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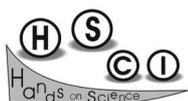
University of Aveiro, Portugal

21 - 25 July



11th International Conference on Hands-on Science. Conference booklet.

Science Communication *with* and *for* Society



AGÊNCIA NACIONAL
PARA A CULTURA
CIENTÍFICA E TECNOLÓGICA



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Science Education with and for Society

21st-25th July 2014

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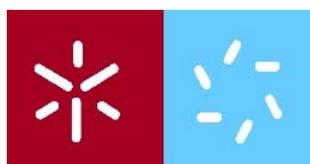
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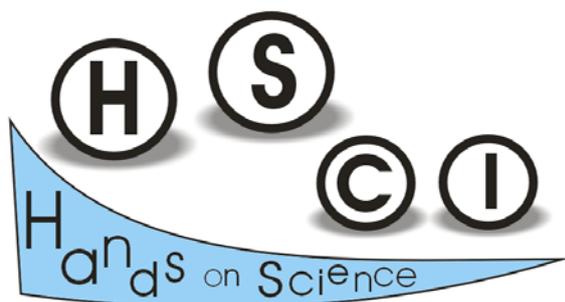
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The Hands-on Science Network





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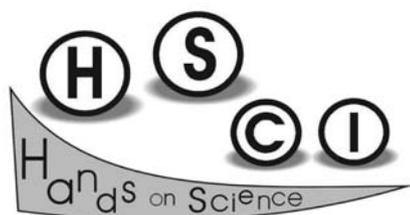
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European Physical Society

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Foreword

Science Education with and for Society

As we all know it is the Society that sets the requirements rules and procedures of Education. It is Society that defines what citizens must learn in what concern either concepts and or competencies, and how this learning can, must in fact..., take place. Society is the ensemble of all of us citizens and of all the structures tangible and intangible we create and created along the years of our common history as a people, as a nation, as humankind. Educational policies set by governments, elected and or imposed, not always reflects the will and ruling of Society.

In difficult times of, apparent, civilizational regression and clear disrespect of people's citizens' and human' rights, as the ones we are facing in the beginning of this new millennium, Education can and should have a decisive corrective role.

The School as pivotal element of our modern educational system must look behind and beyond imposed rules and regulations and persistently seek a permanent and open relation with Society, in all its dimensions, assuming and defending its crucial role on the development of Society and humankind.

The decisive importance of Science to the development of the Society awards Science Education and Science & Technology Education a role of special impact.

The aim of the Hands-on Science Network was set right from the beginning to "contribute to the generalization innovation and improvement of Science & Technology Education at basic vocational training and secondary schools by hands-on experimental investigative practice in the classroom ... *bringing hands-on active learning of Science into the classroom and into the soul and spirit of the School ...*" with a broad open understanding of the meaning and importance of Science to the development of our societies, each individual and of the humankind. Open to all pedagogic approaches that may contribute to the effective implementation of a sound widespread scientific literacy and effective Science Education in our Schools and Society *at large*, we advise the employment of open and flexible strategies to lead our students and fellow citizens to learn about Science in a committed active and investigative hands-on experiments based way, connected with everyday life and to Society,... *feeling the thrill of discovering and understanding the world we leave in.*

Our annual conferences are set to provide an informal friendly and open minded atmosphere allowing the participants to share their experiences concerns and doubts, getting concrete solutions to practical teaching problems and a sound positive peer mutual support. This years' conference, to take place in the beautiful Portuguese town of Aveiro in the end of July, have as main theme the synergetic relation between Society and Science Education in all possible perspectives.

As Chair of the conference and president of the Hands-on Science Network it is my great pleasure and honour to welcome you all to the 11th edition of our annual Hands-on Science conference wishing you a wonderful time in Portugal!

Vila Verde, Portugal, July 5, 2014.

