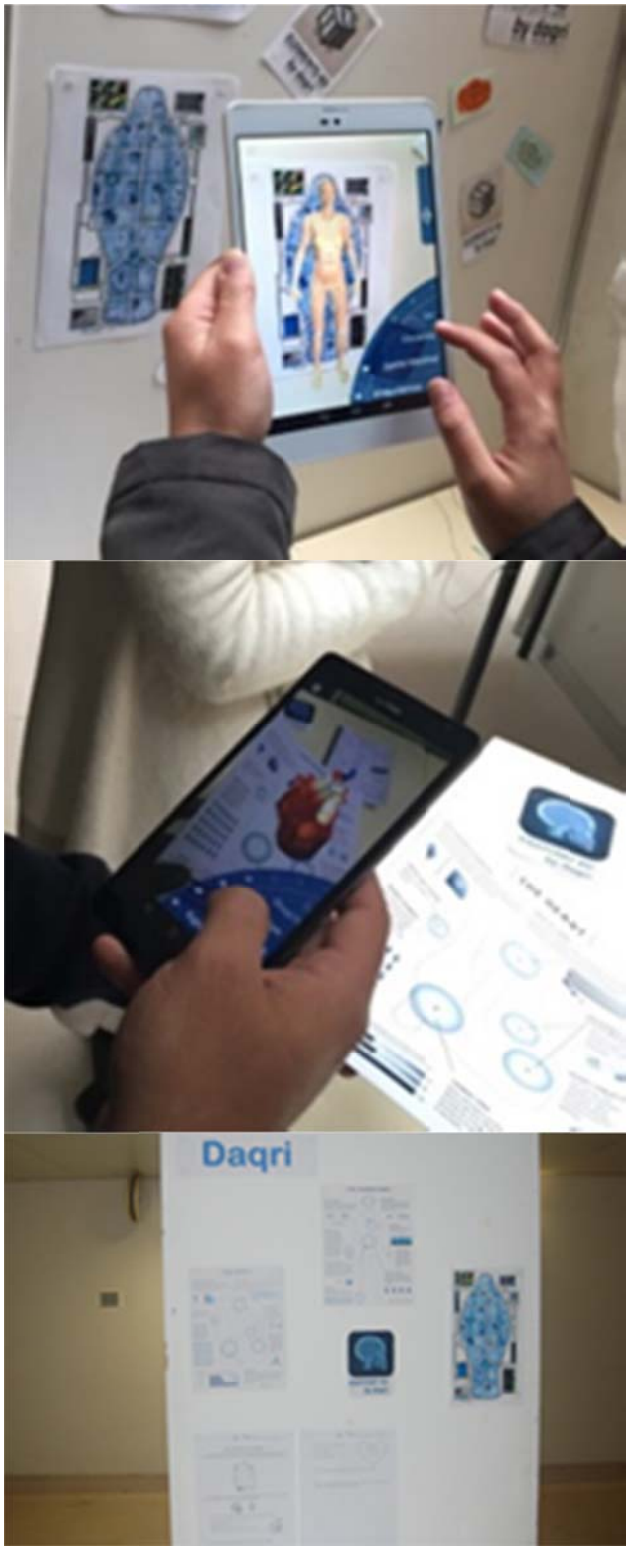

Figure 2

2) Mirage "is a set of applications for mobile devices intended to be used in the classroom.

Figure 3

These applications are related with different curriculum contents and are supported by lesson plans to be used by teachers. With the same paper markers,

users can observe and interact with virtual objects (geometric solids, molecules, planets, satellites, etc.) from all angles" [1]. With this application we have also been creating plans of work in which teachers/students had to create a kind of 'identity card' for the prisms using one application or identity cards for planets with the same cards but with a different application or the same for the molecules, depending on the subject they are working. Teachers liked very much this kind of work, with new ideas for designing learning environments in which their students will have a more active role. All of them related on the final report of the project that they had used this kind proposals on their classroom and that students were very engaged working on it, and learning a lot about this contents.

These are only some examples of what can be done and about the potentialities of augmented reality.

5. Final Considerations

The relation between teaching and learning is not a linear one. There is a lot of teaching without learning and a lot of learning without teaching. [7]. But we as teachers have an important role in design for learning. Although it is well known that the relation between the designed and the emergent is also not linear [7], research shows that there are important elements to consider in design for learning in order to maximize it. To use augmented reality, with an adequate methodology of work and lots of imagination, can help to bring these elements to the classroom. This type of work helps to ensure that educational experiences are not contained within them and can be linked to other realities whether they are scholar or non-scholar.

Designing learning environments geared towards innovation implies anticipating some aspects of the future [9]. In the future, growing up with science also means growing up with technologies. Both have to be part of learning environments of the 21st century School.

6. Acknowledges

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Current Status of Nursing Education in Ukraine

M Shehedyn, N Dub, I Berezovska, T Karpinska
Krupynsky Institute of Nursing and Laboratory Medicine, Lviv, Ukraine
ldmk@ukr.net

Abstract. Monitoring the labor market and the education market in preparation for the profession of nursing showed that health care reform with a reorientation towards improving primary health care and family medicine implementation put new demands on the quality of training of health professionals, including nurses. In Ukraine there are more than 435,000 health workers, or 45.8% of all employed professionals in the health sector. The total number of nurses in Ukraine is 64.8 per 10 thousands of population and 1.8 for one doctor. Personnel shortage of nurses reached almost 14 thousands. Rational use of the same nursing staff will significantly improve the quality, availability and cost of medical care to the population, efficient use of resources in health care and disease prevention.

Formation of market relations and health care reform in Ukraine according to the Concept of Public Health of Ukraine, required to review the contents of nursing education towards its integration into the international system, extending the scope of nursing activities based on the new features due to the new socio-economic conditions. This shows the urgency of changes in nursing as a part of the health system in Ukraine by improving the training of nurses that is the precondition for establishing health care institutions of a new type (hospices, nursing department in a hospital et al.) and the introduction of new nursing positions - deputy chief doctor of nursing, nurse coordinator, chief specialist of nursing Department of health and others.

The Law of Ukraine "On Higher Education", National Strategy for the Development of Education in Ukraine until 2021, Concept of professional education, Concept of higher medical education, Order of the Ministry of Health of Ukraine "On approval of the multilevel education medical directions", the industry standard of higher education in Ukraine [1] and other documents identify trends of modernization of professional training, updating and improvement of nursing activities and nursing education in Ukraine.

Already in 1992, Ukraine began reforming the health system and introduced the graduate nursing educational programs, which aims to ensure the implementation of modern concepts and directions of nursing care and activities in accordance with international practices and standards.

Keywords. Nursing education, Ukrainian health system.

1. Introduction

Article 5 of the Law of Ukraine "On Higher Education" levels and degrees of higher education said that the training of nursing higher education carried out through relevant educational and professional, educational, scientific, academic programs at following levels of higher education: elementary level (short cycle) higher education; the first level (bachelor); second (master) level; third (education and research) level; scientific level.

2. Nursing education in Ukraine by degrees

Higher education at every level of education involves the successful implementation of appropriate educational entity (educational or professional education and research) or research program, which is the basis for assigning the appropriate level of higher education. Here follows the degrees recommended in nursing:

Complete secondary education
1) Bachelor Jr.- for 2-3 years-.;
2) Bachelor - for 1-2 or 4 years.;
3) Master - 2 or 6 years;
4) Doctor of Philosophy - 4 years;
5) Doctor of Science - 3-5 years

2.1. Features of academic degrees in Ukraine

Junior Bachelor - is educational and professional degree that is assigned by a higher education institution as a result of the successful completion of the competitive educational and professional programs, the amount of which is 90-120 ECTS credits. This

amount of bachelor - 180-240 ECTS credits. For Masters - 90-120 ECTS credits. Master's degree in medical, pharmaceutical or veterinary studies is assigned as a result of the successful completing the competitive higher education relevant educational program, the amount of which is 300-360 ECTS credits. Doctor of Philosophy - an educational and at the same time the first degree, acquired on the third level of higher education through a master's degree. PhD degree awarded by a Specialized Scientific Council of a university or a research institution as a result of the successful completing the competitive higher education relevant education and research programs and public defense of the thesis at a Specialized Academic Council. The amount of the education component of education and research training programs PhD is 30-60 ECTS credits. Doctorate - the second degree, acquired by a person on a scientific level of higher education on the basis of the degree of Doctor of Science.

2.2. Training nurses in Krupynsky Institute of Nursing and Laboratory Medicine

Andrew Krupynsky Lviv Institute of Nursing and Laboratory Medicine is one of the oldest higher educational institutions in Ukraine. On October 1, 2017 it will celebrate 244 years. We have our history, traditions, achievements, our anthem and emblem (Fig.1).

Figure 1. The emblem of Krupynsky Institute of Nursing and Laboratory Medicine

Krupynsky Institute of Nursing and Laboratory Medicine began its operation, with such qualifications: medical assistant, obstetric, sanitary and medical assistant, nursing. In 1963 year the Pharmaceutical department was opened, in 1975 - Dental. In 1993 the institute received the right to conduct educational activities in educational and professional degrees junior specialist and bachelor, and in 2017 - for education and academic degree - Master (Fig. 2).

Figure 2. Krupynsky Institute of Nursing and Laboratory Medicine

During the period from 1773 to 2017 years 40,000 specialists was trained at the Institute, including: 25,000 junior specialists and 15,000 bachelors of medicine (Fig. 3).

Figure 3. First bachelors in nursing in the Institute of Nursing and Laboratory Medicine

Since 1998 the Institute has been educating deaf students to get a diploma in laboratory medicine (Fig. 4).

Also in 2006 the Institute enrolled blind students, who will work as massage professionals (Fig. 5).

Figure 4. A group of deaf students with an instructor and a sign language interpreter

Figure 5. The first group of students with visual impairment

Today, the Institute trains more than 1,200 students. Training is conducted on the day and evening basis for two forms of educational and professional degrees and other educational and research the following specialties:

- Bachelor Jr. in Obstetrics, Nursing, Laboratory diagnosis, Health prevention, Dentistry and Orthopedic Dentistry;
- Bachelor in Nursing and Laboratory diagnosis;
- Master in Nursing.

3. Conclusions

Considering all the above, Ukraine needs new standards of higher nursing education to transform our system of training nurses in the universally recognized Pan-European system in order to create common European educational space.

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Scientific Routes for Secondary and High School Students

J Redondas
IES de Candás, Asturias, Spain
javierredondas@yahoo.com

Abstract. In this paper we describe the "scientific routes" designed for secondary and high school students. This program consists of a weekly activity that includes visits to places of scientific and cultural interest, such as industries, scientific and technical museums, natural parks, historic areas, etc.

This educational program, promoted by the Spanish Ministry of Education, is intended to give continuation to the knowledge received by students in the classroom, improve and introduce more attractive way the training received by students at their respective centers, through experimental and visual environments. This benefits not only his training artistic, literary, scientific, cultural, historical, environmental and social, but also their overall development.

Keywords. Scientific knowledge, long-life learning, museums, tourism.

1. Introduction

During the last years, students from different Spanish schools have benefited from the participation in the program called "Scientific, artistic and literary routes".

Eight different itineraries haven been planned along the Spanish regions. During one week, the students had the chance to visit interesting places from the scientific, technological, historical and cultural point of view.

From the selected schools, a group composed by a number between 20 and 24 students participated in each activity, guided by two teachers and two route coordinators.

At the same time, each itinerary has been shared with another similar sized group from a different. By this way, they could share experiences and exchange opinions and feelings with other students with similar characteristics.

2. Aims and scope

This activity is intimately related to the principles that guide our teaching work, trying to ensure a comprehensive development of the students in this stage.

When participating in this activity, we have in our minds that our current society demands a training in which disciplinary specialization is combined with the presence of educational contents essential for the training of citizens and citizens, such as the knowledge and skills that are necessary to sustain the practice Democratic citizenship, life in common and social cohesion, and those that stimulate in the students the desire to continue learning and the ability to learn independently.

Then, the mail goals of these activities are:

- Complement and improve the scientific knowledge acquired in the daily activities in the classroom.
- Promote in our students an attitude of permanent learning, both inside and outside the classroom and individual and team work habits, so that this learning can continue once their studies are finished.
- To stimulate the research spirit in our students, their interest in the scientific method and the subsequent technological development.
- To value the importance of the cultural, social and artistic tradition of the different regions, in order to be able to appreciate and respect the singularities and cultural diversity.
- Open new training and professional horizons for students in this decisive stage of their lives
- To appreciate the significance of the work of scientists, artists and writers in the development of a society.
- Acquire skills for group participation and peaceful resolution of conflicts that allow them to develop autonomously in the personal, social and family spheres.
- Promote sustainable tourism, including ecotourism, for the eradication of poverty

and environmental protection, in accordance with the guidelines of the United Nations World Tourism Organization (UNWTO).

Apart from the scientific and cultural interest of the visited places, one of the main objectives of the activity is to promote coexistence and teamwork, will contribute to develop the personal and social maturity of students and promote their actions in an autonomous and responsible manner.

3. Route: planning and development

The first step is the publication of the announcement and call in the Spanish official bulletin. At this point all schools can apply for participation.

An application document should be submitted. The project presented by the centers should clearly express the objectives that are intended to be achieved with the participation of the group. Such document of participation must be original and specific for the educational level of the applicant group of students, according to the general guidelines.

The evaluation criteria of the applications are also established in the announcement.

Our school has been selected to participate in the route 1 (Murcia region and western Andalucía).

Figure 1. Map of route 1

From may the 7th to the 13th 2017, 24 students and 2 teachers have been involved in this trip. Our partner school was the IES Fernando Lázaro Carreter from the village of Utrillas in the province of Teruel (Autonomic community of Aragon).

Most of the activities during the weed are previously arranged by the Spanish Secretary of State for Education, Vocational Training and Universities. This fact facilitates the tasks for the responsible teachers of the participating schools, and also allows all the visits organized in the same week, since there are very demanded places that must be booked in advance of several months.

Figure 2. Week schedule

From the financial point of view, the students should only pay on their own the costs related to the transportation from their homes to the starting point of the route and the return from the final point to their respective villages or cities. All other costs, such as accommodation and meals, as well as entrance fees to museums, monuments, etc. are fully covered by the grant provided by the Ministry of Education.

The accompanying teachers, throughout the duration of the program, are at all times responsible for their students, they participate and collaborate professionally in the development of the programmed activities and they take care of the correct compliance with the norms and schedules, as well as the appropriate use of the spaces and facilities. nd related compounds) from natural sources.

4. Description of the route

4.1. Historical places

The first day of the route, we visited the historical center of the city of Murcia. The most important building is the Cathedral. The main facade of the Cathedral, which is considered to be a Baroque masterpiece, was constructed in

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the XVIII century, in order to replace the destroyed Renaissance facade.

We walked leisurely around the Cathedral from Cardenal Belluga Square where we had previously visited the Drama School. In this school our students had the chance to assist to real lessons and performances.

Figure 3. The Málaga Cathedral

The roman ancient theatre of Cartagena was built between 5 and 1 BCE, and for centuries was covered by a cathedral built over the upper part of the theater's seating area. Today the ancient arena is a beautiful place that still holds different performances.

Figure 4. The ancient roman theatre of Cartagena

By visiting the theatre, our students could imagine what it would have been like in Roman times. The arena can seat some 6,000 spectators, and is divided horizontally in three parts, in order to be occupied by various social strata. The public would have entered from two side passages and the semicircular orchestra contains three rows of wooden seats which would be reserved for the authorities.

The historical site of The Alhambra was built in the 13th century by the Nasrid Dynasty, this monument attests to the rich influence of Arab culture in southern Spain. The Alhambra was declared a UNESCO world heritage site in 1984 after falling into disrepair during the 18th century and being rediscovered by scholars and travelers in the 19th century. Nowadays, the grounds of the palace and its incredible gardens are well maintained and open to visitors year-round.

Figure 5. Inside the Alhambra palace

To get to the Alhambra, our students had to climb up a large hill, but at the top we could be rewarded with the interesting views of the city below. The white buildings with their terra cotta rooftops stretch outwards for miles and the air seems perfumed with exotic flowers. As soon as we cross the large arched threshold, we could discover a set of palaces, gardens, fountains, etc. We wondered about the immensity of spaces, domed ceilings carved with Arab motifs, traces of centuries, as well as the old blue paint and intricate tiles.

Moreover, the Antequera Dolmen site is famous for its significant geographical location, on the summer solstice, 21 June, the morning sun shines over the peak of the Peña de los Enamorados and straight along the dolmen's entrance corridor. This very exact positioning would have held mystical importance for the prehistoric tribes who built the dolmen thousands of years ago.

Figure 6. The dolmens

The dolmens were built by farmers who lived in the fertile Guadalhorce valley during the Neolithic period and Copper Age. For our students, it has been specially interesting to learn how the stones would have been transported and construct these enormous burial sites.

4.2. Scientific and technical museums

The Granada Science museum is said to be one of the most interesting and complete science museums in Europe. Ithas several exhibition spaces where we could improve our understanding about the world we live in, check physical phenomena such as gravity, the motion of the earth and do some interactive experiments.

The Science Museum has several areas or different rooms starting from the conception of the universe and the cosmos to the fascinating phenomenon of life that is contained in the Biosphere. There are many activities and attractions for are many activities and attractions for children.

In the planetarium we could visit the Astronomical Observatory that has the 75 cm telescope for observing the different features of the universe.

In the Biosphere Room we could follow the movement of the piranhas, count the population of the world in real time or see human DNA.

The Perception Room offers the opportunity to play with sound and light, flying thanks to the reflection of our image in the mirror.

Some of us could climb the observation tower 50 m high, which is a viewpoint of Granada.

The Science Museum also has a tropical Butterfly, Giant Chess, acoustic modules, water games, the House distorted the botanical tours, etc.

Figure 7. A mechanism at the Granada Science Museum

The building of the Cartagena Naval Museum was constructed in the late 18th century. Since that time, it has served many purposes including a prison and a training school.

Figure 8. The first submarine at the Naval Museum of Cartagena

The main displays are arranged by several main topics and themes. There is a good display of models showing naval ships through the ages. As man travelled more by ship, the need to develop navigation methods became essential and so the science of navigation has its own section.

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Ships have been used for military purposes for hundreds of years as a vital part of warfare and the sophistication of naval artillery and weapons are major exhibits, including some items of British origin.

As the methods of causing death and injury increased the need for improved on- board medical facilities became important. So, in the 18th century, modern science developed on board surgical and treatment facilities enabling doctors to keep the crew fit and operational.

Figure 9. Inside the galleries of the mines of La Unión

Probably the most important aspect of the museum is the history surrounding the development of the submarine. Isaac Peral, born in Cartagena in 1851, became an officer in 'Cuerpo General de la Armada' and his engineering skills and ideas enabled him to develop designs for an underwater craft able to attack enemy crafts. He was invited to Madrid to present his unique drawings and plans that gained acceptance along with funding enabling him to build the world's first submarine.

Some kilometers from Cartagena, we visited one of the most important sites of interest from the point of view of industrial archaeology: the mining park of La Unión.

This site offers the chance to learn all about the operations of the old underground mining industry, including the extraction of the mineral, washing and the subsequent smelting process. It also has a mining train so we could explore its distinctive landscape in comfort.

We visited one of the main attractions; he underground mine of Agrupa Vicenta, which has over 4,000 square meters open to the public. It is 80 meters deep and has remarkable interior spaces and a lake of reddish waters. Other visits in the Park include a compressor room, the miners' quarters, a roasting furnace, washers, smokestacks and a mud pond.

The Mining Park surrounds an old route used for transporting minerals known as the Camino del 33, which joins La Unión with the port of Portmán. Its numerous mining-related features have made it a genuine open-air mining museum.

4.3. Places of environmental interest

The Mar Menor it is a lagoon of salty water opened and placed close to the Mediterranean Sea. It has special ecological and natural characteristics, which makes this space a natural unique place and the lake of bigger salty water of Europe with special therapeutic conditions.

Figure 10. Sailing in the Mar Menor

Of semi-circular form, it is separated from the Mediterranean Sea by a band of sand of 22 km from length and between 100 and 1200 metres of width, named La Manga del Mar Menor. Cabo de Gata Natural Park is located in the south-eastern corner of Spain, it is Andalucia's largest coastal protected area, a wild and isolated landscape with some of Europe's most original geological features. It is the only region in Europe with a true hot desert climate.

There, we could find volcanic rock formation with sharp peaks, as well as high cliffs, which are riven by gullies leading to hidden coves with white sandy beaches. Offshore we could

observe numerous tiny rocky islands. Nearby, underwater extensive coral reefs are also present. In 1997 it was designated as a UNESCO Biosphere Reserve. In 2001 it was included among the Specially Protected Areas of Mediterranean Importance. In 2010 it was proposed as a dump for nuclear waste.

Figure 11. The Cabo de Gata cape

4.4. Industries and research centres

The Plataforma Solar de Almería (PSA) is the largest concentrating solar technology research, development and test center in Europe. PSA activities are integrated in the CIEMAT organization as an R&D division of the Department of Energy. At the PSA, our students could understand different ways to receive and take advantage of solar energy:

- High concentration solar energy, by using heliostats.
- Medium concentration solar energy, by using parabolic mirrors.
- Solar Fuels & Industrial Processes at High-Temperature.
- Thermal Storage.
- Solar desalination unit.
- Solar treatment of water unit.

After the visits to the different facilities, students participated in workshops related to solar energy.

In El Egido, we visited the biggest concentration of greenhouses, directly visible from the space. Around 450 square kilometers of plastic foil cover the bottom of the Spanish province Almería. Several tons of greenhouse vegetables and fruits are produced there annually.

Figure 12. A solar concentrator at PSA

Figure 13. Participating in a workshop

Figure 14. Visiting and tasting tomatoes in a greenhouse

Figure 15. Agricultural lessons

The desert-like, Mediterranean and dry climate favors the cultivation of tomatoes, peppers and cucumbers, especially during the winter time.

We had the opportunity to visit some of the greenhouses and attend the given explanations about different modern agricultural techniques, minimizing the water and energy consumption, with natural and artificial soil. Finally, we could taste the flavours of recently collected vegetables.

5. Evaluation

Once the route is finished, an evaluation procedure should be carried out in order to get a feedback from the participants. For this purpose, two evaluation questionnaires have been conducted. The first one, designed by the route coordinators, was filled at the end of the last day by the students and teachers, dealing with the interest and amenity of the different activities. The second one, designed by the accompanying teachers at school was directed to the students and families and covered a wide range of aspects, not only the interest and importance of each activity for the present and future development, but also about practical aspects such as accommodation, transports, meals, economical costs, etc.

As part of the evaluation, a report should be sent to the Ministry of Education containing information about the development of the activity and the main results. This report reflects the following sections:

1) Degree of attainment of the objectives and adequacy to the activities carried out.
2) Degree of integration in the School Educational Project.
3) Description and temporary development of educational activities carried out within the framework of competences.

Evaluation:

A. Students: motivation, involvement and participation in activities.
B. Educational actions.
C. Organization.
D. Results obtained.
E. Resources and infrastructure.
F. Dissemination of expected accomplishments and results achieved.
G. Suggestions and proposals for improvement, where appropriate.

As a result of the evaluation procedures, we could conclude that this experience has been very enriching for our students. This kind of activities strives to make science and culture fun, dynamic and easy to understand with experiments, demonstrations and hands-on activities. Through the Route program, students from distant communities are able to enjoy, learn and develop new understandings and passion for science, history, culture and art

6. Acknowledgements

The author wants to acknowledge the Spanish Secretary of State for Education, Vocational Training and Universities for having selected our school to participate in the above described activity and for financial support.

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A Plotter for a PV Diagram of the Working Fluid in an Engine

CH Chou
Vanung University, Taoyuan City,
Taiwan (R.O.C.)
chou0717@gmail.com

Abstract. Engines have varies appearances. Some of them are simple, while others are more complicated, but the principle of all engines is nearly the same. A heat engine, including all types, is the core issue of thermodynamics.

The main role of all engines involves the working fluid, in general being a gas or a liquid that can be vaporized. The working fluid is heated and then does work on a part of the engine or on the engine itself. The nature of the working fluid is irrelevant: it does not matter how the heating occurs, with external or internal combustion, it does not matter how the working fluid is used, whether repeatedly or once, it does not matter what is the structure of the engine, with piston or turbines; the working fluid is heated and then expands doing work on part of an engine or on the engine itself. The working fluid becomes cooled and successively compressed. Each working fluid of an engine undergoes a similar process, which can be portrayed in a PV diagram as a clockwise closed curve.

We designed and built a Stirling engine containing devices that reveal the pressure and the volume of the air inside the engine. The devices comprise two detectors and two mirrors, which can rotate separately through horizontal and vertical axes. One detector is just a sealed membrane, which becomes concave or convex depending on the pressure of air inside the engine. A lever serves to probe the position of the piston, which reveals the volume of air in the engine. The membrane is also attached to a lever. The two levers attach separately to the horizontal and the vertical axes. Each axis is fixed with a mirror such that one mirror yaws according to the position of the piston whereas the other mirror pitches, depending on the pressure of air inside the engine. A laser beam is reflected by the first mirror and consecutively by the second mirror. The doubly reflected laser beam then portrays the PV diagram of the air inside the engine by its image on a screen.

Keywords. PV diagram, Stirling engine, working fluid.

1. Introduction

Thermodynamics is a very important topic in fundamental physics. However for most of students it is not easy to grasp the main concepts of the thermodynamics.

Actually it is not completely the problems of students. The difficulty results not only from the fact that most of the textbooks in general do not illustrate the thermodynamics well.

In this paper we try to describe thermodynamics more systematically and logically. We also develop a plotter for PV diagram for the working fluid inside an engine to highline that the working fluid is the main role of an engine and the main issue of thermodynamics. An engine actually is a vital and most interesting experimental device in thermodynamics.

In this paper we firstly discuss the basics topics of thermodynamics in an easy but clear manner. And then we address the fundamental principle of any engines. Finally We finally introduce the PV plotter for the working fluid inside an engine.

2. Brief introduction for thermodynamics

There are three main topics in thermodynamics, including the first law, the second law and gases.

The key issue of the first law is the change of internal energy of a given body. The so call a given body includes all the various bodies, such a cup of water, a bottle of gas, a block of metal and a wood etc. The heat is the energy that transfers into the body due to the fact the temperature difference between the body (system) and the environment (another system). In the first law, the given body, which consumes its internal energy and expands, does work on the environment. The concept of the first law is shown as Fig. 1.

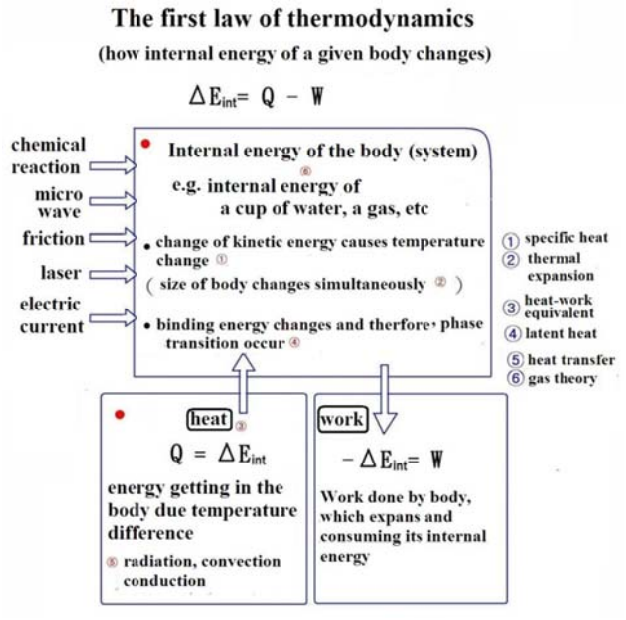

Figure 1 The first law of thermodynamics

The second law deals with a given change. If any parts of the given change relates to the behaviors of numerous molecules or atoms. Therefore, the direction of change is constrained by the statistic possibility. The entropy, relating to the possibility, is used to determine whether or not a change (process) is reversible or even to determine if a given change can happen. The concept map of the second law is shown in Fig. 2.

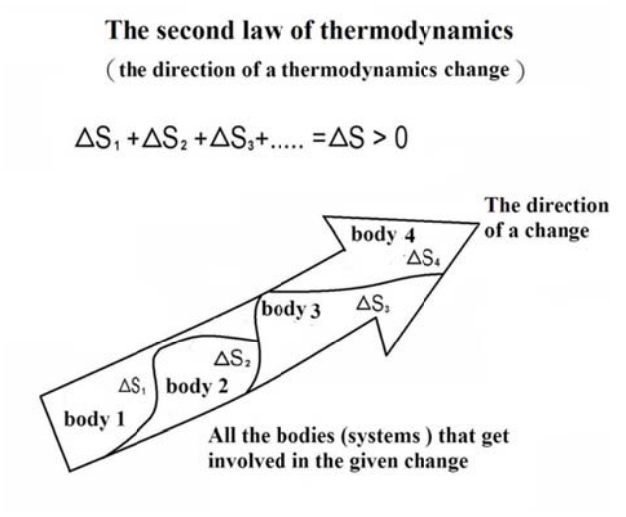

Figure 2 The second law of thermodynamics

In the thermodynamics, the gas is the simplest body (system). In an ideal gas there is not binding energy. Most of real gas is the ideal gas if its temperature is not very low and its density is not very large. The gas could be the simplest example of thermodynamics because the microscope behaviors of numerous molecules are relatively very simple and can be analyzed according basic physics laws. Inside an ideal gas there are only various types of kinetic energies. Any degree of freedom of the various motions relating to a type of kinetic energy possesses the same energy.

Because the pressure is caused by the collisions of the molecules, only the translating motion of the molecules relates to the pressure. And we can calculate the pressure easily. Comparing the result of calculation with the experimental equation, we know how the kinetic energy of each degree of freedom relates to the temperature. Therefore we also know how the kinetic energy of each degree of freedom of other types of motions, such as rotations, vibrations and etc. The concept map of a gas is show as Fig. 3.

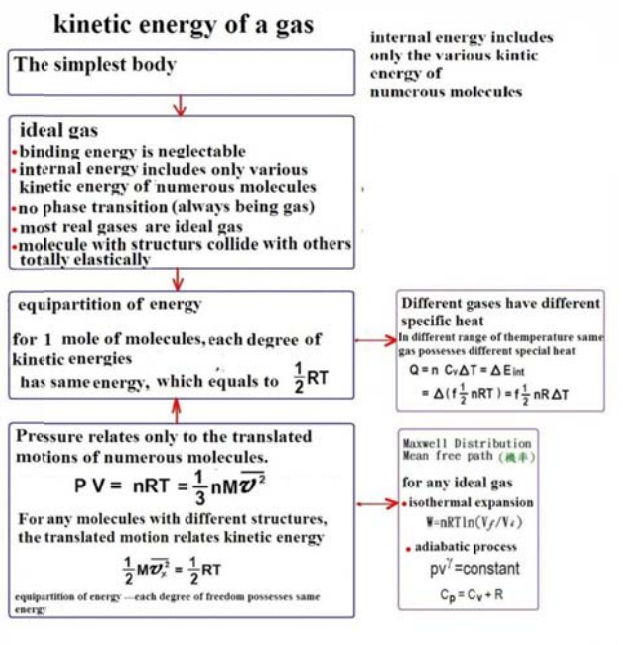

Figure 3 The internal energy of a gas

3. Heat engine

Gas is a very important body (system) in thermodynamics, because it can expand and consumes its internal energy to do work on its environment. Obviously we can heat the gas in order to increase its internal energy. Therefore the gas can do work.

If we put a gas into a machine, the gas becomes the so called working fluid. In a well designed heat engine. The working fluid is heated in advance and then expands to drive a

turbine or a piston. And then the working fluid is cooled before it is compressed. Repeating the cycle, which is heat engine cycle, an engine can transfer energy resource into kinetic energy.

Actually all the engine is governed by the same principle. The PV diagram of the working fluid, which goes through a heat engine cycle, in different engines possesses the same feature. The principle of an engine is based on the first law and the second law. To demonstrate how an engine functions, a science educator can make students interested in thermodynamics and illustrate the extremely important laws of thermodynamics.

4. A PV diagram plotter of an engine

We develop a Stirling engine and a PV diagram plotter to depict the PV diagram of the working fluid inside the Stirling engine. Fig. 4 shows the Stirling engine, which is a low temperature difference Stirling engine. We designed and built a devices that reveal the pressure and the volume of the air inside the engine. The devices comprise two sensors and two mirrors, which can rotate separately through horizontal and vertical axes.

Figure 4. Stirling engine with the PV diagram plotter

One sensor is just a sealed membrane, which becomes concave or convex depending on the pressure of working flluid inside the Stirling engine. A lever serves to probe the position of the piston, which reveals the volume of working fluid in the engine. The membrane is also attached to a lever. The two levers attach separately to the horizontal and the vertical axes. Each axis is fixed with a mirror such that one mirror yaws according to the position of the piston whereas the other mirror pitches, depending on the pressure of air inside the engine. A laser beam is reflected by the first mirror and consecutively by the second mirror. The doubly reflected laser beam then portrays the PV diagram of the air inside the engine by its image on a screen.

5. Acknowledgements

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Crystallization of ADP in Secondary Schools

J Redondas
IES de Candás, Asturias, Spain
javierredondas@yahoo.com

Abstract. In this paper we show the different steps in the process of ADP (ammonium dihydrogen phosphate) crystallization carried out by secondary school students in the framework of a scientific competition. Besides the understanding the basic theory of crystallization and crystallography, this competition aims to stimulate and inspire scientific vocations among secondary school students. Students were organized in teams. They carried out the crystallization experiments under the supervision and guidance of their teachers. The results were submitted to a scientific conference. A0-sized posters were prepared and presented in this conference.

Keywords. Crystallography, crystal growth, encourage scientific attitudes, project based learning.

1. Introduction

The Schools Crystallization Contest is a scientific activity addressed to secondary and high school students and teachers. The contest aims mainly to use the natural attraction of the phenomenon of crystallization to make understand students how to make and enjoy science, and about working in the field of science.

The contest format involves all the ingredients of the scientific method: from research laboratory to the presentation of results in a forum-type 'scientific conference'. Moreover, the values of curiosity towards science, creativity, experimental work, the work plan, analysis of results, design of the posters and their presentation are, all of them present in the different steps that are described below. Moreover this activity has awfully contributed to make science more attractive for students.

2. Aim

The main goals of the crystallization contest are focused not only on the result, buy, mainly in the process, since this activity develops a way of thinking that is new for all the participants.

The competition aims to introduce students to the exciting, challenging and sometimes frustrating world of growing crystals.

The objectives can be summarized in the following points:

- To stimulate scientific vocations among secondary school students and to promote a general interest towards science.
- To explain the basic concepts and procedures of Crystallography and Crystallization taking advantage of the natural attraction of crystal growth.
- To communicate how researchers work and compete in an environment similar to a real scientific conference.
- To bridge the gap between Science and Society by explaining the importance of Crystallography in everyday life.
- To understand the science and laboratory and research activities as an enjoyable, fun and enriching action.

3. Development of the activity

2014 was declared International year of crystallography. Consequently, a lot of competitions have been organized all around the world to celebrate this event and to promote the curiosity among students and young people about this challenging discipline.

Figure 1. Logo of the Wisconsin contest

The contest is divided in different steps, as any other scientific activity. It starts with teacher training course and ends with the conference and presentation of the results.

3.1. Teacher training

The contest began in November with the organization of online courses for secondary school teachers. Attendants learned to use scientific and didactic tools for conducting crystallization experiments with their students. We also learned the importance of crystallography and crystallization in industrial processes and drug development, among other applications. The aim of this online seminar is to provide specific training in Crystallography and Crystallization by means of practical tools that can be translated into enjoyable activities in the classroom. The training was managed by university departments in different regions. In our case, the University of Oviedo led the course for the regions of Asturias, Galicia and Castilla y León.

The teacher training program covered the following topics:

- Introduction to crystallography.
- Basis of crystallization process: concepts of solubility, supersaturation, nucleation and growth.
- How different parameters can affect the crystal formation: temperature, time, mechanical stability, presence of impurities in the raw solution, etc.
- Influence of the substrate characteristics that can affect the crystallization process.
- Videos containing practical demonstrations on how to grow crystals and the use of educational tools such as computer programs and games.
- Illustrative examples of spectacular applications of Crystallography in different technological and industrial fields.

3. 2. Planning

Students were organized in teams of 3-4. The first step was a search for information about crystals and the formation process, as well as some of the most important applications.

The goals of the activity were:

- To obtain the most spectacular crystals. For this purpose, two possibilities were possible: one big, perfect monocrystal or a good combination of smaller crystals.
- To be capable to present the results in the conference, answering correctly to questions required by the referees.

The groups started to work independently; they were free to select the appropriate raw materials, additives and substrates.

Figure 2. Kneading cement to make a cave where crystals grow

Some groups were trying to get a single crystal, not a bunch of crystals. They first needed to grow a small perfect crystal, their seed crystal, around which they will later grow a large crystal. It is therefore essential to avoid excessive rapid growth, which encourages the formation of multiple crystals instead of a single crystal.

Other groups intended to get the more attractive crystallographic arrangement. For that purpose the need to obtain good coloured crystals, but imagination was also important in order to design an appropriate environment.

The main raw material was provided by the organizing University. An innovative crystallization kit of ADP (ammonium phosphate) was the central element of the activity. This kit contains a bilingual tutorial (English and Spanish) and a selection of

numerous photographs and video tutorials about the crystal growth that, owing to its striking beauty, motivates students to discover the fascinating world of Crystallization.

Additionally some colorants can be added to the ADP when solved in water in order to obtain visually attractive products. Alimentary colorants have demonstrated to be good options, as well as some easily available chemicals such as potassium permanganate.

Figure 3. Simple and cheap equipment is needed to get good results

The required equipment for these experiments is neither especially innovative nor expensive. In fact, we could easily find and use very simple gadgets and domestic tools, such as pots, electric or gas cookers, thermometers and scales or weighing machines.

Figure 4. A curious structure obtained unintentionally

3.3. Experimental procedure

As it has been mentioned before, the raw material was a fine powder of ADP produced by a company called Triana Tech under industrial secrecy. This substance should be directly solved in boiling water in order to obtain a supersaturated solution.

Figure 5. ADP crystals coloured with saffron

Then, a controlled slow temperature decrease provokes the crystal nucleation and growth. Different colorants have been used to enhance the appearance and beauty of the results.

Figure 6. ADP crystals coloured with potassium permanganate

The control of the temperature has revealed to be a key point for succeed in the experiment. We should provoke a decrease of temperature as slow as possible. The easier way consisted in enclosing the vessel containing the solution with expanded polystyrene panels or boxes.

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In most of the cases, some days were required to reach the growth of the products. Taking into account that some experiments were unsuccessful, our students needed almost three months to carry out all activities.

The procedure to be followed to obtain a single crystal is even more delicate and should be carried out with care and precision. The experiment has to be conducted in two stages, as we explain in the following lines:

The first stage consists in growing a seed crystal: we warmed about 50 mL of water in a glass container. We dissolved a quantity of the substance to produce a saturated solution at the elevated temperature. Then, we poured the warm solution into a shallow dish and allow the solution to cool to room temperature. After a day or so, small crystals should begin to form. With a magnifying glass we selected a beautiful and transparent small crystal. By this way, we could obtain our seed crystal.

Figure 7. Single ADP crystal

The second state consists in use the seed crystal as a starting point for a single crystal. For that, we had to place about double the amount of substance that would normally dissolve in a certain volume of water at room temperature into that volume of water. Stir the mixture until it appears that no more will go into solution and continue stirring the mixture while gently warming the solution. Once all of the substance has gone into solution, remove the container from the heat and allow the supersaturated solution to cool to room temperature. At this point, our seed crystal must be carefully suspended from the stick into the cold supersaturated solution in the middle of the container with supersaturated solution.

This last step can be repeated several times to increase the single crystal size. The mechanical and thermal stability are crucial to avoid fluctuations in the process which can provoke decrease of the crystal due to solution of the solid phase and the formation of small crystals in the surface and edges. The Intermediate finals of the Competition were organized in each of the 7 Spanish geographical areas.

3.4. Results presentation

Once the experimental work has been finished, the time for presentation of the results has arrived. Having in mind the idea to simulate a real scientific environment, the format of the presentation sessions was similar to a 'Scientific Conference' and it was open for the general public to attend.

Figure 8. Presentations of results during the conference

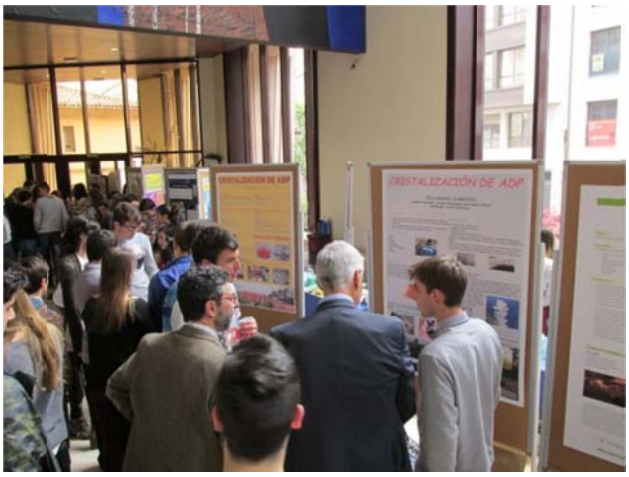

Figure 9. Discussions with the referees during the conference

The Intermediate finals of the Competition were organized in each of the 7 Spanish geographical areas. During the conference, each team of students had to present a crystal model together with a scientific poster, sized A0, detailing the objectives, materials, methods, results and conclusions of their work. A team of referees analysed the content and appearance, taking into account discussions with the authors of the different works and proposed the best ones for prizes.

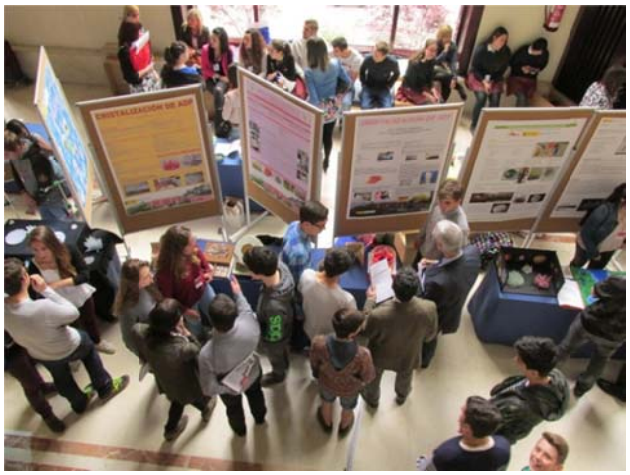

Figure 10. Overview of the conference hall

4. Conclusions

The activities above described had important benefits on the directly involved students and also contributed to encourage their colleagues to participate in similar actions.

From the scientific perspective, the Competition of Crystallization at School is an event intended to convey to make students understand how science is done and to spread how scientists work through a competitive bidding format. In the contest, all the fundamentals of the scientific method are present: from the previous search for information, research tasks at the laboratory to the presentation of results in a conference. The main objective is to highlight the importance of the world of crystals in today's society and especially to promote the study; the systematic, rational thinking and also the communication between the young students, using attractive and interesting crystallization experiments. Moreover, from the educational approach, the following outcomes are important:

- Greater motivation as pupils want to share ideas and work with pupils in partner schools.
- Improved performance and quality of work, because learning has a real purpose.
- Enhanced working relationships between staff and pupils.
- Effective professional development for teachers as pedagogy and skills are shared.
- Improved academic achievement.
- Development of lifelong skills, such as teamwork, cooperation and independent learning skills.
- Improved communications skills.
- Improved ICT skills for both pupils and teachers.
- Improved language skills for both pupils and teachers.
- New opportunities for the school and wider community.

5. Acknowledgements

The author wants to acknowledge the help provided by Beatriz Ramajo and Santiago García from the University of Oviedo for helping and organize this activity and for covering the costs of the raw materials and printing.

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Physics Education from the Cradle to the Grave

D Mandíková, Z Drozd
Charles University, Prague,
Czech Republic
dana.mandikova@mff.cuni.cz

Abstract. The Department of Physics Education, Faculty of Mathematics and Physics, Charles University, offers a lot of activities designed to promote physics education to pre-service and in-service teachers, students of different types of schools as well as children and adults of all ages. The contribution gives information about selected activities that cover wide spectra of topics that can be presented to pupils and students from pre-school to university level and on the example of several physics experiments shows how they can be presented at different age levels.

Keywords. Pre-service and in-service science teacher training, popularization of science in society.

1. Introduction

The main task of The Department of Physics Education, Faculty of Mathematics and Physics, Charles University in Prague, is training of future physics teachers. Other not less important tasks are support of in-service teachers, popularization of physics and research in physics education and in physics. There is a lot of activities designed to promote physics education which the department offers to various age ranges, from small children, pupils and students of different types of schools to adults.

2. Project for pre-school teachers and children

Young children have usually many questions beginning “Why“. They want to know how things around them work and they love to do experiments (Fig. 1).

Encouraging their curiosity and interest is very important. Pre-school teachers should also be ready to do so. Pre-school teachers are the aim of a project, which should support, among other things, children's science literacy. Fifteen teachers are involved in the project. Several universities are collaborating on the project and offer various specific programs and activities to pre-school teachers. Of those, teachers choose the ones they are interested in. We are preparing two such activities. One is outdoor; children perform different observations, such as tracking the length of shadow during the day, simple precipitation measurements, recording weather conditions and comparing with predictions. The second activity focuses on simple experiments with air and water. We prepare methodological materials for teachers to these activities. They will have the opportunity to try out the activities themselves during upcoming workshops.

Figure 1. Small experimenters

3. Courses for pre-service and in-service primary school teachers

Ten years ago we started to teach a seminar Experiments in Science at Primary School, which is designed for future primary school teachers, students of Pedagogical Faculty, Charles University, Prague. Primary school teachers are the first ones in the school attendance who introduce pupils to natural science. Thus it is very important to gain their interest and to motivate them for future work.

Figure 2. Studying water and sound

The seminar takes 135 minutes and is organised every week for two semesters. The emphasis is put on hands-on activities of the future teachers and on self-production of simple teaching aids (Fig. 2), as well as on correct explanations of shown phenomena and on ways how to present them to young pupils. The most common misconceptions are mentioned

and discussed, too.

In view of the good feedback of this seminar, we have decided to offer similar seminars for in-service primary school teachers, too. The first course took place this school year. Two groups of teachers (each with 10 participants) participated in it. We met once a month for three hours. Each meeting was devoted to one topic, such as air, water, sound, heat, light, electricity, magnetism (Fig. 3). Teachers consider these seminars useful and inspirational, so we would like to continue with them next year again.

Figure 3. What the air can do - an experiment with the Magdeburg hemispheres?

4. Experiments for High School Students and Physics Interactive Laboratory

High school teachers with their students have the opportunity to come to Faculty of Mathematics and Physics to see sets of interactive experiments from various physics topics (Mechanics, Optics, Electricity and Magnetism, Thermal Physics, Acoustics, Waves and Oscillations). The main goals of the experiments for high school students are to present and explain experiments that are usually not shown at school (for lack of time or equipment) and to promote physics to wide range of students, not only to science fans.

Each show takes seventy five minutes and three shows are presented every week during the school year. Every year almost seven thousands high school students accompanied by approximately fifty teachers come to see the programme. The experiments are performed by teachers and doctoral students from the Department of Physics Education (Fig. 4).

Figure 4. Experiments from Mechanics and Electricity

Apart from above mentioned shows, high school students with their teachers can visit The Interactive Physics Laboratory (IPL). Students with their teachers come to IPL to do laboratory work under supervision of teachers and doctoral students from the Department of Physics Education. IPL is very well equipped by various sets of modern apparatus. That is probably the only way the high school teachers and students can do complex experiments with such apparatus even from advanced parts of physics.

Students work in small groups of four. Each group performs a set of experiments and conducts measurements and presents the results obtained to their classmates. The sets of experiments are organised from the easy ones to more sophisticated ones and monotopically focused. Teachers can choose from eight sets of experiments, three from mechanics, two from thermodynamics, and one from electricity, magnetism and optics each. This school year about 750 students visited the IPL (Fig. 5).

Figure 5. Students experimenting in IPL

5. Collection of solved problems in physics and Collection of physics experiments

To solve physics problems is a key ability which students should reach during their physics education. There is usually a lack of time to solve enough problems during lessons especially for students with worse previous education or mathematical skills. And moreover, there are hardly any suitable

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materials for home study of these students. For this reason we have developed a collection of fully solved problems. The structure of problems' solutions is specially designed to substitute tutor's help during lesson and encourage students to solve at least some parts of a problem independently. The development of the database started in 2005. Nowadays, it contains more than 800 tasks in Czech, 180 in English and 90 in Polish, available at http://www.physicstasks.eu/.

The electronic collection is designed primary for students in introductory university physics courses to practice and deepen the knowledge gained in high school. It is suitable also for high school students with a deeper interest in physics. Because we want to enlarge the usability of the collection, simpler high school tasks as well as junior high school tasks are also gradually inserted into the database.

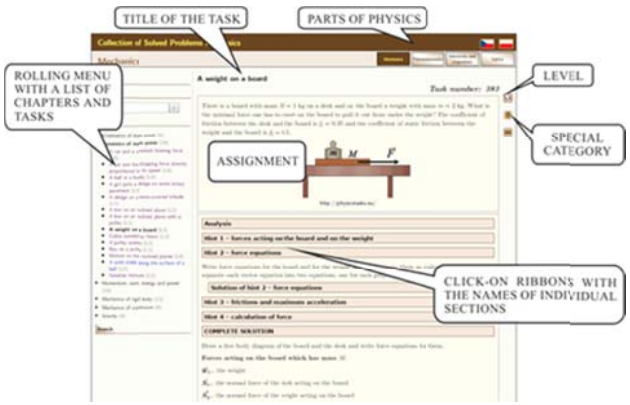

Figure 6. Appearance of the collection

All tasks in the collection contain detailed commented solutions, various hints, notes and other tools to help users with their self-study and to lead them toward active thinking about presented physics problems (Fig. 6). Availability on public web pages enables usage of the collection by both students and teachers not only at our faculty but also at other universities and high schools.

Both the database and the web interface turned out to be an appropriate platform for presenting materials in "step-by-step" mode, so the idea to develop its "sibling" – a Collection of Experiments (http://fyzikalnipokusy.cz/en) – emerged five years ago. Its aim is to collect ideas for experiments in the long term and present it to Czech physics teachers in a unified and systematic manner. In addition to the usual information provided by similar collections (recommended tools, theory, procedure,...), emphasis is placed on exemplary presentation of sample results in the form of photographs and videos and technical and pedagogical notes facilitating the execution of experiments. The collection contains now about 150 experiments in Czech and about 30 experiments in English.

The same technical solution of both databases challenges us to connect problems and experiments. A problem whose solution can be verified by an experiment should be linked to the corresponding experiment and vice versa. The intention is to make it easier for teachers to use problems and experiments together. The collections already include some linked pairs of a problem and an experiment.

6. Outdoor seminar for pre-service physics teachers

Each year, at the beginning of May, our department organizes a five day outdoor seminar for pre-service physics teachers and their teachers. It includes a professional program, which is realized in the form of miniprojects on the given topic (Fig. 7). This year's topic was water, air and other elements. Students and teachers work either individually or in groups and explore the issues they choose either themselves or from the proposed offer. The results of all-day research are always presented to others in the evening.

Figure 7. Active work on miniprojects

In addition to the physics program, a number of games and activities to stretch the body, lift the mood, enlighten the mind, and cheer the soul are also waiting for participants (Fig. 8).

The seminar provides the opportunity to meet elsewhere than at school and spend a few days full of well-being and enlightenment, so that it is something to take away and to remember.

Figure 8. Well – being on Hraštice

7. Children Science Day

Children Science Day at the Faculty of Mathematics and Physics is an event which our department organizes once a year for children and general public. Children and other visitors can try out a myriad of playful experiments from various areas of physics and see interesting physical shows. Two competition circuits where children perform tasks and produce small physics toys are part of the event (Fig. 9). There are more than 800 visitors every year.

Figure 9. Playing with Physics on Children Science Day

8. Example of experiments for all ages

8.1. Yoyo

Yoyo is an interesting physical toy. You can buy different types of this toy or you can make yourself a single one. You need two CD, a piece of paper tube and a thread (Fig. 10).

Figure 10. How to make yoyo

Little kids can try to play with yoyo and learn how to deal with it. Younger schoolchildren can notice how yoyo moves (rotating and at the same time rising or falling), or when it is necessary to pull the string. Older pupils can describe energy changes (potential energy to kinetic energy of translational and rotational motion and vice versa). High school students can calculate the moment of inertia of the yoyo and for example its acceleration.

8.2. Mirror foil

A variety of experiments can be done with a piece of the mirror foil. You can use it as a plane mirror. Little kids can observe their image in the mirror, notice that when blinking with the right eye, it is opposite in the mirror. Younger schoolchildren can also notice where they see the image (behind the mirror). Children can also send reflected light to the designated place. Older pupils can examine with a laser pointer how the light from the mirror reflects and discover the law of reflection.

If we bend the foil, we get a convex or concave cylinder mirror. We can again examine what our image in the mirror looks like. Older pupils can find out how the light reflects from this type of mirror and it can be discussed, if there is some practical use of such mirrors.

Nice activity is to let the children identify what's on different distorted pictures and then let them view the pictures in a cylindrical mirror. Children can also draw their own distorted pictures with the help of square grid (Fig. 11).

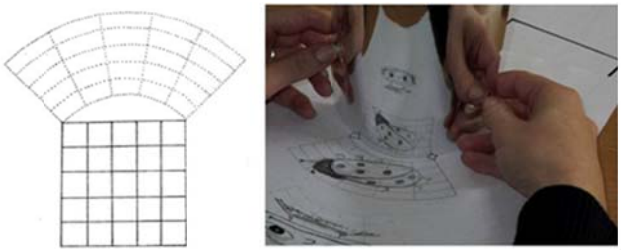

Figure 11. Distorted pictures in cylindrical mirror

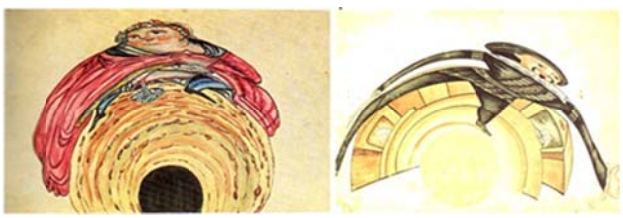

Figure 12. Historical pictures for cylindrical mirror from museum in Coimbra

9. Summary

Among the wide range of outreach and popularisation activities the Department of Physics Education offers to pre-service and in-service teachers, students and public the above mentioned activities represent important addition to standard education. Part of them are designed for gaining the interest in science of small children, some of them enable sophisticated experimental work to high school students, other provide an opportunity to pre-service teachers to increase their experimental skills, or continue a contribution of Department of Physics Education to popularization of physics.

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Science in Eco Park. An Interdisciplinary Project

Y Pavichenko
The Educational Center "MIR",
Kharkiv, Ukraine
nvk_mir@ukr.net

Abstract. How can we make obvious for our students the practical meaning of science? Whereas almost every real life problem is interdisciplinary, it is usually quite difficult for the students to adequately apply their knowledge of specific school subjects in the real situation. In our Educational Center "MIR" private school we are looking for educational strategies and organizational approaches which may allow us to combine project-based, problem-based and team-based learning with the more traditional subject-divided education.

Summer practice in the Eco Park in Kharkov was one of those approaches, with about 15 children of different age (primary and secondary school students teamed together) participating. They were suggested to analyze and describe three ecosystems in the park: a forest, a meadow and a lake. Students were divided into three groups, with every group having its "own" ecosystem to explore. Each day they used in their research the language and instruments of one school subject (Geography, Chemistry, Biology). Additionally, to solve some of the emerging problems, knowledge of school Mathematics appeared to be necessary.

Students were beginning their daily practice with the collection of empirical material in the Eco Park. Then they went to school to analyze it. There they could use computers, handbooks, do simple chemical experiments and apply other research methods and techniques. After the week of practice every group presented a poster with the full description of the ecosystem – from the location of the borders and land area to the structure of food chains. Those results were discussed and compared with the outcomes of other groups' inquiry of their ecosystems.

Due to this research practice students were got essentially trained to apply the subject knowledge in the real life situations. They could perceive the complexity of living nature and enjoyed making their own discoveries (for example they were much surprised to find the soil in the forest to be noticeably moister than in the meadow).

Keywords. IBSE, problem-based learning, interdisciplinary educational projects, hands-on team science activities.

1. Why interdisciplinary approach is necessary in modern secondary school?

How can we make the practical meaning of science obvious for our students? The solution of some modern practical problems requires the using of interdisciplinary approaches. Interdisciplinary researches remind us of the unity-of-knowledge ideal and help our students to acquire an integrated worldview. But the concept of interdisciplinarity is new enough. Since the very end of the twentieth century issues of scientific knowledge has been framed by disciplinarity [1]. It is not surprising that until now teaching has disciplinary organization and students have to learn a set of autonomous subjects and disciplines.

Ukrainian secondary school curriculum involves geography, physics, chemistry and different branches of biological sciences (botany, zoology, human physiology, theory of evolution and so on). Our students get used to perceive this knowledge in isolation and do not think about the possible connections between these disciplines. Very often it is quite difficult for the students to apply knowledge of different school subjects. In real life we encounter situations and problems, look for information and generate solutions. And it is quite different from the fragmented knowledge, which one can obtain at school.

2. The forms of interdisciplinary teaching in "Lyceum MIR" (Kharkiv)

In our school [2] we are looking for educational strategies and organizational forms of interdisciplinary teaching. The problem is how to establish links between traditional school subjects and interdisciplinary tasks and problems, how to show students the wholeness of real situations and interrelations of different disciplinary models and methods. Transferring the idea of the types of interdisciplinarity [3-4] into pedagogy and teaching requires new

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teaching methods and tasks. In order to achieve these goals we try to combine project-based, problem-based and team-based learning with traditional subject learning.

During the school year, there are two weeks, when our students implement pluridisciplinary approach. According to the classification of types of interdisciplinarity, which was provided by OECD [3] pluridisciplinarity represented combination of various disciplines, assumed to be more or less related, e.g. mathematics and chemistry or history and literature. One week is devoted to humanities and the other to sciences. And at the very end of the school year students have ten days of academic practice, when more complicated forms of interdisciplinary teaching can be realized. Now a case of that practice will be described.

3. A case of interdisciplinary project during the academic practice

The students carried out this practice in one of the Kharkiv city parks – Feldman Eco Park [5]. They had to analyze and describe three ecological systems of the park (a forest, a meadow and a lake coastal area). The administration of the park was going to publish a tourist booklet and these descriptions were supposed to become a part of it. Unfortunately the booklet was not released, although our part of the work was completely done.

Figure 1

Ecological system can be defined as the complex set of biotic and abiotic components which are interconnected with each other. It consists of living organisms like herbs, trees, mammals, fishes, birds, micro-organisms with non-living factors like water, soil and people. Ecosystems can vary in size as well as in their components. Various components of an ecosystem depend on each other. Ecology is an interdisciplinary field and the study of ecosystems makes it possible to develop educational projects of varying degrees of complexity.

Figure 2

Last year twenty four students of different age (primary and secondary school together) took part in this project. They were divided into three groups and every group dealt with their "own" ecosystem. Every day they used language and instruments of one school subject (geography, chemistry, biology). Besides for some problems mathematics was necessary. Every day the students gathered data in the park and then returned to school to analyze it. There they could use computers, handbooks, do simple chemical experiments and so on. After the ten days of practice every group presented a poster with the full description of the ecosystem

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First of all they needed to see their plots on the map of the park, find out the relative location of the plots and calculate the area of each of them. Then groups of students went to the park and had to find each ecosystem using the map.

Figure 3

Figure 4

The biological part of the project included the study of plants, insects, birds, reptiles and mammals that inhabit the park. They gathered leafs and insects, listened to the voices of birds and photographed them, tried to photograph lizards and snakes (it was not easy enough). Some of them were lucky enough to see mice, hedgehogs and squirrels. At school they analyzed the collected data and used names and taxonomy resources to identify the species of plants and animals they had encountered. Of course the students could not meet all the inhabitants of the park during these few days, so they compared their discoveries with the available descriptions of the nature of our climate zone. Relying on these data, the oldest students reconstructed food webs of every ecosystem.

Figure 5

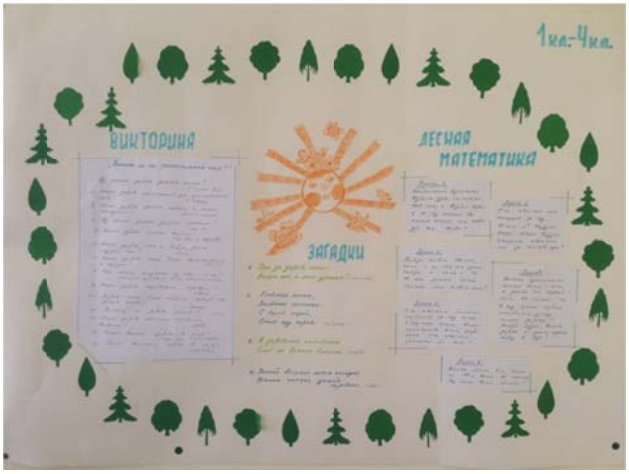

Figure 6

The chemical part of the project was devoted to the investigation of the soil and consisted of three stages: theoretical part (questions about soil), research on the terrain (description of external signs, illumination and vegetation of the area) and experimental part in the chemical laboratory. First of all younger students answered questions and older ones helped them formulate or clarify the answers. The following questions were used:

- What is the soil?
- What does it consist of?
- What types of soil do you know?
- What determines the color of the soil?
- On which the soil moisture depends?

Then every group of students dealt with the soil of their ecosystem. They did not have to dig; vertical slices of the soil were visible

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everywhere because of the earth's failures. Firstly they described everything that could be seen: the quantity and quality of plants, their root system, larvae, the layering of last year's foliage, moisture and looseness of the soil, its color and so on.

Figure 7

Figure 8

Then in the laboratory, the composition of the soil was thoroughly investigated. Students began from the simplest indicators. Immersion of the lumps of soil in the water indicates the presence of air in them (due to the large amount of fungal mycelium, the forest soil is very porous), burning of the soil shows the presence of organic matter, dissolution and evaporation of the filtrate shows mineral salts. The amount of sand and clay was determined by the settling method (samples were weighed), the moisture was determined by heating the soil above the cold glass.

At last the pH was determined. Students used the handbooks to find out, which plants were adapted to alkaline soil. They compared this knowledge with the data collected and were glad to discover that the facts they had detected corresponded to the theory.

4. Pedagogical effects of the project

So due to this work students trained to apply the school subject knowledge in the real situation. They worked with enthusiasm. Each of them got acquainted with such methods of scientific research as data collection, observation and experiment. They have gained experience in correlating the collected data with textbooks and reference books. While preparing for the presentation, they learned to summarize the facts and draw conclusions.

Figure 9

Figure 10

With the help of teachers, the students distributed functions in teams in such a way that even the youngest could contribute to the overall work. Thanks to this they began to understand better what a team is and how teamwork can be organized. In each group there were many situations in which participants could train their communicative and

organizational skills

And last but not least they saw the complexity of living nature and made their own discoveries (for example they were very surprised that the soil in the forest was much moister than in the meadow). Most of them had not even imagined that a complex and diverse life could be found in a city park. They have learned to distinguish between plant, bird and insect species. As a result, they began to treat the trees that they see on the street, birds that sing in the morning under the window of their apartment, etc. with interest and respect.

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Standing on the Shoulders

A Kazachkov[1], V Kostyukov[1], A Pospelov[2]
[1] V.Karazin Kharkiv National University, Kharkiv, Ukraine
[2] National Technical University "KhPI", Kharkiv, Ukraine
akazachkov@yahoo.com

Abstract. Presented are some involving IBSE hands-on projects for high school and university students developed from the experiments earlier described in the popular science textbooks or/and reports at the recent international conferences.

Keywords. Hands-on projects, IBSE, Doppler effect, gas laws, geometrical optics.

Isaac Newton's famous recognition that his scientific discoveries were possible because he "stood on the shoulders of giants" completely applies to any successful research, educational inquiry being no exception. Learning from the creative teaching colleagues and advancement of their achievements are keystones of inquiry based science education.

The workshop reveals how some, mostly experimental, Physics and multi-disciplinary IBSE projects were recently developed from the ones earlier described in the books of creative science activities [1, 2] or reported at the hands-on and IBSE focused international conferences [3]. However entertaining in form, suggested experiments and problems are strongly related to high school and university courses of Physics and cover, in particular, the following topics:

- Acoustics,
- Doppler Effect,
- Gas Laws,
- Mechanical Equilibrium,
- Geometrical Optics.

They are mostly designed as counter-intuitive hands-on experimental activities. Cognitive visual illusions, also considered at the workshop, are generated by computer models created by the students.

During the academic year 2016/17 presented experiments and problems were extensively practiced in the activities of the Students Scientific Society, KhNU, during the program of in-service training of high school Physics teachers and at the numerous informal Physics school visits of the authors. Feedback accumulated due to that approbation resulted, in particular, in the sufficient improvement of the design of the apparatus and of the understanding of the investigated experimental problems in general.

Among the most enjoyed by the students and teachers apparatus should be named a low cost version of the Harbottle Differential Pressure Demonstration apparatus designed to inflate a balloon both inside and outside the glass or plastic jug (see Fig.1). Not only an incredible demo of the open inflated balloon was performed, but the pressure inside the jug was measured by means of a self-made U-tube manometer filled with the dark soft drink for better conditions of observation.

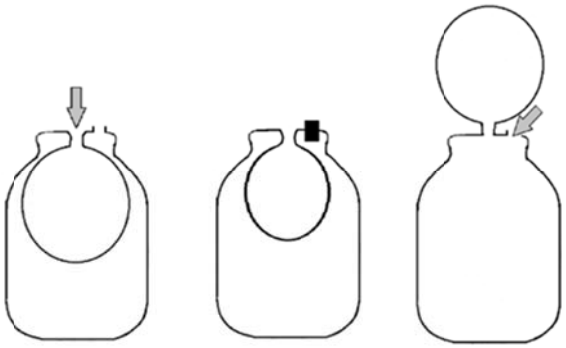

Figure 1. Two way Harbottle jug, drawing courtesy of Darya Dolgopolova and Andriy Paputsya, KhNU Physics students

Same flexible plastic U-bent tube was used also to measure pressure achieved by swirling of the popular whirly Physics toy. Comparison with the calculations based on Bernoulli's formula performed by the students was very agreeable.

Among the many acoustical experiments and their computer explanatory models the one that implied for the team performance of even nontrained students is worth separate notice. A set of plastic or cardboard tubes of the lengths 328, 290, 258, 243, 216, 193, 170, 159 mm [4] proved to be perfect for playing rather advanced tunes by tapping or blowing (Fig.2).

With many the Ukrainian students, especially the youngest ones, taking music classes, improvised performances were often

highly enjoyable, Fig.3. Also a great possibility to discuss standing waves in air.

Figure 2. A set of sound tubes made from cheap materials may well substitute a piano

Figure 3. An improvised concert in an elementary school class

An open-ended nature of the presented activities imply for their further development by the workshop participants and their students.

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de Pedra e Cal pela proteção ambiental! Steadfast...for environmental protection!

F Cruz[1]*, S Courela*[1]*, C Pessoa*[1]*, I A-P Mina*[2]
[1]*Escola Básica (EB) Santo Onofre, Caldas da Rainha, Portugal*
[2]*Universidade do Minho, Braga, Portugal*
fatima.cruz@aerp.pt

Abstract. Following an earlier Project, continued concern with environmental protection has led to the establishment of partnerships to clean up and restore a section of Cal river, located near the school EB Santo Onofre. For this purpose, the predominant invasive (*Arundo donax*) was removed from riverbank, the riparian vegetation was planted to recover its buffer function, and the maintenance and river water quality control, monitored. These tasks were accompanied by activities in which the students of several levels put their hands-on, to learn how to: make plants vegetative multiplication, handmade baskets with reed stems, manufacture woody cores for heating and performed bioassays.

Keywords. Invasive plants, riparian buffers, wastes valorisation, watercourses restoration.

1. Introduction

More often than desirable, urban and suburban stretches of watercourses are excessively polluted by the proliferation of loose litter, too much waterproofing, clandestine construction, ecological reserves' disrespect and destruction or degradation of riparian vegetation [1]. The composition of the aquatic riverine flora is, among several biotic factors that affect wetlands, one of the main indicators of the state of the aquatic ecosystem that they are part of – its biodiversity degree and water quality [2]. In any riparian zone, continuous stream vegetation corridors are fundamental for improving the quality of river water by controlling nonpoint pollution and protecting the riparian environment [3]. In fact, margins vegetation has a buffer effect on several factors. Beyond controlling the transport of diffuse pollution (filtering sediments contaminated with nutrients and pollutants), it improves the habitat and ecological connectivity between the aquatic and terrestrial environment, giving stability to the margins, protecting watercourse from extreme temperatures (through the shade and transpiration of their trees), and contributes to hydrological connectivity, biomass production and carbon sequestration. In addition, it promotes and encourages cultural services [4,5,6]. The buffer function of riparian corridors is especially important in small watercourses [3], which in urban or suburban sections often act as open-air sewers [1]. In urban areas, the most obvious hydrological changes occurring in their watercourses are the replacement of its natural banks with walled margins (cement channels) – engineering strategies to bank stabilization, to withstand increases in flow and floods [7]. All over the world, many riverside areas, when stripped of its native vegetation, have waterways channelled and populated by exotic species, being seriously polluted [8]. The alteration of the margins becomes favourable ground for the installation of invasive plants, mainly exotic but also native (e.g. reeds and cattail) [2]. Invasive species are characterized by uncontrolled growth, damaging natural biotic communities and altering the physical and even chemical characteristics of habitats. In Portugal, examples of riparian habitats invasive species are ailanthus or tree of heaven (*Ailanthus altissima*) and giant reed or spanish reed (*Arundo donax*) [2].

Strategies for management of degraded riverine areas should involve various partners and consider environmental protection, in view of nature conservation and sustainable development. Several issues should be considered [5] to challenge both researchers, legislators and practitioners. There is no doubt that riparian zones play key roles in water and landscape management. To be able to enhance their multiple functions and interactions, riparian ecosystems should also catalyse institutional and societal cooperation [4,5].

2. Cal river Restoration

The problem of river Cal pollution was made aware by 8th year students from EB Santo Onofre, through several visits to the section of Cal river that crosses Quinta do Pinheiro. This river section was chosen because it's near the school and has easy access, being a safe point

due to its weak flow. In addition to water sampling for analysis, Science+ Club' students in collaboration with their natural sciences' teacher and Eco Escolas – Projeto Rios coordinator, made a video with the characterization of the river section, highlighting the main problematic situations [9].

Beyond these activities that allowed contextualization of knowledge acquired in natural sciences discipline, the teachers involved on the Project met with several entities to establish partnerships to carry out the depollution and requalification of the Cal river section selected.

The entities contacted were: environment office of Caldas da Rainha City Hall (CMCR*), Portuguese Environment Agency (APA*) west zone – Caldas da Rainha pole, and Institute for Conservation of Nature and Forestry (ICNF, I.P.*). The agreed strategies to be applied, considering the problems identified were: (i) removal of giant reeds (*Arundo donax*), predominant invasive, (ii) restoration of autochthone riparian vegetation to recover its buffer function in the ecosystem.

With these interventions, it's hoped to mitigate the pollution caused by Cal river in the arm of Barrosa in Óbidos lagoon. In a first phase, the eradication of giant reeds was done by a qualified company, supervised by CMCR, APA technicians and the Project coordinator (Fátima Cruz). Part of the collected plant material was sent to an authorized dump, and the remainder was ground *in situ*. Planting of native plants according to riparian zones floristic cast, was done by volunteers called up via facebook. On the right bank of the intervention area, willows (*Salix* sp.) and ash trees (*Fraxinus* sp.) were planted, on the left bank, in a partially grassed area, shrub species (*Crataegus oxycantha*), lemon verbena or lemon beebrush (*Aloysia citrodora*) and tamarisk (*Tamarix galica*).

On the riverbed, wooden pallets were placed (Fig. 1) for support of marsh lilies (*Iris pseudacorus*) and cattail (*Thypha latifolia*). *I. pseudocorus* has been widely used in wetlands for treatment of eutrophic waters and for ecological restoration [10] and *T. latifolia* is also used in phytoremediation, surviving in the presence of heavy metals [11]. On the unwalled left bank of Cal river section, cattail and bulrush or reed-swamp (*Scirpus lacustris*) were planted. In the future, the plantation will be reinforced by the Caldas da Rainha scouts' group within the framework protocol established between CMCR and Altri Florestal company.

Figure 1. Rafts preparation to support plants with phytoremediation capacity

3. Wastes valorisation

The biomass resulting from giant reeds cutting should be classified as reusable waste. In their two forms (stems and sawdust) these wastes' value was confirmed by the students who witnessed the production of handmade baskets and cores for heating boilers.

Figure 2. Eco-rocket cooker developed at ETEO

In addition, the construction of an ecological-rocket (Fig. 2) also used reusable materials (stainless utensils) and a copper serpentine and, for high temperature insulation, refractory cement and expanded clay.

The cooker or stove was developed at the Technical Business School of the West (ETEO*) in the "Renewable Village".

3.1. Basketry

The giant reeds taken from Cal banks has been used by a craftsman as a family subsistence mean. The handmade baskets technique (Fig. 3), is an ancient art that 8th year students had the opportunity to see, how to do.

Figure 3. Reed stalks cutting for handmade baskets by "Sr. Joaquim"

The slightly dry cane is cleaned and carefully cut into strips on the artisan's lap. Basket construction is carried out on the floor. Its base or bottom starts with interlacing 8 strips, compacted by feet pressing.

The direct application of giant reed, avoids its incineration with harmful effects on the atmosphere.

3.2. Cores Production

Reed wastes were also used, together with plane tree leaves, pine' cones, and corn' cores grinded and mix with sawdust, for production of cores as a solid fuel for heat production in the ecological rocket cooker (Fig. 2). These works are being developed in partnership with the Technical Business School of the West (ETEO) in the "Renewable Village", with 12th year students of the technological course of Renewable Energies. The machine for biomass compaction, although still in experimental phase, was determinant for cores production. To evaluate caloric power of the cores some preliminary tests were performed, and results were compared with a standard biomass type (control) available on the market.

4. Vegetative Plant's Propagation Workshop

In the Ecological and Educational Center of Paul de Tornada with CMRC authorization, plants were collected for vegetative propagation. Willow (*Salix alba*) and hawthorn (*Crataegus oxyacantha*) cuttings, were used in a workshop (Fig. 4) led by Carla Araújo from Altri Florestal company. In this workshop, 6th and 8th years students, learned how to make vegetative propagation by the stake method.

To promote plants' rooting, plant hormones were used: synthetic auxins and natural auxins. The last ones were produced from germinated lentils, of well-sown seeds, to make an aqueous solution.

Figure 4. Plants' Propagation Workshop on Altri Florestal

The plants had an appreciable rooting index, being in the stage of vegetative development. They will be planted in the Cal river section, next autumn.

5. Water Quality Monitoring

Monitoring of Cal river water quality can be done by assessing the toxicological effects of potential pollutants in biological systems. Water fleas (*Daphnia* spp.) are small planktonic crustaceans that, since the early 20th century have been used as a model organism in ecotoxicological trials [12].

Daphnia magna is easy to maintain in the laboratory having high fecundity and parthenogenetic reproduction, resulting in genetically homogeneous populations. Their life cycle is short, the first *nauplii* hatch after 6 to 10 days and juvenilles appear every 2 days. With basic physiological responses, like that of other

animals, its heart beats can be counted in real time through the transparent exoskeleton (carapace), under low power light microscope. Depending on size and age, the daphnia's heart rate range from 200 to 300 cardiac beats per minute (bcm*). Daphnia's used in the performed activities were kept in an aquarium with Monchique® Spring water (MSW) that has a suitable pH for development of these bioindicators which were fed with microalgae (*Chlorella vulgaris*) and baker's yeast (*Sacharomyces cerevisiae*).

According to a protocol provided during a training course for teachers: "Challenges for Scientific Education in the Current School", led by the training center of the association of schools – Externato Cooperativo da Benedita, some experiments were performed on classroom with 8th year students.

The students prepared excavated glass slides with one daphnia in MSW. First, they were trained to observe these unusual animals, under a light microscope (Fig. 5) being able to film and photograph their microscopic observations, on another microscope equipped with a camera (WebCam Companion).

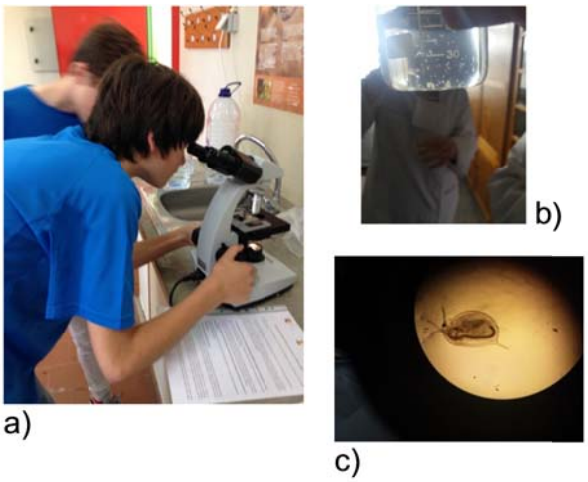

Figure 5. *Daphnia* observations, (a) under light microscope, (b) in culture medium, (c) photographed with a mobile phone camera under low power light microscope

To test Cal' water effects on daphnia, they replaced the MSW medium, by 1 or 2 drops of the test samples: Cal' river water from upstream and downstream the treated section, mineral water, ammonia solution and a dishwashing detergent. MSW served as control. The MSW medium was replaced with the aid of absorbent paper placed on the opposite side of the excavated slide, where samples to test were laid. After that, some groups of students working in pairs, counted the daphnia' heartbeats while the colleague controlled the time. Each student counted three times the heartbeats, during 10 seconds at a time.

Despite the inconclusive results due to the difficulty in daphnia heartbeats counting, students could witness changes in this crustaceans' behaviour: in Cal river water, daphnia presented arrhythmia, stopped moving the antennas and drastically reduced thoracic appendages movements, in dishwashing solution, the daphnia began to move in circles contracting thorax and abdomen and greatly increased its heart rate (420 bcm). The swimming activity markedly decreased as the movements of thorax and abdomen gradually decrease till ceasing in the ammonia solution, while in MSW daphnia had intense swimming activity presenting normal movements.

6. Public awareness and dissemination activities

Experimental activities of the "Open Day" to the community involved the students of the Science+ Club, which contextualizing all the laboratory work done, demonstrated some of the procedures performed with the model organisms (*Daphnia* sp.), in bioassays.

Dissemination and materials related with the activities developed in Projects' scope are available on the school page [13] or in a Facebook page created by the students and teachers involved.

A photo report related to the requalification of the Cal river section [14] and a video report concerning the last year Ilídio Pinho winning project [15] were presented to the Young Environmental Reports contest.

The students made also, informative leaflets (in the Publisher program) to offered in the "Open Day" that took place on 6th May. The dissemination of the project allowed, on the one hand, to actively involve students in the teaching/learning process, on the other hand, Information and Communication Technologies (TIC*) area skills acquisition and sharing experimental work.

7. Conclusion

The partnerships established at the beginning of the project were fundamental to the realization of a series of activities that promoted environmental education not only of the students but of the entire local community:

Cal river recovery began with the giant reeds' cut from the margins of the river, on the selected section, this led to the production of a waste with increased value used in:

a) handmade production of baskets
b) biomass compaction as cores –source of solid fuel for production of thermal energy
c) ecological cooker construction with reuse raw materials for the evaluation of cores' calorific power

Cal river recovery proceed with the plantation of autochthonous flora, students put their hands-on:

a) vegetative propagation by the stake' method
b) margins plantation to reset a buffer zone
c) wooden pallets to support plants with phytoremediation capacity, to place on the riverbed

Cal river water monitoring by an introduction to bioassays with a model organism *Daphnia* sp., used on ecotoxicological analysis.

Students have evaluated all these activities of great interest, and recognized the need for a sustainable way to protect environment. The involvement of local communities has contributed to the dissemination of environmental education, and will promote the development of similar initiatives.

8. Acknowledgements

The authors wish to thanks to: Alexandra Alves (APA), Jesus Fernandes and João Paulo (ICNF I. P.), Teresa Lemos and Carla Pacheco (Paul de Tornada), Carla Araújo (Altri Florestar), Almerindo Almeida (ETEO), Paulo Ribeiro e João Henriques (Secundary school Raul Proença), Paulo Sousa (EBI Santo Onofre) and to the environmental section team of CMCR.

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Note: * Portuguese initialism or acronym.

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Feeling Young and Positive Again with Hands-On: Program of In-Service Teachers Training at KhNU

A Kazachkov, N Makarovskiy
V.Karazin Kharkiv National University
Kharkiv, Ukraine
akazachkov@yahoo.com

Abstract. Traditional system of in-service teachers' training in Ukraine proved to be of a little help regarding creative professional development and motivation. Thus a pilot training program suggested by V.Karazin Kharkiv National University (KhNU) was aimed to break through the current routine, with a strong emphasis on hands-on and IBSE methods. First outcomes of the program realization in the spring semester of 2016/2017 school year are reviewed and analysed.

Keywords. In-service science teachers training, IBSE, hands-on science.

1. Introduction

Basically all of the now practicing school Physics teachers were entering universities as freshman students being enthusiastic and full of positive expectations about the profession. Nevertheless, years of teaching non science inclined students in the poorly equipped classes, everyday school pressure and rush, countless bureaucratic obstacles and other ordeals too often make them disillusioned and routinized. Standard programs of in-service training practiced in Ukraine do not accomplish any sufficient impact onto the creative professional development and motivation of the school teachers. To correct the present situation, Ministry of Education and Science of Ukraine encouraged development of the alternative programs of the teachers' professional advancement.

Newly suggested training program of basic school and high school Physics teachers at V.Karazin Kharkiv National University (KhNU) was designed to meet the demands of contemporary education, in particular by providing an adequate training in hands-on and inquiry-based approach to high school science education. Given the choice teachers are now able to choose themselves between the traditional and novel training programs.

2. Hands-on and IBSE focused program of in-service training of Physics teachers at KhNU

Being informed of a new program via the Ministry of Education and Science channels, an essential part of teachers subject to attend training, decided to participate. Should be noticed that a requirement of lifelong professional development makes it mandatory to every Ukrainian school teacher undergo in-service training once in five years. Enlisted teachers represented a rather diverse variety of communities and schools including the small private Kharkiv downtown lyceums, big educational complexes in affluent city areas, an orphanage, and even a penitentiary institution school for adults. An obvious majority came from the small towns and countryside schools of the Kharkiv Area, with some truly remote from the city communities also represented. Trainees were divided into three comfortably sized groups and had 3 to 4 classes a day in the university auditoriums and laboratories. Full week of classes was followed by two back at their school when the trainees had a good opportunity to apply and test in practical teaching what they were instructed. On return to the program, discussion of these practices was encouraged. Based on that sort of a feedback, program instructors were able to make adjustments and corrections to the current course and to the ones that followed.

Unlike the Hands-on Science Network members or the Project Heureka community of Physics teachers [1], this program's participants have never before been familiar with the hands-on and IBSE ideas and practices. The majority of the teachers came from the small countryside schools especially lacking demonstrational and laboratory equipment and materials. The more open and receptive they were to the suggested hands-on and IBSE courses with the focus on low-budget apparatus. Teachers were often reacting to the material they liked as emotionally as do their own students. On the other hand, a fresh look of the experienced professionals not shy to provide critical feedback was much helpful in making a program more useful and practical.

Being mostly focused on Physics, the training program also included an introduction to robotics and a master-class aimed to develop presentational and communicational skills of the trainees. Also, creative science projects for elementary school students were presented and surveyed based in particular, on the excellent book [2].

Figure 1

The core hands-on course of the program strongly encouraged team educational projects of students, as well as a presentation of the obtained results in conference reports and publications. Another important class instructed to trainees was focused on participation in the activities of the Minor Academy of Sciences (MAS) of Ukraine [3] that imply for an individual student research and result in a personal project. During the discussion, teachers acknowledged that the approaches have their advantages and pitfalls. Especially emphasized by them was that for many the creative students who performed an ingenious research projects the mandatory subject Olympiad preceding the MAS contest too often becomes an insurmountable obstacle hampering to succeed in the contest.

Among the numerous hands-on and inquiry-based activities practiced with and by trainees during the program, should be noticed specially designed for it schemes of experiments and observations.

Figure 1 present a sequence of frames from the movie *Kidnapping, Caucasian Style* (1967). This extraordinarily popular comedy has been watched by literally everyone in Russia and Ukraine, most of its episodes being memorized by the generations of its umpteen fans. The more it was of a surprize for the trainees to discover that an actor playing a hero erroneously reaching for a reflection in a mirror instead of an original glass (both marked white in the figures for better colour contrast) is cheating. He actually observes an image in the place on the mirror (*1)* different from where camera shows it (Figure 2).

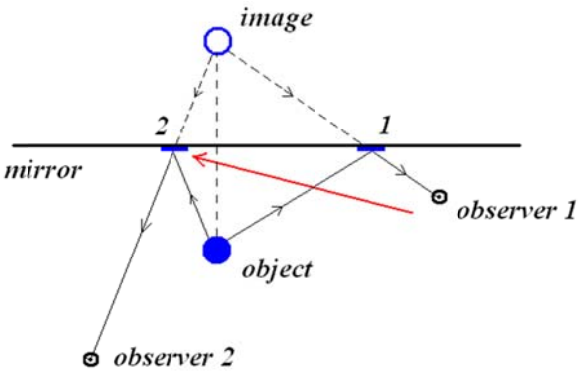

Figure 2

Neither a goof nor a joke by itself, an episode presents a creative solution of a natural discrepancy and lets achieve a strong comic effect. Trainees were suggested to experiment themselves with that kind of images using a big mirror brought to the class.

Another challenge of this amusing inquiry was to add more objects to observe and realize advanced scenarios of an episode, like in Figure 3.

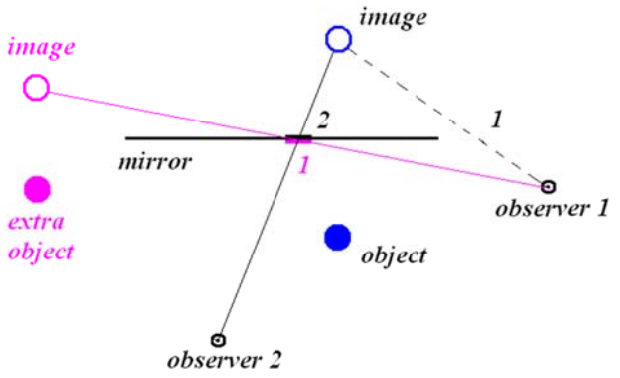

Figure 3

3 Hands-on show must go on: an extension of training program into the school classes

Following the completion of a program, a sufficient number of its participants were fast to initiate at their schools a series of class and informal students' hands-on activities that proved to be a smashing success [4, 5]. In fact, some teachers invited their instructors to meet students yet during the program. Not only the high school students: the strategy of the inviting teachers was to let the kids who will only begin learning Physics next academic year get acquainted with the wonders of hands-on and IBSE approach.

Figure 4

Figures 4 and 5 below reveal how involved and persistent students may be while doing hands-on activities, how they enjoy their success in the independent experiments. Teachers especially liked and began practicing experiments with the most common equipment and materials, ordinarily not perceived as apparatus of the Physics inquiry. For some reason regular wooden brooms became their unanimous favourites for creative hands-on activities in the Physics class (see the Figure 6).

Figure 5

Figure 6

Figure 7

Authors must confess to also favour this apparatus especially when performing

demonstrations in a big hall (Figure 7). Not only brooms are big and well seen from the distance. They also allow for some highly instructive team hands-on students' experiments (Figure 8).

Figure 8

Following an advice to use hands-on activities as an instrument of the informal science education, our trainees were also active in the school summer camps for elementary and basic school kids where Physics became a very special feature.

4. Conclusions

A novel, sufficiently hands-on focused program of in-service training of school Physics teachers at V.Karazin Kharkiv National University proved to be highly appreciated of the trainees and indirectly by their students. It made it possible to establish strong creative contacts between school and university educators opening endless prospects for the further development and co-operation.

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Hospital Information System as an Instructional Tool in Undergraduate Nursing Education

I Berezovska[1], M Shehedyn[1], N Dub[1], U Chernyaha[2], L Gasyuk[3], V Kachmar[4]
[1]*Krupynsky Institute of Nursing and Laboratory Medicine, Lviv, Ukraine*
[2]*Danylo Halytsky Lviv National Medical University, Lviv, Ukraine*
[3]*Heart Rhythm Center, Lviv, Ukraine*
gasyuklmeddoc@gmail.com
[4]*Doctor Eleks Ltd., Lviv, Ukraine*
iberezof@gmail.com

Abstract. Nursing education worldwide has evolved over the decades from in-service training in hospital diploma schools to the idea of higher education for nurses based on four-year baccalaureate or higher degree programs. The recent information technology advances in healthcare have created demand for nurses with solid knowledge of nursing informatics. However the only type of informatics we encounter in nursing curricula in Ukraine is still medical informatics.

This paper discusses the building blocks of a nursing informatics curriculum with a special focus on using the "Doctor Eleks" hospital information system to bring real life nursing scenarios into a classroom. This is a way to develop essential nursing informatics competencies of students (for example, proficiency with applications, knowledge of nursing data sets), and to prepare nursing graduates for entering healthcare industry as care coordinators, primary care providers and health policymakers.

Keywords. Informatics, nursing education, hospital information system, nursing scenario.

1. Introduction

A seamless academic progression to higher nursing education has led to a constant increase in the number of baccalaureate-prepared nurses. In addition, more nurses are educated at the graduate level. New four-year baccalaureate or higher degree programs emphasize critical thinking, leadership, systems analysis and teamwork [1]. It has become a generally recognized fact that nurses should not only know how to carry out a physician's order, but why it is being done.

Ukraine has been reforming nursing education since late 1990s. Currently there are about 700 students at KINLM. 3,000 students are educated in 6 more schools of higher and continued nursing education, and 24,000 nurses work at hospitals in Lviv and the nearby region. Totals for Ukraine are 40,000 students in 72 nursing educational settings.

Information technology (or informatics) enhances the medical field in many ways that has created demand for nurses with solid knowledge of nursing informatics (NI). However the only type of informatics we encounter in nursing curricula in Ukraine is still medical informatics, although nursing as a profession follows its own path in informatics. Moreover, educators often misinterpret the real meaning of NI believing that knowing how to use computers is the same as being proficient in NI.

Understanding the differences is important. While medical informatics is more of an umbrella term for the management of health and medical information in a broad range of fields, NI applies exclusively to the specific functions of nursing and related data (patient records, dosing instructions, lab results, allergy information, care plans etc.).

Nursing undergraduate curricula should provide a set of NI competencies: basic computer literacy; information literacy, including the ability to locate, retrieve and interpret specific information in relation to evidence based practice; proficiency with NI applications and knowledge of nursing data sets, etc. [2]. At present, no adequate learning environment exists in student computer laboratories in Ukraine to incorporate these competencies into curricula.

To bring real life nursing scenarios into a classroom, Krupynsky Institute of Nursing and Laboratory Medicine in Lviv (KINLM), in partnership with ELEKS software engineering company and Heart Rhythm Center (HRC), pioneers the use of Doctor ELEKS Hospital Information System (DE-HIS) and telemedicine facilities as instructional tools in nursing education and in-service training.

2. Hospital information system "Doctor Eleks"

DE-HIS seems to be a perfect instructional tool for its multifaceted functionality and wide application. The system has been installed in 14 medical centers, 6 universities and more than 90 clinics in Ukraine and 50 sites abroad. This allows suggesting that many new nurses would need DE-HIS user skills.

2.1. System architecture and technical requirement

The logical architecture of Doctor Eleks consists of three levels: Database level, Communication Server level and Client Program level (Fig. 1).

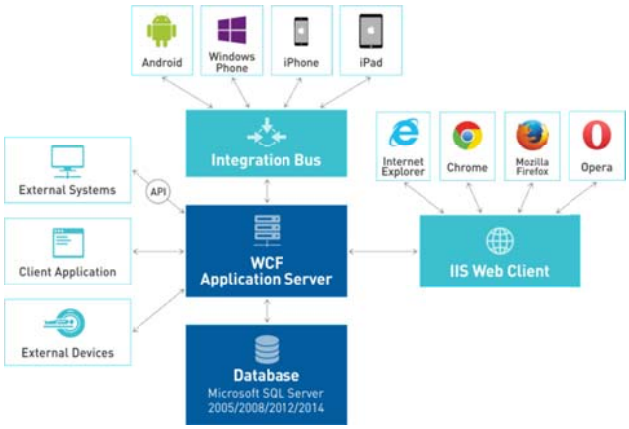

Figure 1. Doctor Eleks architecture

The Database is built using Microsoft SQL Server 2005/2008/2012/2014. The Communication Server is built on the basis of Windows Communication Foundation (WCF) technology.

Communication Server interacts with Client Applications and External Medical Devices via TCP/ IP protocol and provides integration with external systems (financial, hotel, laboratory etc) via application programming interface (API).

Doctor Eleks Client is built using Microsoft Windows Forms technology and.Net Framework 3.5. To ensure secure communication within network, Windows Security Domain Infrastructure with Active Directory service have been used. Full-featured client program runs on Microsoft Windows operating system; Doctor Eleks web client can be accessed via a preferred web-browser.

To ensure interaction of Database with Doctor Eleks mobile applications, the Integration Bus based on WCF technology has been used. Data exchange is performed via HTTP protocol in JSON format, which is considered to be the best solution for mobile platforms which are often limited in resources.

Technical requirements to install and use DE-HIS are quite affordable for educational institutions. For 1-20 workplaces, minimum requirements are: processor 2-3 Ghz, RAM - 3 GB, free disk space - 20-100 GB, Microsoft Windows XP Professional with IIS (Internet Information Services) installed or Microsoft Windows Vista Business or higher, Microsoft Windows 7 Professional or higher, SQL Server 2008 R2 Workgroup for data storage without 4 GB restriction

2.2. Simulation of real-life nursing scenarios with DE-HIS

DE-HIS is a multicomponent system. It includes a number of subsystems: Electronic Medical Record (EMR), Document Template Editor, Reception, Physician, Laboratory, Reports and others. All these components together will enable to simulate a full range of nursing functions.

First of all, DE-HIS allows creating an infrastructure of a health institution in every detail: premises, equipment, staff roles and responsibilities.

- EMR is a core component combining all patient-related data with extensive editing capacity.
- Reception helps to develop practical skills in scheduling patients' appointments and coordinating the co-working of physicians, nurses, laboratory staff etc. taking into consideration available resources and limitations.
- Physician facilitates doctors/nurses' access to patient-related data through EMR and simplifies its processing.
- Laboratory supports a full cycle of laboratory diagnostics and tracks all testing steps including order entry, specimen collection, labeling, delivery to a laboratory, processing the results, data

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integration into EMR, data storage and archiving. Additionally, warning notifications are automatically generated when test results considerably deviate from normal values.

Working with Document Template Editor and Reports, students acquire useful skills in automated document handling and customizing the templates.

3. Telemedicine field trips

Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status. The lack of telemedicine devices in nursing schools makes telemedicine a rare topic in nursing informatics syllabus. A common solution is a multimedia presentation to introduce students to general principles of telemedicine. Unfortunately, this does not allow students to acquire any practical skills.

To overcome this difficulty, KINLM has established a partnership with the Heart Rhythm Center (HRC), a specialized local clinic.

HRC owns the following telemedicine facilities: Heartrak smart (Universal Medical Inc.) event monitoring devices (10 items); Heaco blood pressure monitor (3 items) and DiaCard 3 channel monitors (12 items) (Fig. 2).

Figure 2. Telemedicine devices: 1 - Heartrak smart (Universal Medical Inc.) event monitoring device; 2 - Heaco blood pressure monitor; 3 - DiaCard 3 channel monitor

These facilities provide good opportunities to simulate the most typical situations encountered in everyday cardiological practice. Additionally, students will use various data formats and communication options.

4. Event monitoring

During this instructional activity students realize how a Heartrak smart device is used to provide remote monitoring of a patient's health status, early recognition of arrhythmia, emergency medical care and remote advice from specialists if necessary. Students simulate event monitoring in small groups of 3 persons with different roles: a student-nurse, a student-patient and a student-cardiologist (Fig. 3).

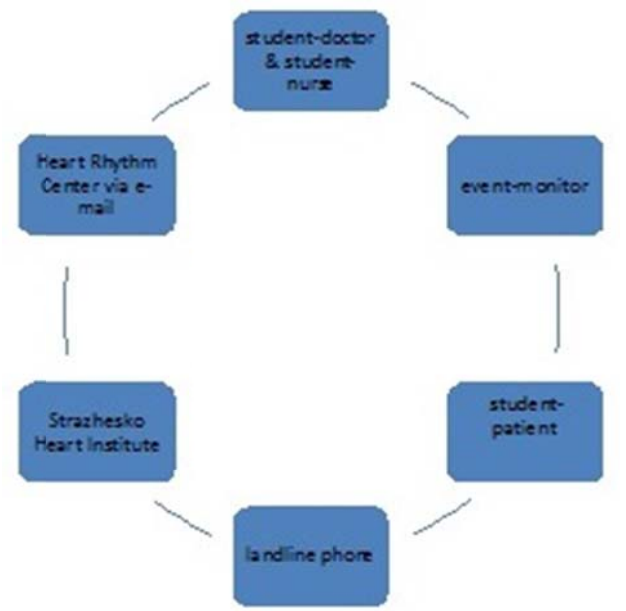

Figure 3. Instructional version of event monitoring

Figure 4. A student-patient (left), a student-nurse (right) and an instructor (center)

Figure 5. A student-patient sending ECG

Playing a role of a nurse, they practice how to place a device on a patient's body and explain what a patient is expected to do in case of warning signs indicating transient cardiac episodes (Fig. 4).

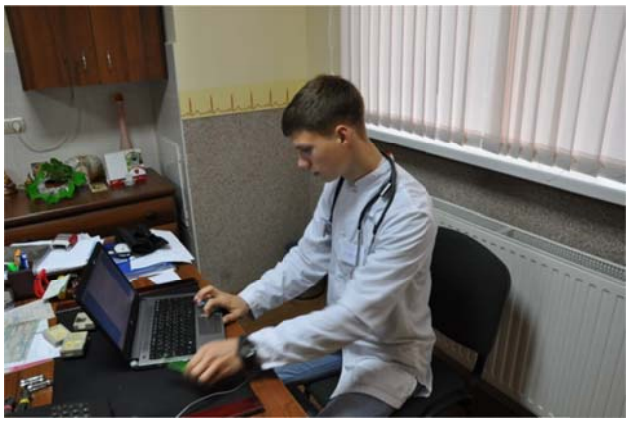

Figure 6. A student-patient sending ECG

Student-patients study how to capture and document transient cardiac episodes: press RECORD button to record ECG automatically taken 40 s before and 60 s after an event, then use a landline phone to send audio ECG to a server in the Strazhesko Heart Institute in Kyiv to visualize the ECG (Fig. 5)

Being in a role of a cardiologist, students receive this ECG at HRC via email, make primary evaluation of a patient's status and contact a specialist when required (Fig. 6).

Additionally, all ECGs obtained with Heartrak smart devices can be exported to patient records in Doctor Eleks HIS.

Currently we continue developing instructional simulations with other telemedicine facilities-

5. Conclusions

Thus, introducing DE-HIS and telemedicine facilities as instructional tools into NI teaching practice results in a lot of benefits for students. This must encourage educators for redesigning mandatory NI courses offered at the beginning of all undergraduate programs to incorporate essential NI competencies and to implement real life nursing scenarios into curricula.

Authors expect that this approach can decrease the gap between actual need for NI proficient nurses currently entering healthcare industry and the actual state of NI education in Ukraine.

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Lively and Exciting Hand-on Experiments: Mechanics

N Sugimoto
Stray Cats Group
Kikuzato High Schoo, Nagoya, Japan
drsugi77@gmail.com

Abstract. Hand-on experiments play important roles in enjoyable and fruitful Physics classes. They tell students that what they learn in Physics class work not in the textbook but in the world around them. And they help students to recognize Physical concepts. By repeating processes between hypothesis and test using hand-on experiments, students' understanding of concepts becomes deeper. In HSCI2016, I introduced some simple and essential hand-on experiments of wave and electromagnetism and discussed their roles in classes. Here, I follow up the discussion with topics in Mechanics. In Mechanics, physical concepts are sometimes not accepted by students easily and sometimes they have wrong concepts before learning. So, the process of competition between their own concepts and correct concepts are needed to change their cognition.

Keywords. Simple and essential experiments, hand-on experiments, mechanics.

1. Introduction

I presented some hand-on experiments in Electromagnet and Wave, and told their roles they play in enjoyable and fruitful Physics classes in HSCI2016 in Czech [1]. We (Stray cats group) are thinking there are mainly two important roles hand-on experiments using materials around us play in Physics classes [2]. One is that they tell students that theories they learn in Physics class work not in the textbook but in the world around them. Second one is that hand-on experiments help students to recognize physical concepts thoroughly. Students' recognition of the concepts is sometimes superficial if the classes are done without experiments or with only commercial equipment. By repeating processes between hypothesis and test using hand-on experiments, students' understanding of concepts becomes deeper.

Here, I introduce some simple and essential hand-on experiments of Mechanics we are using them to make lectures lively, exciting and fruitful and discuss how they work in the classes. In Mechanics, physical concepts are sometimes not accepted by students easily; mass, weight, inertia, force for example. And, sometimes they have wrong concepts before learning. At that time, the process of competition between their own concepts and correct concepts are needed to change their cognition. I show two topics below that show the roles of hand-on experiments clearly.

2. Experiments concerning to "Mass"

Students sometimes confuse mass with weight. For example, if we ask students about the magnitude of force to accelerate objects floating in a zero gravity space, most of them think the magnitudes of force are zero or do not depend on the mass of objects because the objects have no weight there. We can do the same kind of experiment in a classroom. Put two same carts on the floor and put another cart on one of carts. And fix the rubber string to them and pull them by the same amount of force as Figure 1(a).

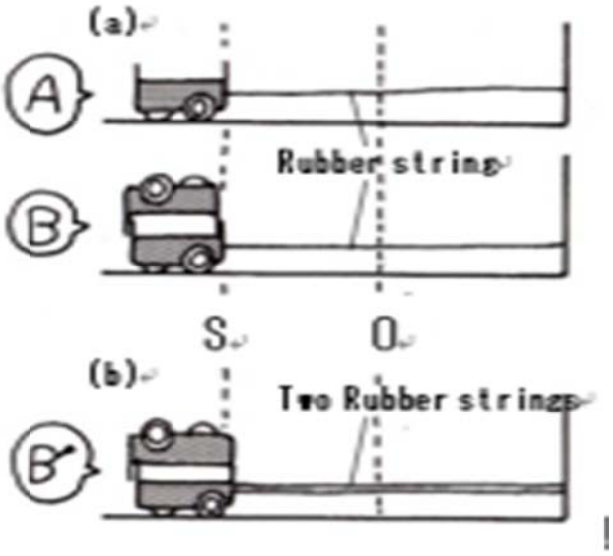

Figure 1. (a) Which is correct? "A and B reach O at the same time", "A reaches faster than B" or "B reaches faster than A"? (b) B' is the case cars are pulled by two rubber strings. A and B' reaches O at the same time

As the weight and normal force are cancelled each other because of the equilibrium, students who have no concept of mass will confused and cannot anticipate the result of this experiment correctly [2]. The

relation between force and mass is tested by comparing the acceleration of two carts A and B' in Figure 1(b). Students surprise A and B' reach O at the same time as predicted by Newton's second low.

Figure 2. Students are trying to measure the mass of the air in the balloon by vibrating the balloon fixed to the spring

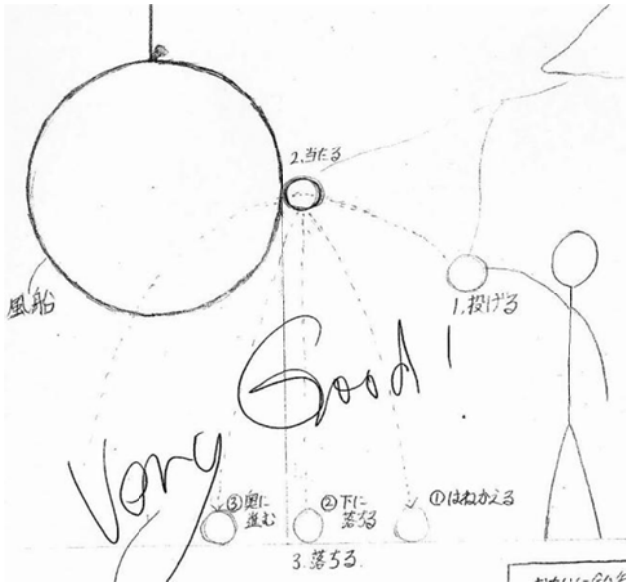

Figure 3. One of the students' report. Throw a ball to the hanging balloon and collide them. If the mass of the ball is equal to the mass of the balloon, velocity of the ball becomes 0 because of the conservation of the momentum

Recently huge balloon (about 1 m in diameter) is popular for exciting Physics experiment. Because the buoyancy almost cancels the weight of the balloon, weight of the air inside the balloon seems to be almost zero. However, mass of the air never vanish regardless of the buoyancy and make students be surprised at big shock when the balloon hit them.

This experiment is also good one to make students realize the concept of mass. We thought that it was interesting to let students think how to measure the mass of the air in the balloon [4]. The assignment given to each group was "Measure the mass of the air in the balloon using equipment in a science laboratory". Some groups tried to measure the volume of the balloon. Some groups tried to fix the spring and measure the period as Figure 2. Figure 3 is one of students' reports. They tried to measure the mass of the air using the conservation of momentum. Their ideas were beyond our expectations.

3. Experiments concerning to "Projectile motion"

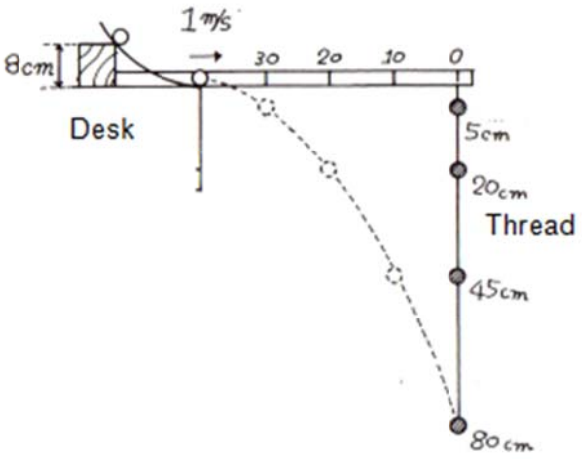

Figure 4. The apparatus to test the rule of the projectile motion (up). If we put the targets at one of positions on the parabola, the ball hits the target as (down)

The projectile motion is a good topic to show the universal rule is hidden in the nature. The projectile motion is explained as the

superposition of two motions: constant velocity motion in the initial direction and the motion of a particle freely falling in the horizontal direction under constant acceleration. Multi-flash photographs of the projectile motion clearly show that the rule is hidden in the projectile motion. However, I think some hand-on experiments are needed to make students realize that the rule is really applicable to the phenomena around students. Figure 4 is one of the apparatuses to test the rule of the projectile motion. [4] The ball is projected with the speed of about 1 m/s horizontally. If we put targets where the ball is expected to pass, the ball must hit the targets. Hand-on "The monkey and the hunter experiment" is one of the most effective experiments to impress students that the rule is really applicable to every projectile motion. The apparatus using blowgun electromagnet and magnet as shown in Figure 5 is easy to make and demonstrate in the Physics class.

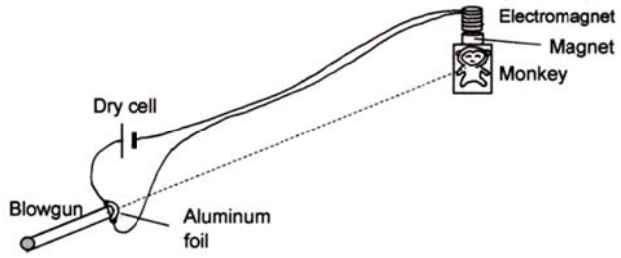

Figure 5. Block diagram of the apparatus of the monkey and the hunter experiment. When the bullet is fired, it tears the aluminum foil at the mouth of the tube. The current flows the electromagnet is switched off at that moment and the monkey falls down

4. Conclusion

Hand-on experiments plays important role in lively and exciting Physics class. They are also effective to help students to understand Physical concept that is sometimes very different from their own cognitions. Because the repetition of "hypothesis and test" process using hand-on experiments enforces their understanding of the concepts, some more experiments are expected to be invented.

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Sunlight, May the Leaf Bring and Translate: Experience Report of Practical Activities Sequence of Photosynthesis, Food Chain Carried Out with Students of Elementary School

B Oricchio-Rodrigues, A Gonçalves Brito, CA Neves Almeida Ribeiro, E Cardoso da Silva Filho
CEF Recanto das Emas, Federal District, Brazil
bernardooricchio@gmail.com

Abstract. The work was elaborated and accomplished with the goal of approaching with 4th year students from elementary school of basic education in a school for public school system (Recanto das Emas, Federal District, Brazil) in order to enroll them in a project about the vegetables photosynthesis process. Among the interests proposed with this research, it could be highlighted the intention of starting the experimentation and contact with several practical activities in the classroom. The students could associate the transformation process of light energy into chemical energy for plant nutrition as well as, its importance in food chain.

Keywords. Food chain, observation, photo-synthesis, record.

1. Introduction

In the professional life of the educator, the mere fulfillment of the school curriculum for years in a row can be a tedious and tiresome action. In science teaching, this is clearly evidenced when opportunities to highlight phenomena in nature and to integrate the active participation of students are not taken advantage of.

From the insertion of the project "Science, Now in the Laboratory" [1], in a public school of the Federal District, it was possible to include in the science classes practical and experimental activities in the science laboratory.

Experimental practices are, besides attractive, partial elements of the scientific action, which provide learning based on didactic explanation, stimulating the development of skills such as scientific observation [2].

The science content approach considered the development, the age / grade of the students being based on the curriculum in movement of basic education of the Federal District [3]. The planning and development of practical and experimental activities were carried out collectively among the participating teachers.

In addition to developing and executing a sequence of practical and experimental activities, the present project also aimed to motivate students and teachers to appropriate significantly the theme of the school curriculum and to encourage students to observe the Photosynthesis, relating their importance to the food chain.

2. Methodology

A recurrent concern among the teachers of the work group was to ensure that the sequences of activities contemplated a meaningful learning to the students, that is, to relate pre existing knowledge to the new ones, as defended by Ausubel [4].