Manuel Filipe Pereira da Cunha Martins Costa
HSCI'2014 Chair

Plenary lectures

Carlos Fiolhais

Department of Physics, University of Coimbra

Rosalia Vargas

Pavilion of Knowledge, Ciência Viva, Lisbon

José Benito Vazquez Dorrio

Applied Physics Department, University of Vigo

Marián Kireš

Institute of Physics Faculty of Science P.J. Safarik University in Kosice, Slovakia

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Faculty of Education, Masaryk University, Czech Republic

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Inquiry Based Science Education





From Teacher Training to Inquiry-Based Science Teaching: Analysis of the Case: “The Reflection of Light” with Primary School Children

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Abstract. Inquiry-based science teaching, although addressed in the curricula of various countries and suggested by some international organisations, continues to have a very low expression in the teaching practices of the majority of primary school teachers. In this sense, we have organised several continuing training courses in order to encourage these education professionals to promote this approach to science teaching in the classroom, with the children. As part of this training process, teachers put into practice, with their students, the didactic knowledge they have developed, in order to become aware of the virtues of an inquiry-based approach to children's learning. Through the implementation of the activity "Reflection of Light", in this article, we intend to analyse the process of teaching and learning promoted in a 3rd grade class by one of the teachers participating in the training courses.

The analysis of the process shows that the teacher in training carried out a successful didactic integration of the inquiry-based science teaching approach recommended for children. In turn, the children also developed a good understanding of the contents of the activity explored in the classroom.

Keywords. Formal, informal and non-formal education, natural science activities outdoors, IBSE methodology.



Hands-on Conceptual Teaching of Physics of Music

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Abstract. In our effort to bridge the gap between fine arts and science, we have created a conceptual hands-on physics course that addresses the physics of sound, music and some basic musical instruments and provides the platform for even non-science majors with minimal algebra skills to develop a conceptual understanding of the physics of music and build simple musical instruments. We present here the general layout of this course focusing primarily on the hands-on aspect of its delivery. The course is an introduction to physics as it applies to the art and science of music and consists of a mixture of lecture and laboratory-like hands-on experiences and an instrument building project. The hands-on experiments are designed with musicians and non-scientists in mind and cover the topics of the course.

Keywords. Physics, music, hands-on activities, inquiry-based.



The Alga Who Wanted To Be a Flower. An Outdoors IBSE Model on Plants Evolution

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Abstract. Identifying the main stages of IBSE implementation, an activity tested at the University of Coimbra Botanic Garden will be presented. In the cold greenhouse, a story is dramatized to young children that recognize the main morphological characteristics of the five major plant groups, corresponding to the hand five fingers, identifying and freely organizing

specimens. Firstly, recognizing the question/problem: HOW to engage young children to the world of plants, regarding to WHAT they know and their curricula demands. Then, the multidisciplinary work design, approaching to everyday-life situations with social meaning and valuing methodological pluralism. Finally, evaluation of the student learning, reproducing this "game" and the "evolution song".

Keywords. Formal, informal and non-formal education, IBSE methodology, natural science activities outdoors.



Hands-on Experiments to Develop Students' Creativity and Critical Thinking

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Abstract. Hands-on science activities have an unrivalled potential to help students develop their creativity and critical thinking, provided they are practiced in a minds-on, inquiry-based fashion. Another advantage of the hands-on approach is the extra motivation and professional progress of the teachers.

Examples are reviewed of successful practicing hands-on science in various academic environments.

Mostly low cost experiments in Physics, those activities were supported with computer and advanced multimedia tools when justified.

Transformation of entertaining Physics tricks and Physics toys into highly instructive educational projects required from the students and their instructors much of an alternative viewpoint. Examples of students' spontaneous observations and creative solutions are given.

Keywords. Multi-disciplinary students projects, hands-on and minds-on educational experiments, efficiency of education,

development of creativity, development of critical and alternative thinking.



Water Condensation: An Inquiry-Based Approach to Science Teaching with Primary School Children

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Abstract. This paper is the result of a pedagogical intervention project carried out at a primary school. The intervention took place in a 4th grade class (n=24) and involved an inquiry-based approach to the teaching of the curricular topic "water phase changes". The project employed an action research methodology whose main objectives were: a) to promote inquiry-based science teaching; b) to describe and analyse the process of the construction of meanings related to the phenomena under study, and c) to evaluate the learning acquired by the students. At the end of each lesson, a class diary was prepared. This is a descriptive and reflective narrative based on the field notes and audio recordings made during participant observation in the classroom. This paper analyses the scientific meaning construction process that occurred in the classroom, based on the analysis of one of these diaries, on the topic of "water condensation".