Thus, with the collective planning between the 4th grade teachers and the coordinator of the project, the aspects that would be relevant to the activities were established. Among the aspects we highlight: the components of a food chain, the relevance of vegetables in the food chain and their nutrition, the stages of photosynthesis, the interpretation of texts and writing from the records relating them to the proposed theme.

To this end, activities related to the study of the environment were adapted (garden, simulating a natural environment), experimental activities (observation of controlled situations), communication activities (which permitted the reading, interpretation and dissemination of the work), and simulation activities (a representative model) [5]. Five mornings were established in order to the activities to be carried out.

The introduction to the theme was carried out with the activity of textual interpretation of the lyrics and music of Caetano Veloso, "Luz do sol" called activity 1, with the regent teacher (Fig. 1). The students were able to listen to the

song and from the collective reading of the lyrics of the song and the script of the activity, identified with the regent teacher, the components of the textual genre linking them to the theme food chain.

Luz do sol (Caetano Veloso)

Luz do sol
Que a folha traga e traduz
Em verde novo
Em folha, em graça
Em vida, em força, em luz..

Céu azul
Que venha até
Onde os pés
Tocam a terra
E a terra inspira
E exala seus azuis...

Reza, reza o rio
Córrego pro rio
Rio pro mar
Reza correnteza
Roça a beira
A doura areia...

Marcha um homem
Sobre o chão
Leva no coração
Uma ferida acesa
Dono do sim e do não
Diante da visão
Da infinita beleza...

Finda por ferir com a mão
Essa delicadeza
A coisa mais querida
A glória, da vida...

Luz do sol
Que a folha traga e traduz
Em verde novo
Em folha, em graça
Em vida, em força, em luz..

Reza, reza o rio
Córrego pro rio
Rio pro mar
Reza correnteza
Roça a beira
A doura areia...

Marcha um homem
Sobre o chão
Leva no coração
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A coisa mais querida
A glória, da vida...

Luz do sol
Que a folha traga e traduz
Em verde novo
Em folha, em graça
Em vida, em força, em luz...

Figure 1. Caetano Veloso`s song

Activity 2 had as a characteristic to stimulate the participation of students to comment on their perceptions and understandings about photosynthesis. Among the various comments, the most constant association to the theme in the student dialogue was that "photosynthesis was a kind of plant food that came from sunlight." With this, in parallel, the subject regarding the food chain was inserted in the dialogue with the class. Affirmations have also been made relating the green color of plants to photosynthesis.

Activity 3 was about the food chain, taking up the subject regarding its components. From the science textbook the students visualized the illustrations and participated suggesting the respective members of a constant food chain of the activity. From the similarity between the living beings they knew, the students suggested other living beings as examples. Afterwards, the students were distributed in groups to receive and play the game of the food chain [6].

Figure 1. Students practicing the food chain`s game

The practical activity of the game (Fig. 2) demanded much attention and, consequently, the excitement of the children in the assembly of the trophic levels. The highlight of the activity was at the end of the assembly of the food chain, when the students demonstrated an understanding of the process of transference of matter and energy between living beings, at which time the student "Alex" (in this work we will adopt fictional names in the student dialogues reproduction) expressed himself: "teacher, teacher The leaf of lettuce that I ate yesterday at dinner is part of me now."

The statement made by the student "Alex" provides a number of situations. Despite its incompleteness and simplicity, the student demonstrated with his words that part of the vegetable that had been fed had been absorbed by his body. This type of participation is fundamental in the development of connections between previous knowledge that can be added to new information, producing a more complete knowledge. It was a great opportunity to talk about digestion.

Activity 4 was the visit to the school garden, exploring the observation. The students were

able to walk around the area and draw the vegetables that interested them. Students were encouraged to think about the possible components of a "food chain" that one could have in the garden. The students then used the examples of living beings they chose to draw and paint the food chain, using as materials: disposable plastic dish, paints, brushes and colored modeling mass (Fig. 3). This activity in question was finalized with the assembly of illustrative panels with the different food chains. The students were asked to explain their drawings and their observations.

Figure 3. 4th year students setting up a food chain

Activity 5 was developed with the students in the execution of an experiment in the Science laboratory (Fig. 4). This activity was accompanied by the professor regente and the coordinator of the laboratory. The proposal of the activity was to use aquatic plants, in this case, the species Vallisneria spiralis, to simulate an aquatic environment with luminosity (clear phase of the day) and without luminosity (dark phase), aiming that students from observation and comparison between the two phases of the day and the consequent discussion about the results obtained, also made some deductions. [7].

Figure 4. Experimental activity in the laboratory

In the experimental activity carried out in the laboratory, after the completion of all the steps: reading of the activity, verification, separation and distribution of the material to be used, assembly of the experiments and their respective application, the students were instructed to record all the steps.

3. Results

The first activity allowed students to increase their engagement in future activities. It is true that understanding and comprehension of a complex process such as photosynthesis requires abstraction and much attention from children.

Motivating the student to become interested in photosynthesis through an accessible language was an important step desired and achieved. After performing the practical activities 1 and 2 the students already had familiarity with the theme.

In the experimental activity, still in the initial phase of observation, the students already deduced that in the presence of light, (artificial) the plants would carry out the photosynthesis. With the formation of bubbles, the students

were asked what the bubbles would be. After a time of observation of the leaves of the plants the student "Maria" deduced speaking: "this bubble coming out of the leaves must be the air that it released by feeding on photosynthesis". "Maria" related the bubbles with the release of oxygen.

Then, in the observation of the experiment (dark phase), which served as a parameter of comparison (control), inferences and dialogues between students appeared. A portion of the students inferred that plants would not carry out photosynthesis in a dark environment and would certainly continue to breathe. An interesting aspect of this experimentation process was that the students were attentive, reflecting and constructing their conclusions and answers to the questions that were being asked in the activity

4. Conclusion

Essential point in the execution of the sequence of activities was not to fear the complexity of the content. To bring content to the level of development of children in a context that arouses students' interest and participation in scientific thinking.

The set of activities performed provided familiarization of the subject by the students of the 4th year. Each activity proposed with the active participation of the children was identified that the content came to have meaning and relevance. In dialogues and questioning considerations, the relation of the importance and interdependence between living beings in the transference of matter and energy was sedimented by the students. Certainly, by revisiting the theme photosynthesis throughout the student life and with the successive increments in the complexity of the content, throughout the series that will still be studied, the students will have a vision and understanding less distant from the concept and the relevance of the photosynthetic beings in the food chain.

5. Acknowledgments

We thank the management team of the Center of Elementary School 801 of Recanto das Emas - DF, the Secretary of State for Education of the Federal District and the University of Brasilia.

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Complex Sounds Analysis. An Experimental Approach to Implement in Secondary Level Teaching

SM Cunha[1], AM Almeida[2]
[1]Escola Secundária de Felgueiras, Felgueiras, Portugal
[2]University of Minho, Braga, Portugal
coimbra@fisica.uminho.pt

Abstract. The teaching of sound in secondary level education, in Portugal, is incipient and without methodologies capable of promoting the effective learning of students, with respect to the concepts of pure and complex sound. This work presents an experimental methodology that allows students to learn effectively about the concept of complex sound using “PicoScope 6” software. The analysis of the sounds collected allows the students to verify the multiplicity of the various harmonics relative to the fundamental sound. Thus, it is possible to explore the concepts of stationary waves, wave interference and harmonic series as conceptual levers of complex sound.

Keywords. Fourier transform, complex sound, harmonic series, spectral analysis**.**

1. Introduction

In the Portuguese education system, the study of sound is made in the discipline of “Physics and Chemistry”. It is approached in the third cycle of basic education, in the "Sound" domain [1] and in secondary education, in the course "Sciences and Technologies", in the domain "Waves and electromagnetism" [2]. In vocational education, there is a specific module called "Sound", plus an extension of the module called "Sound and Music" [3].

Acoustics is one of the areas of physics that is superficially explored in physics courses at Portuguese universities, which is why so many primary and secondary teachers are scientifically insecure about this subject. On the other hand, students show great interest in the study of sound, particularly in their connection with music and the working with musical instruments.

However, the study of sound in Portuguese education system is very incipient, with a very poor compulsory curricular experimental approach and without methodologies capable of promoting meaningful student learning. The distinction between pure sound and complex sound is addressed in the programs contents and carried out in the context of musical instruments, both in primary and secondary education. However the common pedagogical practices consist of definitions and images presented to the students without any deepening of the relationship between concepts, promoting the memorization and not the understanding of the physical phenomena in question.

In this way, it is urgent to create new experimental methodologies that enhance the effective conceptual learning of the students in a meaningful way. The objective of this work is to present a simple, fast and inexpensive experimental approach that allows the understanding of the concept of complex sound for the students of the secondary level.

2. Theoretical considerations

A pure sound can be defined as the structural unit of all sounds. Thus, it assumes particular relevance in the study of acoustics. In the musical world, pure sounds are obtained by tuning forksand for a long time used by musicians to tune their instruments.

A pure sound is a single frequency of vibration and the waveform is a sinusoidal signal, mathematically described by the sine or cosine trigonometric function as described below [4]:

$$x\,(t) = A\sin(\omega t + \varphi) \qquad (1)$$

As $\omega = 2\pi f = \frac{2\pi}{\mathrm{T}}$, equation (1) can be written as:

$$x\,(t) = A\sin\left(\frac{2\pi t}{T} + \varphi\right) \qquad (2)$$

where *A* is the amplitude, *T* is the period, ω is the angular frequency and φ is the initial phase. The physical quantities *x* and *A* can be pressure variation, voltage, or other relevant physical quantity. By convention A is always a positive value.

One of the mandatory experimental activities for the secondary level consists in measuring

the speed of sound using a signal generator, an oscilloscope, a loudspeaker and a microphone. Thus, the aspect of the sinusoidal signal shown in Fig. 1 is quite familiar to the students.

Contrary to pure sounds, complex sounds are made of several frequencies and each of the frequencies is designated as partial, with the lowest frequency partial being the first vibrational mode of the system, called the fundamental sound.

If the frequency of a partial is an integral multiple of the fundamental frequency (fundamental sound) it is considered a harmonic, otherwise it is called non-harmonic.

A complex sound can be considered as a summation of simple sounds, according to the superposition principle and it can be analyzed by applying the Fourier Theorem which states that a periodic signal can be decomposed into a sum of sinusoidal waves with multiple frequencies of the fundamental frequency f_1.

Let *x(t)* be a periodic function of period *T*. The function *x(t)* can be represented by a series, called the Fourier series [4], of the type:

$$x\,(t) = A_0 + \sum_{n=1}^{\infty} A_0\, sin\left(\frac{2\pi nt}{\mathrm{T}} + \varphi_n\right) \quad (3)$$

where the coefficients of each term are given by

$$A_0 = \frac{1}{\mathrm{T}} \int_{-\mathrm{T}/2}^{\mathrm{T}/2} x\,(t)dt \quad (4)$$

and

$$A_n = \frac{1}{\mathrm{T}} \int_{-\mathrm{T}/2}^{\mathrm{T}/2} x\,(t)\, sin\left(\frac{2\pi nt}{\mathrm{T}}\right) dt \quad (5)$$

The term $A_0$is the value of the mean amplitude of the function *x(t)*.

The software used in this work applies the Fourier analysis to the recorded signal, and makes it possible to present the sound spectrum of a complex sound in an easy way, altogether with the oscillogram.

Thus, it is possible to identify the harmonic frequencies embedded in a musical note (a complex sound) and to look for the ratios between each harmonic *n* and the fundamental harmonic:

$$\frac{f_n}{f_1} = n \quad (6)$$

with *n* as a natural number.

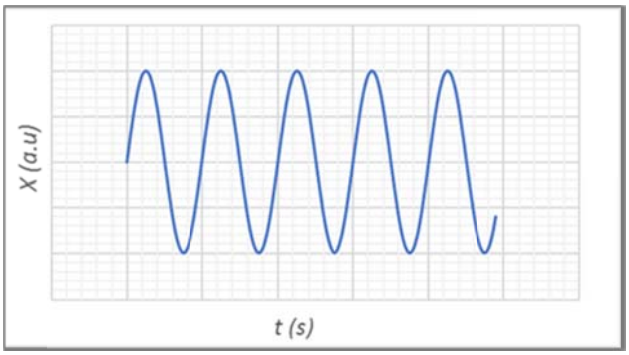

Figure 1. Pure sound

3. Experimental approach

3.1. Equipment

To perform this experimental activity, the following equipment is required: one soprano flute (ordinary plastic model), one computer with the software "PicoScope 6" [5], one microphone, one PicoScope 2000 series (Analog-to-Digital Converter), and one USB cable.

Figure 2. Equipment used

3.2. Experimental procedure

The experimental procedure was carried out following these steps:

- the microphone is connected to the interface, which in turn is connected to the computer through a USB port;

- the software "PicoScope 6" is running in the computer, exhibiting the waveform of the sound collected by the microphone (oscillogram) and the spectrum for a predetermined time interval;
- the background noise was recorded for each experiment;
- various musical notes were played on the flute;
- the oscillogram of each musical note was used to measure the longest period (or the lowest frequency) and all the harmonics were calculated by the software for a time interval and shown in the spectrum.

3.3. Example of results and analysis

As an example, we show the results obtained for the note E5 (Fig. 3). The pitch of the note can be easily measured just by measuring the time length of the pattern seen in the oscillogram (Fig. 3, top). The result is in the first column of Table 1 and it is 668.8 Hz.

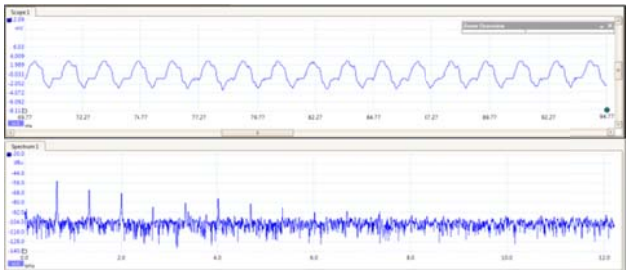

Figure 3. Oscillogram (top) and sound spectrum (bottom) for musical note E_5

Also in Table 1 are shown the frequencies of the harmonics present in this note as calculated by the software.

There can be identified 11 harmonics (Fig. 3, bottom) all being a multiple integer relative to the fundamental frequency, which was determined to be 666 Hz. There is a slight deviation of the measured pitch (less than 0.5%), which can be attributed to the lower precision of the method of measuring directly from the graphics on the computer screen. Nevertheless it is a recommended exercise to perform.

It is also noticeable a progressive decrease of the peak intensities with increasing frequency, except for the 4th to the 6th harmonics, whose intensities are in reverse order (Fig. 3, top).

$f_{osc.}$ (Hz)	Harmonic	f_n (Hz)	$\frac{f_n}{f_1}$
	1º	666	1,0
	2º	1344	2,0
	3º	2003	3,0
	4º	2680	4,0
	5º	3349	5,0
668,80	6º	4008	6,0
	7º	4695	7,0
	8º	5354	8,0
	9º	6022	9,0
	10º	6681	10,0
	11º	7354	11,0

Table 1. Analysis of results for the note E_5

Legend: $f_{osc.}$ – frequency calculated using the period measured in the oscillogram; f_n – frequency of each harmonic obtained by spectral analysis.

4. Conclusions

This work shows the possibility to quickly and easily demonstrate the principle of superposition of waves, to conclude that complex sounds result from the overlapping of pure sounds, to identify the frequencies in a musical note, and to observe the ratio of each harmonic to the fundamental is an integer. This experimental procedure is also very cheap, as in almost every school there exist all these equipments, except for the ADC, but the equipment suggested is inexpensive (it costs around 100€) and the software is free.

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Physics Experiments Anywhere and with Anything

Z Drozd, D Mandíková
Charles University, Prague,
Czech Republic
zdenek.drozd@mff.cuni.cz

Abstract. The aim of this contribution is to give some ideas how to perform experiments using things of daily use. Authors draw on their long-lasting experiences with physics tuition and with various courses for children and students as well as for teachers and public. Emphasis is taken on how to use simple aids in physics tuition of various levels. Instructions how to make such aids are included within this contribution.

Keywords. Hands-on experiments, home-made aids, physics tuition, simple physics experiments.

1. Introduction

"The lack of experimental tools and teaching aids is often seen as an obstacle to experimenting during physics lessons or science lessons respectively. There is no doubt that current prices of the aids are very high and majority of schools cannot buy them. On the other hand, there is lot of cheap and well obtainable things that can be used as useful experimental material. Various ideas how to perform interesting physics experiments with simple home-made aids can be found in [1-3] among others.

We can easily use everyday objects in the lessons. Then students notice that the physics is everywhere. Alternatively, the use of unusual aids can refresh the process of learning. It is not necessary to perform extremely difficult experiments; the untypical aids draw the attention and curiosity of the students like a magnet. Here are a few examples of simple hands-on experiments in this paper. Experiments with a pot and compact discs (CD) are described in the first part of the article. These experiments can be instantaneously performed everywhere. Getting some pot and CD is usually no problem. In the second part, we describe two more sophisticated experiments - easy measurement of the speed of light in the water and a basic principle of tape recorder.

2. Things of daily use as teaching aids

There is a tendency to use many different aids in physics lessons. Which teacher has never used a plastic bottle in his or her lecture? The simple aids are very popular because of their low (almost nothing) cost and easy access. Another important fact is that the students can perform the experiments at home. A teacher can give them homework of an experimental character where they would to use such simple aids.

The first series of the hands-on experiments mentioned within this paper describes few experiments with a kitchen pot and compact discs. In addition, we will only need a few ordinary things.

2.1. Kitchen pot in physics lesson

Kitchen pot can serve as a very useful physics aid. We can perform many interesting experiments with it. Some examples of such experiments are described below.

2.1.1. Electrostatics with a pot

The best choice for this experiment is a stainless-steel pot, which is a common piece of equipment of the household. It is necessary to place the pot on an isolated support such as a piece of polystyrene or stable glass which is also suitable for this purpose. Cut a couple of strips of aluminium foil, 2 cm wide and 10 cm long. Fit the size of your strips to the size of the pot. Bend one edge of the strip to create a hook which enables hanging of the strip up on the edge of the pot. Curve the strip around the pot but do not make a sharp edge – it would not allow the strip to move around. The pot with the hanging strips acts as an electroscope (see Figure 1). Charge it with a plastic tube which has been wiped by a piece of rag (you may draw the students' attention by wiping the tube with the sweater you are wearing). Rub the tube against the pot, turning it all the time to wipe all the charge off from its surface. The strips are tilting now, which indicates that the pot is charged. If we carefully bring the tube near a strip, a repulsion can be observed – the charges of the tube and the pot are the same. The pot can be discharged by touching it with a finger.

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Now you can introduce the task how to charge up the pot with a charge of different polarity than is the polarity of the tube. It is not allowed to use different tools than in the previous case. The experiment is suitable for explaining the phenomenon of electrostatic induction. The procedure is the following: put the charged tube inside the pot without touching the edges. Hold the tube inside and touch the pot with the other hand. After taking the tube out, the tilting of the strips follows. If the tube is brought close to a strip, the attraction of both objects is observed – the charge of the pot must be opposite to that of the tube.

Figure 1. Pot as an electroscope

The pot could also be used as a Faraday cage. It suffices if you hang a couple of strips on the edge of the pot and let them touch the inner side, while other ones are touching the outer side of the pot. Charging the pot up, only the outer strips are tilted.

The connections between electrostatics and electricity are not obvious, especially to students at grammar school who are doing these experiments for the first time. They are not able to imagine that there is something common between the strips tilting at the edge of the pot and electric lighting. They are usually asking “Can the pot-electricity light up a bulb?” It is easy to demonstrate that it is possible (by lighting up a gas discharge lamp, not a bulb, but students will tolerate that) – touching the pot with the edge of the lamp in a dark room, a flash of light appears. The light also appears when you are touching the edge of a gas discharge lamp (which you are holding in your hand) with a charged plastic tube; it happens again even if you are touching the tube at another part, not the edge. It is obvious that the charge is not “moving” through the plastic tube, but stays on one place, until you are approaching to touch it with the discharge lamp. The pot behaves in another way: only one “flash’ appears, because the charge is probably moving close to the tube. This experiment is a good starting point for further explanations of the behaviour of conducting and insulating materials.

2.1.2. Eddy currents in the pot

Electromagnetic induction, the origin of the eddy currents (also known as the Foucault currents) and Lenz’s rule can be easily demonstrated with use of a pot. Perform an experiment with the stopping of a magnetic pendulum. Use the (not ferromagnetic) stainless steel pot again. Make the pendulum from a piece of string and a small magnet. The appropriate attachment of the string and the magnet can be facilitated by using a screw mounted into the string, onto which the magnet can be easily attached. Set up a holder on which the pendulum can be mounted.

Figure 2. Magnetic pendulum above the pot

Place the pot bottom up on the table and put the pendulum above (see Figure 2).

Try at first, to see if the pot is made of ferromagnetic material – demonstrate that it is not possible to attach the magnet to it. Pull the pot away and let the pendulum swing above. Count the number of swings and measure the time until the pendulum stops. Then put the pot under the pendulum and let it swing at a sufficient distance (at least few cm above). Repeat the experiment. Any changes in the damping of the pendulum, with respect to the previous case, are not observed. In the last part of the experiment, place the pendulum with the magnet as close to the surface as is possible without touching it. Swing the pendulum again. Its movement is significantly damped (count the number of swings or the time until the pendulum is damped absolutely). Now you can speak about the creation of eddy currents and the reason why the magnetic field created by such a current damps the pendulum's movement.

2.1.3. The pot and the Newton's laws

The pot can be also used in experiments of mechanics. Try one of them as an inspiration for other experiments. Use the fact that the pot has two handles that serve as two holders. You will also need a string and metal rod (a screw driver or something else). Bind the 50 cm string to the handle. Choose a string which is able to carry the pot, but that is also possible to break (even if it is not easy). It is better to use double-coloured string, because it is more visible. Bind one of the strings to a stable fixture like a blackboard grab handle. The pot with the strings is illustrated in Fig. 3. There is also a string which catches the pot after the breaking of the second string, as otherwise the pot can be damaged after falling onto the ground. Now ask the students which string will break if you are pulling down the lower piece. The answer would probably be "that one on which the pot is mounted". Everything looks clear and simple. The rigidity of both strings is the same but there is the pot mounted on the upper one. While you are dragging the lower string, the upper string is strained more thus its break follows. However, you can demonstrate that by pulling the lower string, you can choose which string will be broken. But how do you break the lower string? You have to pull fast, but your hand could be injured. To prevent this, coil the string around a rod and then pull quickly. The rupture of the lower string follows. Point out also that the string was not broken at the knot, because the students would be suspicious that you might tie a knot which can be easily broken.

Figure 3. The pot prepared for the breaking of the string (The thicker string acts as a safety device to prevent the pot from striking the floor)

Demonstrate also that you can break the upper string. Tie a new piece of string on the lower handle and pull slowly. Then the break of the upper string follows. Now you have a lot of things to discuss, especially in the case of demonstrations of Newton's laws. The pot starts to accelerate due to the force arising from the lower string, it starts to move down and stretch the upper string. This string begins to deform and then reaches its elastic limit. After a sudden tug the force is great enough to induce such a strain that it causes the lower string to reach its elastic limit. However, it is not easy to move the pot because of its mass, as is determined by Newton's second law. Higher force causes a higher acceleration, but only for a short moment of time. Otherwise, it is acting

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only until the string is broken; thus the pot does not have enough time to stretch the upper string. It is possible to perform a lot of other experiments with the pot. Some other ideas how to use the kitchen pot within physics lessons can be found in [4].

2.2. CD in physics lesson

Compact discs (CD) are very interesting from a different point of view. Many teachers use CD as an optical grid for instance. In this chapter we will show some other examples of using CDs as a physics aids.

2.2.1. CD as a flywheel

Figure 4. Spinning CD-flywheel

CD can serve as a flywheel (or gyroscope respectively) after a simple modification of it. The only thing, we have to do, is to glue suitable glass marble into the central hole of CD. Then put the CD-flywheel on the table and spin it. Because of the friction between the marble and table is small, our flywheel will spin quite a long time (see Figure 4).

2.2.2. CD box as a "mixer of colours"

CDs are usually wrapped in a plastic box. This box can be also used as a spinning wheel (spinning top). Remove the upper part of box and glue suitable glass marble into the bottom of the box. The marble can be simply putted under the bottom of the spinning top, without gluing. Then try to spin it on the table, or ground. The manipulation with this spinning top is more comfortable compare to the one from chapter 2.2.1 (but we need the plastic box here). Cut on the circle from a sheet of paper of the same diameter as CD and make hole into the centre of it. Then draw coloured pattern on the paper circle. The pattern can be only black and white. It is not necessary to be coloured, as can be seen from Figure 5. Put the paper circle on the spinning top, spin it and observe the resulting colours and other optical phenomena (see Figure 6).

Figure 5. Mixer of colours (the marble should be glued to a bottom of it, or simply putted under the bottom)

Figure 6. Spinning mixer of colours

2.2.3. Funny cup carrier

Sometimes we need to show some funny experiment during physics lesson. In such a situation this cup carrier can be used.

Drill (symmetrically) three holes into the CD edge. The diameter should be 1 mm approximately. Thread a piece of a rigid thread by each hole and bind them to the CD edge. Finally tie the opposite ends of strings together. Put a cup of water on the carrier and try how it works (see Figure 7).

2.2.4. Bernoulli principle

Using two compact discs, piece of hose and scotch tape can be made an interesting aid for demonstration of Bernoulli principle. Glue piece of hose to the one CD and attach the second one by three pieces of scotch tape (see Figure 8). Then blow into the hose and observe the bottom CD. It will be moving up to the upper CD during the blowing.

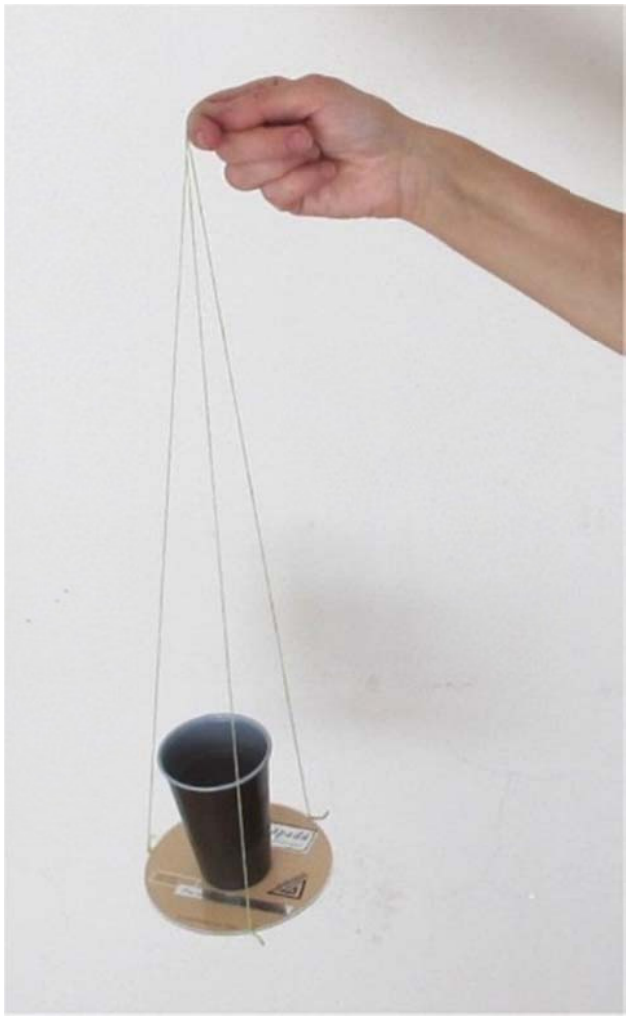

Figure 7. Funny cup carrier in action

Figure 8. Demonstration of the Bernoulli principle

The explanation of this experiment is simple. Air is moving between the CDs with a certain velocity but there is practically no air movement at the vicinity of CDs. It results to a lower air pressure between both CDs compare to the ambient air pressure (see Figure 9).

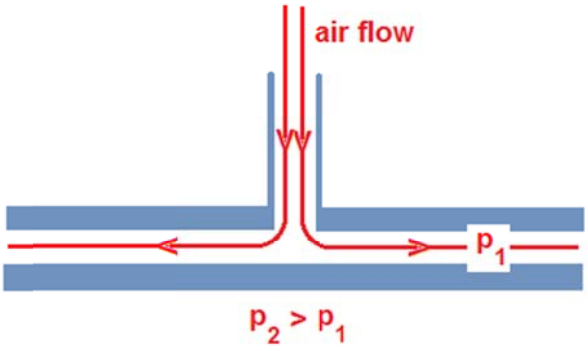

Figure 9. Explanation of the experiment

3. Two hands-on experiments with more sophisticated aids

In this chapter we would like to introduce two hands-on experiments with not simple, but easily accessible aids. The first experiment is focused on the refractive index measurement, the second one shows principle of tape recorder.

3.1. Measurement of the refractive index

In so called hobby markets can be bought electronic distance meter. It is usually equipped by a laser measurement system. We simply shine by the laser beam on the object being measured and read the distance on the display. The device measures, how long the laser signal goes to the object and back. From the known value of the speed of the light (in air) the distance is automatically calculated. If the laser beam goes through some glass container filled by water, the distance shown on the display is not correct. The reason is that the speed of light in water is different from the one in air. This property of the device can be used in our measurements of the refractive index.

Pour water into the glass, plastic or other transparent container. Place the container in front of the wall in such a way so that it touches the wall. Attach the distance meter and measure its distance from the wall. Then do it once again, but without the container. (The distance meter is in the same position as

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before.) By dividing the apparent distance measured through the water by the distance measured in the air we obtain the value of the water refraction index (see Figure 10).

Figure 10. Principle of the measurement of the refractive index

It can be seen from Figure 10, that the distance measured through water was 0.272 m, distance in the air 0.200 m. The refractive index is n = 1.36 approximately. Table value of the water refractive index is 1.33 (at room temperature). It is obvious, that our measurement gave quite a good result. Then students can also calculate the speed of light in water using the value of refractive index.

3.2. Principle of tape recorder

Although the era of tape recorders is over, the principle of the sound recording is still interesting. This experiment is suitable for the demonstration of the applications of our knowledges about electricity and magnetism.

Instead of magnetic tape we will use a tape measure (made from steel). In addition we will need two coils (n = 600 loops and n = 1200 loops), AC source 12 V, magnet and voltmeter.

The coil with 600 loops is connected to the voltmeter – this coil represents playback headstack. Instead of recording headstack we will use magnet. The coil with 1200 loops is connected to the AC source – this is our erase headstack.

Firstly we move by the tape measure inside the erase coil (1200 loops). Then we are moving by the tape through the "playback headstack" – voltmeter shows zero. The recording process is represented by touching the tape by the magnet (alternatively by the north and south pole – for instance: north at 10 cm sign, south at 20 cm sign, north 30 cm etc.) Move the tape through the playback coil again – now the variations in voltage can be seen on the voltmeter. Subsequently the principle of the sound recording can be explained to the students.

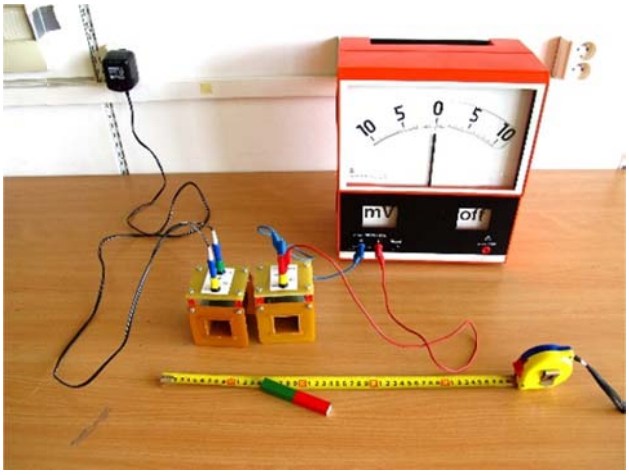

Figure 11. Principle of tape recorder – aids

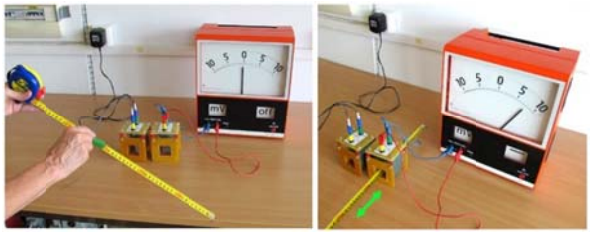

Figure 12. Recording and play-back process

4. Conclusions

The lack of physics aids is an unpleasant thing, but it is not great obstacle for experimentation in physics lessons. It can be seen from our examples, that physics can be studied using ordinary things practically anywhere and with anything. Not only teachers but also the students may bring an idea of some physical phenomenon that can be studied and demonstrated with the use of the things of daily use. Frankly said, this is the best evidence that you are teaching physics well.

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Learning Sciences through a Robotics Project

S Martins
University of Madeira, Funchal, Portugal
smpcm@netmadeira.com

Abstract. In this paper, we will discuss Sciences' learning focusing on Mathematics learning, particularly on the possible engagement of elementary school students in robotics projects. Having, as theoretical support, a situated perspective of learning [1,2] we will focus our discussion on two core concepts: participation and reification. Finally, we will note some observations about the potential of using robots as valuable educational tools

Keywords. Mathematics, robots, sciences, situated learning.

1. Introduction

Today it is widely accepted that the role of the school is a place for the development of scientific literacy for young students from the beginning of their schooling. Several studies emphasise the importance of looking at the teaching of Sciences by addressing not only the scientific contents but also the way in which the students use contents to solve problems and take personal and societal choices. Therefore, it is important to consider the working methods that are capable of providing educational contexts in which students can play an active role in the construction of scientific knowledge.

International documents such as the "Science Teachers' Learning: Enhancing Opportunities, Creating Supportive Contexts" report [3], address the need to think education in Sciences as capable of highlighting not only the content of Science, for example facts and concepts, but also the doing of Science: the habits of mind, skills, and practices that bring science to life and make it a compelling enterprise.

According to [4], a good elementary Science program should not distinguish between those students who will eventually become scientists and those who will chiefly use their knowledge of Science in making personal and societal choices. Hence it is necessary to consider an education for science that is capable of developing ideas and scientific ways of thinking and that aims to provide the students with a core set of skills that enable them to become citizens fully capable to live and work in society in a critical and interventional way.

The report from the European High Level Group on Science Education [5] advocates the significance of pedagogical practices based on inquiry-based methods and problem-based learning in which learning begins with a problem to be solved. The problem is posed in such a way that students need to gain new knowledge before they can solve the problem. Rather than seeking a single correct answer, students interpret the problem, gather the needed information, identify possible solutions, evaluate several options and then present their conclusions.

The potential of the project-based approach has also gained terrain in Science Education. According to this methodology, students and teachers are involved in the development of common projects, having a specific purpose. This purpose can vary from a scientific concept that one intends to know, a technique that one wants to master, an artistic production that one wants to create [6]. In all of the presented examples, it is this purpose that keeps the people involved [7].

In education, there is a growing interest through Scenario-Based Learning [8]. Although the concept of scenario has not yet been conceptualized in the educational field, in the last few years, educators of the most distinct areas have been focusing on the potential of creating learning scenarios as a tool for planning educational activities that aim to develop the critical spirit, the ability to anticipate and to solve problems, allowing students and teachers to engage in innovative ways of working.

Scenarios are a good method when we expect students to 'perform' rather than 'inform', once designing and implementing learning scenarios enables teachers and students to be engaged in learning by doing something, such as developing a practical problem or creating something that is meaningful for them. It is also true that technology has influenced in the way learning scenarios are designed. New roles and new

skills emerged from integrating technologies in learning scenarios.

In this paper, we will analyse and discuss a learning scenario with robots that followed a project-based approach. By doing that, we intend to reflect upon three main questions related to Sciences' learning: i) How to conceptualise scientific knowledge? ii) What opportunities are offered by the school so that this knowledge can be produced by the students themselves? iii) What role does the robot play in Science / Maths learning?

2. Learning as Participation

The research developed by Lave and Wenger [1] supports the idea that learning is placed in the physical and social contexts in which it emerges. Knowledge is something that only makes sense when is conceived in relation to the social practices in which it is relevant and in which it is developed. From this point of view, to learn means to participate in social practices.

Learning in this sense is not a separate activity. It is not something we do when we do nothing else or stop doing when we do something else. According to Wenger [2], there are times in our lives when learning is intensified such as when we are challenged beyond our ability to respond, when we wish to engage in new practices and when we seek to join new communities. There are also times when society explicitly places us in situations where the issue of learning requires our intentional focus, for example, attending classes, memorising, taking exams, and receiving a diploma/certification. But situations that bring learning into focus are not necessarily those in which we learn most, or most deeply.

Wenger [2] presents four premises that support the construction of his social learning theory: 1) we are social beings, 2) knowledge is a matter of competence with respect to valued enterprises, 3) knowing is a matter of participating in the pursuit of such enterprises, that is, of active engagement in the world and 4) meaning – our ability to experience the world and our engagement with it as meaningful – is ultimately what learning is to produce.

To conceptualise learning as a situated phenomenon implies to consider learning as an integral part of the practices in which people are involved and participate. Consequently, learning something will always involve engagement in practices in which that knowledge is immersed. Placing the focus on participation has broad implications for what it takes to understand and support learning, or more specifically, Sciences' learning. In particular, the idea that learning is never disconnected from the context from which it occurs. Therefore, it is evidently important to consider the social and cultural context in which learning occurs.

Along with participation, reification is a very relevant concept in this theoretical approach. Reification means to give a concrete form to something that is abstract. Wenger [2] states that any community of practice produces abstractions, tools, symbols, stories, terms, and concepts that reify something of its practice in a 'congealed' form. This author deeply describes a duality between participation and reification. According to Wenger [2], our experiences of meaning and our understanding about the social practices in which we participate are formed through two processes of participation and reification.

Participation is how we learn through interaction with others and reification is how we give our learning and independent existence, by producing a conceptual or physical product, e.g. a monument, a formula, a poem, a book…

It is through a continuous negotiation of meanings that it is possible to transform something abstract into a concrete thing. Wenger [2] states that "(…) in participation we recognize ourselves in each other and in reification we project ourselves onto the world" (p. 58), thus showing that the duality reification-participation is necessary for learning to take place. According to Wenger [2], participation and reification are processes that cannot be seen by themselves nor seen in opposition. Meaningful learning in social contexts requires both participation and reification. Wenger argues that participation and reification are complementary and mutually reliant on each other therefore, one cannot function without the other. The correct balance of each is essential, for example, by giving form to tacit and explicit knowledge, a new tool (physical or conceptual) is created. The two processes must evolve alongside each other for 'negotiation of

meaning' to take place.

3. A Learning Scenario with Robots

The learning scenario supports this research followed a project-based methodology involving two primary school classes (Year 2 & 3, 24 and 16 students, respectively) from a school in Funchal, Madeira island – Portugal, working together with robots. In the beginning of the project, students watched the movie trailer for 'Wall-E'. Then, they drew what a robot was to them. They then manipulated artefacts, built from Lego parts, but not all of them being robots. Discussion in a large group was conducted in order to construct a shared idea of what a robot was.

In the following session, students began the work in groups formed by students from both classes. Ten working groups in total. For this session, robot assembly kits and assembly instructions were created by researchers, in a number greater than necessary, allowing the groups to choose which robot they would like to build. In this project, students worked with Lego robots: RCX and NXT. Researchers presented the students with the different motors, brains and sensors to make up a robot. As students finished assembling the robots, they began their programming. Next, each group wrote a paragraph describing the physical and emotional features of the robot constructed by the group. Their creations (robots) were to become characters in a play written by them all. After writing the story, students had to program their robots in order to perform their roles in the play. The initial goal was to accomplish those tasks in order to make a play with the robots as characters.

In the next school year, students, teachers and researchers decided to produce a film using the written story as the storyline. Students established new tasks to produce the film and they created teams to accomplish those tasks. Each student chose the team(s) they wanted to work in. At the end of the school year, the movie was ready and was shown to the entire school community.

4. Learning Science with Robots

The learning scenario described above was very 'open' resulting in a high level of interdisciplinary of the developed activities. The contents of different subjects (Language, Arts and STEM - Sciences, Technologies, Engineering and Mathematics) emerged from the developed activities in the project. In this paper, we will give particular attention to Mathematics learning, however we will discuss situations that carry evidence of the negotiation of meanings from other sciences.

In the beginning of the project, the joint negotiation of the definition of 'what was a robot' was very important as it allowed students and teachers to build a shared idea about the artefact that would assume a central role in the following activities. However, it was important that this negotiation had not been made in the 'abstract'.

Figure 1. Students manipulating a non -robotic Lego construction

Instead of presenting an already constructed definition, reified in other practices, of what a robot is, students and teachers had the possibility to manipulate different constructions building their own definition of what a robot is.

The opportunity that students had to manipulate and to discuss the features of the available constructions allowed them to negotiate meanings related with Computer Sciences, namely in the field of robotics, defining a robot as "a machine capable of acting autonomously, according to our will". They also expanded their knowledge about the

components of a robot (motors, sensors, brains, batteries, etc.) and its functions. This knowledge deepened when students built and programmed their own robots.

We observed that within each working group, each student acquired knowledge, in a greater or lesser depth, about how their robot was built concerning its robustness or fragility, the parts that make it up, the motors and sensors used and how those components were used in their robot. Thus, the construction of their own robots helped students to learn about the mechanics of the robotic structure they were building, once they had analysed and chosen which pieces to use, how those pieces fitted together, what their functions were and how and why they produced movement.

Figure 2. Students manipulating a Lego Robot

Besides the undeniable contribution in the development of Computational Thinking [9], the robot programming was a productive tool to the negotiation of mathematical meanings, namely those related with time and positioning. Robot programming was made using sequences of program blocks that represented sequences of instructions for the robots. By doing that, students negotiated mathematical meanings related with time such as before, after, during, at the same time, etc.

Furthermore, in robot programming, students negotiated the meaning of spatial notions such as forward, backwards, turn right, turn left, rotate to the right, rotate to the left, etc. With robot programming, the robot assumed a very important role in the negotiation of these mathematical contents.

Figure 3. Students building a Lego Robot

Figure 4. Lego Robots moving in constructed streets

Students also observed that two robots could travel in two intersecting streets however, there was no a guarantee that those robots will meet each other because they could be traveling at different speeds. They argued that the one moving faster (the one with the greater speed) will go farther than the one moving slower in the same amount of time. By discussing the robot's trajectories, students experienced and discussed ideas in the domain of physics, namely the core idea that speed involves both distance and time.

5. Conclusions

To conclude, to consider learning as participation implies taking into account certain premises. In particular, when we use this theoretical perspective to support a reflection about Sciences' education. It is paramount to give particular attention to three aspects that we consider relevant in the scope of this research: i) how to conceptualise scientific knowledge? ii) What opportunities are offered by the school so that this knowledge can be produced by the students themselves? iii) what role does the robot play in Science / Maths learning?

In the emerging practice of implementing the Learning Scenario with robots, the knowledge gathered by the students was shaped and negotiated in accordance with the emergent situations of the practice. Learning was not an end in itself. It emerged from participation in the developed activities. It is shown that the learning of scientific concepts from different domains occurred through students' immersion in a school culture where those concepts were part of the actions that they were performing in the project with robots.

The discussions in this paper of learning Sciences, or in a general way, learning Mathematics, demonstrates its meaning, 'to participate'. But 'participation' does not refer to the obvious meaning of student participation, of what it could mean to participate in a 'traditional' Science/Math class. To participate did not mean to raise a hand in response to teacher's questions or to solve exercises on the blackboard. In this practice, to participate has involved to negotiate meanings, take responsibilities, be accountable, expose weaknesses and use potentialities in order to accomplish the shared enterprises [6]. But as we have analysed, together with participation, reification has played a central role in the negotiation of several scientific contents and procedures. According to Wenger [2], meaningful learning in social contexts requires both participation and reification.

In Mathematics classes, or more broadly, in Science classes, scientific concepts and procedures are often presented to students as products already reified in practices that go beyond the classroom practice. The reification of these elements was not tangible for the students as they did not participate in the process of constructing its meaning. Another paradigm often presented in Science classes is that students learn, not in function of their present, but in function of what may eventually be their future. According to this assumption, the production of scientific knowledge aims its use and possible reification in future practices, in which students are not yet, nor do we know if they will be involved. Certainly not all our students will be scientists, however it is important to give them the tools to become one or not. As seen in this learning scenario, the involvement that students gave to science in their school practice was related to problem solving whereby knowledge was meaningful to them.

Along with the negotiation of the meaning of scientific knowledge, it is also important that students negotiate the meaning of what Science entails. In this sense, an Education for Science should always allow students to work collaboratively and to set goals and objectives that they want to achieve. It is also important that students have the opportunity to solve problems where the contents of the most varied areas acquire meaning and have space and various opportunities to exercise their creativity and imagination. According to this idea, we think that the design of Learning Scenarios, which involve interdisciplinary projects, surely represents a good resource to improve Sciences learning. Finally, aforementioned in this paper, the inclusion of robotics in a learning scenario may also be an advantage to the negotiation of meanings of several scientific domains.

6. Acknowledgments

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Invest in the Capacity Project and Project Erasmus + STEM For All Seasons. An Integrated and Interdisciplinary Approach in Education

A Lemos, A Céu, A Xavier, C Sobral, F Almeida, F Tavares, J Sousa, L Carreiró, N Batista, O Carvalho, R Sofia, T Martins
Nelas Schools Group, Nelas, Portugal
diretor@edufor.pt

Abstract. World Economic Forum refers to 6 basic literacy skills, 4 competencies that enable the achievement of complex challenges and 6 qualities of character, out of a total of 16 of the 21st century skills necessary for future success. This Forum argues that this is the way to narrow the gap between what is taught and what is needed. We can say that, of these competences, there are few that have not been worked on in the Investing in Capacity Project (PIC) in these five years of existence - allied to this year's Erasmus + STEM For All Seasons Project. This is a project (PIC), based on Gagné's Differentiated Model of Giftedness and Talent, for gifted or above-average students, in which students can develop competences in three multidisciplinary areas: Communication (which includes areas such as History, Archeology, Geography, Philosophy, Psychology, Portuguese, English, Education for Citizenship), Science (Mathematics, Physical and Chemical Sciences, Natural Sciences, Biology, Geology) and Creativity (Music and other forms of Art). Schools are (more or less) prepared to implement norms directed to students with special educational needs, but have been more resistant to implementing Educational Success Promotion Measures aimed at students with more skills - forgetting that these students also have special (or specific) educational needs (even if the term hurts some susceptibility). These students have already received special attention from specific legislation on Special Education, and are still not forgotten in the current legal norms, in Portugal.

Although we have not yet been able to show the influence of the PIC on the students' school results (for more than 25 years CEDET in Brazil has been trying to do so, surrendering to the fact that, for the students' school results, several factors are involved), the students' adherence to it, and the way in which it is expressed (aspects that will be discussed throughout this paper), allow us to propose that the PIC - and now also the STEM For All Seasons - is an interesting form of integrated and interdisciplinary approach in Education.

Keywords. Differentiated intervention, giftedness, talent.

1. Introduction

Literacy, numeracy, scientific literacy, ICT literacy, financial literacy, cultural and civic literacy. Critical thinking / problem solving skills, creativity, communication and collaboration. Curiosity, initiative, persistence / strength of character, adaptability, leadership and social and cultural awareness. These are, according to the World Economic Forum [1], respectively, the 6 basic literacy skills, The 4 competencies that enable the achievement of complex challenges and 6 qualities of character, in a total of 16 competences of the 21st century necessary for future success. The Entity argues that the school should focus on the development of these skills, thus narrowing the relationship between what schools "teach" (different from what students "learn") and what, in the role of active citizens, students need.

It can be said argued that, of these competences, there are few that have not been worked on in the Project Investing in Capacity (PIC) in these five years of existence - allied to this year's Erasmus + STEM For All Seasons Project.

2. Presentation of the PIC

The Project Investing in Capacity (PIC), which was born in the Portuguese Association of Gifted Children (APCS), and has been funded since the first edition by Lapa do Lobo Foundation, has been implemented in the Nelas Schools Group since 2012/13. The diversity of activities that characterize the project has been possible thanks to a very broad set of Partner Entities, highlighting those that have been maintained throughout these years, namely: Nelas Schools Group, Nelas Town Council, Catholic University Of Viseu, all the Higher Schools of the Polytechnic Institute of Viseu, Edufor Training Center, the

Portuguese Institute of Sport and Youth and the aforementioned Lapa do Lobo Foundation.

It arose as a need to respond to students with more skills, not always understood as such, even in the presence of a gap between their abilities and the school requirement - and even in the way it is organized - often leads them to demotivation and to results far short of what they could be. In addition, these more capable students have deficit areas that need to be developed urgently. Removing the preconceived ideas associated with Giftedness is also one of the objectives of this project, information that has already been shared with parents, teachers and Institutions partners of the Project, in Training Actions and sent documents.

3. Myths associated with Giftedness

Here are some myths [2]:

3.1. Gifted children do not have special educational needs

It is enough (and only as an example) to consult the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, 5th edition) to realize that giftedness can occur in students with Specific Learning Disorder, including in this diagnosis Dyslexia. By consulting the immense list of prominent people in society, past and present, there is no shortage of people who, despite their talent and endowment, have presented notorious difficulties in school.

3.2. Gifted children do not suffer any kind of personal and social maladjustment

This is one of the areas where these children and young people most feel the mismatch: the distance between their interests and abilities compared with the age pairs leads to reciprocal incomprehension and sometimes to bullying (both as victims and as aggressors), with all the consequences that we are aware about.

3.3. Working differently with gifted children is creating an ellite, undemocratic

The school has to realize that each student has its peculiarities, that to give all the students the same is not to include. The slogan, for some time now, is equity, not equality: to give each one what each one needs. The current Portuguese legislation (Normative Order 1-F / 2016) allows, among other differentiations, the temporary constitution of groups of students according to their needs and / or potentialities. The PIC has legal framework in this logic, which already comes from previous legal regulations.

3.4. The context in which gifted children are inserted does not make any difference in their development

This and the following myths refer to the theory underlying the PIC, summarized in section 4 of this paper. Giftedness and talent - are, in fact, the contexts that allow to transform the potential (giftedness) into product (talent).

3.5. Gifted children and young people always have good results when they undergo intelligence tests

Linda Gottfredson [3] states that intelligence is a very general mental capacity, which, among many others, involves abilities to reason, plan, problem solving, abstract thinking, understand complex ideas, and learn from experiences. According to the theory behind the PIC, summarized below, we realize that when we speak of intelligence, we are not talking about a single construct.

4. Gagne's Differentiated Model of Giftedness and Talent

In its Differentiated Model of Giftedness and Talent (DMGT) [4] Gagné distinguishes between dotation (a term that prefers to gifted) and talent:

Dotation or natural ability (potential)

The author distinguishes five domains, four of them mental: intellectual, creative, social and perceptual. The latter two are physical capabilities: muscular, capacities devoted to broad physical movements, and capabilities associated with fine motor control and reflexes.

Talent (achievements, performances)

In the DMGT, nine fields of talent appear: academic (languages, mathematics, science, etc.); technician (transport, construction, crafts, etc.); science and technology (engineering, medicine, etc.); arts (creative, written, visual,

spoken, etc.); social service, administration / sales, business operations, games, sport / athletics. The way students are selected for the PIC follows this logic. In fact, there are two forms of selection: (i) through the teachers of the students who are asked to complete an online questionnaire, whose data collected data is processed by a team with knowledge for this purpose - this questionnaire evaluates the talent, that is, what the students produce and that is observed by the teachers; (ii) one form of direct entry into the PIC is through a psychological assessment, which focuses on natural abilities.

Gagné points out that this model allows us to better understand the concept of underachievement, referring to the gifted intellectually students, below the talent they could reveal, students with academic performances below their potential (natural ability).

Natural ability turns into talent due to catalysts: intrapersonal and environmental factors.

5. Competence, expertise and ability(ies)

In addition to the terms dotation and talent, Zenita Guenther [5] addresses these three: competence, expertise and ability (ies).

Competent describes a level of performance that exceeds the minimum requested for common action; it is a broad set of competently trained skills. The term expert refers to consistent and reproducible superior performance. The last term referred to, abilities, is related to a broad set of skills trained (among them, teaching skills). We can find in these three terms the relation between dotation and talent.

The aim of the PIC is to transform the natural ability into talent, and therefore aims to act as a catalyst for this passage. In these five years of PIC, on average 36 students per year participated in the project. All of these students were given opportunities to develop skills considered essential to future success, according to the World Economic Forum.

Divided into three areas, over five years the PIC has aimed to broaden the curriculum goals - either through the enriching experiences it allows, because they are motivated by specialists in the focused areas, or because the proposed goals are beyond the year of schooling of the students - so that, taking advantage of their potential, these students become competent.

5.1. About the organization of the PIC

The PIC is divided into two phases - the group phase and the individual project phase.

From the second to the sixth year of schooling (although this logic has undergone changes throughout the project years), the students are in the group stage: the group of first cycle students - for whom are proposed curricular goals of the fourth and / or the second cycle - and the group of students of the second cycle - whose goals are those foreseen for students also of higher levels of schooling. Here, they develop a set of proposals within three areas, which include, according to a multi and interdisciplinary logic, a variable range, different from year to year.

There is also the individual projects phase, attended by students who have already been in the project and who are in the seventh grade (there have also been changes throughout the PIC). These students are selected according to specific criteria.

In both phases, there is concern about the incentive to practice values - the same ones that the Working Group established under the terms of Order No. 9311/2016, of July 21, advocates [5]:

- Responsibility and integrity: the students can not miss to the activities of the PIC without justification presented by their parents (unexcused absences are grounds for exclusion of the PIC); they should follow the guidelines given or according to what they have defined for their projects.
- Excellence and requirement: this is one of the objectives of the PIC, it is what is expected of all stakeholders (teachers, partner institutions and students); students are encouraged to give their best, accepting that it does not always translate into excellence.

- Curiosity, reflection and innovation: going beyond what is being worked out in the school year in which each student finds himself is one of the ways of achieving these values; the qualitative and quantitative assessment that all students undertake at the end of each activity and, more generally, at the end of each edition of the PIC, also allows for a systematic reflection of what has been done and of the learning carried out in each session; beyond these moments, all sessions are constructed according to the assumption that each student is an agent and not a spectator.
- Citizenship and participation: the activities carried out within the framework of the individual projects proposed by the PIC's older students, aim at this aspect of social participation: intervention with the elderly and with children, survey of architectural barriers, among others, mentioned in this paper.
- Freedom: this aspect is also particularly important in the individual project phase of the PIC, as students select their projects and determine the paths they will take, guided by teachers / technicians in the areas they choose.

5.2. 21st century competencies in the PIC - group phase

We have already remembered them: literacy (and its various types); critical thinking / problem solving skills, creativity, communication and collaboration; curiosity, initiative, persistence / strength of character, adaptability, leadership and social and cultural awareness.

Activities are planned at the end of the previous school year, and after multiple contacts, including face-to-face meetings, activities are agreed with the specialists of the partner institutions or other organizations that we request in order to fulfil the project objectives.

We selected some activities, by way of example, that had as curricular goals and as an objective the development of the abovementioned competences (they are not mentioned by school year nor by group of students):

Area of Communication (includes Portuguese, English, Philosophy, Psychology, History, Geography, Archeology, Citizenship...)

- Produce oral and written speeches with coherence and linguistic correction, in standard Portuguese (Escola Superior de Educação de Viseu);
- Work on self-knowledge (Universidade Católica Portuguesa de Viseu);
- Provide contact and knowledge of the archaeological artefacts in the collection as well as their functionality (José Coelho Archaeological Collection - Viseu);
- Become aware of sexually transmitted diseases; to become aware of the importance of health units for the increase in the average life expectancy (Escola Superior de Saúde de Viseu);
- Write a scientific report (Viseu School of Health);
- Work as a team and engage in collective activities, reflecting on issues that are associated with them; participate in debates, respecting the rules of democratic debate, grounding their opinions and respecting those of others (Nelas Town Council);
- Know the administrative organization of the State; know the evolution of the population of Nelas; know what it means to represent others and to be represented by others; use democratic decision-making, in particular the vote (Municipal Council of Nelas);
- Adapt the discourse to the communication situations and the nature of the interlocutors (Lapa do Lobo Foundation);
- Work on emotions: Program for the Promotion of Social and Emotional

Competences (Catholic University of Viseu);
- Understand the notion of assistance: construction of maps and models (Senior University of Nelas);
- Know and understand the influence of maritime expression in the Portuguese sciences, literature and art (Museu Nacional Grão Vasco);
- Understand and compose/create texts with argumentative characteristics - creative writing (Lapa do Lobo Foundation);
- Recognize the specific contribution of Philosophy to the development of an informed, methodical and critical thought and to the formation of a conscience that is attentive, sensitive and ethically responsible (Portuguese Association of Ethics and Practical Philosophy);
- In contact with sites that are being operated by teams of archaeologists, understand the process of hominization (Nelas Town Hall);
- Know and understand the Portuguese democratic revolution, in a place that played an active role in this historical context (Regiment Infantry 14 - Viseu).

Area of Science (includes Mathematics, Natural Sciences, Physical-Chemical Sciences, Biology...)

- Contact with robotics: flexible cell of manufacture, automated / robotized pharmacy and experiments with automata (School of Technology and Management of Viseu);
- Understand the functions of an Environmental Monitoring and Interpretation Center (Viseu);
- Contact with the notion of forces (Nelas Secondary School and School of Technology and Management of Viseu);
- Establish a first contact with the notion of molecular biology (Biomedical Sciences - Catholic University of Viseu);
- Contact with professions related to health (Dental Medicine - Catholic University of Viseu);
- Understand the BI of the mineral, create dunes, understand the water cycle and its importance for living beings (Living Science Factory - University of Aveiro);
- Explain and represent chemical reactions (School of Technology and Management of Viseu);
- Understand and work on notions of algebra, geometry and functions; (Nelas Secondary School);
- Understand some phenomena related to electric current and electrical circuits (Electrotechnical Engineering - School of Management and Technology of Viseu);
- Systematize the changes occurring in the body, describe the vital systems, explain the function of bones (Viseu School of Health);
- Contact with the anatomical diversity of animals (Biomedical Sciences - Catholic University of Viseu);
- Realize a little of what the scientist BE presupposes: identifying and verifying properties of the materials; Identify materials and organize them on the basis of diversified classification criteria; Identify factors that may influence behavior... (Nelas Secondary School);
- Understanding the levels of biological organization of ecosystems (Escola Superior Agrária de Viseu);
- Understand the phenomena of the day in which the light intervenes; Understand some optical phenomena and some of its applications (Nelas Secondary School);
- Understand the importance of rocks and minerals (Quartz Museum - Viseu);
- Work on aspects related to sense organs, geometric figures and geometric properties (Nelas Secondary School);

- Understand the importance of the digestive system for the balance of the human organism; To work on aspects related to volume (Nelas Secondary School);
- Explore various systems of the human body using various interactive modules (Exploratory - Ciência Viva de Coimbra);
- To develop a set of activities to meet the theme: to discover the carnivorous plants of the Botanical Garden (University of Coimbra);
- The motto "Cai or no cai" allowed to understand situations of fluctuation or sinking of bodies in fluids; Nutritional changes between the organism and the environment; The volume measures (Nelas Secondary School).

Area of Creativity (includes interpretation and artistic-motor expression...)

- Adapt and dramatize literary works (Viriato Theater);
- Enable the interpretation and expression of emotions through movement, camera and light painting sessions (Portuguese Institute of Sport and Youth of Viseu);
- Imagine «the house of my dreams»: construction of a model representing the ideal house of each student (Architecture - Catholic University of Viseu);
- Construct images for animation: materialize the development of an idea, intentionally use the interactions of the visual elements; adapt the means to the idea that is wanted to materialize; make contact with values, attitudes, problems, specific vocabulary of professionals of artistic activities); (Cine club of Viseu);
- Value the musical expression of one's own and others' - rehearsal and recording of a musical theme (Editions Convire à Música - Santa Comba Dão);
- Value one's own and others' musical expression - rehearsal and recording of musical themes (listening to a concert at Music House - Porto).

The activities conclude with a final trip, in two years of two days, which always has two main objectives: to foment the strand of socialization and to extend learning.

6. 21st century skills in PIC - individual projects phase

Project Individual Phase was held in three of the five years, in which students were selected to propose projects in areas of their interest, requesting to supervise this work specialists in the chosen areas. It may be stated that the essential competences referred to in this paper are worked on in these projects. Projects such as detecting architectural barriers, cognitive stimulation with the elderly or building games to work with oral hygiene with children may specifically allow the development of competencies related to leadership and social and cultural awareness.

Figure 1. Individual Project: survey of architectural barriers in Nelas

Projects such as "From cell to molecule or how saliva can be the mirror of the body" have enabled the specific development of scientific literacy.

All individual projects allow you to develop skills related to problem solving, critical thinking, creativity, communication, collaboration, curiosity, initiative, persistence / strength of character, adaptability and leadership.

In the academic year 2016/17, thanks to one of the several PIC Entities - the Edufor Training

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Center - students in the individual projects phase are developing projects aimed at students with more skills from 4 to 12 years old, within the framework of an Erasmus + Project, designated STEM for All Season.

7. STEM for All Seasons project

The overall objectives of the STEM for All Seasons project are: to improve the overall provision in STEM (Science, Technology, Engineering and Mathematics) in all partner schools through effective teacher training; encourage the use of more effective and innovative teaching methodologies; increase motivation of students and teachers.

In the context of this project, a transnational meeting was held in Germany in which three members of the Portuguese team participated, and two formations, one in Ireland and one in Greece, with four members of the team participating in each of them.

The teachers of the team have as mission to coordinate the individual projects of the students, next enunciated, as well as to collaborate in the use of the project for the whole group of schools. The projects selected by the students within the scope of this project have the following designation:

- Influence of climate on caste selection by region;
- Impact of industrialization on the microsystem;
- The permanence of the native plants in the region taking into account the climate;
- Our wines;
- Construction of a digital anemometer to study the location of wind micro generators;
- Our atmosphere.

This project is taking place in five countries: Ireland (coordinating country), Germany, Greece, Slovenia and Portugal. The starting point is the Meteorological Station that each school in each country has acquired and, based on the data that each season allows, activities are built for students between the ages of 4 and 12. The weather station of the portuguese school is online [6]. The activities that have been carried out can be viewed on the project's blog [7].

Figure 2. Student in construction in his project - Biomedical Sciences - UCP-Viseu

The project started in September 2016 and lasts for 30 months. In Portugal, the PIC may be considered to be part of the STEM for All Seasons project, as it is developed by students who are in the process of individual PIC projects.

8. Accountability / evaluation of the PIC

Each year, the PIC is subject to quantitative and qualitative evaluation by the students, who evaluate all the sessions as well as the overall project, at the end of each edition. Also, the parents and PIC's teachers assess the project and the need for continuity of the project. Table a records the assessment of the PIC (from 0 to 10) by the students (excluding PIC 5, which is still ongoing).

Although it is part of the objectives to realize the extent to which the PIC contributes to the school success of the students, the only perception we can have is the opinion of parents and students, according to which there is a positive relationship between (formal and informal) learning and the school success of the participants in this project. In fact, CEDET has for many years been trying to understand if there is a relationship between the project they develop in that institution and gains, especially

academics, in the students, without success. In fact, many factors contribute to school success or lack of it. Isolating each variable can be a herculean task - maybe possible?

PIC	Average for areas		
	Com.	Scienc.	Criat.
1	8,5	8,2	8,3
2	9	9	9,5
3	9,6	9,5	9,3
4	9,5	9,8	9,7

Table 1. Quantitative assessment of the PIC, by area - average of the assessment done by the students at the end of each session

9. Conclusion

It is a fact that we do not know if the existence of the PIC in our Group of schools allows the results of the students that integrate it to be more positive - they would do it without the PIC. However, the evaluation, especially qualitative (also quantitative) that brought to us, referring to the opinion of students, parents and teachers, has been more than enough to continue believing in this project.

10. Acknowledgements

The PIC would not be possible, at least with the quality that everyone recognizes, if it were not for the exceptional Partnerships, especially those that have been in the project over the years mentioned in this paper.

A special thanks to the Nelas Schools Group, to all the structures that, in one way or another, make this project possible. Teachers who have been interested in the project, without specific hours in their timetable attributed for the purpose, others accumulating the functions of experts - as has happened in the area of Sciences. A thank you to the students and parents, who have believed in the importance of this form of differentiated care, contributing to its existence. To the elements of the Directorate, in particular, because they believe in the principle of equity, showing particular attention for the whole and for each one, on both sides of the Gaussian curve.

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Hands-on Earth Science in the Primary School

D Balmer
IOE.UCL London, UK
denise.balmer1@ntlworld.com

Abstract. A career background in earth science coupled with teaching and promoting STEM activities, has led the author to believe that earth science can have a significant impact on early science teaching and learning. The paper identifies the importance of earth science and looks at the ways the topic 'weather' can be used through technology and the learning of scientific skills as well as providing practical everyday science at a level all can understand. The paper looks at issues concerning the role of science education in primary schools, the need for effective learning of science and technology, hands-on active learning of science, developing basic investigative skills and the scientific method, as well as tackling scientific literacy and science and society.

Keywords. Earth science, hands-on, primary school.

1. Introduction

Most of my various careers has been spent promoting science, technology, engineering and mathematics (STEM)– through working in meteorology; teaching geology and earth science; working with primary and secondary schools promoting STEM by working with students and pupils alongside their teachers and professional scientists and engineers; I am now looking to using of these experiences with the aim of developing science in primary schools using earth science.

2. English National Curriculum for primary science and associated issues

Primary science in England has to be taught in line with our 2014 National Curriculum [1]. This curriculum states that the purpose of our science education programme is to provide the "foundations for understanding the world through the specific disciplines of biology, chemistry and physics". (Earth science is not mentioned by name.) Science, the curriculum states, should evoke curiosity and be exciting [2].

The curriculum goes on to say that pupils should be able to understand how science can explain natural phenomena; how things will behave and why. The programme outlines study from KS1 (ages 5-7) through to upper KS2 (age 11), expecting children to acquire an extended specialist science vocabulary and also for science to be included in the wider curriculum by looking at its social and economic implications. However, many of our English primary teachers do not have a science background, and whilst they are often interested in specific topics, they generally do not have the necessary knowledge to teach the subject – and frequently have their own misconceptions. Recently, I was recently in a primary school where the teachers had interpreted the fact that as sediments were deposited in layers, sedimentary rocks would themselves show layers – and slate was being identified as a sedimentary rock. I explained that these 'layers' of sediment were hundreds of feet thick and were really thick beds of sediment which eventually were compressed and compacted into rock which rarely showed layers.

It is these sorts of issues from misinterpreted science language and poorly written texts that contribute to misunderstandings which stay with people for life. Above is just one small example from a recent teaching session. I suggest, therefore, that it is important that what we might be better doing is teaching science skills and understanding of the local environment with fewer (inaccurate) facts/knowledge, in our primary school science.

3. The reason for teaching earth science

Earth science is a subject area which has all too frequently been overlooked in preference for what is commonly seen by curriculum planners in England as 'real science', physics, chemistry and biology. So what is earth science? My diagram will explain (Figure 1). Earth science is at the centre of most of our lives. As young children we are aware of the world around us and have ideas of how it works long before we get to school and start to learn about the intricacies of world systems. As adults we need to be aware of earth science and how almost everything we humans do will have some effect upon our environment – we all need to know what we are doing to our planet and the results our actions will have on

its sustainability. On the diagram, the first ring surrounding the centre divides earth science into its component parts, all of which have a bearing on our everyday lives. The second ring further divides these component parts into more recognisable pieces that can be easily seen to relate to everyday life. The third ring again identifies subject areas that are the components of the second ring. Beyond that we need the language and ways of communicating earth science to everyone.

I would assert that earth science is by far the most important of all sciences, since it appertains to the real world. The need to learn earth science is widely argued by such learned societies as the Geological Society (of London) and the Geological Society of America. Indeed the Geological Society is in no doubt of the great importance of geology and in June 2015 issued its policy document 'Geology for Society' in thirteen languages through the European Parliament. The original, published in Britain in March 2014, suggests that geoscientists must communicate their information better, since the general public really should be more knowledgeable about issues pertaining to earth science, for example climate change, so they can participate more knowledgeably in informed debate. To this end, the Geological Society maintains there is demand for high quality education backed by good training and research funding to sustain earth science skills and its research base in the UK so that the country can compete internationally. This paper outlines the importance of thirteen geological issues such as environmental health, mineral resources, water and geohazards, amongst other issues, as being increasingly significant in everyday life. One interesting section of this report analyses the impact of human activity on the planet, identifying this as a new geological period - the Anthropocene [3].

Possibly the most damaging effect human activity has had on our planet has been the impact on climate change since the industrial Revolution. If our societies became more scientifically literate than at present then they would perhaps understand this kind of impact and work towards alleviating some of the problems.

Figure 1. The importance of Earth science

4. Impact of current primary science

Currently our schools – in England at least - are not necessarily teaching science that enables all students to become discerning citizens where science is concerned. In part, this may be due to the teaching of science in primary schools where many teachers do not have a science background as suggested before and sometimes have difficulty teaching the subject as laid down in our English National Curriculum. There is also still a universal debate about the reasons for teaching science in school whether for career purposes only or to educate scientifically literate citizens [4].

Other European countries suffer from the same predicament, of having few trained science teachers in primary schools. Northern Ireland is currently implementing a new science programme which includes much earth science and early results show that this is being successful in encouraging primary children to continue science in secondary school [5]. Research suggests that when teaching science to young children, the use of ideas and examples known to them using accessible local resources, encourages children to view their environment from experience [6]. Having a vested interest in what is happening and why in their locality increases children's motivation and enjoyment of science [7-8]. Weather is one such activity which is easily accessible. It is also a common topic of everyday conversation between all peoples.

5. Weather in the primary science curriculum

Children can investigate weather – observing, recording and analysing their own data at little or no expense – gaining valuable scientific skills. For example: Turkish children

became highly motivated when investigating real life issues caused by schools being closed because of heavy snowfall, and used observed data from daily weather to draw graphs and communicate their findings. The children seemed very involved with the chance to use their science skills 'for a purpose' [8]. Similarly, children in Suffolk, England, were inspired when they tackled a real life local flooding problem, and devised methods to investigate the problems they encountered [7]. By observing and recording their own data children can investigate and determine issues around their own school sites, where to site a new seat out of the wind or full sun; where to plant trees to provide the best shade during summer. The act of investigating small issues on site and then communicating their findings adds to children's skill list as well as improving their literacy skills.

Understanding the weather has always been an activity practised by farmers and sailors – in many respects their livelihoods depended on reading the signs - the clouds, sunrise and sunsets, wind directions - in some cases animal and bird activity, and even plant adaptation (the pine cone closes up when rain is approaching, scarlet pimpernel flowers only open if it is going to be sunny.) Of course, some of these old wive's tales (fallacies) are inaccurate, but many of you will be able to interpret signals about your own local weather patterns – the onset of specific winds perhaps, the changes associated with weather patterns in a particular month – Greeks seem to know that weather changes about mid-August. There will be many more of these signals which we pass on to our children through our own culture.

Weather information is with us all the time – even if we are lucky enough to have climate, there will be subtle changes that can be identified.

6. Weather as a hands-on activity

So actually recording weather information is a wonderful hands-on activity, made more special if the children themselves have made the instruments to record the weather. Making and refining their own instruments encourages thinking and embraces technology for a purpose – being able to use something that you have made. It is always useful to have accurate readings from manufactured instruments, but home-made devices can record increases and decreases - changes - and often this is sufficient information for young children at this stage.

Recording data requires children to be reliable – collecting information every day. This encourages teamwork. Plotting the data in a manner all can understand, is another skill. Identifying simple changes – increases and decreases, and looking at links – how perhaps temperature changes with more or less cloud cover, for example. Do sunsets really give us an indication of weather to come – simple analysis. All scientific skills that will be gained through a simple activity. This activity need not take up much time during any one day but can be ongoing for several weeks and then looked at, by which time the children will have their own ideas of what is going to happen next. They can become 'forecasters' and experience the fun of 'getting it right' or beginning to understand why the forecast wasn't correct.

7. Conclusion

Weather is just one element of earth science as can be seen in the diagram. However it is an extremely important subject as it underlies rock breakdown and the development of soil which leads to ecosystems and farming activities. It dictates economic activities to some extent - our seasonal weather in England provides great opportunities for the purchase of different clothing and foods. Our buildings are purpose designed to cope with weather (steep roofed houses in areas of snow, flat roofed buildings with courtyards and fountains to provide much needed humidity in hotter areas).

Earth science is important if we, as scientifically literate citizens are to play our part in conserving our planet. We must ensure that our understanding of the Earth's systems is clear to all our young people, and perhaps the best way to do this is to capture their imagination when they are young by making their science local exciting, relevant and understandable.

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Scientix, the Community for Science Education in Europe

B Vázquez Dorrío
Scientix Ambassador in Spain
University of Vigo, Vigo, Spain
bvazquez@uvigo.es

Abstract. Scientix [1] is an initiative for promoting scientific education and vocation in Europe that now brings together over 7000 teachers after seven years in operation. It is open to the education community in general and especially to teachers, researchers and policy makers. Its main aim is to promote and support collaboration between teachers, education researchers, policymakers and other education professionals in the areas of Science, Technology, Engineering and Mathematics (STEM subjects) and was recently recognised at the BETT 2017 Exhibition of Trends in Education Technology as one of the top 100 innovations worldwide in the field of education.

Keywords. STEM, European Schoolnet, Scientix.

1. Structure, resources and activities

Coordinated by European Schoolnet [2], a non-profit organization and network of thirty-one European education ministries. Scientix receives funding from the European Union's H2020 research and innovation programme and has national contact points in 27 countries in Europe and beyond. In Spain, this role is currently fulfilled by the Spanish Ministry of Education, Culture and Sports [3]. Over the course of the project, Scientix assigns a series of representatives or ambassadors in each country whose aim is to spread the word about its activities among the teaching community throughout Europe, help share knowledge and best practice in science education, and support and improve scientific education in general at a local level. The panel of Scientix ambassadors is one of the three main support groups for the implementation of Scientix activities. Spain currently has 43 Scientix ambassadors for the 2017-2019 period, five of whom are linked to different Spanish universities while the others are mainly secondary school teachers. They participate, for example, in activities to raise awareness of the research going on in different science and technology centres not only among the general public but, particularly, among students undertaking training who are likely to find their vocation through direct interaction with labs and research teams. At the same time, the ambassadors present Scientix at education centres, national teachers' associations, congresses and workshops, and they advise other teachers on how to get involved in European STEM collaboration, in the belief that professional development of teachers should include active participation in cooperation and collaboration networks. The ambassadors can undertake assessment and monitoring tasks for projects/tools for teaching innovation at a European level and, at the same time, help not only to publicise the resources, projects and training Scientix offers but also to provide information about periodical events.

Scientix currently provides free direct access to over four hundred European educational projects and almost two thousand teaching resources for the classroom, many translated, or available for translation by Scientix into the official languages from European Union countries, territories, and regions, and H2020 associate countries, on the specific request of teachers when the need arises. Around seven hundred resources have already been translated in this way. Scientix periodically offers online training, inviting users to freely access video conferencing programs in twenty-four languages and various formats: Massive Online Open Courses, seminars or workshops, etc.: spaces for learning that are also times and places for sharing and exchanging ideas. These presentations commonly involve up to 200 people at different sites all connecting for an hour with the possibility of interacting with the speaker in some way. Afterwards, a certificate of having participated is also an option. It is possible to subscribe to the online newsletter tailored for a specific topic which also gives information on news and events and reminders of upcoming activities, competitions, awards and training possibilities. Meet-ups are held nationally and internationally – meeting points in the form of seminars or congresses, although an important way of keeping up with Scientix initiatives is by following a project on social media, where the organisation has over eight thousand followers on Twitter [4]/Facebook [5], or by reading its blog posts,

which are open to collaboration from anyone interested in STEM education.

Figure 1. Images of activities in secondary and pre-university centres during the 2016-2017 academic year

The strategies used to spread and share knowledge include face-to-face seminars with students, teachers and the management and departmental teams in centres. In our case we use a motivational talk packed with fun experimental material in the belief that practical experiments and activities can inspire and help the students to develop a conceptual understanding of the ideas in the curriculum and the competences associated with using the scientific method, such as critical thinking, group work, and so on. So the seminars aim to show experimentally the relationships between the contents of secondary and pre-university Physics topics and the knowledge needed to study Engineering or a scientific degree – encouraging learners to lose their fear of science, technology, engineering and mathematics and to start seeing them as an appealing option they could dedicate their time to in the future. At the same time, this intervention on their own doorstop in schools means informal collaboration networks can be created with the teachers in the places where they work by providing information about the different tools and resources available through Scientix, encouraging them to take part in the activities, and providing them with updates and news about events.

During the 2016-2017 academic year, there have been 25 talks that have taken “Learning Physics by Doing Physics” and the Scientix project to around 1200 students and 100 teachers.

2. Disclaimer

Scientix has received funding from the European Union’s H2020 research and innovation programme – project Scientix 3 (Grant agreement N. 730009), coordinated by European Schoolnet (EUN). The content of the presentation is the sole responsibility of the presenter and it does not represent the opinion of the European Commission (EC) or EUN and neither the EC nor EUN are responsible for any use that might be made of information contained.

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A Tale from Theobromine Molecule, Chocolate

JM Fernández Novell[1]*, C Zaragoza*[2]
[1]*University of Barcelona, Barcelona. Spain*
[2]*2Open Institut of Catalonia*
Barcelona. Spain
jmfernandeznovell@ub.edu

Abstract. Cambridge dictionary defines chocolate as a sweet. A tale about chocolate is introduced to highlight the importance of experimental practices in science teaching. In this tale, chocolate questions such as where is it cultivated, its economic importance, physical and chemical properties and its ancient and present history are presented, studied and answered.

What happens in our students' senses when they test some chocolate? The different students' perception on chocolate appears when they compare theoretical knowledge with testing it. Same changes in perception occur when teachers explain some scientific concepts and students compare them with some experiments about the same scientific concepts.

In this situation, some foods that cannot be obtained in our geographical area will be studied in a theoretical way. The final objective is to emphasize the importance of experimentation in teaching sciences, chemistry, physics, biology, etc.

Keywords. Tales, exotic fruits, theory versus experiments, primary and secondary school students.

1. Introduction

Cambridge dictionary [1] defines chocolate as a sweet, usually brown, food made from cocoa seeds, that is usually sold in a block, or a small sweet made from these seeds: a bar of chocolate; chocolate biscuits /mousse; milk / dark / white chocolate. Hot chocolate also known as hot cocoa is a heated drinking consisting of melted chocolate or cocoa powder dissolved in heated milk or water, and sugar is often added.

To highlight the importance of practical experiments in science teaching, a story about chocolate for all ages is introduced. In this tale, chocolate questions such as where is it cultivated, their economic importance, physical and chemical parameters and its ancient and present history are presented, studied and answered.

All this knowledge is obtained without testing it. What happens in our senses, in our students' senses when we or they have tested some chocolate?

A sense [2] is a physiological capacity to give some kind of perception: smell, taste and touch, will be basically in our examples, chocolate and Lychees

The different students' perception on a particular food appears when they compare their purely theoretical knowledge about the food in question with testing it. The same changes in perception occur when teachers explain some scientific concept compare with doing some experiments about it.

Within this context, some examples of certain foods that cannot be obtained in our geographical area will be displayed. However, they are very important and appreciated in other places on Earth (a possible introduction to globalization of food). If deemed appropriate, students of different educational levels can perform an original story as a new educational experience (the authors with their secondary school students have worked two tales with Lychee and Physalis both exotic fruits [3, 4 for review]).

As a corollary of the story and also the final objective is to emphasize the importance of experimentation in teaching sciences, chemistry, physics, biology, etc. This tale must be performed in the normal classroom, in the laboratory or outside of the school (at home, at the museum or in some university science workshops).

2. Inventing a tale

We had the privilege of collaborating with Professor Leopoldo de Meis (1938-2014) many times, in Barcelona and Rio de Janeiro, always on children and teachers Science Education.

“A Sociedade Brasileira de Bioquímica e Biologia Molecular instituiu o Prêmio SBBq-”Leopoldo de Meis” em reconhecimento a pesquisadores membro da SBBq que tenham

contribuído de forma destacada para a pesquisa e o ensino em Bioquímica e Biologia Molecular no País ao longo de suas carreiras"

Figure 1. Portait of Leopoldo de Meis

Leopoldo was a brilliant biochemist and also an excellent and innovative teacher. He has written two popular comic books both on thermodynamics and the scientific method (O Método Científico, you can see it in the Figure 2). He has recorded a video showing and explaining the mitochondria, and even has prepared a play on the history of science.

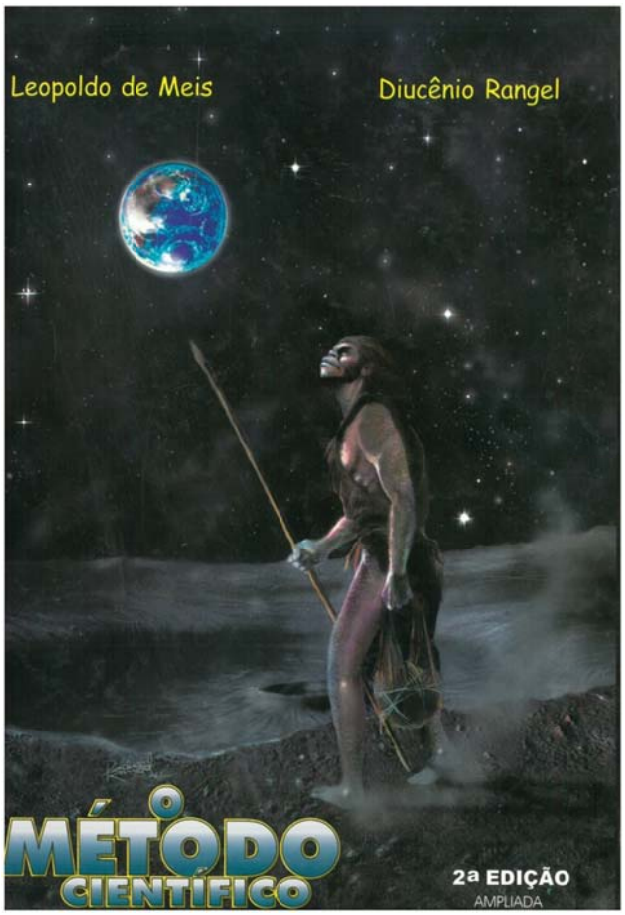

Figure 2. Cover of the book "O método científico"

All these efforts were in order to foster the curiosity and interest in science in both students and teachers.

We accept the idea that "every child is a potential scientist" and the possibility that "the scientific method is indeed natural", and consequently every human being is sure to use it unconsciously in everyday situations. The result is that students develop a sincere attention and curiosity in science.

More Leopoldo de Meis information in Academia Brasileira de Ciências [5] and Instituto de Bioquimica Médica Leopoldo de Meis [6]).

In a Rio meeting we thought together on Leopoldo's idea: "Create a tale comparing theoretical and practical science education". And then we assumed to do it. Chocolate and coffee were our favourites

3. A Chocolate tale

3.1. Once upon a time

Our story started at the end of the last century in a singular area of our planet without internet and no television. Imagine some areas in the Amazon jungle, in a particular Australia area or in the Himalaya region, places where communities do not have yet electricity.

Imagine that, just different ethnic groups want to celebrate Science Olympiad "on a topic". The leader, the King of one of these communities wants to be the winner. For this he acquires the services of a teacher, Mr. T, the best teacher from Europe because lectures must be done in English, the language of the final test.

Mr. T moves to Australaya (invented name of AUSTRAlia and HimaLAYA) with a few books, his tablet and mobile but, there he cannot use these tools. Around he finds children like any other children in everywhere, very enthusiastic to learn, to practise and to play.

Sounds like a good job, Mr. T said.

The first day, our teacher was introduced to the King and the King introduces him to the Shaman of the tribe who indicates him the

names of the best students who will participate in the Science Olympiad.

Finally, Mr. T was known that the final test will take place in a month, more or less, on a highland equidistant from the four tribes which will participate in this "Olympiad".

In addition, he identifies the most important thing, the subject of this competition. It will be "The Chocolate", it is something that these four communities do not know. It is important to remember that they cannot connect to Internet, there is no WIFI in that region.

Suddenly, the shaman loudly asks our teacher if he knows what is "The Chocolate", teachers quickly reply

- Without a doubt, the chocolate is obtained from the cocoa and from....Mr. T promptly responded.

- This is splendid!!! The King says interrupting Mr. T explanation.

- We will be the champions.

And the daily life, in this part of The Earth, goes on.

We can obtain a better idea of the ideal situation of Mr. T if we read the diary of our teacher:

"My first day in the village of Australaya:

People have been very kind to me. After morning presentations I eaten food based on fruits, vegetables and some fish, from the local river.

Zoe, my co-operator, is the eldest daughter of the King, she advised me that I should to prepare the local school teachers. My intention always is to help other people interested in teach science.

There is a severe schedule at school, we start at seven in the morning and at five o'clock in the evening a bell rings and the academic activity stops. Then some children play basket or fighting each other and girls help their mothers and grandmothers to prepare dinner.

Then, at six o'clock in the evening it is already dark night, it is time to dinner. After dinner I ask Zoe what I can do when there is no light, when the sunset and she kindly gave me a kind of candle, it has lasted almost one hour, it was enough to working in this diary.

Then the night has fallen, the whole town sleeps and there is no movement until the sun rises tomorrow"

3. 2. Teaching in the Classrooms

Students have not WIFI but they use a lot of books and also Cambridge dictionary, some examples are:

- Chocolate: a sweet, brown food that is usually sold in a block.
- Bonbon: a small piece of sweet food covered in chocolate.
- Hot chocolate: a sweet drink made with chocolate and hot milk.

How to taste chocolate? The chocolate aroma is an important component of flavour. You can break the chocolate piece in two halves, place one half on your tongue and let it melt slowly. This allows the cocoa butter to distribute in the mouth, thereby muting any astringencies or bitterness of the chocolate [7].

Finally, the taste and texture of chocolate must be studied and its history [8].

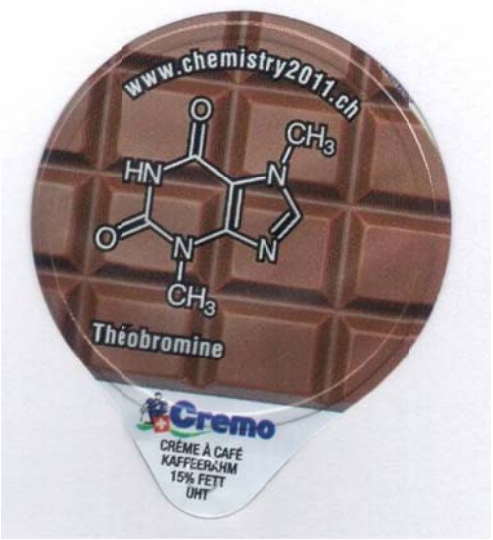

Figure 3. Theobromine molecule in a créme a café, International Year of Chemistry (IYC 2011)

The full course contains:

- Theobromine and lecithin.

- Chocolate's story.
- Polymorphs crystals.
- Chocolate, solid matter, liquid or gaseous.
- The trade of cocoa and chocolate.
- Cocoa producing countries
- Cocoa consuming countries.
- What do we eat when we consume chocolate?
- Obtaining cocoa liquor, cocoa butter and cocoa powder.
- Marketing and chocolate.
- Cocoa, a gift from the gods.

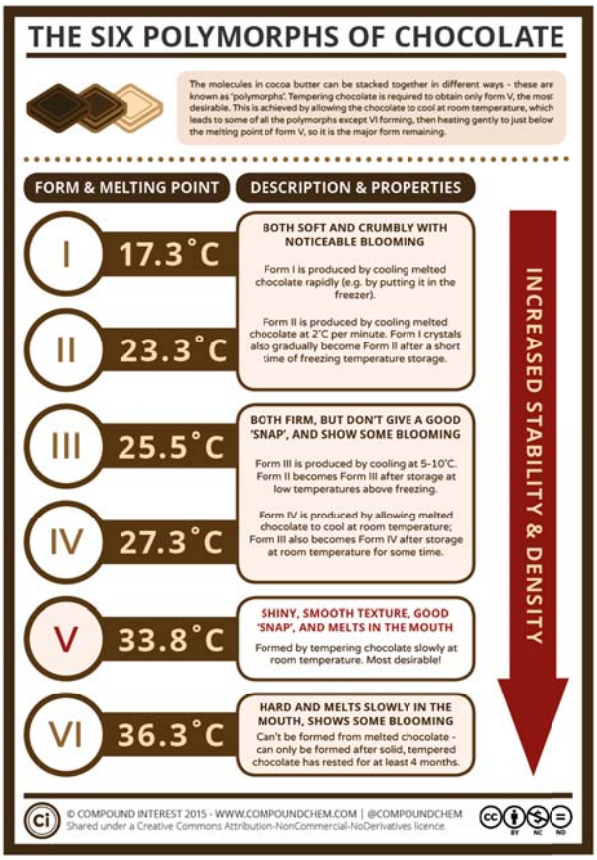

Figure 4. A Table prepared by students

3.3. Final tests

After five weeks working, young students from "our" ethnic community had to pass the final test together with other nervous students from their region. All of them from the same area.

They had to answer:

1. Chocolate composition

2. Is theobromine a compound similar to caffeine?

3. Justify: chocolate was the drink of the Aztec gods

4. Justify: chocolate does not conduct the electricity

5. According to the FAO, indicate the 10 top cocoa producing countries

6. What is cocoa butter?

7. Explain, in 20 lines, the history of Chocolate

8. Economic importance of Chocolate

Mr. T students won this competition and the teacher was a new hero for that community. Students obtained large knowledge and a lot of data about chocolate, they know its nutritional value, how cocoa is cultivated but, nobody never have taste it. No one knows the taste of chocolate, the sweetness of hot chocolate.

What do you think about theoretical knowledge and practical one? Which one do you prefer? Are questions we can ask to the science teachers or students in our countries.

4. Innovative examples

We have been offering new initiatives on teaching/learning science to students from secondary school.

We have reproduced this story, this Chocolate tale, in our classroom at secondary school (students were 15-16 year old). However, we have used an exotic fruit called Lychee [9] instead chocolate.

Figure 5. "Lychee" in Chinese characters

This innovative and didactic work was performed in groups of 3-4 students [10]. At this

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educational level, it is important working in groups. Our students never eat this exotic fruit from southern China. It is a tropical tree native to the Guangdong and Fujian (provinces of China). Lychees are oval to round (about 3 cm in diameter). They have a leathery, scaly, skin, in colour from pink to red. The flesh is jelly-like, containing a shiny brown seed. Lychees taste sweet and juicy.

NUTRITIONAL VALUE PER 100g Lychee	
ENERGY	276 kJ
CARBOHYDRATES	16.53 g
Sugars	15.23 g
Dietary fiber	1.3 g
FATS	0.44 g
PROTEINS	0.83 g
VITAMINS	
Thiamine (B1)	0.011 mg
Riboflavin (B2)	0.065 mg
Niacin (B3)	0.603 mg
Pyridoxine (B6)	0.1 mg
Folate (B9)	14 µg
Vitamin C	71.5 mg
MINERALS	
Calcium (Ca)	5 mg
Iron (Fe)	0.13 mg
Magnesium (Mg)	10 mg
Manganese (Mn)	0.055 mg
Phosphorus (P)	31 mg
Potassium (K)	171 mg
Sodium (Na)	1 mg
Zinc (Zn)	0.07 mg

Table 1

Students obtained large knowledge and a lot of data about Lychees, they know its nutritional value, in addition, Lychee is rich in dietary fiber and tea made from Lychee peelings cures smallpox and diarrhea, and more about Lychee seeds that contain (MCPG) a compound studied and produces hypoglycemia, low blood glucose.

It is important to note that nobody have taste Lychees before this educational method. Our students do not know the taste of this sweet and exotic fruit.

What happens in our students' senses when they tested some Lychee? A sense is a physiological capacity to give some kind of perception: smell, taste and touch, basically in our example.

Figure 6. Image of Lychees

When students could taste it they were delighted and understood everything they had learned in a theoretical way and, effectively Lychees taste sweet and juicy.

In this way, our secondary school students prefer investigate an exotic fruit or a physical or chemical concepts after they have really tasted it (exotic fruit) and, have also developed some practical classes, experiments in the laboratory, about these technical and scientific concepts.

5. Conclusions

It is widely known that misconceptions impair student's learning. Our science education method (A Tale vs. experiments) encourages collaboration among students and improves their academic success.

To emphasize the importance of practical education in teaching sciences versus theoretical one, teachers can use "A tale from... Passion fruit or Loquat or Dragon fruit, or..."

In addition, teachers can implement theoretical explanations with experimental approaches. Here we present several experiments [11, 12] covering chemistry and physics sciences which are very easy to do at school and, most important, they are produced with chocolate.

1) The chocolate floats and goes down in sparkling water.
2) Splashes when boiling.
3) Maillard reactions.
4) Chocolate and electricity.

Learning chemistry, physics, biology, technology, science in general, into laboratory involves a special perception through science and young students.

The concept of “Science for Society” was generally accepted [UNESCO 1983]. It remains a substantial idea because science shakes directly our lives.

Finally, the objective to emphasize the importance of experimentation in teaching sciences, allows young people to increase their interest for science.

6. Acknowledgements

We thank our secondary school students for their inputs and cooperation. We also thank Mr. Jordi Fernández for assistance in preparing the English manuscript.

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Science Week. Science in the Streets of Pontevedra

C Fernández Davila
Concello de Ponteareas
Pontevedra, Spain
ensino@ponteareas.gal

Abstract. The Science Week in Ponteareas was born from an idea of the Education Council. In our presentation, we will see how this idea was welcome by the School Directions as well as their teachers and students. We were also able to get the participation in this initiative from alumni that are studying at the different universities in Galicia. We will see the results of this great teamwork at the second edition of the Science Week: large inflows of public that filled auditorium rooms and positive reviews in the inquiries made to students, teachers and the general public. A specific website [1] has been devoted to present the results of this event.

Keywords. Communities, exhibitions, interdisciplinar, participation, science fairs.

1. Introduction

My name is Cristina Fernández Davila, Councilwoman of Education in the municipality of Ponteareas. Joining me in this presentation is one of the teachers who coordinate the Science Week, Xabier Prado, as well as two students, Clara Alves and Jenny González, who were responsible for the presentation of the different events. Ponteareas is a Spanish village in the south of the province of Pontevedra. At 30 Km. from Vigo and 12 km to the Portuguese border with Monção.

We have 23,000 inhabitants, 11,000 of them in the urban area and the 12,000 remaining divided among 23 parishes in rural areas.

In our village we have 4 High Schools, 5 Primary and Pre-primary Public Schools and 2 concerted schools, and a Rural School Group (CRA) that has seven units in different parishes with an average of 15 students aged 3 to 5 years. The nearest university is in Vigo (with additional campuses in Ourense and Pontevedra), and our students are also frequently enrolled in colleges from the University of Santiago.

2. The Science Week

I belong to a new city government that started in June 2015, but with a long career in the Municipal Corporation, were the gaps in scientific and cultural level as well as in transverse relationship with teaching and schools were evident.

The Department of Education has matured this idea in the early legislature and it was presented to all directions of Schools at the beginning of the course 2015/16, implying also all teachers and students and making them participants of the idea.

With a very limited budget and without any kind of subsidies from other administrations, the First Science Week came to light for the first time in April 2016, and thanks to the selfless collaboration from the educational community and the people who participated as speakers and disseminators.

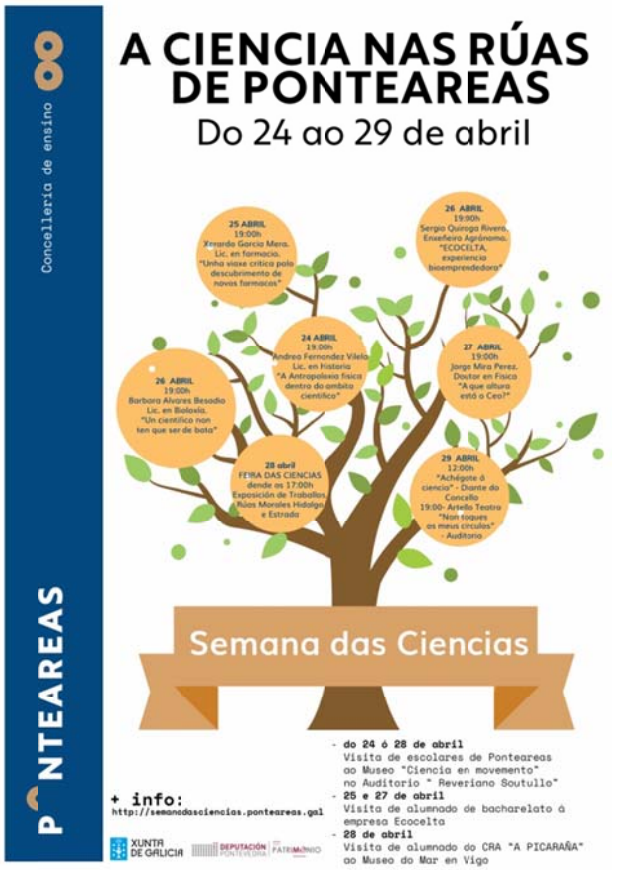

Figure 1. Second Edition - Poster

This year the II Science Week was held from 24 to 29 April 2017 (Fig.1), in areas as diverse as the Auditorium, the conference room, the municipal library, the streets of the town center

and the Gardens of the City Council. This is because the city does not have any fairgrounds or alike, which would allow a unique space in which to perform all organized events.

3. Activities

The different activities within the II Science Week were:

I. Museum "Ciencia en Movimento" (Science in Motion, Fig. 2).- From 24 to 28 April, with 4 passes per day, it was visited by a total of 550 students from primary (6th year) and secondary (4th year) levels. Set up on the stage of the Auditorium.

Figure 2. Museum, Science in Motion

II. Four Micro-speeches: Between 24 and 27 April. Exposed before each conference. Presented by local students (Fig. 3): Paula González Perez and Celeste Sánchez Sarazaga (Vocational School “A Granxa”) with a talk entitled "Natural Values of the Cies Islands"; Alba Ubeira Rodríguez (CPR Santiago Apóstol) with a talk entitled "Can we charge our mobile phone with fruit?"; Zaira Domínguez Romero and Diego Rguez. Souto (IES Barral) with a talk entitled "History of the Numbers"; Estela Dguez. Reboredo and Simón Teijeiro Velasco (IES Pedra da Auga) with a talk entitled "International Conference of Young Scientists of the UNESCO Associated Schools".

Figure 3. Micro-speeches

III. Four Conferences, between 24 and 27 April, by relevant researchers from different science areas, putting value on the participation of women and young people, as well as from researchers from our village (Fig. 4): Andrea Fernández Vilela. BA in History, MA in Physical Anthropology with a talk entitled "The Physical Anthropology within the scientific realm"; Xerardo García Mera. Degree in Pharmacy, PhD in Organic Chemistry with a talk entitled "A critic trip through the discoveries of new drugs."; Sergio H. Quiroga Rivero (Agronomic Engineering, managing director and R & D technical at the local company ECOCELTA) with a talk entitled "Ecocelta as a Bio-entrepreneurship experience" and Bárbara Álvarez Besadio (degree in Biology, Master in Biotechnology – Technician in Ecocelta) with a talk entitled "A scientist need not to bear a robe"; Jorge Mira Pérez. Degree and European Doctor in Physics. Professor of electromagnetism in the Department of. Applied Physics at USC (Santiago de Compostela University): "How high is the sky?"

IV. Workshop for teachers '"Approach to Science Teaching", after stakeholders had expressed their training needs. It was held at the library on April 25 (Fig. 5). With the participation of two relevant speakers, Antonio Gregorio Montes with

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a talk entitled "Enthusiasm for Science: promotion and exploitation" and Benito Vázquez Dorrío, Ambassador of Scientix in Spain with a talk entitled "Scientix, the community for science education in Europe".

Figure 4. Conferences

V. "A Ciencia nas rúas" (Science in the streets) Fair.- In the village center, on April 28. More than 40 booths, where the schools presented through their teachers and students inventions, designs and research of different kinds. The audience watched, manipulated and interacted with each of them. Alumni of the local centers that are now in the university took also part in this activity.

Figure 5. Workshop

Figure 6. Other activities - Science in the streets, Scientific Theater

VI. "Achégate á Ciencia" (Come nearer to Science).- April 29 in front of the City Hall, enjoying the day of the Village Fair. There were different scientific experiments conducted by students and teachers of Ponteareas. With such relevant topics as: Relativity, the problem of Vespa Velutina (Fig. 6), how to make music with our hands, Counting Molecules, Lung Capacity and Educational Robotics.

VII. Theater "Non toques os meus Círculos" (Do not touch my Circles) by Artello Teatro Company. It was the closing ceremony in the Municipal Auditorium of this Science Week. A theatre show created with advice from the Department of Applied Physics of the University of Vigo, which relates with an elegant humor the scientific and humanistic aspects. (Fig. 6)

VIII. Educational visits of the Baccalaureate students to a local company which is relevant in environmental management, Ecocelta. Attended by over 220 students. (Fig. 7). Visit of the young pupils of the CRA (Centro Rural Agrupado, Group of Rural Schools) "A Picaraña" to the Museum of the Sea in Vigo. About 110 children.

Figure 7. Educational visits

4. Evaluation

The evaluation by the educational centers and the general public was positive. The comments were made personally in the different events and also gathered in inquiries that were covered by the public in the Science Fair, as well as by students in the schools.

The majority of the comments or criticisms were about the intensity of the sun and the temperature on the day of the Fair, and that there was little time to make the whole tour and enjoy it properly.

It was clear that for the vicinity of Ponteareas it is important to be able to approach scientific initiatives that are made within the schools. They were until now restricted only to school spaces, and families could now check not only what their children did but also those areas that were worked in other schools.

The relationship that was created is really very positive, as well as the collaboration between different schools, among teachers and also among students. The latter gave great value to the fact that the event belonged also to them, and that their presence had been prominent in the different activities.

5. Future

We just need to talk about the future of the Science Week. Every year there will be a new Science Week with new projects like a Congress of students, and new objectives like establishing a partnership with the universities, to get funding from other public bodies or its internationalization, due to the proximity of our countries: Galicia and Portugal, separated only by the natural border of the Miño river.

We will try to build bridges on it through Science.

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The Use of the Scientific Monologue as a Tool to Spread the Scientific Knowledge in the Society

W Stebniki Tabora
Bardo Científico, Montevideo, Uruguay
willacad@adinet.com.uy

Abstract. Bardo team is a heterogeneous group of scientists who loves what they do: mathematicians, biologists, anthropologist, sciences teachers, chemists, in all rang of ages. Almost two years ago we took these projects that enrich our careers in research and teaching: the social empowerment of science through scientific monologues.

Our mission is to give access to scientific knowledge to different social referents through strategies and learning activities in order to allow the democratization processes and the ownership of this knowledge. The scientific monologue is an excellent resource to approch a scientist topic: is fun, didactical and multidisciplinary.

Keywords. Brain, scientific communication, monologue, neuroscience.

1. Introduction

The content of our material has a simple speech without forgetting the scientific accuracy. It points to a heterogeneous public with humor and expectance. Our audience is diverse; we have different monologues which can be adapted to the proper attendance, for example adults or only teenagers.

Each show is different because it is organize on behalf of the available monologist at the time, one of the great advantage of this learning tool.

The show takes the attendants to a trip starting in the origins of the Universe until the biological evolution of the human kind, going through the more relevant physics, chemists and mathematical inventions in history.

We also have a show call “Feminicencias: monologue about woman and science” which celebrates the fight for women for their rights to participate in the society equally as man and in their development as human beings.The show has differents monologues but all of them are about women in science. Even if they work as a complete show, they can also be play apart one from the other because each one of them comunicate the role played by women in science.

2. The making off the monologue

Even if each member of Bardo has a specific field in a scientific area, the topic selected could be refer or no to this field. For that is necessary to make a deep research about the topic chosen to ensure the scientific accuracy. When all the information is gather, the script could be written comparing real life situations and it should be brief, clear, dynamic and if possible, fun. Then, the monologue is revised by the group who give an opinion and suggest corrections in order to make it better. This procedure goes on and on until the monologue is ready to be shown in public.

Figure 1. The Bardo Scientific Team

3. An example of a monologue: the man with 3 brains…

You have 3 brains, 3 brains, 3 brains...

Yesssss!!!! Everyone has 3 brains living together inside us. In the head, each one of us has a lizard-squirrel-monkey brain better known as a “trione brain”.

The oldest part of your brain is the lizard o reptilian brain with 500 million years and regulates everything that concerns the main system: breathing, sleep, heart rate, etc…

The squirrel brain or limbic brain has around 200 million years and controls our animal skills: to run or to fight, to feed, to breed. There is one of the main part of our emotions: the AMYGDALA (that isn’t what we have in our

throat) makes it possible to feel angry, fear or pleasure, the HIPPOCAMPUS converts the short term memory into long term one and the THALAMUS works as a tower control of our senses.

The monkey brain or cortex started to shape 1 million years ago and it is divided in two hemispheres working together and connected through the callous body. The left one takes care of the linguistic and sequential process and the right one the holistic and visual process.

As we can see, the brain evolved making us not stronger but brighter. To do so the natural evolution shaped smaller heads so they can go through the birth canal with bigger brains folding the cortex inside, without this solution it will be similar to a baby blanket.

Over our evolution, we manage to stay in the planet because we become more intelligent due to the cortex. Our new brain separate us from other animals on Earth and gave some extraordinary abilities such as the lineal thinking, the development of a complex speech and the ability to communicate concepts and ideas through a scientific monologue as this one.

However, the emotions and the instinct are the real leaders of our behavior thousand years ago or nowadays, in the 21 century.

So we are emotional human beings who learned to think and not thinking machines with emotions. Neuroscience proved that everything we do in this life is based on the decision of the brain to minimize danger or maximize reward and this worked like that for millions of years.

It is believed that around 2000 individuals belonged to our tribe of first ancestors in East Africa. Nowadays we are more than 7000 million…

But the brain of the human being in the 21 century works the same way as the one of our first ancestors.

Let's do an experiment; I need the help of the audience, we will make two teams:

TEAM 1: You are going to recreate with your body, your gestures, the everyday activities of any men or woman 1 million years ago. I will describe an action that you need to represent as the story goes along. OK?

You are in the African Savanna

You wake up with the sun in your face, cold and hungry. Your new cortex pushes you to search for food. You pick up also your new spear and go away from the shelter. Your eyes, ears and nose are aware that something is moving behind the pasture. Your breath is fast. A tale shows up. The glance of a leopard meets yours. In thousandths of seconds you need to decide, escape or fight? The leopard is also hungry and decides to run into you. Now it is 2 deadly predators really hungry and only one will survive. Your heart pumps strong, your body sweats, your muscle shakes as you get moving. Spike the spear into the leopard, the claws cuts your skin, you are hurt, and your body segregates endorphins (the "I'm feeling well" hormone). The leopard falls. You take it with you in your back, walk toward the shelter, drives away crows and hyenas that want to steel your food and distract you. The people from the tribe welcomes you with joy, you tell in grumpy language to the others man what you lived.

The reward system of the brain turn on and this feeling of pride will push you to go out to hunt again another day.

Now we travel 1 million years until today and we recreate one day in the life of men and woman of today:

TEAM 2: The clock alarm of your phone wakes you up. You don't need to search food to survive; you open the fridge and search for the option "low calories". But your primitive brain feels the need to hunt and recreate a story of life and death.

You check your email and see than a supplier sent a court order. As in the African Savanna your anxiety raise, you pick up the laptop and the phone and get into the car and go to work. In the street the brain feels threaten, the horns sounds. It is a radar in this corner? The light went red, the car in front nails the breaks and you do the same. You pull it off 5 cm before heating the other car. This time you get off the hook… You continue driving, your heart beats faster, a car wants to pass you by your right, you get angry and you don't let him do it. You arrive to work, you stop in the

parking lot, you walk and you see 3 young men walking towards you. They start running 5 meters before and they surround you, they want the laptop, the phone, the money. Your survival instinct gets in play, you scream and push them. The young men get angrier, now they want also your life, your muscle shake. Just in time two security men arrive and the thieves escape. You segregate endorphin. You call your office and tell them what happen, you are scratched and bruised, with your shirt dirty and the pants ripped off, they said that you can take the day off and go home.

You drive home and in the way you see shopping mall advertisements selling cell phones and this distract you. You arrive home and turn on your plasma TV.

The reward brain system turns on and the sensation of pride will push you to go to work again another day.

Did you see any similarity between the brain life of our ancestors and our life today?

Or not?

Remember, the emotions and the instinct are the real leaders of our behavior. We are and we will be emotional human beings which learnt to think.

One million years ago our difficulty was to communicate our actions but even if our monkey brain evolved, we are still commanded by our lizard and squirrel brain.

Not in vain, even if the Cheetah (Tarzan) was a big movie star, Wally Gator and Chip and Dale weren't less famous…

4. Conclusions

The scientific monologue used as a tool for spreading popular science is making its firsts steps in South America. In 2015 and 2016 with the sponsorship of UNESCO, a team of Big Van scientists on wheels made a Workshop about scientific monologues in Uruguay. This planted the seed where Bardo Cientifico was born with the goal to spread science in all social levels, going to schools and high schools, teachers' congress, museums, theaters, universities, etc. In December 2016, the team went to the Hakaton in Punta Arenas, Chile where they were granted with the BID award to make the First South American Festival of Scientific Monologue to be held in Montevideo in November 2017. It is the first time that such an event is held in South American allowing to participate young people older than 18 years old.

Throughout Scientific Monologue, Bardo Cientifico become a reference in popular science in Uruguay and South America, with a strong sense of fun and learning spirit establishing coordinate actions with others scientists. This allows to build communication bridges where the scientist knowledge is embrace by all social levels opening democratical spaces.

5. Acknowledgements

My gratitude to all the Bardo Cientifico team for the critics and suggestions in the monologue, for the ideas and for the translation of this presentation. My acknowledgment to Big Van Scientists on wheels for being at the start of our life as a scientist Uruguayan monologist and for the support and advices they are continuously bringing and to UNESCO to be one of our sponsors.