Keywords. Water condensation, inquiry-based science teaching.



Creativity in Early Science Education. A Case Study

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Abstract. The importance of creativity in education is recognized and is mentioned in Portuguese educational policy documents.

The need and importance of science education to foster students' creativity was the main driving point of this study.

This qualitative study aims to reveal the potential for creativity and the role of Inquiry Based Science Education in preschool and early primary education.

The fieldwork was documented by the use of sequential digital images capturing detailed interactions; field notes supplemented by audio recording later transcribed; and an overall timeline.

This communication presents a set of data analysis in relation to one case -application of one hands-on IBSE activity in one classroom. The case study herein reported contains different episodes, documenting examples of mathematics learning through the lens of creativity.

Keywords. Creativity, IBSE, primary school, science teaching.



Realistic Model-Eliciting Activities Based on IBSE. An Experience to Repeat

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Abstract. This paper aims to illustrate how teachers can implement mathematical modelling activities in classroom using hands-on mathematical experiments based on Inquiry Based Science Education (IBSE).

Ciência Viva de Tavira Centre promotes an in-service training course where teachers (from preschool to secondary level) learn how to experiment, create and apply Realistic Model-Eliciting Activities (RMEAs) in classroom.

During the first training course teachers developed related activities in class with students and the result was an increase in students' performance, motivation and understanding how mathematics is used in their daily lives.

Keywords. IBSE, Hands-on mathematical modelling activities



A Study of Integrated Metacognitive Strategy into Modeling-Based Inquiry Teaching

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Abstract. The purpose of this research was to explore the effects of integrated metacognitive strategy into modeling-based inquiry teaching (MIT) for elementary school students.

This research analyzed the effects of integrated metacognitive strategy into MIT and compared with their related characteristics as the reference of refining the teaching of science and technology. The participants of this research were made up of sixty five 5th grade students. The 30 students were in the experimental group, had received the teaching method integrated the metacognitive strategy, the 25 students were in the control group, had only received modeling-based inquiry teaching. These two groups had been taught the same teaching units, including Electrostatic, Thermal expansion, Atmospheric pressure and Light reflection.

In quantitative aspect, this research compared the abilities of modeling-based inquiry among each unit with analysis of

repeated measures and use ANCOVA to analyze the effectiveness of learning between the two groups. According to the research result, students who had adopted metacognition strategy showed better abilities of modeling-based inquiry than students' in the control group only at the unit 4.

Keywords. Modeling ability, metacognitive strategy, modeling-based inquiry, transfer of learning.



The Use of Computer Simulation as an Object of Investigation in Inquiry Based Teaching

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Abstract. Investigative approach in physics teaching is very effective tool that gives students the opportunity to try their self procedures used by scientists in investigation of the real problems. The appropriate object of examination can be an interactive computer simulation. The simulation "My Solar System" developed in University of Colorado Boulder was used for this purpose. Students of grammar school were invited to examine this own "pocket universe". The program simulates movement of 2 – 4 gravitationally bound bodies. The students can measure position, velocity and mass of the bodies versus time. The students' results, their activities and obtained skills are described in this paper.

Keywords. Physics teaching, investigative approach, computer simulation.



Concepts or Context? Hands on Science in Early Learning, its Crucial Role. Understanding from the Pri-Sci-Net Project

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Abstract. Working on the FP7 project Pri-Sci-Net has shown that experience using cognitive and kinaesthetic skills is essential in learning and understanding science in the observable everyday context. From their earliest years children are hands-on intuitive scientists observing thinking and trying out things and observing the results, hence collecting and evaluation data. Such observations and investigations occur in everyday contexts, often unasked and is verbalise through hidden questions resented an s statements. They are often observed during play, which is divisible into experimental investigative play and narratives, when they are working through a past experience imaginatively or interpreting a story they have heard.