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Virtual Laboratory of Nuclear Fission. A New Pedagogical Tool for Student Training in the Experimental Nuclear Physics

V Belaga[1,6]*, E Dolgy*[6]*, D Kamanin*[1]*,*
K Klygina[1,2]*, P Kochnev*[2,6]*, ML Lekala*[5]*,*
VD Malaza[3]*, NM Mkaza*[3]*, M Osmachko*[1,2]*,*
Y Panebrattsev[1,2]*, Y Pyatkov*[1,4]*,*
P Semchukov[1,2]*, A Strekalovsky*[1]*,*
I Vankov[7]*, N Vorontsova*[1,2]
[1]*JINR, Dubna, Russia*
[2]*InterGraphics LLC, Dubna, Russia*
[3]*Stellenbosch University, Stellenbosch, South Africa*
[4]*National Nuclear Research University MEPHI, Moscow, Russia*
[5]*University of South Africa, Pretoria, South Africa*
[6]*Dubna University, Dubna, Russia*
[7]*Bulgarian Academy of Sciences, Sofia, Bulgaria*
belaga@jinr.ru

Abstract. In this report, we would like to present a software and hardware complex used to training of university students for their further work in real physical experiments. Our educational tool “Virtual Laboratory of Nuclear Fission” consists of several complementary components: a) general view: key ideas in nuclear physics and nuclear structure, basic theoretical models of nuclei, introduction into instruments and methods for the study of radioactive decays, virtual practicum and real measurements; b) specific tasks: physics of spontaneous fission, experimental studies of spontaneous fission, light ions spectrometer (lis) spectrometer, measurements, data analysis.

Use of this tool during the summer student practice will enable the professionals to be able to prepare experiments in a relatively short time and perform measurements simultaneously with data analysis. We plan to integrate this educational tool into the traditional educational process applying the blended learning model.

Keywords. Nuclear physics experiment student practices, processing of the experimental data, scientific project work, virtual lab.

1. Virtual labs based on real experimental data for development of skills and competences in nuclear physics experimental techniques

One of the main trends of the modern university education is the inclusion of experimental data and research methods into the educational process. It is crucial to ensure that university graduates are able to engage in research in modern scientific laboratories with relative ease.

This project proposes to develop the educational model on the basis of the modern physical setup — Light Ion Spectrometer (LIS).This model will be developed in collaboration with the Flerov Laboratory of Nuclear Reactions. At this model students will be required to study the nuclear physics phenomenon such as spontaneous fission, which forms the basis for the studies of multi-body decay modes.

A distinctive feature of this model is its relative “simplicity”, while it uses the most advanced radiation detectors, nuclear electronics and other equipment to make precise measurements. This allows the students in a relatively short training period to go through all the stages of preparation of the experimental setup in order to perform the experiment and obtain physical results.

The following skills set students will acquire:

- Spectrometry of alpha particles and heavy charged fragments with the help of modern semiconductor detectors (pin-diodes),
- Learn techniques on the time-of-flight measurements using time registered detectors based on microchannel plates,
- Data analysis from modern digitizers. Measurement of time-of-flight spectra with high precision and the study of plasma delays effects in the registration of fragments with high charge in the semiconductor detectors,
- Processing of the experimental data and obtaining of the mass spectra of the fission fragments.

The set of these virtual labs form the

competencies that are necessary for students' work in a modern experiment in the field of nuclear physics.

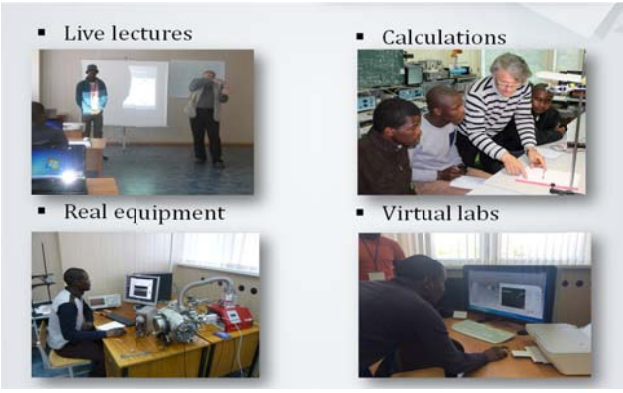

Figure 1. Student Practices

2. "Interactive Platform of Nuclear Experiment Modelling" as a multidisciplinary tool in the training of specialists in the fields of ICT and experimental nuclear physics

A new approach for conceptualization and skills development in scientific and engineering project work is proposed. In this computer-based approach libraries of various components of nuclear physics experiment (radioactive sources, various types of detectors, instruments and components of nuclear electronics) are used. This is different from traditional labs with defined equipment and measurement methods at the beginning of work.

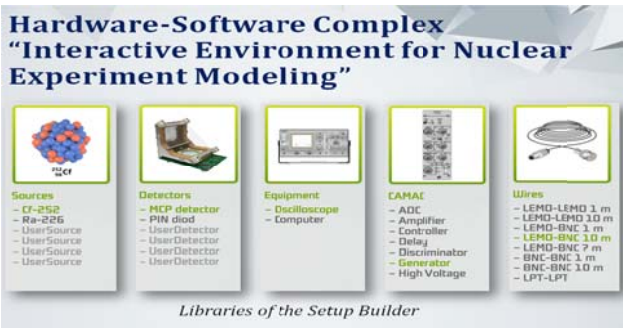

Figure 2. Libraries of the Interactive Platform of Nuclear Experiment Modelling

One of the advantages of this computer-based approach is that students specializing in the field of experimental nuclear physics are able to assemble preferred virtual experimental setup using existing components of the libraries. Using high-level programming languages (C ++, C #, etc.) with the set of libraries students can develop new components of virtual experimental setups.

This multidisciplinary tool has possibility to be used by a range of students from different scientific and engineering disciplines e.g. ICT specialists, engineers etc.

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Euro4Science 2.0 –Promoting STEM Career Attractiveness and Societal Values of European Students Using a Forensic Educational Toolbox

L Souto, H Moreira, R Pinho
University of Aveiro, Aveiro, Portugal
lsouto@ua.pt

Abstract. Following the Europe 2020 strategy of reducing early school leavers, Euro4Science proposes a strategy applying forensic sciences to educational purposes.

The Euro4Science 2.0 project is a spinoff of Euro4Science, an Erasmus+ European strategic partnership,

In this version, new countries (Greece and Turkey) were added to the previous partnership of Portugal, Bulgaria, Poland and UK, allowing reaching a critical priority of European policies – the refugee waves.

Forensic, CSI like, topics, represent a motivational clue to enhance students interest in STEM but also to discuss societal values. As so, in Euro4Science 2.0 the topics covered by experimental and field activities not only promote general scientific and media literacy of secondary students but also the values of European citizenship aligned with Europe 2020 strategy.

The Students will address values and topics such as freedom, tolerance, non-discrimination and respect for human rights, along with environmental sustainability and health by exploring transdisciplinary "Case Files" supported by a detailed storyline and a scope of lab and field activities around a Forensic Science Educational Toolbox.

The Forensic Science Education Toolbox allows and encourages the use of recycled and/or affordable price materials enabling its exploration by schools in different stages of educational and lab resources. The inclusion of a diversity of topics from physics, chemistry, biodiversity, genetics and societal challenges of modern science and technology encourages transdisciplinarity.

For example, a "case file" may explore issues like virus contamination and that may lead to promotion of health: it shall tackle social exclusion in turn. A bullying story line and thus addressing discrimination and violence may inspire another “case file”. The exploration of the "case files" may require experimental lab activities, field tasks (complemented by mobile and web digital challenges as in the popular "Geocashing") or indoor classroom proposals.

Following a test period in a university laboratory environment, a Beta Version of a Forensic Science Education Toolbox will be applied in a series of teacher’s workshops with a complementary video library. These “Train the Trainers” workshops involving five partner countries Poland, UK, Turkey, Greece and Bulgaria, should form the basis for a network of hotspot teachers around Europe, certified for further dissemination.

Besides teachers, students are also directly involved by their participation in forensic science festivals where students from each participating country demonstrate their forensic school year projects to a public composed by the visiting colleagues, local stakeholders and especially younger students.

Euro4Science 2.0 is devoted to spread, as widely as possible, this forensic science educational motivational strategy in particularly among less developed countries.

The Euro4Science 2.0 project culminates with International Symposium of Forensic Education, to discuss the strategies of forensic sciences education including university and secondary education.

Keywords. CSI effect, transdisciplinarity, Euro4Science, refugees.

1. Introduction

Following the Europe 2020 strategy of reducing early school leavers a strategy of applying forensic sciences to improving young people’s interest in scientific and technological areas, a previous Erasmus + project was implemented – Euro4Science- which included an educational “forensic” toolbox that has been used in four European countries.

Euro4science 2.0 [1-2] is a spinoff of Erasmus + KA2 "Euro4Science”: exploring

students interest in crime scene based television series ("CSI: Crime Scene Investigation"; "Bones", etc.) by developing real and fictionalized forensic case files supported by a tool box of experimental activities to be used in classroom. In version 2.0 interdisciplinary is enhanced by extending the scope of experimental activities in order to include the values of European citizenship such as human rights, tolerance, non-discrimination, along with environmental sustainability and health education.

The Euro4Science 2.0 also became more comprehensive in terms of participating countries. Adding Greece and Turkey to the previous partnership of Portugal, Bulgaria, Poland and UK strengthened the potential of this forensic based approach to address the present refugee question, one top priority of European concerns.

Experimental activities included in the educational toolbox of Euro4science 2.0 are based in "Case Files" supported by a detailed storyline and a scope of lab and field activities with a complementary video library.

Teacher's involvement in Euro4Science 2.0 is backed by training workshops and a network of identified hotspots that further disseminate locally the use of the educational toolbox.

2. Forensic Science Education Toolbox (Version 2)

The Forensic Science Education Toolbox (Version 2) is an improved and scaled up (several units are distributed among selected schools) of the previous (prototype) Forensic Educational Toolbox developed under Euro4Science. This improved 2.0 version expands the application of the activities to new fields, such as health, environment and societal values of non-discrimination and human rights. This is an educational kit designed and developed to be used by students under teachers' supervision. In this kit, students can find different materials that allow them to perform activities related to Forensic Sciences adapted to high school context, bearing in mind the respective school curricula. The activities proposed enable teachers to educate and inspire their students in the principles of scientific inquiry, analysis and creative thinking.

This forensic educational kit consists of a main box with materials and several support documents:

- Toolbox: a box containing materials that allow the simulation of crime scene analysis techniques to be used as a pedagogical and scientific basis in the classroom. All materials of the Toolbox are inexpensive, recyclable and can be complemented by the resources available in schools.
- Students Guide: a working manual for the implementation of the activities, including guidelines for the use of material in a classroom context or other environments, such as science clubs, youth groups, etc. These activities are associated to learning contents, addressing scientific concepts adequate to each education level.
- Teachers Guide: a manual that includes detailed guidelines for the use of the Toolbox in a classroom context. Specific lessons that join different activities offer the possibility of shortening or widening the length and level of lesson.

The proposed activities are supported on one fictitious crime case. This case consists in suggestions of integrated skills around a story, using the resolution of the problem/mystery and complemented with the discussion of the sociological implications with students.

The Forensic Science Toolbox allows and encourages students to explore different topics related to Chemistry, Physics, Biodiversity, Genetics and Science in general, promoting interdisciplinarity as well as the interconnection to societal challenges.

After a review of potential forensic experimental activities capable of meeting educational requirements, selected activities are subjected to lab tests at the Applied Genetics Laboratory in the Department of Biology, University of Aveiro, Portugal.

Experimental activities are also monitored by assessing the degree of realisation during school visits to university labs.

3 Proposed Experimental Activities

3.1. Environmental Education

The following activities may include sample collections made by students while participating in field classes to a forest, river or beach locations.

3.1.1. Forensic Entomology

The use of insects is important for criminal investigations as they are the first to find the dead body and they are present in all stages of decomposition. The ecological sequence of colonization of the corpse is also used for the estimation of the time elapsed after death in cases of longer post mortem intervals [3].

The experiment consists in monitoring the succession of different corpse decomposition stages while exploring insect life cycles (Fig. 1) and its use in forensic science. An illustrated catalogue includes insect's images accompanied by biological data that enables students to classify insects.

Figure 1. Insect Life Cycle

3.1.2. Forensic Botany

Forensic palynology is the application of pollen and spores in solving forensic issues. Pollen and spores can be obtained from an extremely wide range of items, from the clothes to the bodies themselves. This organic material provide important clues as to the source of the items and the characteristics of the environments from which the material came [4].

Considering this, the aim of the experiment is to prepare and observe different pollen grains corresponding to distinct ecosystems. Students will understand the evidence value of palynology while comparing traces that show biodiversity. An illustrated catalogue includes pollen images accompanied by biological data that enables students to essay a taxonomic classification of the specimens (Fig. 2).

Figure 2. Example from the catalogue

3.1.3. Diatoms

Diatoms are unicellular aquatic algae that grow in almost all natural environments, such as rivers, streams and seas. They have characteristics that are useful for species identification. Many species are habitat-specific due to their sensitivity to environmental variables such as temperature and salinity. These have been studied in cases of drowning and in the identification of the respective place of death (fresh or salt water) [5].

The experiment consists in observing two reference definitive preparations of different water samples (fresh and salty water) (Fig. 3), analyzing the different diatom genera and

comparing them with a questioned supplied sample (from the “corpse”).

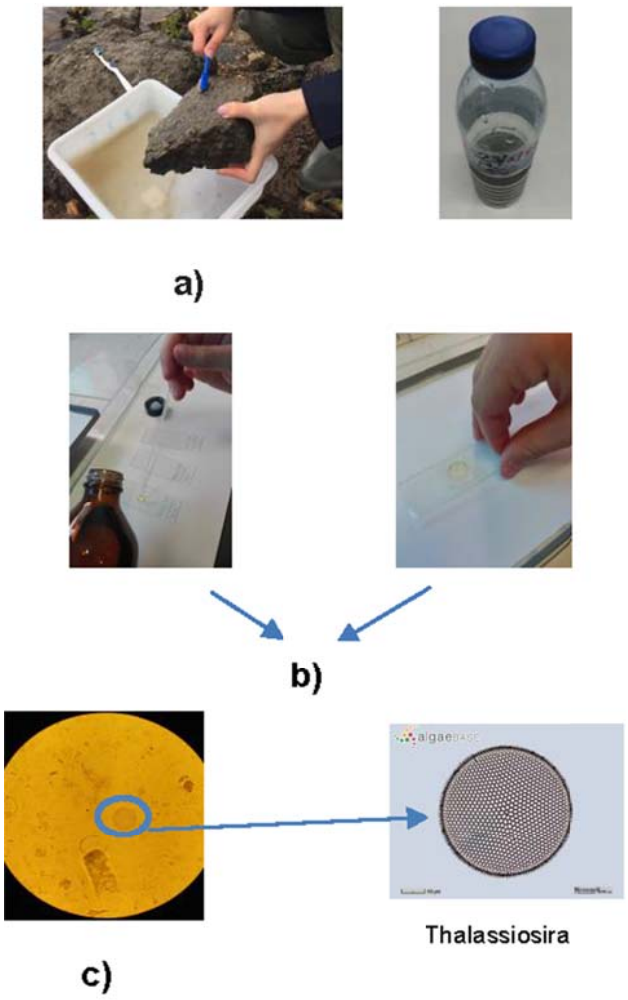

Figure 3. a) Sample Collection; b) Preparation of the slides for visualization in microscope; c) Salt water sample

3.1.4. Animal footprints

Footprints are important traces that can be found at the crime scene since they allow reconstructing the events of the crime as well identify source species. This may also be relevant to determine whether the body has been moved from the crime scene [6].

The experiment consists in comparing plaster models of footprints from different species and understanding their relevance in the environment (Fig. 4).

Figure. 4. Footprints of different species

3.1.5. Hair as a Forensic Evidence

Hair is a protein filament that grows from follicles found in the dermis. Hair is one of the defining characteristics of mammals. Each animal species has characteristic hair length, color, shape, root appearance and internal microscopic characteristics that distinguish one animal from another.

The experiment consists in observing preparations (longitudinal and transversal) of different hair samples and comparing them with a questioned supplied sample (Fig. 5).

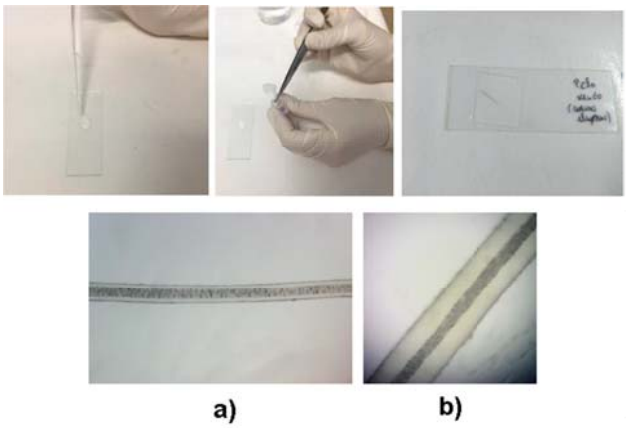

Figure 5. a) Canis lupus familiaris hair; b) Wolf hair

Following an advice to use hands-on activities as an instrument of the informal science education, our trainees were also active in the school summer camps for elementary and basic school kids where Physics became a very special feature.

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3.2. Health Education

3.2.1. Evaluation Alcohol Effects on Hepatic Cells

Alcohol is currently one of the main health concerns in modern society, so it becomes crucial to make students aware of alcohol effects on human body cells.

In this experiment tissue damage and dehydration of hepatic cells (from pork and cow liver) is evaluated under different concentrations of ethanol (Fig.6). This evaluation uses a colorimetric test (resazurin) that will estimate cell viability along with an evaluation of the physical measurements of the liver sections before and after exposure to ethanol.

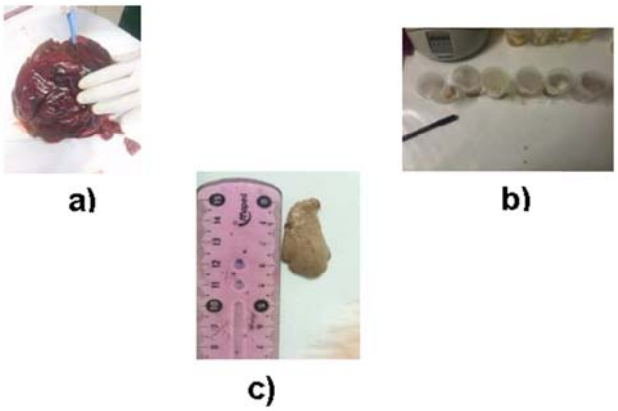

Figure 6. a) Removing liver fragments; b) Liver fragments on ethanol solutions; c) Liver after exposure to ethanol

3.2.2. Quantification of Sugars in Food

Childhood obesity including high levels of sugar consumption among students has become an important health concern. The experiment consists in evaluating the sugar content of common food/drinks applying both qualitative (through a color scale) (Fig. 7) and quantitative (through the amount of precipitate) methods using Benedict reagent.

3.2.3. Document Analysis

Documentation is the area of forensic science that deals with the analysis of documents whose genuineness is questioned. In the experiment, students analyse both different inks (by a chromatographic technique) and handwritings (Fig.8).

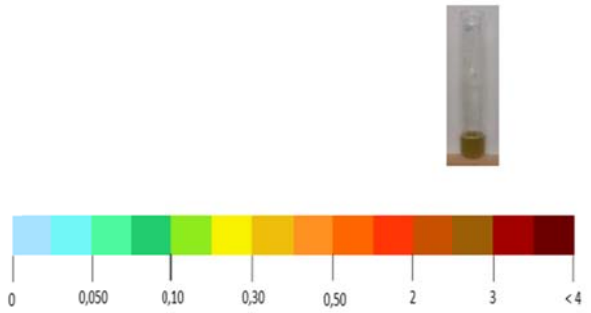

Figure 7. Evaluation the sugar content in food according color scale (different amounts of fructose (in grams))

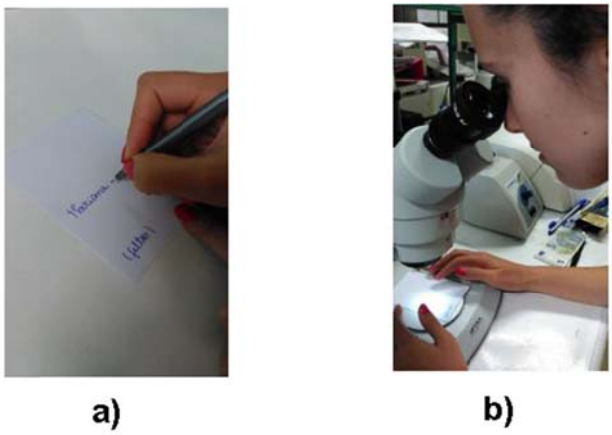

Figure 8. a) Producing a sample; b) Observing the differences under the microscope

3.3. Integration of Societal values

The integration of lab experiments with interdisciplinary approach over societal values and human rights is explored in the context of the fictionalized forensic case files.

For example, experiments such as hairs, footprints, pollen and diatoms will lead to a discussion on the importance of recognizing the concept of Ecosystems as complex systems involving a diversity of individual organisms and their physical surroundings in a bidirectional interaction and the relevance of preserving the biodiversity taking in consideration different biological roles such as decomposition.

Analysing sugar contents and alcohol effects on tissues allows to a reflection on health education but also on understanding the different (overweight students are especially targeted of discrimination) and preventing addiction (understanding and examining alcohol effects).

Finally, the script for the storyline of fictionalized case file may include human rights issues (for example, a victim can be a minority member). The forensic toolbox integrated with a comprehensive school year project about justice which will ultimately lead to a trial where students play different roles (lawyers, judges), based upon the evidences collected and analysed with the forensic educational toolbox.

4. Teacher Workshops and Addressing Refugees

After the planning, design and optimization of the Forensic Science Educational Toolbox version 2.0 and following initial evaluation of student's performance on their visits to the University (Fig.9), the educational kit is presented and tested by teachers of different subjects and school years.

Figure 9. Students testing Euro4Science 2.0 activities

The Euro4Science 2.0 includes demonstrations of the Toolbox consisting of 5-day practical workshops in six countries (Portugal UK, Bulgaria, Poland, Turkey and Greece). Refugees (mainly in Turkey) will be addressed by integrating teachers involved directly in refugee education activities.

5. Forensic Science Festivals

The Euro4Sciene 2.0 project also contemplates Forensic Science Festivals, science fairs where students from each country present their forensic-inspired education projects to an audience of teachers, students and the community.

The Forensic Science Festivals in Portugal, United Kingdom and Turkey, involve an exchange of 10 students and 2 teachers from each country. For the period of one week, students participate in various activities and present the socio-cultural context of each country along with their experience in the use of the Forensic Science Toolbox in the classroom context during the school year as well as new contributions from their initiatives of inspired forensic like activities.

6. Conclusion

The development of a forensic-inspired educational Toolbox (integrated within the European Erasmus+ Project Euro4Science 2.0) with a close integration with school curricula and educational objectives constitutes an opportunity to use an educational tool with highly engaging content, multiple possibilities of interdisciplinary exploration, and capable of reaching and motivating students at various levels of education.

The use of the Forensic Science Educational Toolbox Version 2 does not require special technological resources, allowing it to be used in a variety of school environments. The project strategy is also based in the involvement of teachers in the evaluation and improvement of the proposed activities through training actions (workshops).

The Forensic Science Educational Toolbox version 2 can be complementary to other educational resources, contributing to minimize the indifference and dropout of students in critical ages, and contributing to the motivation of teachers. This improved version will expand the application of the activities to new fields, such as health, environment and societal values such as non-discrimination and human rights.

7. Acknowledgements

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A Slight Approach to the Use and Understanding of the Internet in the Galician Educational System

A Pita[1], N Barcala[2], B Vázquez Dorrío[1]
[1]*University of Vigo, Vigo, Spain*
[2]*IES Valle Inclán, Pontevedra, Spain*
alpita@uvigo.es

Abstract. Internet is a technological tool that is currently widespread and fundamental in our modern societies, causing very significant changes, such as overinformation and hypersocialization. However, the knowledge about this tool and its potential advantages and risks is scarce in the majority of the population, which is especially worrying in our children and teenagers. That is why the UNESCO and other organizations are emphasizing the use and the study of Information and Communication Technologies (ICTs). Thus, internet knowledge studies in educational communities, such the addressed in this work, prove to be very useful in the evaluation of this problem.

Keywords. Educational intervention, ICTs, internet knowledge, use of internet at schools.

1. Introduction

Internet is a technological tool that is currently widespread and practically fundamental in our modern societies, causing very significant changes such as overinformation (i.e. increasing of insubstantial reading [1]), hypersocialization [2] and the way of communicating (i.e. role of internet in social movements and the outraged [3]). It is estimated that there are more than 3000 million users, representing approximately 40% of the world population [4], and it is used frequently in Spain by the 76.5% of the population between 16 and 74 years old [5]. However, the internet appeared much earlier that the generation of digital natives we have nowadays in primary, secondary and high school, and a basic knowledge about this tool (history, usage protocols, programming languages, etc.) and its potential advantages (access to information global intercommunication, didactic resources, etc.) and risks (piracy, electronic fraud, etc.) is scarce in the majority of the population. This is especially worrying for our children and teenagers, because they are the generation that will have to face with new digital challenges in the near future but they are the most exposed group to the associated risks of this technology at the same time (i.e. bullying in social networks). Even more when the next technological leap proposes to install the internet in all kind of objects, the so-called "internet of things" [6].

That is why international organizations and educational curricula are emphasizing the use and the study of Information and Communication Technologies (ICTs). Comprehensive training in new technologies in high school classrooms has emerged as a key aspect in today's societies, which has been reflected in the latest educational laws of many countries. Nonetheless, the United Nations Educational, Scientific and Cultural Organization – UNESCO defined twenty years ago the four basic pillars of education ("learning to know", "learning to do", "learning to live together, learning to live with others", and "learning to be") [7] which are being implemented since then in some education systems around the world. In our case, the European Union (EU) has been claiming for their implementation and the use of basic competences while warning about a "widening skills gap", particularly in the TICs [8]. As a result, both institutions, the European Parliament and the European Council, have urged the development of key competences for a lifelong learning [9]. Such competences are defined as a "combination of knowledge, skills and attitudes appropriate to the context" and are those "which all individuals need for personal fulfilment and development, active citizenship, social inclusion and employment" [9]. There are eight key competences: 1) communication in the mother tongue, 2) communication in foreign languages, 3) Mathematical competence and basic competences in science and technology, 4) digital competence, 5) learning to learn, 6) social and civic competences, 7) sense of initiative and entrepreneurship, and 8) cultural awareness and expression [9].

Spain, as an EU member state, regulates the implementation of the key competences in the educational curricula of all Autonomous Communities. This is done through an Order published in the *Boletín Oficial del Estado* (BOE), which describes seven key competences, encompassing both communication competences in a single one

[10]. The topic treated in this work, the knowledge and use of internet in children and teenagers, has a high impact in all the key competences. Therefore, a correct and responsible use of this tool in the education system might help to close the skills gap mentioned before.

The external practices of the "Master's Degree in Secondary Teacher Training, Baccalaureate and Vocational Training" taught by the University of Vigo was a huge opportunity to make an approximation to the knowledge of the internet and the use of its applications by an educational community. The educational intervention was carried out in the "IES Valle Inclán" in the city of Pontevedra (Galicia, Spain) on the students attending the optional subject "Scientific Culture". This subject aims at students to acquire a basic scientific knowledge that can be applied in different contexts of their daily life, such as the monitoring of scientific news, awareness of the different dimensions of reality and the promotion of their responsibility. Four objectives were set before the intervention: 1) to identify previous ideas about the internet in high school students, 2) to know and to analyse the habits of use and the internet consumption of students in their leisure time, 3) to analyse the use of internet for academic training, and 4) to quantify the use of new technologies and applications based on the internet.

Based on the available data and the applicable educational legislation in recent years, it is expected that the students evaluated in this study know the fundamentals of the internet and use their applications effectively in response to the training received in the education system.

2. Material and methods

Pontevedra is a small city in the Northwest of Spain. It has an approximated population of 83000, although its metropolitan area reaches 186500. The high school selected to carry out this study, the IES Valle Inclán, is the oldest one in Pontevedra and teaches about 500 students a year in six courses (four courses of Secondary School and two years of Baccalaureate).

Due to the short time scale of the external practices, it was not possible to evaluate all students, focusing the study in those who attended the subject Scientific Culture in the first year of Baccalaureate. There were two groups of students: 1) classroom 1ºAB with 17 students, and 2) classroom 1ºC with 18 students. All of them between 16 and 18 years old. The intervention was the same in both classrooms and consisted in seven sessions of 50 minutes combining different kind of didactic resources (i.e. theoretical presentations, documentaries, debates and discussions).

To achieve the proposed objectives a questionnaire of 19 questions was prepared following the requirements of the educational curricula. This questionnaire was composed of three different blocks: previous knowledge about the internet, habits of use during the leisure time, and the use of internet in the academic environment. The students filled out the questionnaire during the first session of the intervention as well as at the end of it.

Data were stored in an Excel sheet to perform tables and graphics. The methodology Force Concept Inventory [11] can be applied to several questions that were answered at the beginning and at the end, what will be of great help determining the effectiveness of the intervention. In addition, the Hake factor [12] was used in those questions subject to a possible learning gain.

3. Results

3.1. Previous knowledge

Five questions were asked in the first block. The students had big problems to identify the origin of the internet, only 12 out 34 selected the most correct answer (i.e. military agencies). This contrasts with the answers obtained to the question about the first use of the internet that was formulated as an open question. Most of them were related with military purposes (i.e. military, military communication, etc.).

Three out 16 students in 1ºAB were right placing the origin of the internet in the decade 1960-69 during the first session. The correct results slightly increased after the intervention (5 out 16 students). In group 1ºC the number of correct answers tripled the amount obtained in the first session, from 5 to 13 out of 18. This last increase corresponds to a Hake index of 0.6.

Both classrooms showed a positive response to the intervention as they doubled the number of correct answers after it about the number of internet users (more than 3000 million users). Correct answers went from 4 to 10 out of 16 in 1ºAB, which generates a Hake index of 0.5. The Hake index was 0.3 in classroom 1ºC, where correct answers went from 6 to 10 out of 18 (Fig.1).

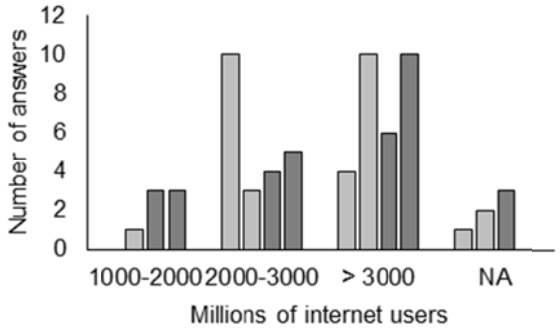

Figure 1. Distribution of answers about number of internet users. First and second bar correspond to initial and final tests of 1ºAB, third and fourth bar correspond to initial and final tests of 1ºC

3.2. Habits of use during leisure time

The students answered eight questions in this block. All of them assured to use internet in their mobile phones, while most of them also confirmed the use of laptops (25 out of 31) and tablets (23 out of 31) to connect to the net (Table 1). The average use of internet during the leisure time at the beginning of the intervention was 31.0±18.9 hours per week in 1ºAB, dedicating 22.1±18.6 to social networks. While they were 33.9±36.9 and 27.1±37.1 hours per week in 1ºC. After the intervention the average use of internet decreased to 27.2±17.4 hours per week in 1ºAB (time in social networks remained stable) and to 29.2±20.3 in 1ºC (21.5±20.0 hours per week in social networks).

Both classrooms know twice as many social networks as they use. Students of 1ºAB know an average of 6.5±2.8 social networks but they use only an average of 3.6±1.4. Students in 1ºC know more social networks than students of 1ºAB (an average of 8.6±3.6) and they use an average of 4.1±1.5 of them. The social networks most known by the students were Twitter, Instagram and Facebook (more than 90% of students). Instagram is the most used by students of 1ºAB (13 out of 15), while WhatsApp is the most used in 1ºC (14 out of 16 students). Facebook is only used by a third of the students who said they know it (10 out of 29).

Device	1ºAB	1ºC
Mobile phone	15	16
Laptop	12	13
Tablet	12	11
Computer	10	6
Others	5	1

Table 1. Number of students who use internet in each device. 1ºAB N = 15; 1ºC N = 16

The information shared by the students in social networks is mainly photos, videos and messages, but 1 out of 3 is sharing personal information such as the age, gender, location or phone number. Only 3 students out of 31 reported not sharing anything on social networks. Sharing information on social networks was not seen as something completely safe by the students of both classrooms (i.e. depends on the use). An opposite behaviour was observed in each group after the intervention: some of the initially doubtful students of 1ºAB finally answered “no-safe”, while a greater number of students in 1ºC opted for “depends” at the end of the intervention (Fig. 2).

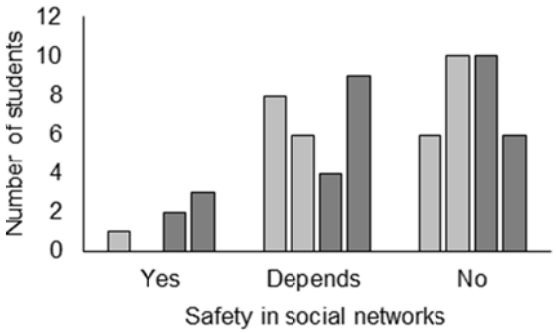

Figure 2. Distribution of answers about number safety in social networks. First and second bar correspond to initial and final tests of 1ºAB, third and fourth bar correspond to initial and final tests of 1ºC

3.3. Internet in academic environment

The first question of the last block was about the number of hours that the students dedicate to academic issues, including study, preparation of homework, etc. In classroom 1ºAB was observed a decrease in the average number of weekly hours, from 5.5±4.3 hours per week declared in the first session to an average of 3.9±2.8 obtained after the intervention. Classroom 1ºC showed the opposite trend, from an average of 3.4±2.3 hours per week before the intervention to an average of 4.3±4.2 at the end.

The information sources handled by the students are mainly wikis (used by all students) and blogs (21 out of 34). Most of the students use internet applications as autonomous users to solve their own doubts, while the majority acknowledged not having used them in class. The most used applications as autonomous users (i.e. at home) are Wikipedia, blogs and YouTube channels. Those students who recognized the use of internet applications in class mentioned Yoformulo, YouTube and Geogebra. An increase in the use of internet and its applications in class was considered necessary by a high number of students (27 out of 34 after the intervention). The reasons given for claiming such an increase were "more entertaining classes", "improvement of learning" and "very useful". On the contrary, the justifications of those who thought that it is not necessary are "the classes are well as they are" and "we already use too much internet" (Fig. 3).

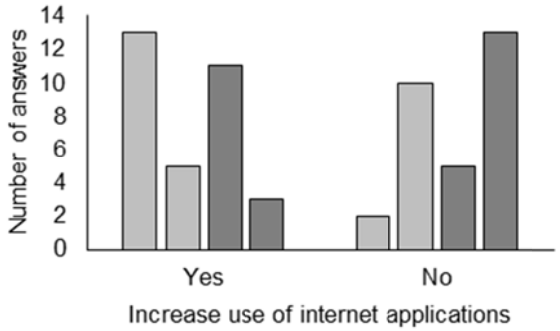

Figure 3. Distribution of answers about increasing the use of internet applications. 1ºAB students in light grey, 1ºC students in dark grey. First and third bar correspond to autonomous use, second and fourth bar correspond to use in class

4. Discussion

Although a great sampling effort was made given the limited time available to access the students and to carry out the educational intervention, it is necessary to recognise that the sample size of this study is not meaningful to draw conclusions on a large scale. However, it can be considered as a good approximation to the overall behaviour of the students of this high school, because all students share the same social, economic and educational context. There was not enough information on how the high school structured the different groups (i.e. randomly, by surname, etc.), but during the intervention it could be seen that students of 1ºC (more than 80% of girls) were more applied than students of 1ºAB (69% of boys) (i.e. better grades). This is on the line with the latest PISA reports showing that girls normally score higher than boys do around the world [13].

4.1. The starting point

The generation that is currently attending primary schools and high schools has already surpassed the one denominated the digital natives [14]. In other words, these young people should be already fully prepared in the use of network technologies, even more when most of them have access to new generation mobile phones and to high-speed internet connection [5]. However, it has been observed that their basic knowledge about the history of the internet (i.e. origins, people involved in its development, economic impact of e-commerce, etc.) is rather scarce.

Since the beginning of the internet in the sixties, this tool has been developed through many contributions. Some of them were a major qualitative leap such as the TCP/IP communication protocols developed by Vint Cerf and Robert Khan or the design of the "World Wide Web" by Tim Berners Lee [15]. These answers were among those given by the students about the origin of the internet, which denotes that some students identify the internet with the WWW tool they use daily in their computers. This identification can also be seen in the answers about the temporal moment of the origin of the internet, since 15 out of 31 students believed at the beginning of the intervention that was invented after 1980. This appreciation could be partly corrected, since

the Hake index observed in the students of 1ºC (g = 0.6) indicates a medium gain according to the intervals established by Hake [12]. These intervals establish that a high gain occurs when g is higher than 0.7, medium when it is in the range 0.3 – 0.7 and low when it is lower than 0.3, as the case of the students of 1ºAB (g = 0.14). The gain detected in the group 1ºC makes doubt on how students cover the questionnaire, since the interrelation of questions seems scarce. Most of their students already said that the first use of internet had a military component and many of them added that such use was linked to the Cold War, so a better correlation would have been expected between questions.

Finally, this section can be closed with a certain optimism due to the observed medium gain in learning in the last question (i.e. number of internet users). Although the number of internet users may appear to be a specific data and it could be expected a higher Hake index, it should be noted that the number of internet users is not easy to estimate since several users may access to the internet through the same device.

4.2. The leisure time

A growing concern in western societies revolves around the increasingly early age that our children enter to the world of leisure. This includes the internet access and their applications, which is used by 93.6% of children between 10 and 15 years old [5]. In addition, the 90.9% of the Spanish population of 15 years old has a mobile phone, most of them with internet access [5]. This implies exposure to the inherent risks that exist in the network, what it is difficult to control at home due to the increase of workloads and lack of family reconciliation [16, 17]. That is, we spend less and less time with our children, and when we are with them, we do not want to deny them anything [18].

Another problem, as noted in the results of this study, is that the use of the internet on wireless devices is gaining ground to the traditional cable connection of desktop computers. The fact that all students evaluated have access to the net on their mobile phones makes it more difficult to control the content they visit. Moreover when the percentage of students using these devices for their academic activities increases in both, Latin America [19, 20] and in the United States and other English-speaking countries [21]. It is not a question of parental prohibitions but of improving the education regarding the use of these tools. It is therefore necessary for teachers to increase their skills in the use of the internet and new technologies and to avoid the image of outdated staff [22].

The most recent studies establish that Spanish spend an average of 3 hours a day on the internet excluding work tasks [23] and that 90% of young people between 10 and 17 years old admit to using internet more than one hour per day [24]. Our results go in the same direction, since although the average number of hours is higher (i.e. 4 hours a day), it is necessary to take into account the high standard deviations that reflects a high dispersion in the answers. In fact, the majority of students fall within a range of 10-30 hours per week, where the midpoint would be those 3 hours per week. However, the current feeling of western societies is to be permanently connected to the net, which is reflected in the three answers detected above 50 hours a week.

A survey of the Spanish Minister of Home Affairs carried out on young people between 10 and 17 years old states that in the last 30 days the 94.5% had visited YouTube, the 82.2% admitted to use instant messaging, and the 67.8% had visited a social network [24]. Therefore, it is not surprising that the students know many social networks and use several of them. Especially when in recent years there has been a media boom caused by famous people competing to have the largest amount of followers. At this point is symptomatic the fall detected in the use of Facebook and the recognized leak of young users towards other options like Snapchat or Tumblr (i.e. decrease in number of users between 13 and 17 years old of 25% in the US between 2011 and 2014 [25]). Social networks invite you to share details of your private life, and most of our students admitted to share photos and videos or to publish messages. However, it is more worrying that a third recognized to share personal information, which collides with the advice of the Office of Internet Security [26]. Most students think that sharing information on social networks is not safe or depends on the use given. In this sense, it is confirmed the

need to have teachers with more training on new technologies and the security policies associated with their use.

4.3. The near future

Since the explosion of the internet with the appearance of the World Wide Web in the 1990s, we have been hearing from various sectors the need to incorporate this technological world into the education system (i.e. Spanish education laws). Not only to improve learning in schools and to highlight its benefits, but also to raise awareness of its risks, especially in such a vulnerable and influential population spectrum.

The 95.5% of Spanish children and teenagers use the internet to carry out their homework [24], which is in agreement with the data obtained in this study where an average of 4 hours per week dedicated to academic issues was observed. However, some students showed some tiredness about a possible increase in the use of internet applications in class saying that they used it enough. These complaints are a fact to bear in mind at a time when the high expectations of improving learning are being discussed through the introduction of TICs [27]. One of the advantages of the effective increase of TICs in teaching rooms would be the maximization of the use of didactic resources, not only wikis and blogs. It should be noted that this field is constantly evolving and that there are currently more than 80000 educational applications. This figure contrasts with the number of students who said they did not use them or with the low number of applications used by those who answered affirmatively. Furthermore, it is noteworthy that after the intervention a higher number of students found interesting the introduction of these applications into teaching.

5. Conclusions

Previous knowledge about the subject of study were rather scarce although with enough potential to obtain a significant gain in learning.

The students evaluated had a last generation mobile phone with internet access, being the preferred device of students to navigate on the net and use social networks.

The number of hours the students are using the internet is increasing in the last decade, ranging between 3 and 4 hours a day. In addition, cases susceptible of being associated with an addictive behaviour were observed after some of them recognised to use it more than 50 hours per week.

The use of social networks and the publication of photos and messages in them is widely spread among the youth population in light of the results of this study. Although many of them are aware of the problems that entail in terms of security.

The introduction of educational applications in the classroom remains the greatest pending task in our educational system. However, this process should be gradual in order to avoid the over-saturation of students and to definitively form the teachers in the use of new technologies.

6. Acknowledgements

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On the Determination Coefficient and Global Adjustment Test of Goodness of Fit

C Azevedo, R Silva, A Horta,
M Correia-Neves
University of Minho, Braga, Portugal
cecilia@math.uminho.pt

Abstract. The contents of Statistics courses in Universities almost always include the study of linear regression models. The versatility and the simplicity of this kind of models allow its wide use.

However, it seems that there are some misunderstandings about what one can, or cannot, conclude about the usefulness (and even relevance) of some models. The use of the coefficient of determination R-squared is well established in classical linear regression analysis and its definition, as the proportion of variance "explained" by the regression model, makes it useful as a measure of success of predicting the dependent variable from the independent variables. In general, the higher the R-squared, the better the model fits the data. But the value of R-squared does not indicate whether a regression model is adequate. In fact we use overall F test for goodness of fit of a linear model to test if the proposal model is better than the mean model. Recall that the mean model uses the mean for every predict value!

We present an example with real data to clarify our point: a R-squared very low, which means that the obtained linear model in not adequate for predict (with accuracy) dependent variable value, but better than mean model and relevant in medical studies.

The example presented here concerns to the behaviour of CD4+ T cell counts in patients with Human Immunodeficiency Virus (HIV) during antiretroviral therapy (ART).

The principal hallmark of HIV infection is CD4+ T-cell depletion, which progressively compromises the immune response to opportunistic infections, leading to Acquired Immunodeficiency Syndrome (AIDS), the final and most severe stage of the disease. For this reason, the count of CD4+ T cells is a primary indicator used to measure progression of HIV infection.

In this study, we consider CD4+ T cell counts in 50 patients with HIV-1 (the most spread HIV type worldwide), that are in ART. The observations are made in 17 time points starting at baseline (BL) and up to 60 months of treatment.

In the plot below, Figure **1**, we have the data for different subjects in separate panels with the axes held constant for all the panels, to allow the examination of the time trends within subjects and for comparison of these patterns between subjects. The line drawn in each panel is a simple least squares line fit to the data in that panel only. It is provided to enhance our ability to discern patterns in both the slope (the change in in CD4+ T cell count per unit time of treatment for that particular patient) and the intercept (the average baseline value for that patient).

The mean behaviour along time on the number of CD4+ T cell seems to have identically trend, but with great variability in the values of each patient.

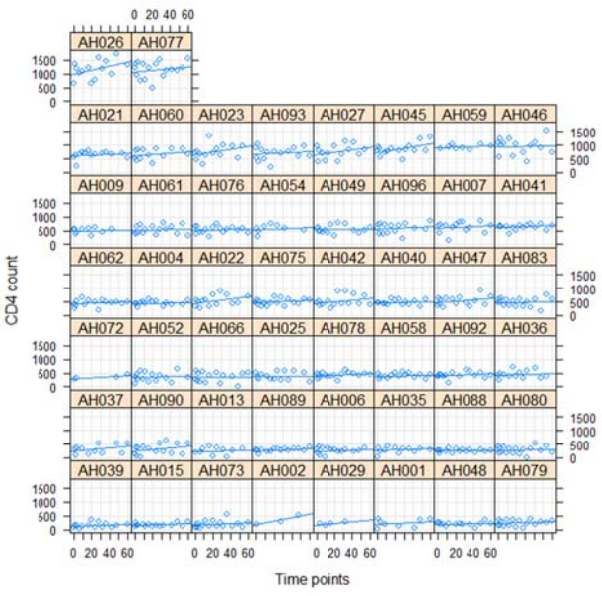

Figure 1

In this study we are interested on the global growth trend.

If we consider the set of slopes of the least squares line fit in the data of each patient, we obtain a skewed empirical distribution, as we

can see in Figure 2. There are two observations positive moderate ouliers (patients AH002 and AH026 - Figure 1).

Also we have the median value of slope in the interval]1.022; 1.924] with 95% of confidence.

But the main point is if with all the data of these 50 patients we have a statistically significant linear growth of CD4+ T cells with time.

We fit a linear model to data, and obtain an estimative for the intercept of 466 cells, with 1.63 as estimative of slope, which agrees with the confidence interval obtained above, with a p value of 0.0046 for the F test. So this linear model is better than the mean model.

The obtained result makes sense to medicine expertises but the R-Squared value is only 0.01174, i.e., despite the pertinence of the model and its relevance for the clinical practice, this model is useless for making predictions.

Concluding, we have a very low R-squared value but a statistically significant predictor, which means that with time the values of CD4+ T cells, tends to increase. The significant time coefficient represent a positive mean change in the CD4+ T cells and this type of information can be extremely valuable.

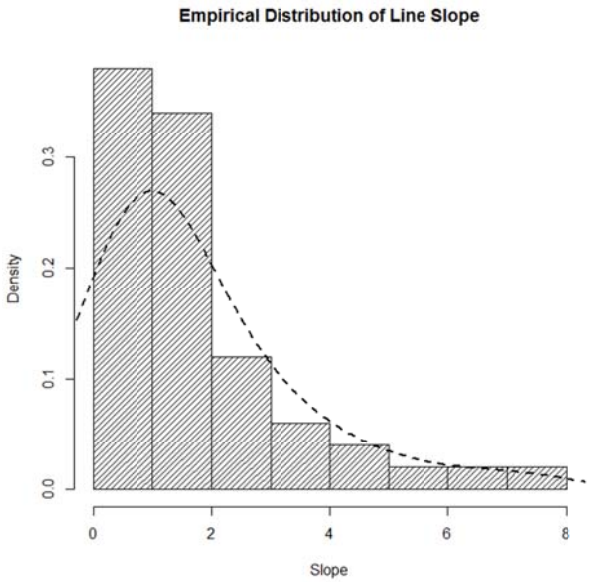

Figure 2

Keywords. R-Squared, goodness of fit, $CD4^+$ T cells.

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CIVICS- PHYSICS. Knowledge May Stimulate Thinking and Acting "Politically Correct"

IR Chisleag Losada, R Chisleag
University Politehnica, Bucharest, Romania
Chisleag@gmail.com

Abstract. Political correctness ('PC") is a term which denotes language, ideas, policies, and behavior seen as seeking to minimize social and institutional offense in occupational, gender, racial, cultural, sexual orientation, certain other religions, beliefs or ideologies, disability, and age-related contexts and, as purported by the term, doing so to an excessive extent.

The often quoted "earliest cited usage of the term" comes from the U.S. Supreme Court (1793) [6], where it clearly means that the statement it refers to is not literally correct, owing to the political status of the United States as it was understood at that time: The contemporary use of the term political correctness is said to derived from Marxist-Leninist vocabulary to describe the Party Line. Communist parties in Eastern Europe used it to ask for strict observance of the parties' decisions. Since then, the term was transformed and used and jokingly and seriously within the Left and Right, governments, academic and media due to a tendency by some of those dedicated to these causes to be more concerned with rhetoric and vocabulary than with substance. Use of the term declined in the late 1990s, and it is now mostly seen in comedy or as a political slur with questionable meaning or in propaganda in hybrid wars.

Presently, in countries with a not developed democracy, PC is largely invoked by autocratic parties and governments in power. In current Anglo-Saxon usage, the term is primarily pejorative, while the term 'politically incorrect' has been used as an implicitly positive self-description.

The converse term, politically incorrect (PCI), connotes language, ideas, and behavior unconstrained by a perceived orthodoxy or by concerns about offending or expressing bias regarding various groups of people.

The debates around Political Correctness (PC) need objective, non partizan tools. Such tools are offered by Civics Physics [1,2], which apply principles analogous to Principles of classical, Newtonian Physics, valid for bodies composed of many molecules (mono- or poly-atomic ones) [1,2,3,5]. If we refer to the social behavior of an individual, the Quantum Physics and Wave Optics [4] seem to the authors as being adequate.

CIVICS -PHYSICS could be useful to approach debates on PC. Particularly, because Civics-Physics has large spectra of models and because its bases - Physics and Civics Education - are introduced from the school age as components of general education, Civics-Physics is called to suggest scientists, practitioners, students, laymen, politicians, media and to help them to apply (since learning them) Physics tools: principles, postulates, laws, methods, structures, models, to identify, understand, explain, describe, manage and control by analogy with natural phenomena the Civics phenomena - the relationships between citizens and their communities, the rights and obligations of respectively, citizens and communities.

Many models used as yet in the debates on Political Correctness issues in politics, research, practice, media and education, are intimately connected with Physics models, f. e.: “proportionality with action” corresponds to II nd law and the relationship between PC and PCI might correspond to the III rd-action and reaction law ("Postulate of Action and Reaction" - PAR).

In approaching PC by Civics Physics, there are to be considered multiple dimensions simultaneously, variations of the local values, different horizons in space, time, available natural and creative resources, decision procedures and bodies aso depending of the environment, on the balances of interests and approach among the promoters.

As a consequence, the Physics models when used to study PC, might have some characteristics relaxed and even a little different from those of the Physics models. The definitions or the conditions for space, time, objects, resources and interactions (linearity aso) are relatively less rigorous than in Physics, but even, objective;. When different, they might

lead to different results. Interdependence and co-operation play important roles. The authors consider Civics-physics principles, when possible, as being postulates (acceptable, based upon partially pragmatic check), offering a higher level of common sense to be applied to Civics PC

The authors select, in the paper, Civics-physics versatile tools based upon objective models from : Dimensional Analysis; Basics of Processing of Experimental Data; Averages and Errors [1, 2, 3]; I st, II nd and III rd Newton's Laws of Mechanics, Principles of Conservation; Equilibrium of bodies; Wave Optics and Quantum Mechanics [4] and give their own examples of such models used to explain PC and PCI.

The Dimensional Analysis is to be largely used in PC debates when determining the conditions of applications of PC allegations, because individuals or communities are not to be supposed - as in Physics - as insulated and therefore, independent from the environment and changes are finite.

F.e., to overpass difficulties in using many terms attacked to be politically incorrect, there has been applied the dimensional changing of the propriety describing the same group. F. e. English male-centered nouns such as "chairman" where proposed to o be replaced by "correctly political" more inclusive terms such as "chairperson". The Civics Physics may explain, by dimensional analysis the common criticism of politically correct terms: how happens that terms chosen by an identity group, as acceptable descriptors of themselves, then pass into common usage, including usage by the racists and sexists whose racism and sexism the new terms mean to supersede. Alternately put, the new terms gradually acquire the same disparaging connotations of the old terms. The new terms are thus devalued, and another set of words must be claunched, giving rise to lengthy progressions such as Negro, Colored, Black, Afro-American, African-American, and so on. From a Civics Physics approach it means that the time horizon or/and the space horizon are changing with the passing of time and the changing of place, of user of the term aso.

In many cases the new dimension, the new horizons aso used for comparison tends to mask the actual situation.

Recently, (May 2017), USA announced that they withdraw from the Paris UN Framework Convention on the Climate Change because it would be dis- advantageous to the current USA economy. Both, USA and the other partners of the Convention are right in their approach. The Civics Physics explanation is the time horizons are different: 1-2 presidential mandates for USA and centuries for the Convention time horizon. The space horizons and other dimensional horizons are also different.

The term "politically correct" when opposed to "politically incorrect",oin the same topics rarely observe the Postulate of Action and Reaction. The explanation is in the different dimensions considered for action and for the reaction to the action, this dimensional change may changing the evaluation of a phenomenon from "politically correct" to politically "incorrect".

PC as a linguistic concept encompasses both the language in which issues are discussed and the viewpoints that are expressed. Critics of political language choice argue the new terms are often awkward (of limited horizons), euphemistic substitutes for the original stark language (using only a dimension for describing the groups)

Speech censorship may be avoided by using other dimension (propriety, characteristics) to describe the situation that means using speech codes. Thus meaning against using different dimensional approaches to mask the reality. Speech codes are frequent and important for hybrid and propagandistic wars. By changing the dimensions used, their horizons of validity and leveling the charge of 'political correctness' against "the enemy" it could discredit the enemy. This is a key technique employed to manipulate the masses. Political correctness manipulations have lots of power and money behind them.

Many "politically correct" terms are being linguistic cover for an evasion of personal responsibility, for instance when "juvenile delinquents" became "children at risk" or when "illegal aliens" became "undocumented workers".

Applying Civics Physics tools to approach PC and PCI debates one may save much political efforts, the general population being only able

to consider much less dimensions to describe reality.

The use of political language modification (of using different dimensions to describe the same reality) has a history in satire and comedy.

Mainstream science is dominated by politically correct thinking. The dimensions used in science are, usually, politically correct.

The quantitative approach made possible by Civics Physics is extremely important. F. e., we may compute the efficiency of changing PC term into its PCI term.

By systematically asking students taken courses in Physics to find applications of the newly got Physics knowledge, to model civic and even everyday life phenomena, they may correct many "politically correct" items.

Keywords. Civics-Physics; Jus-Physics; political correctness, Socio-Optics; Socio-Physics.

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Eukaryotic Cell and Factory Analogy in Brazilian Textbooks: Is It still Used?

CMY Araujo, A Marinho
Universidade de Brasília,
Campus Darcy Ribeiro, Brazil
carlayaraujo@gmail.com

Abstract. The project We are made of cells! (Somos feitos de células!) overlaps academic, research and community actions to achieve its main goal: the creation, development, application and evaluation of educational materials and educational processes in Cytology, Histology and Embryology. Several demands related to teaching research emerged over the seven years of this project. One of them refers to the use of analogies in Cytology. In this preliminar research, we analyzed the use of analogies in Cytology in brazilian textbooks, especially the comparison of the eukaryotic cell with a factory of any consumer goods produced on an industrial scale.

"An analogy is the comparison of similarities between two concepts" [1]. A broader definition is found in [2]: “An analogy is a correspondence in some respects between concepts, principles, or formulas otherwise dissimilar. More precisely, it is a mapping between similar features of those concepts, principles, and formulas.”(p. 383).

These similarities can aid the learning process by encouraging students to draw conceptual bridges between concepts they are familiar with and the new concepts addressed in the school environment [3]. These concepts, in the context of analogies, are also referred to as target domain and analog domain [4], terms that we adopted in this work. Frequently, new domains represent complex, abstract and integrated systems, such as the cell, the ecosystem, and photosynthesis [3]. In these situations, analogies can serve as the first mental models to be used for the beginning of the understanding of complex scientific domains [5]. As the teaching and learning process continues, more sophisticated mental models would be adopted by students, supplanting the phase of using more simplified analogies [3,5].

It is noticeable that research in education has consolidated works that include the systematic use of analogies, with the establishment of didactic procedures that, regardless of their format, include actions that compare the different domains and investigate the limits of the analog domain in order to minimize misconceptions which may arise during the learning process. In this context, for the cellular subject, this preliminar work had as general objective to carry out theoretical work to begin to qualify the reflection regarding the relation domain-target (cell) and domain-analog (factory), through the analysis of the use of this analogy in some brazilian textbooks and how this analogy is showed to students.

In this paper, we have analyzed six brazilian biology high school textbooks [6,7,8,9,10,11] to verify the current use of factory-cell analogy. Content related to analogy was examined according to some previous established criteria [12].

An average of 26 analogies were found in the cytology section, and the most frequent were those of the functional type, in which the functions of the analog are assigned to the target domain, with a simple enrichment level, establishing that the target is similar to the analog without further explanation [12].

In none of the six textbooks examined we detected the organization and functioning of a factory being compared with the morphology and physiology of a whole eukaryotic cell. A more general analogy was observed only once, in which the cell was compared to a city, with shared structural and functional attributes such as "organization of different activities in different areas" and "transportation of raw materials, construction of new structures, obtaining energy, removing undesirable residues, efficient communication systems " [8]. Explicit reference to a factory appeared only when some organelles and cell molecules were compared as a manufacturing machinery and the nucleolus as a ribosome factory [7].

However, other analogies that emphasized comparisons of machinery, building and power generation components were observed in the approach of specific cellular components. The most frequent analogies of this nature refer to the function of the mitochondria and DNA. The difference between the ionic concentrations in the outer and inner faces of the plasma membrane (membrane potential) is compared

with the different poles of an electric cell [7] and an electric capacitor [6]. The affinity between membrane receptors and their activator molecules is repeatedly cited by comparing to a key and a lock [7,8]. The energy used by cells was compared with fuel to supply a machine and mitochondria was compared to power plants or powerhouses [8]. ATP synthetase was cited by several ways: hydroelectric plant generator rotor [7], hydroelectric plant turbine and rotational molecular motor [6]. The ATP molecule is cited as an energy coin that supplies energy expenditures [6].

The DNA molecule is a fertile ground for analogies related to machinery. For the explanation of its functions, the molecule is related to a magnetic tape in which information is recorded [6], for example. The role of rRNA in protein synthesis is compared to adapters [6]. Some other analogies were verified such as: the cellular cytoplasm as a building under construction with anchors [7], Schwann cells as electrical insulators [7], cellulose wall structure comparable to iron rods with cement and stones scores [6].

The examination of the content of cytology in these brazilian textbooks revealed the absence of analogy of organization and function of a factory as a whole with the morphology and physiology of a eukaryotic cell. It was concluded that this comparison is not encouraged by authors of these textbooks. However, the cell comparison to some machinery components was still present and focused on specific cellular components such as the function of mitochondria (power plants), ATP protein synthetase (hydropower turbine) and the functions of DNA molecules.

The comparison of animal eukaryotic cell morphophysiology with the organization and operation of a car factory or any mass-produced consumer goods is still presented in US literature, for example [3, 13, 14].

What it is also noted in these textbooks was the lack of pedagogical orientation for the student to how to use the cytological analogies. It is important to point that research in science education has consolidated works that include a systematic use of analogies, with the establishment of pedagogical procedures that, regardless of their format, include actions that compare the different domains and investigate the limits of analogy in order to minimize misconceptions that may arise during the learning process. It is suggested to include this approach in the brazilian textbooks to minimize the appearance of misconceptions by the students.

Acknowledgments

PIBIC Edital 2014/2015 and FAP-DF.

Keywords. Analogies, cytology, factory, brazilian textbooks.

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Observations, Experiments and Measurements in the School Course of Physics

V Belaga[1,3], *I Lomachenkov*[1,3],
Y Panebrattsev[1,2], *N Vorontsova*[1,2]
[1]*JINR, Dubna, Russia*
[2]*InterGraphics LLC, Dubna, Russia*
[3]*Dubna University, Dubna, Russia*
belaga@jinr.ru

Abstract. The report is devoted to the use of the educational-methodical complex “Spheres Physics. 7–9 grades” in the educational process. Project “Spheres” of the publishing house “Prosveshcheniye” is an interdisciplinary project aimed at creating a unitary system of the modern school informational educational environments which provides new approaches to the educational standard at a secondary school. Teaching methodological complexes (TMC) “Spheres” are published in the series of “Academic school textbook” which was developed in the framework of a wide-scale project “Russian Academy of Sciences, Russian Educational Academy, the publishing house “Prosveshcheniye” — for Russian School”.

During last 5 years there has been published the educational complex on Physics for the 7th – 9th grade which includes:

- Textbook
- Additional software
- Exercise notebook
- Laboratory notebook
- Exam notebook
- Task book
- Teacher’s book

Figure 1. The educational-methodical complex “Spheres Physics. 7–9 grades”

The school course of physics is a basic one for natural science subjects, because physical laws underlie the content of chemistry, biology and astronomy. Here we would like to highlight the following tasks of the school physics course:

- Familiarity of students with the method of scientific knowledge and methods of research of nature objects and phenomena;
- Study by students of such general scientific concepts as a natural phenomenon, an empirically established fact, a problem, a hypothesis, a theoretical conclusion, the result of an experimental check;
- The ability to use methods of scientific research of natural phenomena, to conduct observations, plan and perform experiments, to process measurement results, to present measurement results using tables, graphs and formulas, to find out the relationships between physical quantities, to explain the results obtained and to make conclusions, to estimate the limits of measurement error;
- The ability to apply in practice of theoretical knowledge in physics, to solve physical problems for the application of acquired knowledge.

We would like to demonstrate examples allowed to solve the above-mentioned problems using some materials of the Textbook, Exercise notebook and Laboratory notebook, as well as additional software.

The study of physics in the 7th grade begins with the Module "Physics and the world in which we live". For example, Lesson #3 "Observation and experiment" consists of sections "The role of observation in our life", "Getting knowledge in our life", "Physical law" and "Instruments for measuring". Studying this section, students learn about a sequence of events, as a result of which new knowledge usually is born: observation – hypothesis – experiment – conclusion. As a result of this lesson, students:

- Learn to understand the meaning of each stages of new knowledge obtaining;
- Learn to distinguish a hypothesis from an experimentally established fact;
- Yourself express assumptions — hypotheses; Learn the simplest

measuring instruments: ruler, stopwatch, scales etc. and call the area of their application.

Figure 2. Lesson #3 "Observation and experiment"

Further, the distinction between hypotheses and facts, models and real phenomena, as well as experimental verification of hypotheses, is paid attention throughout the whole course of physics 7–9.

For example, in the textbook for 7-th grade in Lesson "The impossibility of creating a perpetuum mobile" is discussed the hypothesis of the perpetuum mobile existence, various models of ones are given, and the reasons about wrong of these models are explained.

Acquaintance with measurements in physics begins already in the first section of the textbook for the 7th grade from the Lessons #4 and #5: “Physical quantities and their measurements" and "Measurement and accuracy of measurement». Here, students:

- Familiarity with the concepts: physical quantity and unit of physical quantity;
- Learn to compare physical quantities, operate with multiple and divided units of physical quantities;
- Learn to determine the scale interval and the error of the measuring device, and to calculate the average value of the measurement results.

To consolidate the acquired knowledge in the textbook under the heading "My physical research" it is proposed to perform a number of home research works. The Exercise notebook has many exercises of the following types: "We look and think", "We count and compare", “We solve problems", "We work with the text".

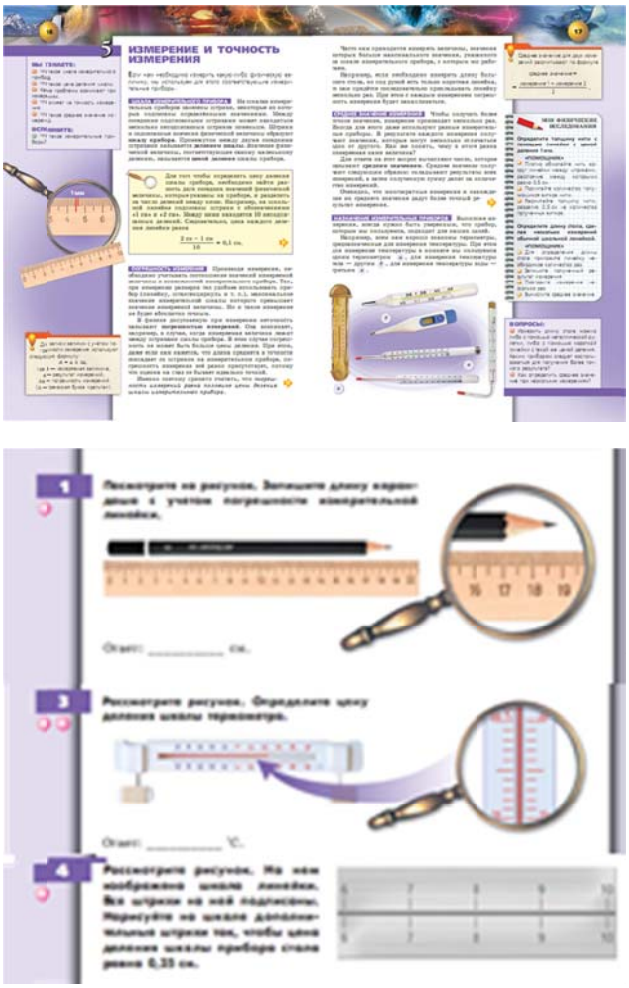

Figure 3. Examples of various exercises in the Textbook and Exercise notebook

In the Laboratory notebook 6 labs are offered:

1. Determination of the measuring instrument scale interval.
2. Determination of the volume of a solid.
3. Working with a caliper.
4. Comparison of the accuracy of measurements by different types of rulers.
5. Determination of the diameter of the thread.
6. Measuring the table length.

In resources for 8-th grade these skills are fixed using specific tasks and labs.

An important step in the expansion and deepening of the knowledge about measurement errors is the introduction in the 9-th grade of direct and indirect measurements, absolute and relative, systematic and random

errors. To do this, in the Laboratory notebook of the 9-th grade, before carrying out basic labs, two practical works are proposed: "Measurement of the diameter of a thin wire with a micrometer" and "Measurement of the reaction time". It is very important that in the Laboratory notebook for the 9th grade in the Introduction, the matter is discussed: "... among many reasons that lead to the appearance of errors, one can also identify such a factor as the incomplete correspondence of the real physical object with which measurements are made, the physical model that is used to describe the observed phenomenon".

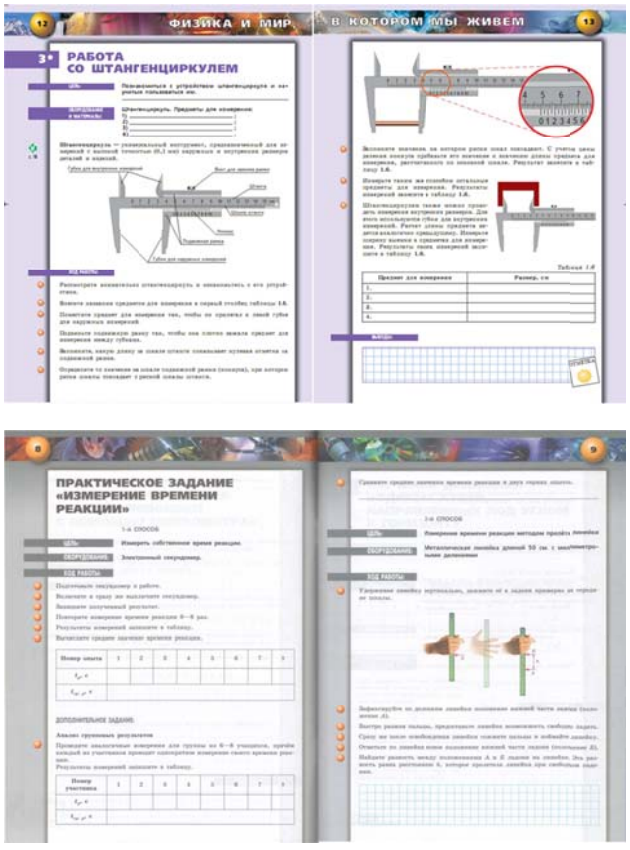

Figure 4. Examples of Labs in the Laboratory notebook

In addition to the teaching methodological complex materials the complementary software were developed in the form of multimedia presentations and online courses.

These educational resources help to learn how to use:

- experiment as a way of posing the question,
- experiment as a tool for studying physical phenomena,
- experiment as a form of answer to the question.

Very often "simple" physical questions have unexpected answers that depend on the specific conditions of the experiment. Demonstration of such experiments and an explanation of the results obtained in them can turn out to be extremely interesting. Moreover, studying this software, students make up for the lack of time for experiments, that is felt in the standard educational process.

Keywords. Experiments, labs, measurements, observations, school course of physics.

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BaFu Project (Ballistic and Fulminates)

N Francisco[1], *L Santos*[2], *G Leite*[2]
[1]*Colégio Cedros, Porto, Portugal*
[2]*Colégio Cedros,*
Vila Nova de Gaia, Portugal
nunofrancis@gmail.com

Abstract. There are three different types of ballistics: internal, which studies the ignition of the propellant as well as the trip of the bullet down the barrel and out the muzzle; then there's external ballistics that investigates the flight of the projectile along with all its variables since the projectile leaves the barrel until right before it collides with the target; finally, there is terminal ballistics, the one that focus the forensic aspects of ballistics.

Since the main goal of our article is to establish connection points between ballistics and the high school Physics and Chemistry's subject, when talking about internal ballistics, our attention will be directed towards the redox reactions and the combustion processes. Concerning external ballistics, aerodynamics as well as the factors that may influence it, such as the air drag, the exit speed, the shot angle e the bullet shape.

Besides all this, a timeline of the evolution of both bullets and guns is part of the article as well, including subjects of technological and scientific interest, relevant to the knowledge of science in general, and specially its history.

It can be seen that the oxidation-reduction reactions occurring in the metal alloy that constitutes the shell of the ammunition affect its performance insofar as its surface is no longer smooth to become rough. In one hand, these irregularities, considering the internal ballistics, increase the friction in the barrel of the weapon; on the other hand, increase the effect of air resistance, also interfering with the external part of the ballistics. Even so, it must be borne in mind that, before the shell is affected by exposure to the elements, its propellant load has already lost its qualities, and it is no longer possible to fire the ammunition.

Thus, it is a transdisciplinary project, based in inquiry modules, which extends through a wide range of subjects that can go from History to Geology and, of course, Physics and Chemistry. Starting with a motivational question, our investigation methodology tries to reach both students and teachers in order to promote the learning of scientific matters having as starting point a more curious situation instead of the usual ones that students are uses to hear, applying their knowledge to real life occasions. Nevertheless, our objective is not to spread the use of firearms, in fact, we try to provide you with the scientific knowledge that allows you to responsibly make your decisions when it comes to the using of these objects.

Finally, it is important to point out that this work is not intended to appeal to the use of firearms or projectiles. On the contrary, its didactic function aims to publicize the ballistics, making each person aware of the responsible use of this type of artefacts, changing their awareness of citizenship, from a very young age, which can even be a precursor to collateral re-education for the elderly, such as their parents, family and / or friends.

Keywords. Evolution of firearms, modules inquiry, types of ballistics, transdisciplinary project.

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Cars and Races. Challenging STEM Education in Secondary Schools

A Gonçalves, B Gomes, B Rocha,
C Teixeira, F Dias, G Santos, H Morais,
J Natal, R Alves, A Carrancho, R Rocha
Colégio Luso-Francês, Porto, Portugal
rita.rocha@lusofrances.com.pt

Abstract. Ten 12th grade students from Colégio Luso-Francês wanted to work out a project in the field of automotive engineering throughout the year. The LRT-01 [Luso-Racing Team] a race car prototype, began to gain shape in their heads. The prototype to be designed and constructed had to answer a premise: to maximize the distance traveled with a minimum amount of fuel.

The project began to take shape: from studying the underlying concepts, to search for possible partners, or a competition where the prototype could be tested, students had much work to develop.

Shell Eco Marathon competition, organized by the Shell Oil Company, has emerged as the perfect event to analyze LRT-01 performance in a real context. Shell competition challenges pre-university students and university students around the world to design, build and drive the most energy-efficient car.

The Department of Mechanics at the Faculty of Engineering of the University of Porto turned out to be the ideal technical partner, for LRT-01 team. Mechanics, automotive design, energy consumption and the reduction of the pollutant gases emission were the premises that, from the outset, were the design of the prototype. The LRT-01 was designed to be a three-wheel drive, fully covered, with a solid floor and frame, having a permanent and rigid bulkhead that completely separated the vehicle's propulsion and energy storage systems from the driver's compartment. In order to accomplish ecological purposes underlying the competition, the prototype should comply with reasonable environmental standards regarding the exhausted gases. The vehicle dimensions as well as the wheel and tires types were carefully chosen, in order to complete 10 laps in a maximum time of 39 minutes with an average speed of approximately 25km/h. LRT-01 used gasoline as internal combustion fuel. Performance calculations were expressed in kilometers per liter (km/l), corrected to a temperature of 15°C on a tank-to-wheel basis. Using the net calorific value [NCV] and the energy consumed from the battery, corrected to allow for the efficiency of the electricity production process, students could calculate the fuel equivalent consumption. LRT-01 vehicle was adapted from a previous built prototype that accomplished already more than 1000 Km with one single gasoline liter.

In order to present LRT-01 to all the school, from kindergarten to the secondary level, the team organized an Open Day event at the end of the school year. The event had three main activities: i) a racing simulator, where students could, virtually, drive a car. The simulator was, for some students, the first contact with driving; ii) science workshops, where students could manipulate functional models about several subjects related to LRT-01 mechanicals such as Engines, Transmission System, Braking System and Aerodynamics; iii) real testing race with LRT-01, having the students mounted a track in the school playground.

In HSCI 2017 the authors will present a three year school project process, which focused on Project-based methodologies.

The LRT-01 project participated, for the second time, in Eco Shell Marathon Europe, which took place in June 2015 and May 2016 in London, United Kingdom.

Keywords. Learning design, project-based learning, formal education, collaborative work, tutoring teaching, hands-on science, car prototype, automotive engineering, energy-efficient, pollutant gases, fuel, internal combustion, net calorific value, engines, transmission system, braking system, aero-dynamics.

Collective Metacognition in Improvised Music Ensemble

P Barreiros[1], *R Soeiro*[2]
[1]*Universidad de Aveiro, Aveiro, Portugal*
[2]*INESC, Porto, Portugal*
pedrobarreiros@ua.pt

Abstract. In ensemble music created in real time, the proportion of improvisation is indexed to aesthetics (Pressing, 1984) [1]. However, all music interaction relies on synchronisation/ entrainment and, according to Repp & Keller (2004) [2], adaptation to tempo changes rests on two processes: period and phase correction. Thus, a musician develops mainly two cognitive behaviours: a sequential memory, and a library with audio symbols. With improvisation the musician has the possibility of using this library to create new content “driving” or to change the context “backing” (soloist/ rhythmic and harmonic support). The goal of this work is creating improvisational contexts to study and develop these two roles.

There are 9 participants forming 16 trios and 33 consecutive weekly sessions where one trio (voice, guitar, double-bass) performs 21 songs. In each song the drive/ backing roles are distributed over 5 distinct moments with a written plan for each musician to play both roles. A common digital music sheet is used to continuously present a visual reference with the dynamic localisation of the harmonic progression and tempo reference at measure resolution. Every session is recorded with video and multitrack audio, including the tempo reference. The collective musical metacognition is developed through this bi-modal entrainment context: musicians and digital music sheet. “Driving” requires a perception of the “backing” rhythmic flexibility, and “backing” requires an understanding of the “driving” music narrative. The visual reference information allows evaluating the collective tempo deviation.

Keywords. Adult, behaviour, entrainment, music.

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Demonstration of an Electrical Generator and Power Plant

CH Chou
Vanung University, Taoyuan City, Taiwan (R.O.C.)
chou0717@gmail.com

Abstract. Inside an electrical generator, what happens? What are the basic principles of an electrical generator? The answer from most students might be that Faraday's law is the principle of an electrical generator, whereas most students might believe that Ampere's force governs driving a motor, quite apart from an electrical generator.

No physics law applies uniquely. Inside an electrical generator, Ampere's force, Faraday's law, Lenz's law and even other laws of physics are collectively applicable and effective. Inside an electric motor, all physics laws, including Ampere's force, Faraday's law and Lenz's law are pertinent.

An electrical generator is, notably, an energy converter that transfers kinetic energy into electrical energy. It is difficult to teach students the details of how an electrical generator functions and to allow students to understand how to apply the relevant physics laws to an electrical generator. The fact that students believe only Faraday's Law has something to do with an electrical generator prevents them from innovating new electrical generators and from understanding the function of a real generator.

In most textbooks, a generator is presented as an example of Faraday's law, which becomes the main topic of the given chapter, whereas a generator itself seldom becomes the main topic of a chapter. This defect of most textbooks fails to teach students one of humanity's greatest inventions that influences significantly the life of mankind. The problem results from the fact that for a student to learn all details simultaneously is not easy. In most textbooks there is no suitable way to teach all complicated issues clearly and effectively.

Although in the market [1] for science education apparatus, the so-called eddy-current pendulum is famous for demonstrating magnetic braking, this instrument, widely used in classrooms of physics, fails to show the eddy current directly and vividly. This instrument also cannot illustrate the eddy current and cannot highlight the fact that magnetic damping due to the eddy current relates to energy transfer. Because the instrument is so famous with the so-called eddy current and magnetic damping, some students, after seeing the experiment, acknowledge the fact that an eddy current causes magnetic damping, but it is worth emphasizing that any induced current includes an eddy current in a plate of metal, causes magnetic damping.

To illustrate the entire picture of an electrical generator, we have created a set of innovative apparatus. One apparatus is a transparent tube surrounding several induction coils; each induction coil connects two sets of LED, which are in parallel and have opposite forward biases. Similarly to a famous experiment concerning Lenz's law with a metal tube [2], when a super-magnet drops in a transparent tube, induction coils cause the LED to light up, which illustrates vividly when and how an induced current occurs. This apparatus shows the basic phenomena magnetic induction and Faraday's law.

A second apparatus is a magnet pendulum. The magnet, as a pendulum, swings and passes through a fixed induction coil. The coil connects with LED in two sets, which are in parallel and have opposite forward biases. A switch is used to control the connection and disconnection. Because an induced current lights up the LED, audiences can observe when and how the induced current occurs and notice the relation between the induced current and magnetic damping. This apparatus illustrates that magnetic damping is a mechanism of energy transfer from the kinetic energy of the magnet to the electrical energy that lights up LED.

A third apparatus is a generator driven by gravity. This gravitational generator is driven by a heavy mass to light up a given number of LED. If the number of LED is doubled, two heavy masses are required to drive the generator to light up these LED. This experiment demonstrates that the energy is conserved during the energy transfer.

A fourth apparatus is just a tiny steam-turbine generator; the entire system is totally

transparent. The audience can see the water boiling inside the glass container, and the details of the steam turbine and the generator. This apparatus reveals the main instruments in a real power plant.

The apparatus in these sets illustrates vividly all vital knowledge about an electrical generator in an interesting manner, from basic theory to advanced techniques. No related instrument can show an audience the same knowledge as this apparatus.

The work of developing the apparatus was supported by the government of Taiwan (R. O. C.) with grant No. 104-2511-S-238-001.

Keywords. Ampere's force, energy transfer, Faraday's law, Lenz's law.

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Demonstrations in Small Scale Chemistry. In a Little You Can See a Lot

R Worley
Brunel University Science Park, UK
bob.worley@cleapss.org.uk

Abstract. Attitudes are changing towards microscale chemistry techniques in the UK.

Most of our schools are relatively well equipped and teachers have technicians to assist in material and equipment preparation and disposal of waste. Teachers have been performing the same procedures in chemistry, many for over 100 years.

The purpose of practical work is also under question. Is it just an opportunity for students to switch off, even misbehave or does it enhance learning, how to think as a scientist as well as teaching practical skills [1].

UK Examination Boards are now becoming very interested in the microscale techniques pioneered at CLEAPSS [2] including them in their exemplar experiments.

Reports from teachers say they add variety to practical work, solve many logistical issues of class management, especially if there is no designated laboratory, and address pedagogical issues of understanding chemistry. They can be are carried out more quickly during a lesson so that more time can be used in discussion and questioning allowing the teacher to press home the teaching objectives of the work.

Figure 1

The techniques can to the surprise of many can produce improved quantitative results. They also come with green credentials using less material and producing less waste.

Some of these ideas are being used in Universities in the States and as outreach in the North East of England. Using web cams and USB microscopes, a whole class can see demonstrations as you will in the talk which will include several demonstrations.

There is no commercial kit. The equipment (Petri dishes, pipettes and syringes – no needles) is obtainable from all laboratory suppliers, but new commercial products are now available such plastic folders, balances and carbon fibre rods for use as electrodes. New but easily constructed equipment (eg, conductivity indicator, “Lego” colorimeter) will be exhibited which help to provide evidence of chemical processes, some of which can be tried in the workshop and Fair.

The demonstrations will include the electrolysis of a molten salt on the open bench. Molten silver or lead bromide is electrolysed and bromine can be seen coming from the anode. The existence of ions and their ability to promote the conduction of an electric current in solution and molten state are at the heart of chemistry. Yet it is a difficult concept for students to understand. Here, important evidence is provided.

Figure 2

Precipitation is viewed as chemical magic by

students Moving from the macro event to a nano interpretation demands a conceptual leap into invisible world of particles, an issue developed by Alex Johnstone some years ago [3]. The dramatic diffusing precipitate procedure in 1.5cm diameter “puddles” on plastic folders, illustrates stages in the reaction.

Figure 3

Salts are pushed into the sides of a 1.5c, dimeter puddle of water. The salts dissolve and diffuse forming after about 10 to 30s a precipitate forms down the centre of the puddle.

These techniques also markedly reduce the cognitive overload present in practical work. Titration is a particular area which will be addressed and again it can tried in the workshop.

A very quick method to show catalytic cracking of hydrocarbons will be shown. This removes many of the safety issues such as suck back. Also it provides the teachers time to tackle the chemistry in the same lesson as the practical activity, leading to more efficient lesson planning. The technique can be extended to form gaseous alkenes from alcohols for further tests.

The microscale Hoffman Voltameter will running all through the talk. It produces enough gas to produce a good bang and rocket to keep the “edutainers” happy!

Keywords. Chemistry, Practical chemistry, Green issues, sustainability, microscale chemistry, pedagogy, Short and Long term memory, cognitive overload, classroom manangment.

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Explaining Molecular Genetics in Secondary School through a Linguistic Analogy: a Practical Activity to Work Mutations and Changes in Open Reading Frame

JM Marcos-Merino[1], *R Esteban Gallego*[1], *JA Gómez Ochoa de Alda*[2]
[1]*University of Extremadura, Badajoz, Spain*
[2]*University of Extremadura, Cáceres, Spain*
jmmarcos@unex.es

Abstract. Genetic is a cornerstone of Biology but concepts regarding their molecular level, such as mutations or changes in open reading frame, tend to be laden with misconceptions [1-2]. Thus, in order to prevent the retention of these misconceptions, the development of effective teaching materials focused on underlying concepts of Molecular Genetics is strongly required. Research has compellingly demonstrated that analogies are a valuable pedagogical tools that foster understanding and avoid misconceptions [3-4].

This contribution describes different linguistic analogies that secondary teachers might use to present, through practical activities, kinds of mutations and how they affect protein synthesis. The human genome has been for a long time compared with a book containing the instructions for life in the form of genes (each sentence) composed of nucleotides (the word letters). This analogy is based on the fact that words and genes are represented by sequences of letters (26 letters and 4 nucleotides) that determine their function (the meaning of words and the molecular functions of genes). On the basis of this general analogy, some practical activities to approach mutations at molecular level in Secondary School are set out in this work.

Biologists use the alignment of sequences to compare genes and proteins and highlight differences and similarities. This task, usually performed using bioinformatic software, can be manually done in the case of very short or very similar sequences (for instance words). For example, secondary teachers may ask their students these questions: What types of changes can you distinguish between the Vulgar Latin word 'factu' and the Latin word 'factum'? And between the Romance word 'facto' and the French word 'fait'? Then, secondary students may observe changes in words due to three different processes: insertion (incorporation of new letters), deletion (removal of old letters) and replacement (substitution of a previous letter by a new one). This example could help to introduce mutations at molecular level. Developing this idea still further, secondary teachers could draw another analogy with which work changes in open reading frame, raising the following issue: Imagine that to be able to understand a sentence and could communicate with other people, words always had to be composed of three letters. What would happen if you introduce any of the 3 sorts of mutations in sentences such as 'The fat cat sat' or `She was his mum'? Then, secondary students may observe how changes in triplets of letters affect the message they encode, just as changes in mRNA codons with amino acids sequences.

The development of practical activities based on these analogies can help teachers to introduce and approach these tough contents. The inclusion of these analogies could make Molecular Genetics an accessible resource for new learners, as referencing to familiar topics helps break concepts down into digestible units for students.

Keywords. Analogy, molecular genetics, secondary school.

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Game of Genomes: Didactic Adaptation of the Nature's Dice Kit (NCBE)

T Ribeiro, M Paz, S Pereira
University of Porto, Porto, Portugal
tiago.ribeiro@fc.up.pt

Abstract. The purpose of this work is to approach laboratory techniques in biology and genetics, in a simple but rigorous way, possible to be replicated in a school, with students of the 12th year of Secondary Education. To achieve this goal, we outline this activity to respect the following main points: use of a case familiar to most students to arouse their interest and motivation; adaptation of laboratory techniques to the school context; simplification of the techniques and materials used to be enable (methodologically and economically) their replication in the school, but respecting the scientific accuracy; encompassing several subjects included in the Biology curriculum of the 12th year of schooling.

Given the nature of science, it is natural that learning science should involve seeing, handling and manipulating objects and materials. The scientific knowledge cannot be built only on a theoretical basis. It is essential to promote the critical spirit and the investigative capacity, integrating the theoretical knowledge with the practice, understanding that these two domains are complementary in learning and teaching sciences.

The school science curriculum in most countries has two distinct purposes. First, it is a 'scientific literacy' aim, providing every young student with adequate understanding of science to participate assertively and effectively in the current world. Second, the attempt to encounter the labor needs of advanced societies, preparing students for jobs that require more scientific and specialized knowledge [1].

In this sense, this work results from the adaptation of the National Center for Biotechnology Education (NCBE) teaching kit - "Nature's Dice" (simulation of genetic screening), to the context of a popular fictional series - Game of Thrones (HBO). What is intended is to set up an experience that is challenging for students, stimulates their skills and fits into the school program. The experimental design must consider not only the theoretical field, but also all the techniques. Our aim was to use some of this kit materials and main strategy, but replacing some of the materials and procedures, making it simpler and faster, intelligible and economical.

The major focus of this work is the learning of DNA manipulation techniques, Mendelian genetics, character transmission and genetic screening (including ethical discussion).

The techniques used were the preparation of agarose gel, DNA restriction through endonucleases, DNA electrophoresis and its coloration and interpreting the obtained DNA profiles. In conceptual terms, we resorted to the construction of a genealogical tree based on the pathologies such as color blindness and Huntington's disease.

Color blindness is a genetic condition related to the X chromosome, being a heterosomic recessive disease. The Huntington's disease is a rare neurological disease and is autosomal dominant, expressing itself both in homozygosity and in heterozygosity.

This work is, in some respects, based on the original kit, namely in the use of plasmids (DNA) and the restriction enzyme BamHI, but the scenario is different and some materials too. The scenario adopted is the story of Game of Thrones that unfolds around the paternity of Jon Snow, allowing to obtain a family tree simpler and intelligible to interpret by the students. This allows the saving materials, and it is possible to repeat the procedure more often.

We also replaced, the Kit's electrophoresis buffer by the SB (Sodium Borate) buffer, which is more economical and equally effective. [2] The use of non-toxic fluorescent DNA stains such the Roti-GelStain or GelRed dye allows the use of 4 times less DNA (compared to the dye of the original kit) making the activity cheaper.

It should be noted that this activity is not a way of diagnosing the above-mentioned pathologies. This kit only provides a reproduction of genetic screening. It gives an ideal occasion to arouse discussion about genetic counselling, privacy of genetic information and other ethical anxieties.

Keywords. Agarose gel electrophoresis, DNA profiling, genetic testing, laboratory practice in teaching.

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Implementation of Radioactivity Workshop in Science Center and its Improvements During the First Year in Action Research Design

K Kolář
Charles University, Praha, Czech Republic
karel@fykos.cz

Abstract. This contribution is a glimpse of processes connected to preparation, implementation and self-evaluation of a workshop. The chosen workshop, for this research, is aimed to teach some basics of radioactivity to high school students (ISCED 3) or students in the last years of a lower secondary school (ISCED 2). The research sticks to the basic principles of action research (e.g. [1]). Therefore, it is based on cycle of observation, evaluation, implementing some improvements and repetition of the cycle again.

The discussed activity is a workshop at one of the largest Science Centers in the Czech Republic. Science Centers, as intended here, are the most interactive science and technology museums. They are usually more based on joy and fun rather than precise scientific knowledge. But the best of them tries to combine what could seem impossible – scientific accuracy and entertainment. Science Centers are not only scientific and technique exhibitions but they have also other programme – e.g. workshops, science shows, planetarium programs and other such activities. Some of these activities are generally for public and some of them are specially for pupils and students of different age. This workshop is activity for school groups of 15 ~ 24 students.

The workshop Radioactivity was prepared by one of the Science Center workers at the beginning of the school year 2016/17 and it was chosen to be part of this research. My research started just before the workshop was introduced to other instructors and cooperated since then.

The workshop takes about 90 minutes. Workshops generally starts with brief introduction to problematics and then the participants (students/pupils) make groups of two or three students and cycle among sites with different tasks. At every station, they use methodological list and solve tasks according to it. This workshop is made of 8 different sites, some of them are actually measurement places (distance, kind of material inserted and its thickness), some of them are other activities related to radioactivity (trying of a protective suit, ordering of years and pictures…)

To try to measure whether the participants learned something, short five-minute test was introduced. Participants solve it before the introductory speech and then solve the same test at the end of the workshop. It is written on paper but we are preparing and want to change the form to table questionnaire.

I was present at several (and most) of the workshops and I could observe the work of students. I also critically went through the texts. That already lead to some improvements, also the discussions of the main lecturer who prepared it with some other assistants lead to some improvements – like other texting of lists, change of some tasks.

But there is still much work to be done. The test, for example, indicates that many participants think that radioactivity is always dangerous. Maybe that this activity should show that this is not the case.

This contribution will bring more insight to these activities and our efforts to improve the education in Science Centers.

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Keywords. Informal education, radioactivity workshop, science center.

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Innovative Mathematics Teaching-Exchanging Horizons

OE Par[1], B Peker[2], SS Guvenc[3], D Kiziltas[1], NS Uysalli[4]
[1-4]Hacettepe University, Ankara, Turkey
[2]Necmettin Erbakan University, Konya, Turkey
[3]Keciören District Directorate of National Education, Ankara, Turkey
[4]Feda IT Company, ANKARA, Turkey
par@hacettepe.edu.tr

Abstract. Ten 12th grade students from Colégio In today's world, teaching Mathematics is a crucial part of education and every country tries to get its mathematical success to higher level. Day by day, the new approaches, methods and techniques are being applied in the mathematics curriculum parallel to the world's changing needs. In addition to that, using technology as a supportive material in the classes is also getting popular. As a matter of fact, to increase learners' numerical skills and ability to use mathematics in the daily life is one of the most common needs of our era. In order to achieve this, it requires teaching basic mathematical skills well in primary education and develop them in the next steps of school education.

It's already accepted that PISA tests seek to find "what students can do with their knowledge and the achieved curriculum or what students have learned [1]. It focuses on mathematical literacy, which is defined as "An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments, and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen [2]. In Europe 2020 Strategy, it's stated that by 2020 less than 15% of 15-year-olds should be classed as 'low-achieving' in those basic skills (literacy, mathematics, science and technology), as measured by PISA tests. The PISA results (2012) show that 22.1% of European students were low achievers in mathematics. In order to overcome this underachievement, in the light of the European Policy Network of National Literacy Organizations in February 2014, European Commission launched, this network has the purpose to, amongst others, raise awareness, exchange good practices, policies, campaigns and initiatives promoting literacy.

In order to analyze the achievement and underachievement of our country and other countries in mathematics, we reviewed the PISA exams reports. As the PISA 2009, mean scores of mathematics findings are viewed, it is seen that OECD average of mean score in mathematics performance is 496. Turkey is reasonably below this average with its 445 score. When we have a look at the results in 2012, it's difficult to see a difference in our country's score. In PISA 2012, OECD mean score is 494 and Turkey's 448. (PISA 2012 Results in Focus, OECD, 2013). Apparently, there is a need to make a change and development in mathematics teaching in Turkey.

So, this study to exchange authentic and innovative mathematics teaching methods has been prepared. However, Portugal and Italy have nearly same scores in 2009 and 2012, also better than Turkey but in the moderate level, which means that they also need to renew and upgrade their mathematics teaching styles. Portugal and Italy have been determined as project partner countries. It means that all partner countries such as Turkey, Portugal and Italy can learn from each other and create an increase cooperatively in mathematics teaching altogether.

The goal of the study which has been founded by European Union is to learn about authentic and innovative mathematics teaching methods and techniques from each other, adapt and apply the good and innovative practices and policies in the classroom environment.

Researches show that the innovative approaches and different teaching methods applied to mathematics teaching, computer and information technology based education programs will raise the students' interest and motivation towards the courses. Thus, it can be expected that learners' mathematics success will increase with the adaptation of these innovations.

Since, ancient times, games have been part of a human culture [Huizinga50]. Students and teachers are the two most important factors in any educational system. In this information age, digital learners and digital teachers have new

characteristics involving the use and integration of technology into learning and instruction [7]. As technology is rapidly advancing towards Web 3.0 applications, an increase of publications focusing on the new technological possibilities for learning and instruction is expected for the next 5 years [9]. Computer simulations and games have great potential to catalyze this new approach. They enable learners to see and interact with representations of natural phenomena that would otherwise be impossible to observe - a process that helps them to formulate scientifically correct explanations for these phenomena. Simulations and games can motivate learners with challenges and rapid feedback and tailor instruction to individual learners' needs and interests [8].

Many researchers believe games should properly combine good game design and pedagogy in optimizing its benefits and effectiveness in education [4]. Although computer-aided educational games are day-to-day popularized, the design of these games is not easy at all. For this reason, designing patterns which have been obtained by academicals workshops and studies are applied [3]. The study is a part of ongoing Erasmus + Project, the results are obtaining according to time schedule of the Project.

Mathematics attitude scale which is to be conducted on all of the participant staffs. Pre-test and post-tests are to be used with the training activities. This test is to show the students' attitudes towards mathematics.

Keywords. Mathematics, educational game, PISA, OECD, EU project, innovative.

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Learning Computational Language with Robotics in Secondary School

A Muñoz Pancorbo
IES Az-Zait, Jaén, Spain
antonio.munoz@iesaz-zait.es

Abstract. The computational thinking will be seen as the future language in the new working market. Educational center must start to prepare our young boys and girls to this reality.

Is necessary to adapt the educational curriculum in obligatory secondary schools and to integrate these contents in a direct and regulated form or in a transversal one. This is why we treated that all our pupils have access to this language (independently their economical and a social actual situation).

All the robotics platforms used to work are organized in different levels, in all moments e-learning platforms and nothing of paper are used (all are digital: simulators, collaborative documents....):

- First level: Learning basic concepts of computational language using blocks and graphic language, basic sensors (digital as touch sensor and easy analogic as ultrasonic, sound and light sensors), basic controllers and actuators using "Lego Mindstorm NXT". To study the architecture of robots is very important.

- Second level: Learning advanced computational language using digital and analogue signals (with temperature, light, color, gyroscope, infrared and magnetic sensors) about the relationship with the environment (using loops or switches), introduction to PID (proportional, integrated and derivate studies) using "Lego EV3".

- Third level: Object-oriented programming relating hardware with the environment and introducing to the use of electronic components with "Crumble" platform [1]. Designing and complete assembly of electronic components thinked to solve different educational challenges. Study and use of variables and logics functions (loops for example) and mathematical operators with constant and/or variables.

- The students mixed digital and analogues signals and sensors (reflexive, ultrasonic, PIR sensors, LDRs ...) and actuators (LEDs, RGBs, DC motors…) to solve real tasks

- Fourth level: Learning high level code language with "Processing" [2]. It´s a language used to art design in movement. If we interrelate wrote code with Open Hardware using "Arduino" IDE [3], we approached to the use of industrial devices in class, made a real work situation. In this case, the use of objects-oriented language with "APP Inventor" and the way Bluetooth communication between mobiles and Arduino shields with own mobile APPs, designed, made and tested by the pupils, change the class in an authentic maker laboratory. Applying robotics items and concepts to solve real problems with real technical devices and with an engineering mind.

Way of working: In all levels, robotics is teaching with UDIs (Integrated Didactic Units), it allows to try all robotics contents through a serial of tasks, activities and exercises that it´s oriented to skill learning, it`s the porpoise of European Union [4]. At the same time, it`s a very motivational tool to learning the computational language.

The continuous use of e-learning platforms (Schoology [5]) and working in net (using Google Suite APPs), do easy teaching with different rhythms of learning that they are adapted to all kind of students. To last work in the academic course in all levels is a technological project about the contents learned, the students should show their results using augmented reality.

A motivational element used, and with a great acceptance by the students, is to organize and participate in official robotics challenges. In these events, we follow to get better the relationship with pupils of other cities or regions (exchange experiences about FIRST Lego League, World Robot Olympiad [6], Technology Andalucia´s Fair, Creative Technologies Challenge or STEM Challenge).

Transversally: At the same time, by the innovation character of its contents, can propitiate students exchanges around different

schools in all countries in Europe to work this contents using English how vehicular language, helping thus the learning of another foreign language.

Evaluation of acquisition of skills: the training to resolve problems with work by tasks, carries associate to work with a qualities evaluation criteria based on associated learning European standard. By the versatility of robotics working and learning, the students improve all key competences recommended by the European Union (digital, linguistic, scientific, mathematical, social, entrepreneur competences, learn to learn ...) [7].

Future proposals: creation of the fifth level of code learning. Introduction to remote control systems to govern industrial elements and to participate in FTC (FIRST Tech Challenge) with the youngest team in Europe against post obligatory High Schools or different Technologies Universities. The first priority will be to obtain the multidisciplinary with robotics items to teaching and learning other subjects such as Spanish and English language, physics, music or arts.

To use gammification methodologies to teaching computational language, such as Code Combat [8], allows students to work more motivated.

Short conclusions: The study of computational language improves performance and academic results, not only in technologies subject but also in mathematics, foreign language, science and arts. The academic orientation to the next studies happens to be mainly scientific and technological, both in girls and boys.

Keywords. Robotics, technology, computational language, e-learning.

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Learning to Teach Physics in Primary School through Hands-on Science Experiments

G Martínez-Borreguero,
FL Naranjo-Correa, M Mateos-Núñez,
J Maestre-Jiménez
University of Extremadura, Spain
mmarbor@unex.es

Abstract. One of the topics of particular concern in the field of Didactics of the Experimental Sciences is how to improve science teaching in primary education. For this reason, one of the main focuses of attention is the scientific instruction of teachers in training [1, 2]. Previous studies of our research group [3, 4, 5] revealed very little scientific knowledge in the students of the Degree in Primary Education and a high percentage of negative emotions towards learning content related to this subject. These initial results were especially worrying since these students will be in charge of forming and imparting scientific subjects to future generations in the school stage of 6 to 12 years.

The general objective of this work was to develop workshops on hands-on science experiments to improve the scientific competence and beliefs of self-efficacy of the future teacher of primary education. Likewise, the emotional competence was strengthened in a collective way with the scientific content developed during the sessions. The purpose of these workshops was to spread positive emotions in our students so that they lose the fear, the stress, the anxiety or the insecurity of learning to teach physics in the early ages. The experience was carried out during three academic courses with 430 students of the Faculty of Education, of the 4th year of the Degree in Primary Education. Their ages were between 20 and 30 years. The design of the research was quasi-experimental, mixed, with pre-test and post-test.

Different didactic work models were chosen for the development of the classroom interventions. The students worked individually or in groups, and the models were adapted to the modality of Great Group and the development of different thematic workshops. The students were divided into subgroups of about 20-25 people to work in the various workshops. Each workshop took about 3 hours. In these workshops, the teacher in training carried out experiments in physics in a playful and recreational framework with the objective of elaborating models of educational intervention applicable to primary students (aged 6-12 years). The hands-on physics experiments were designed to be carried out from a constructivist point of view linking the subject with real day-to-day applications.

The qualitative and quantitative analysis of the results obtained in the different measurement instruments used revealed the usefulness of these types of workshops from a cognitive and emotional point of view. The design and implementation of workshops with hands-on science experiments allowed our students, future teachers of primary education, to acquire skills and abilities in programming and developing their own practical science seminars. The teachers in training changed their initial perception of the subject of physics. The evaluation carried out allowed us to conclude that this type of activities reinforces the scientific knowledge of the students. Likewise, positive emotions and their beliefs of teacher self-efficacy in the presence of contents that they did not master at the beginning of the experience were increased significantly (Sig. < 0.05). From an educational point of view, the teachers in training were competent to design and implement science activities for early ages, both in formal and non-formal contexts.

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Keywords. Emotions, hands-on science experiments, physics, teachers in training.

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MIP. A Project-Based Learning Experience in a Secondary School

R Rocha
Colégio Luso-Francês, Porto, Portugal
rita.rocha@lusofrances.com.pt

Abstract. The link between school and non-formal educational institutions allows the development of truly Science research at a pre-university level. The non-formal works as a territory where the real problem solving is made, regulated for society, while the school works, at a primary level, on a student individual-needs basis. Being Project-based Learning [PBL] focused on the resolution of real world problems it works frequently with the surrounding environment as the main subject and the source of data.

Thus, PBL allows to orientate the formal curriculum onto objective goals and to value the real context experience, the one with whom students identify. Besides that, having the results of student's actions a real solution at the end of the project, PBL methodologies add a social, emotional and civic dimension to the educational process.

Finally, and perhaps the most important implication of PBL potential, relates to approach the university and schools, promoting knowledge sharing, the exchange of new scientific techniques and subjects that can be adapted to innovative lessons in the classroom.

Educational experiences in informal learning environments are promoted in the national standards as a way to reinforce the Younger's motivation to pursuit scientific careers.

PBL focuses on working with wider contexts in which schools are in, absorbing and, necessary, being absorbed by a particular social and cultural environment. The student carries a story, a personal journey that will be critical to the way he learns and to what he values as a person. According to this point of view, knowledge is no longer a target, but rather a means to achieve a target, that is to increase scientific literacy as an all to create citizens that can be able to, in a reasoned and informed manner can shape the future.

Some of PBL's pillars relate to an inter and transdisciplinary approach, shaped by a CTSA approach - Science, Technology, Society and Environment – and by a methodological pluralism in and out of the classroom, regulating the learning process by a formative evaluation, where the truth and the error are assumed as fundamental to knowledge progression.

MIP [Project and Investigation Methodologies Acquisition] is an extra-curricular subject offered at Colégio Luso-Francês in which students develop research projects on Science and Technology. MIP is based on i) Project-Based Learning methodology; Ii) Academic partnerships with Universities and Research Centers located around the school to allow students to experiment a iii) Shared Classroom Model, having the student two tutors – a pedagogical one at school and a scientific one at university.; iv) Participation in academic conferences and science fairs as a way to learn how to argue and communicate efficiently with the public; v) Soft Skills training; vi) Contact with Project management tools (e.g. Learning Design Platform).

PBL organizes itself and learning cycles structured in three key moments: 1st moment – Research-Question finding; 2nd moment – Methodological Process and; a 3rd moment - Final Evaluation.

In Research-Question finding students are confronted with contemporary problems, in order to contextualize a work theme to be developed. After this stage, the framework of the theme is worked with the formal school curriculum and the anchoring of the theme with previous concepts students already have acquired. Here a first evaluation is carried using concept maps to clarify the new subjects' relations. After this exercise, concepts are reorganized by the four CTSA pillars and the Learning Design platform begins to be planned.

In Methodological Process moment students carry out Preparatory Visits to the research centers or other partners identified previously in the project. In this visit, students discuss with the scientific tutor and other researchers of data collection and data analysis techniques that can be tailored to the objectives students defined initially for their work. After adapting/ creating the data sheets and all the materials to collect data, students pursuit with field work and laboratory classes. Processing the data, is

the next stage and this is made both with the school teacher and with the scientific tutor in order to guarantee the quality of the data. The 3rd moment comes as follows, with a final evaluation. The evaluation can assume the products produced along the process [i.e., scientific Posters, laboratory protocols, field sheets, reports], or the learning process, focusing on skills developed during oral communications, events organization or even a student's reflexive essay.

In HSCI 2017 the author will present several projects developed by students in the school.

Keywords. Learning design, project-based learning, formal education, collaborative work, tutoring teaching, hands-on science, field work evaluation.

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Nutrideal Project. An Overview on the Caffeine Effects in the Organism: a Preliminary Experimental Study

N Francisco[1], B Coelho[2], J Mesquita[2], J Gomes[2]
[1]*Colégio Cedros, Porto, Portugal*
[2]*Colégio Cedros, Vila Nova de Gaia, Portugal*
nunofrancis@gmail.com

Abstract. Among all substances considered as stimulants, surely caffeine is the most appealing and used, whether in its nature form, through the good and classic coffee, or through capsules or powders manipulated. Regardless of form, caffeine is widely desired in several situations for its stimulating and odoriferous properties. Much has been written and studied about this stimulant, but there are, however, some opposing opinions about its use.

In this work, first, we intend to compile the main aspects, discussions and conclusions of several studies related to the effects on the organism of this caffeine compound: main sources of obtainment, metabolism, beneficial and adverse effects and their applications in the medical field.

In the background, the present research aims to test the effect on caffeine in the body in adults from 18 to 40 years of age, in biliary vesicle volumetry, influenced by the behaviour of the sympathetic and/or parasympathetic autonomic nervous system (ANS). For this, a new methodology based on measurements of changes of electrical permeability by Ryodoraku at specific points of meridians for evaluation of the ANS was used, and an ultrasound probe suitable for the study of the variation of volume of the gallbladder in volunteers of both sexes, with random coffee or decaffeinated intake. The beverage distribution was performed under single-blinded conditions. The volunteer population was selected among staff and students from the Department of Aquatic Production of ICBAS-UP.

Regarding the results obtained on the variation of vesicular volume, by echography comparatively to the zero moment, there was no significant alteration between the individuals who took coffee or decaffeinated. So, although premature, it can be understood merely as a positive automatic reflex when ingestion of any beverage. On the contrary, there were very significant variations in the electrical permeability values obtained by Ryodoraku relative to other microsystems, which resulted in a stimulation increase of about 83% in the sympathetic system in general, after drinking, while a reduction in activity of about 83% in the same system after decaffeination. On the other hand, It may also be speculated that the reduction effect of electrical permeability values (with decaffeinated) could be complemented by an additional increase of the parasympathetic system activity.

Keywords. Autonomic nervous system caffeine, Gallbladder, health, Ryodoraku measurements.

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Positive APPtidude. From Social Entrepreneurship to ICT Programming

V Moreira Martins[1], MFM Costa[2]
[1]AE André Soares, Braga, Portugal
[2]Universidade do Minho, Braga, Portugal.
mfcosta@fisica.uminho.pt

Abstract. This communication reports the development of an ICT programming project for the creation of applications for mobile devices developed with 5th grade students of the 2nd and 3rd Cycles classes of André Soares Basic School in Braga. The project run in the frames of the 14th edition of the "Science in the School" competition of the Ilídio Pinho Foundation, under the theme of Science and Technology in the service of a better world.

Initially designed to respond to the need to promote innovative teaching practices through the development of new methodologies and promotion of multidisciplinarity in the teaching and learning processes in the 2nd and 3rd cycles of Basic Education while encouraging entrepreneurial skills and the creation of collaborative knowledge. The project was supported by the Hands-on Science Network Association and was also integrated and disseminated in an international cooperation partnership for innovation and good practices of the European Erasmus+ program.

The first phase of the "Science in the School" competition required a proposal of new project ideas. After being selected for the second phase, project development, with financial support, the group obtained extra motivation to implement this methodology of science and technology learning.

The project started by identifying a problematic situation and finding a possible solution/response in the context of programming a mobile application (app). It was decided to seek a functional yet simple app capable of helping people in an early diagnosis of illnesses or malaise identifying the disease and advising how to address the proper resources available of the Portuguese National Health Service. This prototype was aimed for an older, living alone, population with little mobility and who are facing a situation of insufficient family support. However it can easily be put at the service of the entire society.

Students begin discovering the App Inventor, a tool that fosters a hands-on learning environment and reflective teaching as it allows the student to create and improve programming while discovering and exercising creativity, making learning more playful. This tool has a block-based development environment that incorporates web-based services, interaction with social networks, reading bar codes, interacting with orientation and geolocation sensors, as well as other advanced features such as text-to-speech and speech recognition. The teaching of the programming logic is stimulated by several challenges requiring problem' understanding and abstraction while leading the students to express themselves adequately in order to identify and solve a problem. To do so it was necessary for students to master the programming language adopted in programming. Students experimented, discovered, tested and concluded, creating information processing responses in the form of logical-mathematical reasoning. In this process, the students had fun, relating the use of technology to cognitive absorption, shaping the construction of this project always taking into consideration the students' preferences. This programming process that allows you to create applications for mobile devices that can meet real needs is significantly important for student' motivation. App Inventor provides a meaningful learning environment, allowing young programmers to overcome the difficulties of developing a programmed application for mobile devices that previously was limited to computers and microcomputers. At the same time along the project key skills and entrepreneurial spirit was developed. The SCAMPER process of generating ideas was transmitted, channelling it to overcome situations/problems and stimulating the creativity needed in this process. It was at this moment that ideas/suggestions were collected, elaborating a main idea/guiding line for the project - clearly a moment of great construction of metacognitive knowledge.

Building on the acquisition of this knowledge and on creating a mobile application to aid decision making, students focused on building and programming the app, structuring a prototype while potentiating and stimulating cognitive processes. This was an interactive

process that reconciles the concrete and the abstract in problem solving and that involved several steps such as structuring, constructing, implementing, automating and controlling a device. In all these stages a process of knowledge-building took place in alive and participated experiences. This metacognitivism interconnects distinct scientific areas (sciences, mathematics, physics, technology and linguistics) with the consequent acquisition of transversal competences.

The final product is the result of a blended-learning process (B-learning), creativity and hands-on processes. The processes of collaborative work, the moments of verbalization and experimentation, allowed to develop a way of seeing how to do science, transferring the new knowledge to the creation of new skills and knowledge for the benefit of society.

Keywords. App Inventor, app, entrepreneurship, hands-on, creativity, mobile devices, smartphones, B-learning.

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Revealing the Science of the Micro World

E Nogueira, F Martins, G Silva, R Rocha
Colégio Luso-Francês, Porto, Portugal
rita.rocha@lusofrances.com.pt

Abstract. Phytophthora cinnamomi is a oomycete, known widely to be responsible for the ink-disease. Unlike fungi, P. cinnamomi has a cellulosic cell wall, resulting in an ineffectiveness of most commercially available fungicides against P. cinnamomi. This phytopatogenic is in the list of the hundred most harmful invasive species worldwide, being present in more than seventy countries and affecting more than a thousand species.