Hands on activities are essential in the learning of science in the early years the science explanation does not need to be given but the practical experience of the phenomenon inessential to further learning. At this age the foundations for observational and planning skills are laid as well as the process skills of manipulating items, collecting and evaluating such. Later in a child's formal science education such fundamental experiences provide them with an experiential foundation on which go construct the curriculum science required for examinations.

Keywords. Pri-Sci-Net, IBSE, preschool.



An IBSE Approach for Teaching the Concept of Density in Preschool and Primary School

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Abstract. This paper intends to suggest strategies for planning, development and implementation of simple activities, related to “density”, in the classroom, in an Inquiry Based Science Education (IBSE) perspective, i.e. science education based on research/inquiry/experimentation. In this sense, we begin by contextualizing the curricular context on science teaching in pre-school and primary school, and presenting the theoretical context related to the teaching of science based in IBSE. The choice of the suggested activities was based on a set of criteria including their inclusion in preschool and primary school national curriculums, as well as the possibility that it can be addressed with varying degrees of depth, depending on the grade and level of cognitive development of students. The activities are proposed to explore the issue of density that is a subject commonly address in classroom from pre-school to primary school, and was developed to be applied in class with students of those school levels.

Keywords. Density, physics, IBSE.

with meaningful and effective learning experiences that can prepare them to face the demands of a changing society, strongly linked to science and technology. Taking this into account, the present communication aims at describing students’ perceptions about the implementation of an inquiry activity that addresses the artificial satellites and uniform circular motion, using the current event of the launching of the Galileo’s satellites to engaging students. The research reported is qualitative, adopting an interpretative orientation. Participants were 24 students who attend the 11th grade of a scientific-humanistic course in Science and Technology. The implemented activity was designed in line with the BSCS 5E Instructional Model. The data were collected using two different instruments, namely observation and written documents. According to a naturalist research paradigm, the data were analyzed using a content analysis method that consisted into an interactive process of reading and re-reading data so to uncover patterns, singularities and themes which were associated to the research question. Results show that students perceived the activity popular and relevant, because made learning more enjoyable, helped them to learned the curricular scientific contents and also to made connection between science, technology and everyday life.

Keywords. Artificial satellites and circular motion, IBSE, BSCS 5E’s Instructional Model.



Students Perceptions about Artificial Satellites and Circular Motion through Inquiry Based Science Education

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Abstract. Contemporary trends in teaching and learning science acknowledge inquiry-based science education (IBSE) as a powerful approach for engaging students



Scientific Toys from Daily-Use Materials

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Abstract. Teaching science at schools has evolved during the last centuries, mainly due to the increase of supporting, demonstrative and experimental materials to be used in classrooms. Recently science has left the

classroom to meet society and general public. An increasingly number of people shows interest in learning and understanding small daily things that can be explained by science. Hands on activities came to help our job to promote science to society. It is also notable that during an activity developed for general public, an easy way of calling attention is to develop small projects that at the end can be taken home. However, resources are becoming a limitation, especially at small science centres or public institutions. It is then mandatory to overcome this limitation and keep our major goal of promoting science outreach and informal education. Using everyday materials, available at every common shop or supermarket is a way of meeting our purpose since most can be bought at low cost. Moreover, introducing and deepening science with everyday objects that we can find at our homes will motivate the reproducibility to family and friends, and once again meeting our major goal of disseminating science to society, this turn using citizens as "science actors". Using straws, pushpins, styrofoam, toothpicks, aluminium foil, old Christmas lights, wire and common batteries we propose to build two scientific toys. The first will be a big hand to explain Bernoulli principle where a blowing toy will demonstrate the forces that keep things on air, whereas the second will show and motivate the understanding of an electric circuit.

Keywords. Bernoulli principle, electric circuit, everyday materials, scientific toys.

PriSciNet in a Brazilian School

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Abstract. Different studies show the problems in the student's learning and in the training of teachers of mathematics and science in the first scholarship years. This paper present the initial results of the

implementation – within the European project FP7 pri-Sci-Net", of activity based on IBSE perspective – with Brazilian children from 4 to 10 years old that attends at Núcleo "Joanna de Ágelis" in Botucatu with cultural and socio-economic problems in an attempt to overcome this difficulties. The results obtained show a greater involvement of students, parents and teachers and more creativity, the improvement in the academic results and in the student's self-esteem.