P. cinnamomi begins its infection by the smaller roots and advances in order to destroy the tree nucleus and its vascular system. To date, there is no known specific treatment to eradicate this oomycete.

ShealS project aimed to create a specific-Phytophthora fungicide based on seaweed extracts from the Portuguese coast.

Six species of marine macro algae [Grateloupia turuturu, Gracilaria vermiculophylla, Sargassum muticum, Chondrus crispus, Corallina sp, and Codium sp.] were selected, according to two main criteria: i) the presence of potentially inhibitory biopolymers on fungal growth; ii) their ecological role in ecosystems, namely the fact that some of the selected species are exotic and even invasive in Portugal.

The biological material was dehydrated and the biopolymers were extracted using three types of solvents [Ethanol, Petroleum Ether and Ethylic Ether] in order to ensure the maximum extraction of the macro algae chemical compounds. For the extract preparation, a 10% concentrated solution [dry seaweed/solvent] was introduced in a Soxhlet extractor during two hours. A 20mL sample was then sent for chemical compounds characterization, while 30mL was introduced in a rotary evaporator to dryness. The dried extract was, subsequently, re-suspended in 5 mL of the initial solvent to obtain the solution to be applied to test plates. Potato Dextrose Agar was used as a growth medium.

The extracts were further tested in vitro, using several incorporation methods [antibiograms discs, dry medium extract incorporation, and liquid medium extract incorporation] to eliminate the variable thermovolatility of the extracts and to also ensure a uniform spreading of the extracts into the plates.

After the inoculation, P. cinnmomi mycelium was measured during nine days, on a daily basis, measuring medium diameter of x/y axis, since the mycelium does not grow uniformly. Micelial Growth Rate Index and Inhibition rate were then calculated.

On 455 inoculated plates, results show that pure cultures of P. cinnamomi [control] had a mean IVCM value of 0.693 cm/day while Corallina sp. macro algae presented the highest inhibitory power [62.67%], when in the presence of the solvent Ethyl Ether, registering an average value of IVCM of 0,182 cm/day.

In vivo tests followed in vitro tests using the chestnut [Castanea sativa] infected with P. cinnamomi. The seedlings were inoculated, using several application methods. The results will be ready for September 2017. Sheals revealed to be a promising solution, so far, to reduce the ink-disease impact in the environment. In HSCI 2017 the authors will present a three year school project process, which focused on Project-based methodologies.

The Sheals project won the first prize in the 3rd National Science Contest À Descoberta da Luz/ 7th Hands-on Science Fair, which took place in May19 in Viana do Castelo, Portugal. It also won the 2nd prize in FCT Nova Challenge, which took place in June7 in Costa de Caparica, Portugal, as well as the 2nd prize in Young Scientists and Researchers, which took place in June7 in Porto, being selected to represent Portugal in Tallinn, Estonia in September at the final of the European Union Contest for Young Scientists.

Keywords. Learning design, project-based learning, formal education, collaborative work, tutoring teaching, hands-on science, disease, phytoremediation, ink-disease, marine macro algae, bioactive compounds.

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Rocky Shores. An Outdoor Experience in Real Field Laboratories

R Rocha
Colégio Luso-Francês, Porto, Portugal
rita.rocha@lusofrances.com.pt

Abstract. Intertidal ecology provides an opportunity to understand and predict the dynamics of biotic communities in a changing environment. In this sense, rocky intertidal monitoring projects provide scientific data about ecosystems' health, using biodiversity as environmental quality indicators. Intertidal organisms colonize the substrate according to their ability to be adapted to periodic variations in luminosity and water, the main limiting factors to their growth. In general, the more resistant species require less water. Thus being located at the higher [i.e. more discovered] tidal zonation. On the other hand, less resistant species colonize the lower tide zones, where the ecological stress has a smaller impact. While tolerance to environmental extremes [such as desiccation] seems to be the main responsible factor for biological zonation at higher tidal limits, competition effect is known to be the most determinant factor for lower limits biological colonization.

Praia do Homem do Leme is a beach located in Porto. Since 2006 this beach became the school investigation sampling area. Several studies have been developed over the years relating to temperature and pH effect on biological distribution [Climate Change subject], exotic invasive species [Ecological Webs] and microplastics inventories [Marine pollution]. This way the projects touch several subjects [Chemistry, Physics, Mathematics, Biology, Geology, and Environmental Sciences] and allow students to train different skills and to integrate knowledge in a single conceptual map.

This paper describes the study of distribution patterns of organisms in intertidal substrate from Praia do Homem do Leme. The project was integrated in a wider platform promoted by CIIMAR - Interdisciplinary Centre of Marine and Environmental Research - called MoBIDiC [Intertidal Biodiversity Monitoring and Scientific Dissemination]. Students used a semi-quantitative analysis methodology in order to analyze the intertidal communities. Two transects were established along a topographic profile of the beach.

In each transect, students identified the Upper, Middle and Lower tidal zone and three 50cmx50cm replicates were made in each, using sampling squares. The biological abundance was calculated in two ways: i) for seaweed and sessile animals was used a coverage percentage calculation, ii) for non-sessile animals the count was based on density values. Species identification was carried out in situ whenever possible, using specific identification guides. When doubts arose, specimen was collected and identified in the lab using microscopes and herbarium collections. During the first years, the data were collected in field record sheets. Since 2012 a citizen science web platform allowed students to fill the data in situ directly to the web. The platform www.mobidic.pt also allowed students to analyze the graphs that are automatically generated and to discuss the impact of their inventories on a longitudinal study basis.

In HSCI 2017 the author will present a ten year school project process, which focused on Project-based methodologies. The project won the second prize in Young Scientists and Researchers, which took place in May2007 in Lisbon, being selected to represent Portugal in Suisse Alps in July 2017 at the 18th International Wildlife Research Week; students were also invited to present a communication in A Sea of Opportunities Congress, which took place in May 2017 in Viana do Castelo and also in Planet Earth International Year Launch Reverse Session, which took place in September in Lisbon; an article has been submitted to the Young Reporters for the Environment International platform and three European school courses were organized under the theme Marine Environmental Science Monitoring and Sciences Outreach.

Keywords. Learning design, project-based learning, formal education, collaborative work, tutoring teaching, hands-on science, marine macro algae, bioactive compounds, intertidal, zonation, biodiversity.

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Sending Balloons and Cans into the Atmosphere and Stratosphere

A Azevedo, A Sabença, A Cruz, A Vale, E Fonseca, F Caetano, F Silva, G Nunes, H Morais, I Pinheiro, J Coelho, J Soares, R Rocha
Colégio Luso-Francês, Porto, Portugal
rita.rocha@lusofrances.com.pt

Abstract. An atmospheric aerosol can be described as a system of solid or liquid particles drifting in Earth's atmosphere from the stratosphere to the surface. Aerosols differ in size from a few nanometers to several tens of micrometers. The great majority of aerosols (i.e. almost ninety percent in mass) have natural origins. The remaining fraction is considered to have an origin in a variety of anthropogenic sources. The size and the source are precisely what allow us to categorize aerosols into three main modes: the nuclei mode (particle size < 0.1 μm), the accumulation mode (0.1 μm < particle size < 2.5 μm) and the coarse mode (particle size > 2.5 μm). The two first categories rely on the so-called "fine particles" while the last remains in the" course particles" definition. A third category is within science scope: the "ultra-fine particles", also known as nanoparticles. These are great promises as atmospheric toxics' absorbents. Fine and coarse particles exist together in the atmosphere as two chemically distinct aerosols. Fine particles contain the major constituents of cloud condensation nuclei. They remain suspended for many days, long enough to travel global distances. On the contrary, coarse particles contain most of the crustal materials and their oxides, as well as large sea salt particles. These particles tend to fall out near the source. The main problem with aerosol particles is precisely their ability to establish complex hybrids that are difficult to distinguish. The smaller they are, the more reactive they become. Understanding what happens within clouds – i.e., how certain aerosols behave and interact with cloud droplets - remains a huge challenge. Aerosols also play an important role in ozone depletion and global cooling. Although we might think of this as counteracting the greenhouse warming, aerosols are not distributed evenly around the planet, so their impacts are most strongly felt on a regional scale. Using aerosols as atmospheric tracers might be an excellent way to see how the Earth's atmosphere moves, namely the dynamics in the stratospheric transport from low to high latitudes, or the exchange of air between the troposphere and stratosphere. Moreover, knowing more about their composition would improve our understanding of how clouds form or the influences that pollution may have on clouds and precipitation. The atmospheric chemistry is ruled by aerosols in a sense that these particles provide surfaces on which certain gases condense and react. By studying the smallest and most recently formed aerosols, scientists should be able to understand how the presence of gases outside the aerosol relates to the chemical composition of the aerosol and the transformations taking place within it. In order to measure the Aerosol Optical Depth [AOD] on a vertical air column students built a low-cost satellite, within the volume and shape of a soft drink can. This microsatellite was named LusoSat and it integrated a wider project [Cansat] promoted by the European Space Agency.

LusoSat measured AOD at different heights, by using and cross referencing data from pressure and humidity sensors, and also red and green light emitting diodes [LED], which, in turn, measured light intensity in two different channels in the visible part of the spectrum: 550nm (green channel) and 625nm (red channel). Light from the sun causes the LED detector to generate an electrical current which goes to an amplifier that converts it into a voltage and it is boosted by the amount of the feedback resistance. The amplifier boosts the signal from the LED by a factor of the value of feedback resistor. The 9 volt battery from LusoSat supplied the power to the LEDs. Through the use of pressure and temperature sensors - along with a GPS for better accuracy – LusoSat01 acquired altitude data. Along with a humidity sensor, it allowed students to calculate the air density at several heights. To obtain the AOD, the team used a simplification of the Beer's Law, which requires the measurement of data such as the pressure, the relative air mass, the solar elevation angle and the Earth-Sun distance, all of these at the time and location of the measurement. The students had the opportunity to launch LusoSat from an aircraft, at an altitude of 1km. The flights took place in Aeródromo de Santa Cruz, Torres Vedras in May 2015. The project evolved and a new mission was developed to LusoSat: to

incorporate a VOR air navigation aid system, similar to the ones used for air traffic control at airports. To achieve this goal, LusoSat integrated a Software Defined Radio receiver based on the popular RTL2832 integrated circuit, connected to a Raspberry Pi Zero, through which it will receive and demodulate signals from the VOR air navigation aid system. The signal reception from each VOR station allowed students to determine a radial of each VOR station. The radials intersection allowed to calculate the trajectory of the receiver, which was compared with the information obtained by GPS. In addition to real-time data processing, the challenge of the mission laid in designing a filamentary VHF antenna on the tiny LusoSat can surface. This last mission was developed with the guidance of the Department of Electrical and Computer Engineering from the Faculty of Engineering of University of Porto. The challenge became so motivating that a third mission was assumed by the team: to build an instrumented capsule for measuring parameters in the stratosphere. The LusoBEE – Stratospheric Balloon from Colégio Luso-Francês – was launched on June 2016, reaching 26.9km of altitude. After two hours of ascension, the balloon burst and the capsule began to fall, aided by a parachute. The landing took place in Amarante, in the north of Porto.

An aerospatial group is being created in school as a consequence of these projects and so, in September 2017 a new LusoBEE mission will be carried out: to test the effect of pressure and temperature on chicken embryonic development, using fertilized eggs in different development stages. In HSCI 2017 the authors will present a three year school project process, which focused on Project-based methodologies. The project was for two years finalist in Cansat Portugal Science Contest.

Keywords. Learning design, project-based learning, formal education, collaborative work, tutoring teaching, hands-on science, cansat, stratospheric balloon, aerosol, atmosphere, stratosphere, anthropogenic, fine particles, ozone depletion, greenhouse warming, atmospheric tracers, aerosol optical depth, Beer's Law, VOR air navigation aid system.

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The Earth's Magnetic Field: A Science's Fair Tour from the Exploration of Mineral Resources to the Reconstruction of the Distant Past

L Matias[1], M Moreira[1,2], J Duarte[1], C Corela[1], E Font[1], P Fonseca[1], P Silva[1,2], M Neres[1,3], E Almeida[4]
[1]*Instituto Dom Luiz, Lisboa, Portugal*
[2]*Instituto Superior de Engenharia de Lisboa, Lisboa, Portugal*
[3]*Instituto Português do Mar e da Atmosfera, Lisboa, Portugal*
[4]*Universidade de Lisboa, Lisboa, Portugal*
lmatias@fc.ul.pt

Abstract. Geomagnetism is one of the oldest disciplines in Geophysics and the main properties of the Earth's field are known since the XVth century. The magnetism is one of the simplest and economic techniques used in Geophysical Exploration. In the 60's of the XXth century Paleomagnetism in the oceans was the essential proof for the ocean spreading hypothesis that together with the continental drift formed the pillars for the Plate Tectonics theory. In this session, we will present a series of simple experiments on Geomagnetism and Paleomagnetism, organized as a Science Fair Tour, that illustrate the main applications of the magnetic field from Exploration Geophysics to Global Tectonics.

The Earth's field is a 3D vector. Earth magnetism is best known by its effect on the compass. Its field forces the magnetic needle to point in a direction close to the geographical North. In appearance, the magnetic field is a 2D vector. Far from true! In Portugal mainland, the magnetic inclination, measured from the horizontal plane, is close to 53o. In this activity, we use a magnetic dip needle to show that the earth's magnetic field is a 3D vector to measure its inclination. The same apparatus can be used to show that magnetism and electrical currents are related, a classical experiment where the current on a wire deflects a magnetic needle.

To be or not be? That is the (magnetic) question. Several metals and rocks are probed for their magnetic properties. Each rock has its own history, one age, location where it was picked, an origin, which opens the discussion for some basic geological concepts. The metals are bound to some surprises, is steel magnetic or not? The comparison between the magnetic properties of rocks and metals also brings up the concepts of induced and remnant magnetization, which are important to understand the foundations of Paleomagnetism.

Where's (magnetic) Wally? One magnetic object is hidden and its location must be uncovered by the measurements of the vertical magnetic field done on the surface. For this purpose, we use an Arduino and a small vector magnetometer. The vertical field is echoed on the screen of a computer and the average value on each location can be taken on a regular grid if additional processing is desired. The location of the magnetic object is inferred from the large variations of the field. The anomalous magnetic field can be plotted on 2D and 3D using a simple script and free software.

Magnetic memory. During its formation, rocks acquire magnetic properties that testify the direction of the Earth's magnetic field at that time. Igneous rocks form from through the cooling of magma or lava. When they are hot the particles of magnetic minerals are free to align with the Earth's magnetic field. When rock cools below the Curie temperature, magnetic minerals freeze and save the memory of the magnetic field direction and intensity. The demonstration of this effect requires the heating and cooling of an iron nail which is an experiment to be done on very controlled conditions.

The secret message. The Earth's magnetic field is generated by electric currents on the external nucleus which is thought to be composed of liquid iron and nickel. These currents are induced by thermal convection, tidal and Coriolis forces. The nucleus is assimilated to a dynamo that shows a chaotic behaviour, changing the field polarity aperiodically. This polarity is memorized by the rocks that thus contain a secret message. This procedure is simulated by a game where one team writes a secret magnetic message on strips of magnetic tape that must be decoded by the other team.

Reading the oceans. Oceans are created on mid-ocean ridges by spreading and are

destroyed on subduction zones. When the lithosphere is created from cooling magma and lava the rocks they preserve on their magnetic fabric the memory of the field polarity at the time of their formation. By measuring the magnetic field over the seafloor, the geophysicist reveals a symmetrical series of parallel bands irregular alternating polarities. Given the "Rosetta stone" that shows the ages of each polarity change it is possible to decode the history of oceans, reading the magnetic messages that are written on them. This piece of evidence was essential for the success of the Plate Tectonics Theory on the early sixties of the XXth century.

The Earth's magnet. The Earth's magnetic field measured on the surface today is very close (~90%) to the one that would be generated by a magnetic dipole (or magnet) located at its centre and aligned close to the rotation axis. The magnetic axis is known to move around the rotation axis by precession and on average (for a few thousand years) it is expected to coincide with the geographic axis of the Earth. This is known as the geocentric axial dipole hypothesis that is at the base of the Paleomagnetism. The Earth's dipole is demonstrated by probing one model of the Globe with a magnaprobe, a simple device with a small magnet that can orient itself on 3D. The magnetic field of the dipole is shown to be vertical at the geographical and horizontal along the equator. Furthermore, it is demonstrated that there is a relationship between the magnetic field inclination and the paleolatitude.

Lines of force. The dipole magnetic lines of force are visualized with magnetic iron fillings, a very common experience in the physics lab. When the magnetic is covered by the model of the Earth we are suddenly looking at the field lines of Earth's magnetic field. Using a strong neodymium magnet, the iron fillings allow for the measurement of the magnetic inclination and these data can be used to demonstrate the fundamental equation for Paleomagnetism that relates the paleolatitude and the inclination.

Plate tectonics puzzles suck! This is a very common exercise used to demonstrate the success of Plate Tectonics. The contours of continents, or continents and their continental platforms, are cut on a flat piece of paper and then they are placed side by side on a perfect fit that normally illustrates the supercontinent Pangea. This type of exercise is indeed very misleading since it completely ignores that the Earth's shape is very close to a sphere. Its planar representation is done at the cost of deformation, usually very large at the poles. Puzzle designers then must falsify the Earth's representation to derive a perfect fit. To obtain a 3D puzzle we built a magnetic sphere and designed the magnetic plates on a 3D printer. Plates adhere to the sphere using small neodymium magnets. This 3D puzzle demonstrates the difficulty of obtaining a perfect fit between the continental boundaries. We learn that Plate Tectonics imply that continents must have deformed since Pangea times, a feature that is completely ignored in common descriptions of Plate Tectonics.

The old Earth. The oceans that provide a detailed history of Plate Tectonics using the magnetic polarity scale demonstrated above, dye young. The oldest oceans on Earth are only 180 My old and most oceans are floored with oceanic lithosphere younger than 100 My. Paleomagnetism is the tool that allows the geophysicist to reconstruct the plates location up to 600 My. By measuring the remnant magnetization, its declination and inclination, it is possible to recover the location of the paleomagnetic pole. By the geocentric axial dipole hypothesis this pole coincides with the Earth's rotation axis. The paleomagnetic pole is like a nail that is connected to the tectonic plate by a long rod. The paleomagnetic poles of different plates must have coincided in the past at each given age. This provides information on the latitude of each plate but not on the longitude. Other information and hypothesis must be considered to derive the plate reconstruction on the past. Using the 3D magnetic sphere the foundations of the Paleomagnetic reconstruction is demonstrated by adjusting the declination and paleolatitude on selected sites for each plate.

Keywords. Geomagnetism, paleomagnetism, plate tectonics.

The Emotional Journal in Physics Classes as a Strategy of Cognitive Self-Regulation in Teachers in Training

FL Naranjo-Correa, G Martínez-Borreguero
University of Extremadura, Spain
naranjo@unex.es

Abstract. . Recent reports at European level alert about the future problems that society may have due to the increasing decrease of scientific vocations in the last years. It is paradoxical that, in a society where scientific knowledge is considered as one of the fundamental pillars to achieve social and economic advances, there is an attitudinal and emotional decline in students towards these disciplines. Various researchers have noted this fact, which is accentuated as the student's age increases [1, 2].It is necessary to carry out reflection processes with our students to lessen this lack of attitudinal and emotional motivation towards the learning of scientific contents, to analyse the reasons for these causes and to try to feedback their reflections and perceptions towards subjects such as physics and chemistry positively.

Previous studies [3, 4] revealed that the emotions experienced in science subjects during the school stage might have influenced both the scientific vocation and the beliefs of self-efficacy towards the learning and teaching of these contents in the teachers in training. For this reason, the general objective of this work has been to analyse the emotions that the future teachers of primary education experience when they face processes of teaching and learning of physics. The teachers in training should improve their scientific skills to learn to teach science content to their future primary education students (aged 6 to 12 years). They should also promote a change in their emotions towards this subject, mainly because the vast majority shows an initial rejection towards it. This emotional change is of particular relevance in our society since it is in the primary school stage where the students begin to establish the first emotions and attitudes toward science.

The sample, which was chosen for convenience due to the ease of access to it, was formed by 62 fourth year students of the Degree in Primary Education and their ages ranged from 21 to 26 years. The design of the research was a mixed non-experimental type with a descriptive and inferential statistical analysis. The self-developed measurement instrument used consisted in the elaboration of emotional journals during the physics classes, used as tools for cognitive and emotional self-regulation for the teacher in training. The educational methodology carried out in the different sessions was considered as the independent variable in the study. The dependent variables were the emotions, their causes and the learning achieved by the students involved.

As [5] points out, the journal can be a means to make explicit the emotions, to investigate their causes and to be aware of them to self-regulate them, something essential in the didactics of the experimental sciences.

The results obtained reveal the existence of statistically significant differences (Sig. < 0.05) in the emotions experienced depending on the methodology used. These results are expected, due to the different didactic approaches of each of the sessions carried out for the teaching of physics contents.

A high percentage of students expresses in their emotional journals some difficulty both in understanding the problem and in the mathematical tools for its correct resolution. Additionally, they indicate low levels of teacher self-efficacy for the delivery of these contents.

Emotional journals were a critical tool for establishing a metacognitive process in the teachers in training. Becoming aware of their limitations and how the emotional domain affects the learning of physics contents has allowed our students of the Degree in Education to self-regulate at the cognitive level, to enhance their emotional competence and to promote a reflexive attitude that has a positive impact on their professional development. Emotional meta-reflection helps them as teachers to improve their ability and competence to learn to teach science, coming to recognise that with certain educational strategies they feel joy, enthusiasm, or even fun for physics content, even when it was initially rejected by them during their stage school.

Acknowledgements

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Keywords. Learning design, project-based learning, formal education, collaborative work, tutoring teaching, hands-on science, car prototype, automotive engineering, energy-efficient, pollutant gases, fuel, internal combustion, net calorific value, engines, transmission system, braking system, aerodynamics.

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Training Future Teachers to Introduce Microorganisms into a Primary Classroom through Hands-On Experiments

JM Marcos-Merino[1]*,*
JA Gómez Ochoa de Alda[2]*,*
R Esteban Gallego[1]
[1]*University of Extremadura, Badajoz, Spain.*
[2]*University of Extremadura, Cáceres, Spain.*
jmmarcos@unex.es

Abstract. Microbiology teaching faces the difficulty of approaching in the classroom living beings not observable by the human eye, and usually related to different sort of diseases: microorganisms. As a result of this, basic concepts of Microbiology are often related to numerous misconceptions such as the identification of viruses as living organisms and all microorganisms as pathogens, the unfamiliarity of sterilization and asepsis or lack of knowledge of ubiquity and diversity of microorganisms [1-2-3]. These misconceptions reinforce the negative view of microorganisms as pathogens and obviate their importance for ecosystems, industrial processes and pupils' daily life [4]. Research has pointed out that misconceptions about scientific concepts of teachers are one of the main origins of student misconceptions [5-6]. Thus, it is necessary to develop teaching-learning sequences of Microbiology that are effective and accessible from Primary Education and address these interventions in Science Education courses of future teachers training. The present study describes an intervention carried out with 139 future teachers (students of the Degree in Primary Education of the University of Extremadura) in which basic microbiological concepts are approached through microorganisms' culture. Moreover, it is discussed how adapt these activities to implement them in a classroom of Primary Education. Finally, main learning results (evaluated by pretest and postest) of this intervention are shown.

The intervention consists of a laboratory practice in which students work ubiquity and diversity (bacteria and fungi) of microorganisms, their appliances and sterilization and asepsis methods. First of all, teacher explains briefly what a Petri dish is and how microbiologists prepare culture medium for microorganisms in a laboratory. Then, in order to show microorganisms' ubiquity and diversity, they leave opened Petri dishes in different places of the Faculty (such as cafeteria, canteen, baths, library, laboratory, events hall, classrooms, photocopying service…) during 20 minutes. Afterwards, they test the effectiveness of methods of asepsis (handwashing) and sterilization (ethanol). Finally, to show a beneficial application of microorganisms in their daily lives, students investigate how yogurt and bread are made and put it into practice using everyday materials. A week later, they come to another session in which see the results and discuss these concepts. Subsequently, students discuss, headed by teachers, how prepare a culture medium for microorganisms in a homemade way (daily materials and instruments that they could use and how maintain asepsis and sterility) to be able to perform this activity in Primary Education.

The analysis of the learning results of this interventions shows that it was effective, since a significant increase was observed (p-value<0.05 with Wilcoxon test, due to data did not follow a normal distribution) in the percentage of success of questions related to basic microbiological concepts such as microorganisms as living organisms that perform the three vital functions (from 61.87% to 71.94%, p-value=0.02), bacteria and yeasts as living beings (from 24.46% to 48.20%, p-value<0.0001), concepts of sterilization (from 29.49% to 63.31%,p-value<0.0001), and asepsis (from 45.32% to 68.35%, p-value<0.0001) and the water as the basic nutritional requirement of all microorganisms (from 15.82% to 29.50%, p- value = 0.004).

These results reinforce the need to implement this kind of practical interventions in order to improve Primary teachers' qualification and their future teaching action.

Keywords. Hands-On experiments, micro-biology, primary education teacher training.

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Ups and Downs of Technological Literacy

D Valeriu[1]*, Z Florin*[1]*, F Corneliu*[2]
[1] *"Dr.C Angelescu" College, Buzau, Romania*
[1] *"Dr.C Angelescu" College, Buzau, Romania*
[2]*School Inspectorate – Teacher"s House, Buzau, Romania*
dumitrescuprof@yahoo.com

Abstract. During the last 70 years (but especially during the last 15 years), mankind has witnessed an exponential increase in the rhythm of scientific discovery and its use in storing and using data, which lead to an increased pace of life, giving us the feeling of a permanent time-crisis.

The sequencing of events has become so alert that life goes over us and we fail to live it and to keep up with its pace, which requires constant training and adapting from our part.

The first computer appeared in 1939, eleven years later the first modern one, the Internet in 1969 while the first commercial PC appeared in 1975.

Together with the 8080 microchip in 1979 the first PC with gaming options was developed. The virtual world, as we know it today, appeared in 1990 due to the Englishman Tim Berners Lee who created the World Wide Web. The first smartphone appeared in 2002, the first I phone in 2007, the tablet PC in 2010 and the triple screen laptop in 2017.

3 D holographic projections are about to appear as well as interactive connections between man and computer, which will represent the beginning of a new age in this field.

It was proven that using a PC as a means of increasing the processing capacity with a minimum of mental effort generates negative side effects if used in a wrong manner, thus becoming a matter of public health.

Using the PC and the Internet gives you instant but passive access to countless amounts of data because the brain has a lower speed of storing and processing data.

While a PC comes with pre-installed software to store and process a certain amount of data, the brain has to come up with its own system of storage (inter-neuronal synapsis) to help it store data, which, later on, through increased use, creates logical thinking (the software) thus making it fundamentally different from PCs.

The question is whether we are ready to cope with this informational tidal wave, and, if so, at what age?

A detailed research into the way human brain functions has been able to answer the numerous problems that appear in human behavior, taking into consideration its decline due to various brain medical conditions.

Because of its marked incidence, it has come to represent a social issue that humankind has to be aware of, in order to avoid an educational collapse or irreversible genetic mutations.

While we watch TV the human brain undergoes a series of functional modifications that most people ignore. A seemingly harmless pastime is in fact a true menace to physical and mental well-being of humans through affecting their levels of intelligence and preventing the development of their attention span.

Following detailed and lengthy research Martin Haracz underlines the point that television is a very effective means of mind control.

In revealing these finds by [1] we see that the appearance of behavioral issues caused by this the sleep-like hypnotic state. CT scans of the brain indicate a low level of brain activity during the entire period of watching TV.

Some of the finds were that:

- The attention span and capacity decrease
- Subjects were unable to show empathy
- They tend to isolate themselves
- They lack critical reasoning
- The level of superior cerebral functions decrease
- Physical and psychological addiction is manifest
- It mainly affects cerebral development for the prefrontal lobes in children.

Aric Sigman says that the TV is no place to be for a child under 3.

Taking into account that the shaping of the cortex and the prefrontal lobes are not final until 25 years of age, due to the much lower speed of growth compared to the speed of the events unfolding in virtual reality on TV and the Internet the consequences are easy to see.

It is easy to understand that regardless of age and occasion (at home, on the street, at work) people spend more and more time in front of a screen.

We may conclude that due to all these, at low ages the brain is prevented from developing properly while later on it decays at an increased pace.

Keywords. Technological Literacy, mental, PC, smartphone.

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Chemistry for All

A Ribeirinho, P Parpot
Universidade do Minho, Braga, Portugal
parpot@quimica.uminho.pt

Abstract. In everyday life young people have contact with chemical reactions as many of those are based on many aspects of their way of life. Nowadays Chemistry teaching is struggling against a specific issue with several difficulties towards students, due to the empirical nature of the approached knowledge, as well as the degree of abstraction required at the level of microscopic versus macroscopic relationship. It was taken into account not only the previously referred but also the fact that in a school there are students with Special Educational Needs (S.E.N.) and an evident lack of answers adapted to the educational needs of each student. Therefore, regarding the above and in an attempt to go towards the needs presented, it is intended with this study the following:-to identify among 8th grade students with S.E.N., the ideas and knowledge related to the chemical reactions topic in contrast to regular students of the same year; -to build, develop and implement a teaching methodology: learning the chemical reaction topic, based on a set of enlightening experiments so that there can be an understanding related to this part of the chemical world;-to evaluate the success of the methodology;-to develop a short program of cognitive stimulation, focused in young people with S.E.N., particularly with learning disabilities (L.D.) and mental disorders (M.D.). This study, accomplished in a middle school of the city of Barcelos, included 45 students, 8th graders, from two classes, five of which identified with S.E.N. It was used as research instrument a questionnaire given as pre and post-test, as well as worksheets (consolidation worksheets); and also experimental activities, sustained with some interviews in certain situations. This study was carried out in two stages. In the first stage, the pre-test was applied. The students' responses were studied and the data was taken to be used in the preparation of the teaching units. In the second stage, the teaching units were planned and introduced to students afterwards. All the students involved in this study participated, executed, experienced and concluded their own contents of the planned lessons. Despite the limitations in this study, the showed results determine that the proposed teaching methodology proved effective in promoting the conceptual progress of students. The achieved results confirm the belief that improving the quality of teaching implicates the appreciation of "my ideas".

Keywords. Chemical reactions topic, enlightening experiments, learning disabilities, mental disorders.

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Cognitive and Emotional Learning of Chemical Reactions through Activities Lab in Secondary Education

MA Dávila Acedo[1]*, AB Borrachero Corté*[2]*, F Cañada Cañada*[1]*, J Sánchez Martín*[1]*, D Airado Rodríguez*[1]
[1]*University of Extremadura, Badajoz, Spain.*
[2]*University of Rioja´s, Logroño, Spain*
mdavilaacedo@unex.es

Abstract. The chemical reactions, also called chemical changes, are present in all aspects and areas of our everyday life. The teaching of chemical reactions is a fundamental content in the curriculum of Compulsory Secondary Education.

There are many difficulties and problems to differentiate between the chemical and physic changes, both microscopic and macroscopic level, because the conceptual understanding of both changes involves the representation and interpretation of the properties and changes of the matter in both levels.

Students develop their own ideas or misconceptions of scientific contents, due to need of give explanations to the phenomena that happen in their everyday life. In this way, students of Secondary Education have ideas about the concepts related to the physical and chemical changes of the matter. These include, among other, the confusion between the changes of the state of substances like chemical change, mix or dissolution of substances with chemical reaction or the oxidation of iron like physical change [1]

This work presents a teaching/learning proposal based on development of workshop activities in the classroom related to physical and chemical changes of the matter. The main aim of this research is to improve the learning process of the students either from cognitive and emotional point of view. The involved students belong to 3rd of Compulsory Secondary Education.

The results depict a clear evolution in the learning process in both dimensions after workshop activities.

Keywords. Emotions, teaching sequence, physical and chemical changes.

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Detection and Separation of Lycopene and Beta-Carotene in Tomato Products: A New and Sustainable Chromatographic Approach

A Dias, P Costa
Universidade do Minho, Braga, Portugal
ad@quimica.uminho.pt

Abstract. Science experiments are crucial tools in the teaching/learning process because students learn more effectively doing by themselves. In the chemical education, experiments revealing the chemistry around us through high visual impact activities are particularly motivating and may influence students to choose Chemistry for a future career.

Plant pigments, due to their beautiful colours and their vital importance in life on Earth, are privileged molecules for establishing important relationships between chemistry and daily life in classroom.1 Carotenoids are the yellow-orange pigments occurring in flowers, fruits and leaves, where they play essential functions in photosynthesis and photo protection. They possess high antioxidant activity providing protection against aging and human diseases like, cancer, cardiovascular diseases.2 Moreover, some carotenoids, such as β-carotene, additionally have provitamin A activities which is essential for vision process. Carotenoids also contribute to the colours of some birds (flamingo, canary), insects, and marine animals (shrimp, lobster, and salmon). Animals and humans are incapable of carotenoid biosynthesis and they should be obtained from the diet.

Lycopene is an unsaturated carotenoid with antioxidant properties superior to those of β-carotene, which finds important applications in the food, pharmaceutical and cosmetic industries.2 It gives the red colour to several commonly consumed fruits and vegetables, representing more than 80% of total tomato carotenoids. Besides lycopene, beta-carotene is also present in tomato.

As an extension a previous work, we here report another high visual impact and eco-friendly experiment enabling the separation of beta-carotene and lycopene from tomato sources using sustainable chromatographic techniques. This activity may be implemented in basic and secondary schools, allowing the teaching/learning of several key concepts of the Chemistry Curricula listed for Basic and Secondary Education.

Keywords. Pigments, β-carotene and green chemistry, chromatography, lycopene.

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Geographical Information Technologies and Mobile Learning to Learn About Nature: PhenoloGIT Project

MJ Rodríguez Malmierca[1], *A Martínez Gracia*[1], *E Abad Vidal*[1], *D Nieto Caride*[1], *M Trigo Miranda*[2], *L La Velle*[3], *J Georgeson*[3], *H Brandt*[4], *P Ulla Andersen*[4], *E Čeponis*[5]
[1]*CESGA, Santiago de Compostela, Spain*
[2]*CPI O Cruce, Cerceda, A Coruña, Spain*
[3]*University of Plymouth. Devon, UK*
[4]*VIA University College, Århus C, Denmkark*
[5]*ITC Vilnius, Lithuania*
mjrm@cesga.es

Abstract. This communication will present the partial results of European Project PhenoloGIT [1]. PhenoloGIT is a major trans-European project which aims to design, build and test a collaboratively created educational environmental information platform, supported by state-of-the-art mobile technology and Geographical Information Technologies (GIT) aimed to be used by students and teachers in primary and secondary schools.

Phenology is the study of the timing of recurring biological events in the animal and plant world, the causes of their timing with regard to biotic and abiotic forces, and the interrelation among phases of the same or different species.

This project has already produced valuable outputs that will be presented at the HSCI2017 conference:

- A Report including Needs Analysis and Best Practices in order to reveal current uses of GIT and mobile digital technologies in gathering phenological data by schools across four European countries: Spain, Denmark, Lithuania and the United Kingdom.
- A report detailing Methodologies, phenology and science education research, big ideas for selecting curriculum content, and curriculum mapping for piloting GIT in schools and developing online platform.
- A complete technological solution to facilitate data gathering and analysis of phenological observations, composed by a mobile app (both for Android and IOS platform) and a geomap accessible in a web browser.- Example GIT open educational resources to be used in primary and secondary schools.

Keywords. Citizen science, education, GIT, IBSE, mobile-learning.

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Guide in the Dark

F Mota, J Guedes, M Guedes, A Ribeirinho
Agrupamento de Escolas Gonçalo Nunes, Barcelos, Portugal
anaribeirinho@aegn.pt

Abstract. In the 7th year of schooling, the beginning of the study of physics and chemistry, the students felt the need to extend their knowledge in the scope of electronics.

Thus, they intended with this project to begin the construction of a walking stick that allows the blind to free themselves from the fear of walking.

Since the walking sticks are a universal symbol of visual deficiency, they are also considered a great and efficient signal support in the orientation and mobility of the blind.

With this project it is possible to reconcile the technology-science with the current walking sticks and improve the quality of life of its users.

For this to become reality it was necessary to research the most suitable material and to elaborate a scheme of admiration.

After this step, the construction was started using a 32mm diameter electrician's tube, in which an electronic decoder board (Arduino) was installed, in turn connected to the proximity sensors (ultrasonic technology). To enable more energy-efficient use, a switch was installed in the circuit. A buzzer was added for the user to identify the obstacle approach. It is purpose to develop this project, with differentiating buzzeres of direction. For connecting cables, connection wires, a battery holder (4 4.5V batteries) were used.

In the context of the conclusions it is important to mention that the association of technology / science is also possible for students of this level of education. It allowed them to begin in the world of creativity, to develop the critical, analytical and reflective spirit. It has also provided the challenge of evolving into new use spindles, particularly on treadmills. You will therefore need to insert programmable material that visually detects certain obstacles and translates them through voice.

Lastly, mention is made of the placement of a signaling led, so that this feature can also be detected at a considerable distance.

Keywords. Visual deficiency, walking stick.

Hands on Science Experiments from Pre-School to Post Retirement

R Holubova
Palacky University Olomouc,
Czech Republic
renata.holubova@upol.cz

Abstract. The aim of the paper is to discuss our experience with teaching science principles with the assistance of simple experimental tools through the ages - from kindergaden to great age. Hands on science experiments play an irreplaceable role in science education. In the last few years a lot of activities based on students´ experimental work have been prepared. They became an internal part of science education at primary, secondary and high schools. All mentioned activities are based on the IBSE methodology. It is obvious to present the application of scientific knowledge in everyday life. Hands on science experiments got across the kindergarden physics, the Kid´s university, and, at our department for the first time, the Third Age university. On demand of the Third Age university students the education program has been changed. Hands on experiments have been incorporated to the curriculum instead of theoretical presentations. In this paper we elucidate the reason for this change. The arguments will be put into the context with the pedagogy and psychology of science education. The ways of motivation of the Z- generation learners in comparison with the concept of lifelong learning will be described. The impact of simple experiments will be discussed so as our practical experience of teaching across all the ages.

Keywords. Third age university, kid´s university, simple experiments, physics.

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Measurement of Electrochemical Cell Potentials

S Magalhães[1], *F Bento*[2]
[1]*Escola Secundária Martins Sarmento, Guimarães, Portugal*
[2]*Universidade do Minho, Braga, Portugal*
fbento@quimica.uminho.pt

Abstract. The concept of electrochemical cell potential is introduced during the 11th grade, in the subject of Physics and Chemistry, according to the present curricular goals of the Portuguese education system.

The construction of electrochemical cells and the measurement of the corresponding potentials are presented as fundamental experimental activities.

An efficient planification and test of the experimental setup is essential for a successful activity, particularly when a numeric quantity is envisioned. Experimental errors, associated with uncontrolled variables, may be considerable deviated experimental data from reference values.

Measurement of electrochemical potentials is a critical activity as the acquisition of reliable values may be limited by experimental factors such as: i) the state of the metal surface, that may vary during experiments; ii) the design of the half-cells and the contact between semi-cells that can input ohmic drop contributions to the final potential and iii) the voltmeter used.

In the present work, we report a study comprising 21 electrochemical cells prepared using 7 different half-cells that comprise a metal, M(S) (M= Cu, Zn, Al, Mg, Pb, Ni and Ag), immersed in a 1.0 M solution of the corresponding metal cation, Mz+(aq). The ionic contact between the two half-cells was made using an agar saline solution were the tip of all half-cells was immersed [1].

The values potential evaluated for the 21 combinations of the half-cells were analysed considering the repeatability and deviation from literature values of E°.

The fundamental conclusions of this work may be outlined as follows:

- Not all electrochemical cells are appropriated for a teaching-learning experimental activity as some values of cell potential exhibited low repeatability and/or high deviation.
- None of the half-cells is fully rejected from the trials, as all gave consistent cell potential for at least one electrochemical cell.
- Lower repeatability and higher deviations were observed for cells with higher potential pointing out for errors associated with ohmic drop and/ or variation of cell composition due to electrical current flowing in the circuit.

As a result of this work a set of electrochemical cells are suggested for an activity to be carried out with students.

Keywords. Cell potential, experimental activity, voltmeter.

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Methodology for the Teaching of Chemistry in 3rd Cycle of Basic Education Chemistry for Everyone: A Study Focusing on the Structure of Matter, Chemical and Physical Transformations, Lavoisier's Law and Velocity of Reactions

A Ribeirinho[1]*, P Parpot* [2]
[1]*Agrupamento de Escolas Gonçalo Nunes, Barcelos, Portugal*
[2]*Universidade do Minho, Braga, Portugal*
parpot@quimica.uminho.pt

Abstract. In this changing society, which has given rise to a more heterogeneous system, it is the responsibility of the school to provide all children with the pleasure of culture and not to legitimize the differences in aptitude. Thus, diversity and plurality curricular, pedagogical, methodological, organizational and professional becomes imperative.

Thus, in view of the above and in an attempt to meet this situation, we intended to: -construct, develop and apply a teaching methodology, based on a set of didactic materials and experiences aimed at children with special educational needs.

The study, carried out in a Basic School (2,3CEB) in the municipality of Barcelos, had 45 students from the 8th grade, distributed in two classes, of which 5 with N.E.E. A questionnaire applied as pre- and post-test was used as research instrument; Work sheets (consolidation forms); And experimental activities, complemented with interviews in certain situations.

The study was developed in two stages. In the first stage, the pretest was implemented. The students' answers were studied and the data were grouped to be used in the planning of the didactic units. In the second stage, the didactic plans were elaborated and later presented to the students. All students involved in the study participated, tried and completed the content taught.

The objectives to be achieved with this study are presented as follows:

1) Investigate "my ideas" from each of the students regarding concepts involved in the field "Chemical Reactions"

2) Plan and implement a pedagogical intervention for the teaching of the "Chemical Reactions" domain, which, taking into account the previous knowledge identified, favor a constructivist approach to learning.

3) Evaluate the effectiveness of the intervention made in the evolution/restructuring of students' previous knowledge.

In this line of action, all of them need, during their schooling, various "pedagogical aids" of a technical, human or material type, and with the objective of assuring the achievement of the learning, the intention was to provide a Teaching that stimulates the students, that stimulates and reinforces their curiosity, the taste for participation and the desire to learn. In the development of the attempt to adapt an education that fits the interests and needs of students with special educational needs,

The "Brinca e Aprende Química" didactic space was created, which makes use of didactic games. In order for play to be fun and stimulating in learning, there must be adequate resources at the level of teaching and the needs of the students. In this way, and in order to follow up on this process, a "game" was built.

Both students with special educational needs and those who are not, should be able to look at science-chemistry as a particular content in order to develop a coherent view of the world and be scientifically literate.

Despite the limitations in this study, the showed results determine that the proposed teaching methodology proved effective in promoting the conceptual progress of students.

Keywords. Chemical reactions topic, learning disabilities, special educational needs.

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Microplastics Inventory in Coastal Environments

R Rocha
Colégio Luso-Francês, Porto, Portugal
rita.rocha@lusofrances.com.pt

Abstract. Plastic debris is any persistent solid material produced or processed directly or indirectly, either intentionally or unintentionally. Microplastics are plastic debris smaller than 5mm.

Plastic global production has increased considerably since the 50s due to a mass consumption of synthetic polymers. The properties that make plastic so beneficial are simultaneously what makes them so environmentally pollutant. Its stability and resistance to degradation are the causes that make it a potential environmental pollutant, especially when it does not receive the most appropriate destination at the end of its life cycle.

If we associate the previous two characteristics to a decrease in the product life cycle per se, caused by consumption and discard usage patterns, it is not surprising to find plastics representing 75% of the total amount of the marine litter today. Its impacts are of particular relevance in marine environments due to several factors: i) due to its low density and high floatability, plastics have a great dispensability, appearing in places far from its source; ii) plastics' photochemical degradation present high rates, which induces its fragmentation into small particles. The small particles are, in turn, introduced into the food chains by ingestion by filter feeding marine organisms [Barnes et al., 2009]; iii) plastics present a high adsorptive capacity for Persistent Organic Pollutants, of which DDT is an example that continues to be detected on the surface of microplastics after twenty-six years of its ban on commercial use; iv) because plastics have a high dispersion capacity, they are substrate and vector of several invasive species, whose impact on marine ecosystems is already consistently documented.

The Portuguese coastline is very vulnerable to plastic debris accumulation due to its extension, the potential terrestrial sources' abundance, such as discharges of untreated effluents, the high pressure on the country's coast and, not less important, the potential marine sources´ abundance, given that the country is an important commercial shipping route. Studies have been demonstrating that domestic laundry is a major source of synthetic fibers, which are not retained in Wastewater Treatment Plants and are therefore drained to the ocean. These microfibers enter the food chains and are readily found in fish tissue samples in fish markets. It is estimated that a single piece of clothing can release approximately 1900 acrylics and polyester fibers in each wash. Students aimed to clarify how relevant plastic debris were at a beach located near the school, the Praia de Matosinhos beach. To pursuit of their investigations, they first calculated plastic debris abundance per unit of sampling; then, the samples were classified by typology and size. As a means of comparing the results of their investigation with the evaluation of the beach quality carried out by official entities, students also applied the Clean Coast Index to their research area. There was identified 4.990 plastic debris in the field samples. 84.96% of the total sampled debris corresponded to microplastics. The debris was mainly distributed by two major typologies: synthetic fiber (62.14%) and Styrofoam (22:53%). The amount of microfibers presented in the samples mobilized students to study a way to retain microfibers in domestic washing machines through the development of a Nano filter. This way, the project continued for a new school year with new students.

In HSCI 2017 the author will present a two year school project process, which focused on Project-based methodologies.

The project won the first prize in the 13th National Science Contest Prémio Ilídio Pinho Ciência na Escola, which took place in September2016 in Pinhal Novo, Portugal. It also won the 2nd prize in Clean Tech Competition – Making an Impact, which took place in July2016 in Miami, EUA and Puerto Plata, Dominican Republic. The project was also selected to represent Portugal in the Suisse Alps, in June 2016 in the 27th Wildlife Research Week. It won the 1st prize in Sustainable category in the 15th International Science Contest “Ciencia en Acción” (Science on Stage), which took place in October 2015, in Barcelona, Spain. The students were also

accepted to present a communication in the 2nd EMSEA, Conference of the European Marine Science Educators Association, which took place in October 2014 in Gothenburg, Sweden.

Keywords. Learning design, project-based learning, formal education, collaborative work, tutoring teaching, hands-on science, micro-plastics, plastic debris, synthetic polymers, pollutant, photochemical degradation, food chains, invasive species, persistent organic pollutants, microfibers, nano filter.

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Microscale Chemistry Experiments from the UK

R Worley
Brunel University Science Park,
Kingston Lane Uxbridge, UK
bob.worley@cleapss.org.uk

Abstract. Here are some microscale chemistry experiments on hand from the UK for visitors to examine. Some will be working. They will illustrate the simple techniques which can be used to quicken the pace of the practical work in in classes, allowing time to teach the content at the same time. It will become obvious that these techniques do not always require laboratory conditions. This is not a kit, but the equipment is easily available from laboratory suppliers as well as more unusual places.

The exhibits will include work with solutions on a plastic sheet (Fig. 1), seeing microelectrolysis (Fig. 2) under the USB microscope, the use of a conductivity indicator (Fig.3) and how titrations can be performed. To make these activities more attractive to traditional methods they always need provide added value! Some of these techniques are now being recognised by UK Examination Boards.

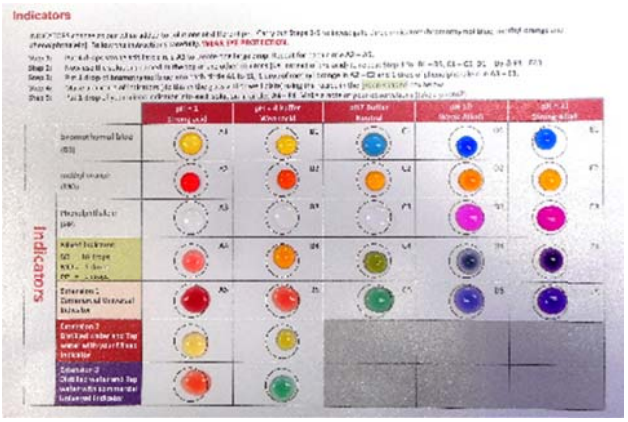

Figure 1. Indicators and buffers on a plastic sheet

Keywords. Chemistry, Practical chemistry, Green issues, sustainability, microscale chemistry, pedagogy, Short and Long term memory, cognitive overload, classroom management.

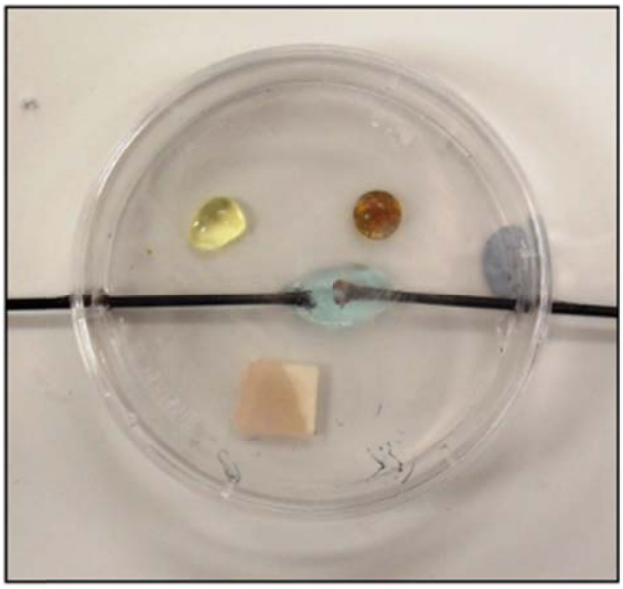

Figure 2. Microelectrolysis of copper(II) chloride solution

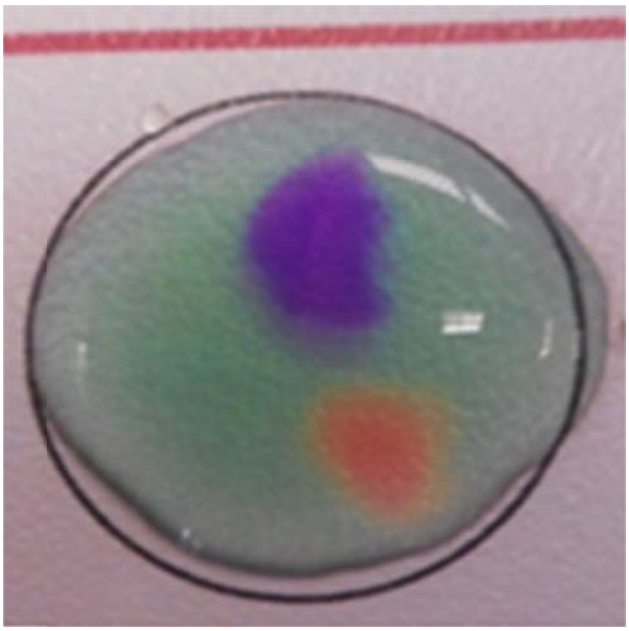

Figure 3. Electrolysis in a puddle of water on a plastic sheet

Open Science to Students

JM Fernández Novell
University of Barcelona. Barcelona. Spain
jmfernandeznovell@ub.edu

Abstract. Since ancient times, scientific curiosity has been a constant that has encouraged reflection and learning process through trial and error. Observation, ask questions and experimentation form a constant approach leading to knowledge and progress. However, the interest for science studies is decreasing in Europe.

To change this vision, the Department of Biochemistry and Molecular Biology of the University of Barcelona, in collaboration with the “Sociedad Española de Bioquímica y Biología Molecular, SEBBM”, has been conducting annually some workshops about science, morning or afternoon sessions. Scholars received information about what is Science in general and, at the same time, laboratory teachers prepared a series of experiments.

How many people could be saved each year if they were vaccinated against malaria? Would you like to contribute to the discovery of an AIDS vaccine? What attracts you most word "science", "technology" or "innovation"? What a synchrotron can serve? What do you find most attractive respond or ask questions? These are some questions requested to school students in their third or fourth year of Compulsory Secondary Education before starting scientific meeting.

In addition, students learn the safety standards in a laboratory, how to use the volumetric equipment and automatic pipettes and scientific method reaching, universal gravitation. They have experienced on: glucose, sugar, diabetes and how to measure the concentration of glucose (urine test strips, glucometer), pH to precipitate milk casein. Also, from the Internet, they have worked on how to clone a mouse and how to formulate biomolecules and organic molecules by "smiles" programme.

After each session, two types of surveys were planned, one to the students and another one to the science Secondary School teachers. Then, they were collected and analyzed to know the degree of activity acceptance. The results indicate that teachers appreciated this proposal and students welcomed these interesting activities which serve to increase the students' interest towards the sciences.

Keywords. Workshop, science questions, science experiments, secondary school level.

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Scientific Documentation. Natural Reservations

F Corneliu[1], *Z Florin*[2], *D Valeriu*[2]
[1]*School Inspectorate–Teacher's House, Buzau, Romania*
[2]*"Dr. C. Angelescu" College, Buzau, Romania*
corneliu_philips@yahoo.com

Abstract. The poster made for the "Economical Development of Buzau County's Hilly Area" project is meant to be a short and illustrative summary of the stages, actions, studies, accomplishments and ideas for future projects, which, seen clockwise, gives the feeling of an active involvement in the project.

The poster made for the documentary, a snapshot of the most expressive and suggestive sequences of the actions taken during the project, in a backward temporal sequencing will captivate your attention and entice your interest.

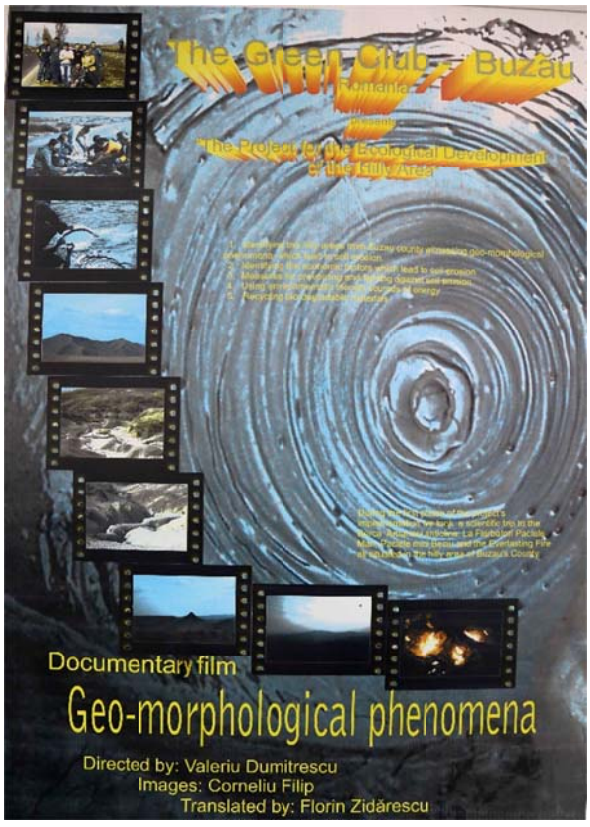

Figure 1

The documentary "Geo-morphological Phenomena" which was the result of countless investigations and much research of the "Paclele Mari" and "Paclele Mici" natural reserves, also known under the names of "Muddy Volcanoes" is meant to convey, beside the accurate scientific observations related to the geo-morphological phenomena, some rare imagery, of an impressive moonlike beauty.

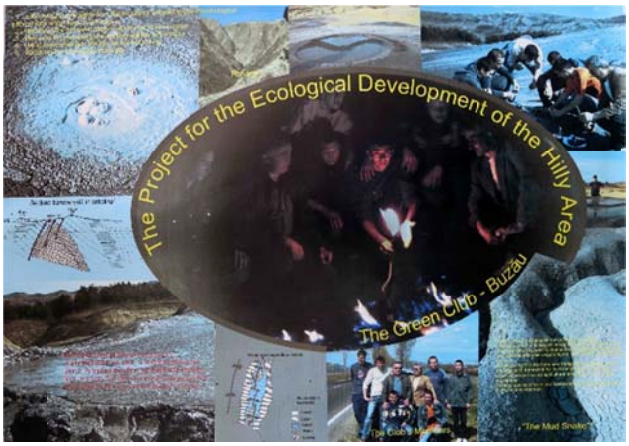

Figure 2

Keywords. Geo-morphological phenomena, natural reservation

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Senior Citizen Science through Local Monumental Trees

R Pires Lopes[1], C Schreck Rei[2], P Renato Trincão[2]
[1] University of Aveiro, Aveiro, Portugal
[2] University of Coimbra, Coimbra, Portugal
raquellopes@ua.pt

Abstract. This Citizen Science project was developed to counter Plant Blindness [1] phenomenon i.e, the inability to see or notice the plants in one's own environment and to promote the natural richness of Coimbra, Central of Portugal. A partnership between a local Senior University and researchers from Aveiro University and "Exploratorio, Centro de Ciência Viva de Coimbra" was developed to positively influence the engagement with science, particularly botany, among senior students (adults from 50 to 91 years old), in non-formal learning settings. Participants were engaged in the identification and exploration of monumental trees, based on their local knowledge, by developing a project to promote the discovering of trees with natural, scientific, historic, cultural and aesthetic value. Science workshops with outdoor activities were developed to explore Coimbra's gardens and green spaces motivating and enhance senior citizen scientists in a science awareness experience about monumental trees. This project was developed in collaboration with others disciplines of the Senior University (Photographic and Historical classes) by promoting interdisciplinary. This project also contributes to an active ageing by optimizing opportunities for health, participation in social, cultural, spiritual and civic affairs, to enhance quality of life of senior citizen. By their experience, knowledge, and availability of time, with the orientation of guided researches, senior students can contribute to give a decisive step to promote the natural value of a community and also to a public understanding of the value of monumental trees and at the same time maintaining their autonomy and independence. Trees selected will be a part of a final exhibition, to the general public, and will be purposed to be listed as National Interest to the Institute for the Conservation of Nature and Forest (ICNF). A "Botanical Guided Walk" around the region will be done, to willingness and ability share personal experiences with monumental trees as well the community interest in plant science.

Keywords. Active ageing, citizen science, monumental trees, plant blindness.

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The Chemical Change. Seeing is Believing

MJ Perry, J Vaz, M Costa
Universidade de Lisboa, Lisboa, Portugal
mjprocha@ff.ul.pt

Abstract. Approaches to chemical reactions made with children and young students explore mainly demonstrations in which substances are mixed and then color changes, or increase in volume, production of a gas or a smell, changes in temperature are observed in an enthusiastic way [1]. And when none of these phenomena occur? Is it because there is no place for a chemical reaction?

There are methods that allow us to confirm and follow chemical change, and that are in common use for those who work in research laboratories. One such tool is Thin Layer Chromatography (TLC). It is an excellent technique for separating and identifying the reagents and products of a chemical reaction. Associated with TLC we also have a wide range of methods to visualize the chemical transformation, such as Ultra-Violet radiation or the use of developers [2].

The hands-on experience proposed in this poster communication aims to demonstrate how the combination of two reagents, which at naked eye do not seem to react, gives rise to a new product. To do this we rely on the simplicity of the TLC technique and the use of developers [3].

This hands-on experience is suitable for young and high school students as well as science outreach activities. Those interested may play the part of the chemist, who needs to follow the chemical reaction, see if the reaction has occurred, whether it is complete or has come to an end. With these experiences, one visits the backstage of the chemistry lab.

Keywords. Chemical change, chemical experiences, thin layer chromatography, TLC developers, visualization methods.

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Multimedia Video-based. A Science Communication Tool

S Barata[1], *M Serra*[1], *P Pombo*[1,2]
[1]*Fábrica Centro Ciência Viva de Aveiro, Aveiro, Portugal*
[2]*Universidad de Aveiro, Aveiro, Portugal*
sofia.barata@ua.pt

Abstract. The Fábrica is a Portuguese Science Centre that belongs to the University of Aveiro and the National Agency for Science and Technology - “Ciência Viva”. A space for the dissemination of science, where all resources are valid if allow a good experience for all citizens. In this context, some investment has been made to implement a project in the audio-visual production named "Fábrica Media". This project has developed around multimedia, video-based production and broadcasting. The content has been produced for the Internet, TV, radio, cinema and applied to other categories such as: science & literature for general public and educational programs for scholars. A weekly publication for the TV and radio show, a documentary and fiction for cinema, are some examples of content produced. The main goal is to communicate science to all audiences and to promote public engagement on science and technology. Partnerships have been established with the media, more specifically, national television and radio stations, to obtain better results in the dissemination of science. This project is focus on the public and aims to increase the tools and the access to science involving different audiences and different regions of Portugal. Our demand is to contribute to the development of a well-informed society and to embed a scientific and technological culture within the public at a national level. Different audiences were involved, such as children, youth and adults and specific communities, through a model that includes two main strategies: the approach of different thematics and the promotion of closeness with experts and scientists. Our study aims to find if contents are suitable to the goals established, based on the interest demonstrated by the entities involved, the visits and subscriptions on the internet (YouTube) and through external requests and challenges for the creation of new productions and contents. Finally, we hope to demonstrate that multimedia video-based is a suitable tool for science communication to explore different contexts, thematic or purposes. Our final challenge is to have the ability to attract all partners involved and to engage the general public.

Keywords. Audio-visual, communication, media, multimedia, science communication.

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The Mureş River Valley Ecological Status

E Pop
Scoala Gimnaziala "Lucian Blaga",
Alba, Romania
popy_elena14@yahoo.ro

Abstract. The Mureş River covers 10,800 km of water course and a catchment of 28,310 km^2, and features a mean annual discharge of 184 m^3/s .It originates in, and flows across Romania, but the lowermost part downstream of Arad (28 out of total 789 km) flows in Hungary before entering the Tisza River. Although scattered basic catchment and river information is available, an integrating catchment approach and hence river basin management are clearly missing. In order to get a holistic catchment view on the long-term and ultimately the implementation of river basin management according to the EU Water Framework Directive to obtain "good ecological status", The Mureş River is well suited as it is large, transboundary, moderately regulated and highly polluted, to provide a variety of research topics. This paper is based on study compiling data on geology and geography, land use, river hydrology and morphology, chemical pollution, and aquatic flora and fauna.

The many relief forms of the River Mureş catchment, mountains, tablelands, hills and plains, can be attributed to seven geologic-structural units .High lithologic diversity and various tectonic elements are both essential for the catchment morphology. Few areas, e.g., the Gurghiu Mountains, feature granite rocks where the measured background conductivity in river water is 10 ‰) prevail in the mountainous tributaries, while the main course of Mureş River is rather flat (1500 mm in the eastern respectively western slopes of the mountains.

Multiannual dynamics of Mureş River discharge (measured at Mako, Hungary) shows a slight decreasing trend between 1960 and 2000, that is also evident in the Lower Danube River. Global climate change may account for this decrease since long-term records show enhanced precipitation in the northern part of Europe while this is reduced in the central and southern parts .Mean annual precipitation in the Mureş River Basin is 500-600 mm in the Transylvanian Plateau, but can amount to 700-1000 mm and >1500 mm in the eastern respectively western slopes of the mountains.

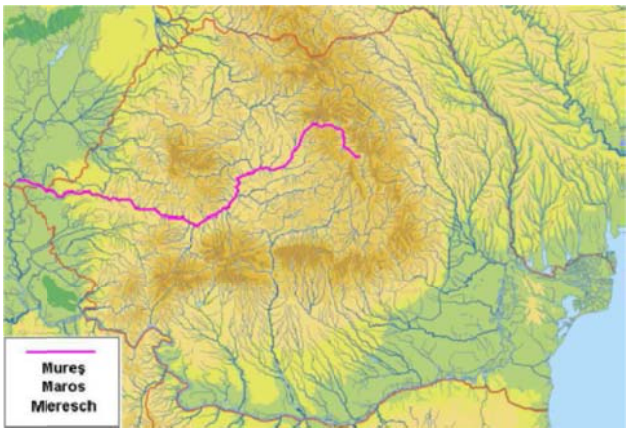

Figure 1. The map of the river Mures valley – Romania

Agriculture is widely applied in the plains and a major diffusive source of nutrients and pesticides. The highest nutrient load is recorded for the area of Ocna Mureş and Alba Iulia (on Mureş River), and Târnăveni (on Târnava Mică tributary) – the mean areal export of nitrogen (more than 30 kg N/ha) and phosphorus (more than 10 kg P/ha) significantly exceeds the average for the Danube River Basin. Various industries (metallurgic, chemical, ceramics, food production and textiles) are prominent point sources of pollution in the Transylvanian Plateau and along the Mureş River and major tributaries. The northern Apuseni Mountains are known for their mines, providing major point sources of heavy metal pollution. The heavy metals accumulated in the sediments in the Mureş River and were available for bioaccumulation in fish.

Besides chemical impact, thermal pollution represents another stress factor in the Mureş catchment. The survey made in October 2005 revealed temperatures significantly increased downstream of Iernut thermal power plant, which may adversely affect aquatic communities. Overall, Mureş River hosts >200 species of phytoplankton, 66 species of zooplankton, 148 species of protozoans, 143 species of benthic diatoms, 60 species of macrozoobenthos, and 55 species of fish . They all reflect local impacts and organic pollution by changed species composition, reduced biomass or abundance. High numbers of coliform bacteria indicate domestic waste

water input. In general, self-purification is fairly strong along the course of the Mureş River.

According to Romanian Waters Administration, 1051 km (10% of the total hydrological network) are regulated and 563 km (5%) are embanked, while 13 39 reservoirs, 11 water abstraction schemes and 26 fish ponds reflect the rather low technical impacts.

Fields of further research may be, for example, more detailed studies of amphibians, crayfish and fish as special indicators of pollution, biomarker studies to track sub-lethal and chronic effects of pollution, heavy metal speciation in sediments of mining areas with regard to bioavailability, ecological restoration of affected areas, longitudinal changes in bacterial and diatom communities with respect to changes in flow, temperature and pollution, and a hydromorphological survey as the basis of sustainable management and nature conservation.

River modeling focusing on hydrology, sediment transport, load of chemicals and food web interactions may further add to the understanding of ecosystem function.

Keywords. Ecology, river, school.

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Drones in Schools. Demonstrating Aerodynamic Concepts

A Endisha
Algilany Secondary School,
Misurata - Libya Abbas
endaisha@gmail.com

Abstract. Drones have increasingly become cheaper and more available, and now, they are being widely used in various aspects of life. As a result, schools and educational institutions are able to obtain them easily for educational purposes. The use of drones in classrooms can be of benefit, because, they can be used as a teaching tool where students can have the possibility to practice their knowledge of mathematics, physics and technology.

To begin with, drones can attract students' attention for being a new and enjoyable method of learning that they are not accustomed to. In addition, they can help students develop their problem solving abilities, creative thinking and they can also encourage group participation and activities during classes.

To carry out this research, the researcher has attempted to apply the use of a minidrone (Type: ParrotNewZ) to demonstrate principles and ideas of physics such as aerodynamic, drag force and terminal velocity.

Firstly, a simple theoretical mathematical model has been set to identify the motion of the drone, and later, this model has been compared with the experimental data of velocity of the drones (vertical velocity and horizontal) in medium resisting (Air), and then, the velocity will be calculated by using Tracker Video Analysis Software.

The drag force can be measured by using the same software or can have an estimated value by the area of the drone.

The preliminary results show a similarity in the case of vertical velocity for the two values, yet, more work needed to develop the vertical velocity measurement. The uncertainty in the calculation is due to the estimation of the drag coefficient and the area of the quadcopter. The researcher will try to better estimate those values and develop the mathematical models in the final poster.

Finally, flying a drone at schools is great fun as well as a wonderful tool to encourage students to apply their skills in robotics, mathematics, electronics, chemistry, coding and programming.

Keywords. Drones, physics education, aerodynamic, quadcopter, Tracker.

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Earth Science that Works in the Classroom

D Balmer
UCL, London, UK
denise.balmer1@ntlworld.com

Abstract. This 'hands on' workshop identifies a number of earth science topics suitable for children aged from 4 to 11, which can be used in a normal working classroom to link in with other ongoing earth science topics. There are a range of different activities which everyone can try out after a short introduction by the presenter.

Activities:

- Stargazing (age 4+)
- Earthquake position identification (age 6+)
- Continental Drift (age 8+)
- Looking at rocks (age 6+)
- Making weather instruments (age 4+)
- Evolution Time-line (age 7+)

The objective of all these activities is to stimulate curiosity and be exciting, as well as being relevant to the everyday circumstances that children find themselves in.

The Stargazer is a simple method of identifying groups of stars in a clear night sky that can be adapted for any part of the world. Teachers can use those given examples which are present in the northern hemisphere or can adapt for certain times of the year, for example Christmas, when Venus becomes very prominent in the sky.

Earthquake finding: Finding the position of an earthquake is relevant to many parts of Europe and identifies the different strengths of shake felt at varying distances from the earthquake centre. This activity has proved very popular with children in English schools and whilst based on a very small quake which occurred in central England gives an idea of the kinds of experiences felt at different distances from the epicentre. Your own geological services will have details of the differing tremors felt away from the earthquake epicentre. Warning: where there have been recent disastrous earthquakes, this activity should be used with great sensitivity. However, children can identify with the experiences and plot them to find the isoline (lines of equal activity) and the potential epicentre. The idea of earthquake waves can be introduced in upper classes if wanted.

Continental Drift. The idea of the Earth's land mass forming the one huge continent of Pangea millions of years ago is exciting especially when children try to fit present day continents together. This activity starts with a puzzle which needs solving, and then several other ideas are added to help prove that these land masses were joined – perhaps the most interesting is the fossil evidence and the dispersion of the marsupials who became isolated in the southern hemisphere, mainly Australia. This activity can also be linked to the movement of land masses over the globe over time and the different climates which are embedded in the rocks of all countries.

Looking at rocks. Samples of different rocks are available for examination, observing differences which are recorded on a data sheet. The rocks can be examined in air, and hypotheses made as to whether they are permeable or not based on these observations. Simple investigations can be carried out to verify the hypotheses.

Making weather instruments. The workshop will show how simple weather instruments can be made using easily available resources. These are rain gauge, barometer, wind direction finder, wind strength finder, thermometers. Some ideas of simple projects to use these instruments will be offered.

Evolution Time-line is a series of pictures which children can order and then pin on a washing line of 500 million years in length. This not only gives a picture of evolution through time but also emphasises the short period during which animals have evolved. Writing this onto a toilet roll also helps emphasise the long periods of time when nothing evolved.

Keywords. Earth Science, hands-on, work-shop.

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Informal Talks Concerning Light

RMS Sousa[1], *P Pombo*[1,2]
[1]*Fábrica Centro Ciência Viva de Aveiro, Aveiro, Portugal*
[2]*University of Aveiro, Aveiro, Portugal*
regina.sousa@ua.pt

Abstract. "Conversas com Luz" (Informal Talks Concerning Light) was a series of science talks promoted by Fábrica Ciência Viva Science Center and University of Aveiro, which sought to bring together researchers and general public in an informal way. These talks were integrated in the celebrations of the International Year of Light 2015 and aimed to explore the subject light through different areas of knowledge. In this way, it was possible to engage the public into research being developed in different Departments of the University of Aveiro, as well as other national institutions. These were always addressed in an informal way although never neglecting scientific rigor.

"Conversas com Luz" was held from September 2015 to June 2016, on Fridays, every fortnight, at 9:30 pm, in a hotel in Aveiro, Hotel Moliceiro. This regular schedule aimed to instil regular routines in participants.

"LEDs for a sustainable future", "Black holes: a history of darkness, light and shadows", "Light in telecommunications" or "Materials seen in the light of Medicine" were some of the topics covered. The variety of subjects enabled to attract different audiences and showed the diversity of the research being carried out.

This presentation will address the collaboration model between the scientific community, the science communicators and the public, the methodology used for selecting topics, speakers, venue, schedule, and communication strategy. Some quantitative data on this series will also be provided.

Keywords. Informal talks, light, science communication.

Scientific Experiments with Elementary Materials in Primary Science Teaching

S Simões da Costa[1], *P Varela*[2]
[1]*Agrupamento de Escolas de S. Martinho, Santo Tirso, Portugal*
[2]*Universidade do Minho, Braga, Portugal*
pibvarela@ie.uminho.pt

Abstract. Science teaching with experiments in primary school is still incipient in most of portuguese schools.

Primary school teachers refer, as an obstacle to the science teaching with experiments in primary school, the lack of materials and equipment, among others.

When speaking of scientific experiments, there is usually a tendency to think of expensive and sophisticated laboratory materials that frighten primary school teachers, both because of the difficulty of manipulation and because of their cost. However, scientific experiments do not necessarily have to be carried out with sophisticated and expensive materials.

With some creativity, it is possible to carry out several simple scientific experiments, enclosed in the current curricula of Physical Environment, with non-specialist materials that are easily obtained, low cost and easy to handle. Some materials result from the reuse of daily usage materials, such as plastic and glass packaging, carton, among others.

This paper presents some simple materials and the various scientific experiments that can be carried out with them, as well as the fields of science they allow us to study and their framework in the current organization of primary school curricular area of Physical Environment.

Keywords. Scientific experiments, simple materials, primary school, science education.

Anti-Cancer Potential of Bi_2O_3 Nanoparticles

D Yigci
University of Istanbul, Istanbul, Turkey
defneyigci@gmail.com

Abstract. For over a decade, attention has been drawn to nano-scale products in industrial, cosmetic and medical applications because of their unique physicochemical properties and functions. The nanoparticle can give chance to good medical treatment with more potent, less toxic, and high therapeutic effect. Many nanoparticles are still under investigation for targeted drug delivery in especially cancer therapy with high incidence of death. Although there are many questions about their safety, the nanomaterial is investigated with substantial efforts by both academia and pharmaceutical fields.

Bismuth based nanoparticles are one of the most important metal based nanoparticles frequently used in medicine with bioimaging, biosensing, and biomolecular detection as well as pharmaceutical drugs. However, there are few studies about the therapeutic potential of bismuth oxide (Bi2O3) nanoparticles. In the study, we aimed to investigate the anti-cancer potential of Bi2O3 nanoparticles in liver (HepG2 hepatocarcinoma cells). Firstly, the particle size and size distribution were analyzed with transmission electron microscopy (TEM) images. The average size was found as 183.0 nm (range: 91.2 - 353.4 nm) in the cell culture medium. The median of inhibition concentration (IC50) value of Bi2O3 nanoparticles was determined as 35.11 µg/mL by MTT cytotoxicity assay, and the main cell death pathway was established as apoptosis at the exposure concentration range of 0-50 µg/mL. Western Blot techniques used to explore mainly the cancer pathways, caspase-3 and AKT. The result showed that especially caspase-3 was activated by exposure of Bi2O3 in HepG2 cells.

The present study is the first study to evaluate the effects of Bi2O3 nanoparticles on carcinogenesis pathways. As indicated our results, Bi2O3, nanoparticles might be safely used for targeted drug delivery or medical applications if dose rates are adjusted depending on the route of exposure. However, with the limited data and knowledge in the field, further in vitro and in vivo studies are needed to elucidate their action mechanisms.

Keywords. Nanoparticles.

Integrated Teaching of Mathematics and Sciences

L Constantin Vladescu
Scoala Gimnaziala Ipotesti, Olt, Romania
lucconstvl@yahoo.com

Abstract. In this paper I will exemplify the method of integrated teaching of Mathematics and Sciences. Being able to teach Math better and being able to teach Science better are powerful reasons for the Math and Science teachers collaborate with each other. In Science, geometric principles such as reflection, symmetry, shape, and structure reach down to the atomic levels. This paper represents a pleading for integrated teaching of Mathematics and Sciences. LYPS – Let Your Passion Shine is a project which tried to serve this purpose.

Keywords. Mathematics, science, motivation, project.

How Do We Learn. A Practical Approach

JJ Cerqueira
Universidade do Minho, Braga, Portugal.
jcerqueira@med.uminho.pt

Abstract. In this talk we will discuss the neural mechanisms of learning, from molecule to system, and understand how to use this knowledge to help our students to learn.

Keywords. Learning, neural mechanisms of learning.

Controlling the Life Time of Soap Balls

D Geraldo, F Bento, P Bettencourt, A Esteves
Universidade do Minho, Braga, Portugal
gdulce@quimica.uminho.pt

Abstract. Science teachers often need to develop experimental activities to be used in classes and in science clubs. The effectiveness of those experiments, in terms of learning, can be ameliorated by improving the activity design. The IBSE (Inquiry-based science education) approach is meant to boost students' creativity and critical thinking while solving day-to-day problems using the scientific method [1]. Activities based on this approach can be developed following simple guidelines: i) problem definition, ii) hypothesis formulation, iii) experiment design, iv) experimentation, v) observation and analysis of the results and vi) conclusion. In this workshop the production of soap bubbles will be used in the development of an IBSE activity.

I. The problem will be presented considering questions such as:

- What's a soap ball made of?
- How long do the soap balls last?
- Does the nature of soap influence the duration of soap bubbles?
- Does the temperature influence the duration of the soap balls?

II. Based on the responses, hypotheses that can be tested experimentally will be formulated.

III. Experimental activities will be projected, selecting materials and methodologies, that can be used to test the validity of formulated hypothesis.

IV. Experiments will be performed and optimized.

V. Data will be recorded using tables and / or graphs.

VI. Results will be discussed and conclusions will be outlined.

These activities can be implemented considering children between 10 to 15 years old.

Keywords. Informal talks, IBSE, light, science communication, soap ball.

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Eco-Friendly Experiment for Determination of Iron(II) and Copper(II)

H Hazarkhani[1], Z Arzani[2]
[1]Science Education Center, Tehran, Iran
[2]Office of Teaching and Training, Karaj, Iran
hazarkhani@gmail.com

Abstract. In some developing countries, performing chemical experiments in high schools is quite a challenging task. This can be due to the fact that the required materials and equipment can be inaccessible. Nowadays most of the experiments that students are interested to observe need special reagents or glass-ware. Apart from these difficulties in these counties, there is not a disposing system for the waste chemicals, solvents and contaminated materials. The aim of this paper is to show how with inexpensive chemicals and simple material one can conduct interesting experiments for students in high school. With crucial point in mind to make waste materials as little as possible and show how the dispose them is an adequate manner. In a two hours section laboratory work, we have demonstrated that the student are able to determine Fe2+ and Cu2+ ions in unknown solutions with inexpensive and accessible equipment that can be used to illustrates the Beer–Lambert law.

Keywords. Environment, eco-friendly, beer-lambert law, iron ion, copper ion, dispose.

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Browning of Fruits. How to Avoid it?

P Bettencourt, A Esteves, F Bento, D Geraldo
Universidade do Minho, Braga, Portugal
abete@quimica.uminho.pt

Abstract. Nowadays, science and technology are present in the daily life and they are crucial for the society development. Therefore, it is important to ensure that the new generations are able to understand the problems of the world [1].

Scientific explanations should be introduced to children as early as possible and ideally based in the observation of experiments. This methodology seems to be the most successful approach allowing the children to explore several scientific concepts. Hence, it is expected that the teachers are able to implement easy experimental activities. However, the question for the majority of educators and teachers is: "How to do this in the classroom?" [1,2].

In this workshop, planned to kindergarten and elementary school teachers, an experimental activity based in several simple observations related to the browning of fruits and its prevention will be carried out [3]. This activity aims to clarify that oxidation is promoted by air and it depends on the fruit, and to observe that peeled fruits oxidise faster than the unpeeled. Some common substances will be tested as effective anti-oxidants.

The workshop envisaged an Inquiry-based science education (IBSE) strategy to the implementation of the aforementioned activity that will be developed in five steps: i) contextualization of the problem; ii) proposal of hypothesis; iii) planning experiments to test the hypothesis; iv) hands-on activities; v) analysis of results and conclusions.

During the workshop the teachers will be faced with the browning process of some fruits and they are invited to think about this chemical situation and how to teach it to their children. The activity will start with the formulation of several questions, for example, "Why do fruits turn brownish on air exposition?", "What are the fruits that brown most?", "How can we prevent the browning of fruits?". The activity will go on with the formulation of some hypothesis and the design of several simple experiments that will be carried out. The results will be analysed and conclusions will be achieved.

By the end of this workshop the teachers will be able to plan and implement an easy experimental demonstration based on everyday observations, directed to children of three to nine years old.

Keywords. Workshop**,** Browning of fruits, daily life, oxidation.

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Hands-on Robots with botnroll.com

J Cruz, B Costa
www.botnroll.com
botnroll@botnroll.com

Abstract. Ever wanted to use robots in your classroom? Join us and explore the robotic tools that are available for your classes. Touch, program, test and ask questions. You can do it all with botnroll.com during Science Fair.

Keywords. Education, robots, ask, touch, try, program, test.

Soap Balls: How Can They Last Longer?

F Bento, D Geraldo, P Bettencourt, A Esteves
Universidade do Minho, Braga, Portugal
fbento@quimica.uminho.pt

Abstract. The IBSE (Inquiry-based science education) activities, exploiting the scientific method, are adequate to awaken children to an effective learning of the physical environment. Activities based on this approach can be planned by educators and teachers of basic education following a simple set of guidelines, using easily accessible resources [1].

In this workshop an IBSE activity using soap balls will be performed. A simple activity will be designed with the aim to foster critical thinking and creativity of young children.

The activity will be developed considering the following steps: (i) problem contextualization, (ii) hypothesis construction, (iii) design of experiments to test hypotheses, (iv) experimental activities, (v) results analysis, and (vi) conclusions.

I. The formulation of questions, scientifically oriented, stimulates the curiosity and induces the construction of hypothesis, such as:

- How do you make a soap ball?
- How long do the soap balls last?
- Can we increase the lifespan of a soap ball?

II. The compilation and systematization of the children's responses enable the production of hypotheses that reflect the opinion of the group.

III. To demonstrate hypotheses, experiences are designed with children participation. Materials and methodologies must be selected and tested in advance.

IV. Experimental activities must be performed by children, alone or in groups, in safe conditions.

V. Observations are recorded by children in different ways, including representation by a draw or by construction of graphs.

VI. Sharing of results interpretation and ideas is encouraged to build up a scientifically valid conclusion.

These six steps will be explored during the workshop giving particular emphasis to the design and exploration of experimental activities to be performed by children.

Keywords. IBSE, preschool and 1st cycle, scientific method, soap ball, workshop.

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Nature Inspires Science. A Multidisciplinary Approach

AM Almeida
I A-P Mina, I Correia Neves, J Pamplona, MA Forjaz
Universidade do Minho, Braga, Portugal
coimbra@fisica.uminho.pt

Abstract. A field trip can have several goals but the main one consists on nature contemplation.

Under a watchful eye on seldom conspicuous details, Leonardo da Vinci has created his ingenious inventions. Like him, this workshop aims to enhance the observation of nature around us in such a way as to integrate multidisciplinary knowledge. Geology, biology, chemistry, physics and mathematics make a joint venture to a unique approach to everyday phenomena.

Keywords. Field trip, multidisciplinary.

Preventing Oxidation of Fruits

A Esteves, P Bettencourt, F Bento, D Geraldo
Universidade of Minho, Braga, Portugal
aesteves@quimica.uminho.pt

Abstract. It is widely recognized the importance of science in children's and teenagers' learning and development. The current way of life imposes them the need to become critical citizens towards the problems of world. In this sense they should be trained to develop thinking skills namely about scientific knowledge [1].

The most efficient way to develop the aforementioned skills is an experiment-based approach. Clearly, the teachers play an important role and they should be able to implement this methodology in the classroom [2].

In this workshop, planned to high-school teachers of 10 to 15 years old students, an experimental activity related to the oxidation of fruits and its prevention will be planned and executed. The experiments aim to clarify that the oxidation is promoted by oxygen present in the air and also to study the factors that influence the oxidation process. Some common substances will be tested as effective anti-oxidants.

The workshop is organized as a hands-on experiment in which the teachers will follow the different stages of an Inquiry-based science education (IBSE) strategy. This strategy involves the following steps: i) contextualization of the problem; ii) proposal of hypothesis; iii) planning experiments to test the hypothesis; iv) performing of the experiments; v) analysis of results and conclusions.

The problem under study will be the oxidation of some peeled fruits due to the action of the air. In this sense, the teachers are invited to think, plan and execute an experiment, and discuss the observations based on the type of fruits and on the exposure times. The activity also aims to investigate the use of some common substances as antioxidants [1]. A discussion is promoted among teachers regarding the implementation of a simple and already planned set of activities in chemistry in a classroom context, using an approach based on experimentation.

Keywords. Antioxidants, oxidation of fruits, Workshop.

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Submarines: Density

MR Pereira
Universidade do Minho, Braga, Portugal
mrui@fisica.uminho.pt

Abstract. On this workshop it will be carry out small IBSE activities that will allow, through observation and / or measurement, to empirically understand the functioning of nature, the interactions between bodies, establish relationships between physical quantities, and determine properties of bodies. Small experimental activities related to the measurement of mass, volume and density will be explained.

Keywords. Physics, fluids, density.

Safety in School Practical Science. Does It Scare You?

R Worley
Brunel University Science Park, Kingston, UK
bob.worley@cleapss.org.uk

Abstract. Science teachers and educators are usually in agreement that teaching via practical work (not videos) enriches science education. Observation at the macro level, measurement of results, and treatment of data leading to interpretation and modelling at the invisible

nano-level, and onward to further inquiry, teaches students the skills that academia, industry and commerce require. At this conference, I am talking to the converted but good practical work is often poorly directed or simply not done at all [1].

There are many reasons why schools do not offer practical work in science, a shortage of suitable rooms, relevant teacher training, lack of professional development and, of course, money. Added to which is poor student behaviour, ever increasing workload with government concerns with position in the PISA tables. Safety though is often cited as the main hurdle with scares about civil action from parents with too much bureaucracy and poor interpretation of State-government, National-government and European law.

In this talk, I will show how CLEAPSS [2] in the UK, using a sensible approach to risk assessment and working closely with our National Enforcement agency, the Health and Safety Executive [3] has enabled our teachers to continue to offer enjoyable and safe practical work in their school science lessons. This is not a recruitment campaign; CLEAPSS is a small organisation which can barely cover the UK. Although much of CLEAPSS published material is available only by subscription, there are many freely obtainable video clips on the You Tube video channel [4]. The speaker is about to take over the chair of ICASE [5] safety. Information on how safety in school practical science is organised and monitored in other countries would be welcome.

Keywords. Control measures, hazard, risk, safety,

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Where Do the Colours Come from? How Do Our Eyes Work?”

J Tovar, S Franco
Universidade do Minho, Braga, Portugal
sfranco@fisica.uminho.pt

Abstract. Workshop of introduction to light and vision: How do we see? Where do the colours come from? Activities will be developed that show how lights and colours mix together, how lenses work, how the eyes work, why do we wear glasses. Simple activities are proposed, easy to put into practice in the classroom

Keywords. Physics, light, vision.

The Role of Chemistry in Environment: Water Treatment Plants

P Bettencourt, D Geraldo
Universidade do Minho, Braga, Portugal
abete@quimica.uminho.pt

Abstract. The theme of water is explored at several levels of education being transversal to different subjects. Particularly, the topic of water treatment is addressed since primary school, where students get in touch with the physical and chemical processes used in Water Treatment Plants (WTP). The role and mode of operation of drinking water treatment plants and wastewater treatment plants are also introduced to students.

During secondary school the various aqueous systems and the classification of water according to its origins and applications are described. Therefore students should be able to interpret the differences in the composition of different types of water and assess their quality.

The use of experimental activities can contribute significantly to the success of the

teaching processes given the recognized role of these activities in the promotion of science learning.

Taking into account this objective a hands-on activity for students of the 3rd cycle and of secondary school is proposed.

In this activity one of the roles of Chemistry in the Environment is presented. The mode of operation of a WTP will be explained through the accomplishment, in the laboratory, of a set of basic unitary operations. These operations mimic some of the steps of the water treatment process from water capitation until delivery to consumers.

The activity also includes some simple tests to evaluate water quality, namely the determination of pH and of residual chlorine.

Keywords. Hands-on activity, 3rd cycle and secondary school, water treatment plant, pH and residual chlorine.

After All, What Is Gluten?

E Lima
Colégio do Minho, Viana do Castelo, Portugal
zita.esteves@gmail.com

Abstract. This important component of the masses and cereals goes in the mouths of the people. But does everyone know what it is?

The gluten has the function giving elasticity to the dough and, at the same time, more resistance not to burst when stretched.

Another important function of gluten is to aid in the growth of cakes and bread. Gluten develops and forms a protective net that do not let the carbonic gas formed during fermentation to escape. It is this gas, retained inside the mass, that makes bread or cakes grow. It is also the gluten that gives the soft texture to cakes, pizzas and pasta and makes them easy to chew.

Gluten can be obtained by separating the insoluble protein with water. Once cooked, the gluten acquires a firm consistency and the flavour of the broth in which it was cooked. This property makes it appreciated as a meat substitute in vegetarian and Buddhist cuisines.

Sensitivity to gluten is known as Celiac disease, and has no cure. People intolerant to gluten cannot consume foods that contain it because they cannot metabolize the gluten. This disease damages the villi of the small intestine. The symptoms are diarrhoea, vomit, anaemia, irritability, and weight loss.

In addition to gluten, we also obtain starch which has a very interesting particularity, that is, when subjected to high pressures this works as a barrier, but when subjected to low pressures it allows the passage to any object that the you want to cross.

Keywords. Celiac disease, school.

EBiFaT Project (Energy Balance in Food and Toxicity)

N Francisco[1]*, R Castro*[2]
[1]*Colégio Cedros, Porto, Portugal*
[2]*Colégio Cedros,*
Vila Nova de Gaia, Portugal
nunofrancis@gmail.com

Abstract. This project's purpose is to test cookware made out of four vastly used materials in the cooking world, assessing the efficiency of the heating process, taking into count, as well, the potential risks each metal or alloy carries to the human health and its benefits. In order to test the efficiency of the material that pans are made of, an experimental procedure was made, to be able to validate matching results. Therefore, it's possible to determine the best pan to cook food, according to each individual's health, cutting the energetic expenses as well. Another main purpose of this experimental activity will be the one of scientific disclosure in order to encourage a change of habits amongst the general population, as well as the everyday cooking practices in everyone's outsold.

Keywords. Efficiency, food, health, metals, thermal conductivity, toxicity.

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Activities from “O Continhas”

MT Malheiro, PA Pereira
Universidade do Minho,
Guimarães, Portugal
mtm@math.uminho.pt

Abstract. The School of Sciences of the University of Minho (ECUM) promoted a project of Mathematics extracurricular activities for pre-school students - "O Continhas". It was also included in the European PriSciNet project, as they are based on the same basic principles: the IBSE principles which state that a child at pre-primary and primary level should learn science (in particular, mathematics) by research. "O Continhas" includes activities for children which invite them to solve problems and contain challenges involving mathematical concepts and science in an interdisciplinary approach developing mathematical reasoning. This training workshop aims to help educators and teachers to develop, guide and create Mathematics activities involving other fields of science, facing their role not as a transmitter of knowledge but as a facilitator, guiding children to discover a way to solve problems.

Objectives to be achieved:

- To promote new strategies in addressing problems and challenges in mathematics.
- To promote new methodologies to guide the student's learning process, in the extracurricular context.
- To understand ways to communicate, to teach and learn science.
- To encourage collaboration between teachers and sharing ideas and experiences.

Keywords. Creativity, mathematics, extra-curricular activities.

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Stratospheric Balloon

A Loureiro, A Oliveira, C Deger, D Oliveira, F Barros, F Abreu, F Pinheiro, J Fernandes, J Silva, L Fernandes, M Lima, M Couto, P Silva, R Pereira, C Lima
Agrupamento de Escolas de Padre Benjamim Salgado,
Vila Nova de Famalicão, Portugal
1768@professores.aepbs.net

Abstract. Students from the Club Science4All participated actively in the celebrations of the Group Day, working together with the teachers in the accomplishment of various scientific activities, where they sought to combine the spectacular nature of Science with the pertinence of the contents.

In addition to the launching of rockets of water and ionization of gases with plasma lamps, the launching of a balloon for the stratosphere, which reached altitudes close to 40 000 m, stands out. In addition to several sensors and cameras for capturing images, hundreds of greeting messages were transported on board, carried out by students from all the establishments and teaching levels of our Group, which were dropped at tens of kilometres of altitude.

In the several months that preceded this launch, in addition to the details of logistics and technology used, it was necessary to obtain authorizations from the authorities (Portuguese Air Force and National Civil Aviation Agency) and a videoconference preparatory to the activity, with Instituto Superior Técnico.

The balloon was followed in the ground by a rescue team and after the blast (near the upper limit of the stratosphere) was recovered on the border between Chaves and Verín, in an isolated region of difficult access. The recovery of the cameras launched together with the balloon allowed the collection of hundreds of images and videos of high quality.

Keywords. Balloon, stratosphere, science.

Water Reuse: Simple Activities

D Geraldo, P Bettencourt
Universidade do Minho, Braga, Portugal
gdulce@quimica.uminho.pt

Abstract. Water is an essential resource for all living beings. The assurance of its quality is important for the safety and health protection of consumers. This theme is transversal to various subjects and levels of education and many teachers of Physics, Chemistry and Biology have sought formation on this topic.

We have developed a short-term training course aimed to explore simple experiments carried out with low-cost materials in order to increase the awareness of the need to reuse water.

To increase the awareness of the scarcity of this good and the asymmetric distribution of drinking water on the planet a short presentation of the theme is carried out.

Steps that take place in a water treatment plant, from water collection in a river or lake to the delivery in the house of consumers, are simulated at the first experimental activity.

The evaluation of the pH of waters is also explored using several indicators, universal paper and pH meter. Different types of waters are characterized in terms of pH and the values obtained are discussed taking into account the origin and type of waters.

In another activity a simple and sustainable method of purifying the water using a solar distiller is proposed.

By exploring these activities, we expected that teachers can easily apply the experiments in the classroom and demonstrate the physical and chemical concepts involved. We also believed that students will become more motivated to study science and their environmental awareness will increase.

Keywords. pH, short-term training course for teachers, water reuse, water treatment plant.

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How to Connect Makerspaces with Hands-on Science?

P Pombo
Fábrica Centro Ciência Viva, Aveiro, Portugal
University of Aveiro, Aveiro, Portugal
ppombo@ua.pt

Abstract. Fábrica Ciência Viva Science Centre develops informal and non-formal Science Education programs that connect formal science education with our Science Centre, putting in contact school students and teachers with science communicators from our Science Centre and scientists from our research labs. These programs involve exhibitions, workshops, teacher training, lab demos, co-creation, maker events and annual projects oriented to curricular studies, STEM education and professional development. During last years, several schools from Portugal were collaborated in our educational programs, with the aim to promote advance formal science education and to engage students into STEM education. We will address how we can develop learning environments that have direct impact on school teaching and how we can develop programs to support teachers' professional development. A model, based on Maker movement and STEM education was developed and implemented, involving several teachers and students from different School years. This model takes into account the approach with schools, the links with curricula and a framework to involve students and teachers. This talk will present our model and results from its implementation and it will explore and discuss some results obtained.

Keywords. Makerspace, STEM education, science education, science communication.

Teaching the Dependence of the Boiling Point of Water to the Pressure

H Alinejad
Banoo Amin School, Tehran, Iran
Hanieh1117@gmail.com

Abstract. For teaching the dependence of the boiling point of water to the pressure, we usually refer to the motion of the liquid and gas molecules theory which is somehow difficult and hard to remember for the students, and to show that experimentally, we usually use the syringe experiment which is somehow difficult to perform and interpret. The idea of using a fluorescent tube to have a better vacuum is very exciting and beneficial. One should use the little hole at the bottom of the tube and an iron nail to reach the vacuum inside the tube. It should be done in a large bucket of coloured water. As soon as it breaks the barrier and reaches the vacuum, the water starts to come up though the tube, as it's boiling in the room temperature very clearly. The interesting point is that the water will stop just near the top of tube that depends to the pressure inside the tube. By observation and performing this experiment, the students will never forget the dependence manner of the boiling point to the pressure.

Keywords. Boiling point, Hands-on activity, observation learning, pressure, vaccum.

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Light and Colour

A Loureiro, A Oliveira, C Deger, D Oliveira, F Barros, F Abreu, F Pinheiro, J Fernandes, J Silva, L Fernandes, M Lima, M Couto, P Silva, R Pereira, C Lima
Agrupamento de Escolas de Padre Benjamim Salgado,
Vila Nova de Famalicão, Portugal
1768@professores.aepbs.net

Abstract. In order to explore the meaning of vision and the perception of colour, several activities were carried out together with students at the initial levels of schooling.

Different radiation sources, spectroscopes and materials with different coatings were used.

Vision is one of the meanings that allows us to interpret and perceive the universe. However, the way in which it is carried out is not always evident. In this way, after distinguishing the bodies in luminous and illuminated, will be tried to define the cause of the colour.

Thus, different systems (everyday objects and pictures illustrated by the students) were illuminated with different radiations, in order to conclude that their colour depends on their intrinsic characteristics, as well as the incident radiation.

The electromagnetic spectrum was approached and an IV camera was used to observe radiation outside the visible range.

The activities were developed by the coordinating teacher and the finalist students (monitors) of the 12th year of schooling.

Keywords. Radiation, spectroscopes, vision, luminous, illuminated, colour, electromagnetic spectrum.

ISeeU

A Loureiro, A Oliveira, C Deger, D Oliveira, F Barros, F Abreu, F Pinheiro, J Fernandes, J Silva, L Fernandes, M Lima, M Couto, P Silva, R Pereira, C Lima
Agrupamento de Escolas de Padre Benjamim Salgado,
Vila Nova de Famalicão, Portugal
1768@professores.aepbs.net

Abstract. With the prototype created is intended to reduce the number of road accidents and / or its severity, particularly with regard to pedestrians and cyclists.

Given the growing number of citizens who use bicycles as the main vehicle for their daily travel and those who use them recreationally, whereas a large number of members of the educational community moves on foot and bike on its way home-school-home, we want this project to create a device that allows the realization of these more safely travel, alerting cyclists and pedestrians when a vehicle (motor) approach, particularly where it is present outside the field view (cyclist / pedestrian). The information is automatically received by the cyclist / pedestrian by visual indication as well as through the sense of hearing (which allows the receipt of the notice even when the rider is not to observe the information display).

Moreover, it is intended that the drivers (motor vehicles) also receive an information on the existence of cyclists and pedestrians on the road (or edge); whenever you approach the bike / rider / pedestrian, not in accordance with the road traffic regulations, they will be alerted directly by the system.

Keywords. Prototype, pedestrians cyclists, bicycles.

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Tsunami

A Costa, E Gonçalves, M Ribeiro, M Araújo, S Salgueiro, A Ribeirinho
Agrupamento de Escolas Gonçalo Nunes, Barcelos, Portugal
anaribeirinho@aegn.pt

Abstract. In the seventh year of schooling, students first contact physics and chemistry and understand that these areas of knowledge easily combine with that of the natural sciences.

In a real-time attempt to understand this reality and approach the theme of force, we chose to reproduce a tsunami and explain in the light of physics the reasons and the effects caused by this phenomenon.

For this purpose we have chosen to use everyday materials: glass, sand, earth, props of different polymers, glue and wood.

A glass box was constructed, where by layers and profiles a sample of the earth's crust was reproduced. In one of the inner areas of the glass box, the ocean reproduced. In this way it was possible to observe the movement of the tides, created with the use of a manual manipulation platform.

As the critical and creative spirit were reinforced, the group understood that in a next opportunity it would also try to resort to a strategy that allows to put the tectonic plates with movement. Interdisciplinarity, among areas of knowledge, is also reinforced here

As the critical and creative spirit were reinforced, the group understood that in a next opportunity it would also try to resort to a strategy that allows to put the tectonic plates with movement. Interdisciplinarity, among areas of knowledge, is also reinforced here. One of the conclusions allowed the students to conclude that the currents of economics are not limited to the explanatory world of physics chemistry but also to that of the natural sciences.

Keywords. Physics, Chemistry, modell.

An Impressive and Simple Hands-on Activity for Meaningful Teaching of Chemical and Physical Concepts

H Hazarkhani[1], H Alinejad[2]
[1]Science Education Center, Tehran, Iran
[2]Banoo Amin School, Tehran,Iran
hazarkhani@gmail.com

Abstract. Hands-on learning has many benefits for our students. It can give the students a better feeling, make them interested to science, increase their self-confidence and help them to learn science concepts deeply and meaningfully. Here we report a hands-on activity that helps to teach different concepts and facts. For example the fact that metals have energy, batteries can prepare the energy for combustion of matter, combustion needs oxygen and the resistance of a wire depends to its diameter. In this activity we need a battery and some steel wool. Once we contact the two poles of a battery to the fibrous steel wool, it sparks and completely burns, whereas using a thicker wire of steel wool on the battery poles, has no effect.

Keywords. Battery, chemical and physical concepts, steel wool, combustion.

Submarines: Archimedes Principle

MR Pereira
Universidade do Minho, Braga, Portugal
mrui@fisica.uminho.pt

Abstract. On this workshop it will be carry out small IBSE activities that will allow, through observation and / or measurement, to empirically understand the functioning of nature, the interactions between bodies, establish relationships between physical quantities, and determine properties of bodies. Small experimental activities related to the Archimedes Principle will be explained.

Keywords. Physics, fluids, Archimedes.

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Discovering Light and Optics

MFM Costa[1], *B Vázquez Dorrio*[2]
[1]*Universidade do Minho, Braga, Portugal*
[2]*Universidade de Vigo, Vigo, Spain*
mfcosta@fisica.uminho.pt

Abstract. Optics is in our days indubitably one of the most important domains of physics. It is therefore essential that a solid knowledge on this subject is acquired as early as possible, right from primary school or even at kindergarten, in a process of active and participated discovery by the pupils themselves who naturally have an empathy, interest and special curiosity for this Light and Optics subject as it directly relates to one of our major senses: the vision. This 3 hours' workshop target the upper basic and secondary teachers. This section of the "Growing with Science: From Preschool to Adulthood" training course aims to introduce a hands-on approach to the study of basic concepts of light and optics. A series of demonstrations and experiments will be carried out and explored on topics such as: the nature of light and its properties including coherence and polarization, frequency and wavelength; speed of light and refractive index; the basic principles of geometric optics; Interference and diffraction; holography and optical fibres and waveguides.

Keywords. Hands-on optics, light, optics, teacher training.

New Ways of Looking at Physics

F Neri
Escola Secundária de Amares
Amares, Portugal
fernanda.neri@nery.name

Abstract. The use of different resources in the classroom has driven to better results, in the "teaching-learning" process, not only concerning the learning experience but also increasing motivation to science. The use of sensors in practical activities could represent an advantage when trying to motivate the students. TI – Nspire – CX with the Data Collection Systems and Sensors allows the realization of experiments in which the collected data includes small time lapses, extremely long data collection, eliminates accidental error and allows simultaneous measurements.

It also allows teachers to create dynamic scenarios, making the comprehension of the subjects easier.

This workshop intends to explore some practical activities of Physics using Sensors.

Keywords. Physics, sensors, measurement.

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Rediscover Integral Calculus

MT Malheiro, PA Pereira
Universidade do Minho,
Guimarães, Portugal
mtm@math.uminho.pt

Abstract. The School of Sciences of the University of Minho (ECUM) has always been linked to teacher training. Recently, Integral Calculus was integrated into the new Program of the course Mathematics A at the 12th grade level. This workshop intends to help teachers in the revision and continuous training of this theme. Objectives to be achieved:

- To review concepts related to Integral Calculus.
- To present strategies of introduction to the theme to be applied in the classroom.
- To understand ways to communicate and teach science, and to learn science.
- To encourage collaboration between teachers and the sharing of ideas and experiences.

Keywords. Integral calculus, mathematics.

Educational Robotics Today

J Cruz, J Costa, B Costa
www.botnroll.com
botnroll@botnroll.com

Abstract. In recent years using robotics in education has emerged and several new hardware and software solutions are now available to aid in the teaching. Using robotics helps to inspire, motivate, and encourage youngsters in the learning process. With a bit of imagination, one can easily adapt the tools from this discussion to the classroom making teaching and learning a fun and engaging experience.

Keywords. Robotics, education, teaching, learning, hardware, software.

Robotics Demonstration with the Lego EV3 Equipment

JA Silva[1], RJ Alves[1], N Almeida[1],
R Quintas[1], N Reigota[1], MFM Costa[2]
[1]Agrupamento de Escolas Carlos Amarante, Braga, Portugal
[2]Centro de Física, Universidade do Minho, Braga, Portugal.
jsales@aecarlosamarante.pt

Abstract. Grade 7th students of the school AE Carlos Amarante in Braga have worked this school year with LegoTM EV3 robotics kits provided by the Hands-on Science Network, exploring its different capabilities. In particular they dealt with some challenges using the commands to control the motors based in the data acquired with touch, infrared or sonar sensors. In this science fair presentation the students will show interactively the results of their work.

Keywords. Hands-on, educational robotics, basic school, sensors and actuators.

A Practical Approach for Learning Robotics

J Cruz
www.botnroll.com
botnroll@botnroll.com

Abstract. Robotics is a technical discipline with theoretical concepts difficult to convey to newbies, however, with a controlled and guided experimentation approach one can transmit knowledge efficiently and at an incredible speed. You think it´s possible to teach the basic concepts needed to build and program a standalone mobile robot in three days? RoboParty proves it is possible.

Keywords. Robotics, education, program, autonomous, mobile, robot.

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Anti-Stress Balls

JP Pinheiro, L Laranjeira
Colégio do Minho,
Viana do Castelo, Portugal
zita.esteves@gmail.com

Abstract. Materials: Balloons, water, maize starch.

Procedures: Fill in the balloons with maize starch and add some water. Attention: If you add a lot of water, some kind of glue will be formed, if the maize starch is added in big quantities related to the water, wheat flour balls will be formed inside the balloon.

Effect: If the proportions are well done, the balloon will have in its interior a non-newtonian fluid. It will be liquid, but if we use some force, it will be solid.

Function: This balloon can be used as anti-stress because the more we squeeze it, the more rigid it will be.

Advantages: It doesn't make any noise, can be an alternative to the Fidget Spinners as it is very easy to prepare.

Disadvantages: Some days after, the maize starch absorbs the whole water and some groats are formed. They lose their initial elasticity, besides losing their initial shape

Keywords. Mechanics, Physics.

Physics is Fashionable!

M Lago, R Cerqueira, A Moreno, S Rufo
Colégio do Minho
Viana do Castelo, Portugal
zita.esteves@gmail.com

Abstract. Our project consists in stamping t-shirts in a very healthy, ecological, and funny way. It's healthy because the way we stamp them is by pedalling our bike, ecological because we use non-polluting ink, and fun because it's not hard to do it. When we pedal on our bike, the mechanism consists on a rotating cylinder where the t-shirt is fixed both at the bottom and the lid with handles. The cylinder starts rolling and the t-shirt start to gain colour (we are able to mix two different colours in our tubes).

The best part is that the patterns always come out different, and that way, we always get original and unique t-shirts!

Keywords. Physics, environment.

Relativity with Our Hands and Science Week Collaboration

C Alves Martínez, J González Otero
IES Pedra da Auga Secondary School,
Ponteareas, Spain
alumnado.quimica@gmail.com

Abstract. We will present to the audience a way to understand relativity effects like the ultimate speed of light in a short show using body movements and with the help of RelatiCop, which is a specially designed robot for accompanying and helping us during our presentation. It can also interact with the audience.

We will also complement the presentation of the Week of Sciences by the Education Councilor of our Municipality, explaining how we took part in the organization:

- participating in the preparatory meetings, with high school and primary school teachers, students of universities, and the councilor of the municipality with her assistants;
- presenting the speakers, very prestigious scientists who gave their lectures in the afternoon, in total there were four scientists and four students who gave micro-speeches; and
- making a disclosure explaining the theory of relativity.

Additionally, we also prepared a survey for visitors to the Science Fair.

Keywords. Organization, participation**,** relati-ity, science fair, students.

Hands-On Experiment to Determine the Size of Molecules

A Gómez Rodríguez, F González Castro
IES Pedra da Auga Secondary School,
Ponteareas, Spain
alumnado.quimica@gmail.com

Abstract. The Avogadro number is the number of elemental particles in a mole, it's equal to 6'022x10²³. The firsts tries for the determination of this number begun in the XIX century.

We'll use the formula for the area of an ellipse (a squeezed circle). We found this formula on the Internet: A = πxRxS

We are going to use also the formula that our teacher has shown to us: N=S³/V². This is an adimensional factor. With that formula, we can obtain the number of objects from the volume and the surface of a monolayer.

Our aim is to arrive to the magnitude order of the Avogadro's number (number of zeros). But this is a challenge for us, because we are trying to sum up some very difficult calculations to obtain quickly the range of digits. In this way, the public could understand the insignificant size of a molecule.

Keywords. Avogadro, molecules, nanoscience, science fair, students.

Health Research on a Simple Lung Model

I Fernández Pardo, P Vázquez Gándara
IES Pedra da Auga Secondary School,
Ponteareas, Spain
alumnado.quimica@gmail.com

Abstract. Our project is to observe the differences between the status of a healthy lung and another one under the effects of nicotine. We made two very simple models of lung, introducing cotton to simulate the alveoli. In the first case, we observed what happened when breathing clean air, and in the second case we made it artificially breathe the smoke from several cigarettes. We checked if there were differences in the appearance of the cotton in each case. The models have served us also to know the functioning of our respiratory system: the lungs, the diaphragm, the chest and airways.

Keywords. Lungs, modelling, nicotine science fair, students.

Ballon Bed

E Montes, G da Câmara, J Furtado,
J Sá, JP Pimentel
Colégio do Minho,
Viana do Castelo, Portugal
zita.esteves@gmail.com

Abstract. With this experiment, we intend to illustrate the difference between force and pressure, in fact, having a person on top of a " bed "of balloons these do not burst! As our weight is distributed through the balloons through the surface or table, the force in each balloon is insufficient for them to burst.

Keywords. Hands-on, preasure, force.

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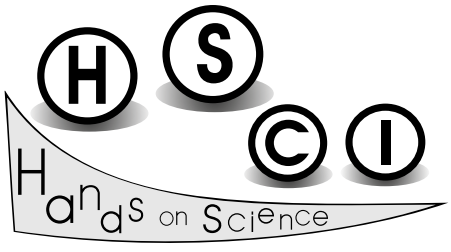
This book is conformed of a set of works presented at the 14th International Conference on Hands-on Science held in Braga, Portugal, July 10 to 14, 2017. The editors would like to acknowledge these endorsements and sponsors as well as the efforts of the conference organizers the members of the conference committees and the contributions of all conference participants.



HSCI2017

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Growing with Science

10th-14th July 2017
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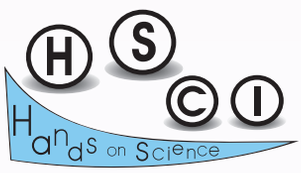

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