Keywords. Creativity, mathematics, PriSciNet, science.



From Popularization of Science, through Inquiry Lessons to Students' Scientific Literacy

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Abstract. Nowadays students have a lot of information resources containing remarkable, motivating and amazing experiments, demos or observations of scientifically based phenomenon and processes. Within our popularization activities such science days, camps, open door days, festivals and many other forms of non-formal education we try to attract young people and change their attitude to science and technology. Within the first part of lecture by the series of amazing experiments e.g. inductive cooker, we will demonstrate the role of popularizations for science education. The deeper study shows the students' outputs from popularization activities in level of sensation, fun and amusements, minor matter to conceptual understanding of the problem or further study interest. With increasing level of demonstrations' attractiveness, also students' expectation during school lessons are increased. Finally, traditional and appropriate school experiments and measurements are not so popular and it's harder to attract student for systematic work and complex problem solving. The core of the problem is in missing of additional (didactical) value of the

activities. We need to pay attention not only on popularization, but all the more on educational background, integration with students' pre-concepts, skills and focus our activities to the scientific literacy development.

The importance of the scientific literacy for the different public professions are illustrated by practical examples oriented on problem solving, making predictions, formulating hypothesis, using of coherent arguments and data interpretations. All necessary scientific competences/skills could be developed by inquiry based science education activities with different level of students' work independence. We introduce the levels of inquiry activities with examples of physics problems solving. For their school implementation well educated teacher play the key role. More than school textbooks, the worksheets for inquiry activities are important. Within the fp7 projects Establish and Sails, the series of activities were developed and are shared through inquiry science teacher community of practice. The structure and examples of the teacher and student material is introduced.

The progress of inquiry skills development must be measurable, and the different tools of formative assessment can be used. The feedback for student as well as for teacher must be used for the next steps of activities. The selected assessment techniques are presented with results from case studies from upper secondary school level.

Keywords. Assessment, inquiry, popularization, scientific literacy.



MIP. A Hole in the Fence of Formal Learning Paradigms

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Abstract. MIP (Research Methodologies Project) is a non-curricular discipline created in Colégio Luso-Francês School for PBL (Problem Based-Learning development with Secondary students. MIP mediates school

and university integrating the students in a research context. Through specific problem-based solving strategies, students develop personal skills - such as time management, inter-relational and argumentative thinking - through peer collaboration, and research methods - through the acquisition of specific tools and procedural methods from science investigation field.

In this communication, we'll share an eight year experience of PBL development in a school, highlighting the resources, the processes and the outcomes achieved so far. From collaborative and interdisciplinary work to the creation of a practice community between the school and researchers leading to tutoring supervising, MIP crosses new trails in formal science education, preparing the students for a permanently challenging society.

Keywords. Problem-based Learning, formal education, collaborative work, practice communities, tutoring teaching.



Formal Science Education: the Role of Schools and Universities





Botanic Kits "Let's Sow Science!"

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Abstract. The Botanic Kits "Let's Sow Science!" were idealized and developed by the Botanic Garden of the University of Coimbra, Portugal, aiming the involvement with science, particularly botany, among children and their families in non-formal learning settings. The kits are mainly address for children aged 5 to 10, which is an important target group since young children are particularly interested and sensitive to living organisms and their questioning minds are very active. Although children can use the kits autonomously, the interaction with family is encouraged through the collaboration in some activities or in investigations and explorations of additional challenges proposed.

Keywords. Botanic kits, plant involvement, hands-on activities, science engagement.



Toys as Change Agent for Children. An Indian Model

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Abstract. Young people of the world are our future. The future technologies, economics, culture, vision, development, etc. is all dependent on the young people. Educational institutes today have become mark and degree producing factories. In educational context, a child is first asked his marks gained in the examinations rather than what has been learnt. In this scenario it is very important for us to educate the child in a multi dimensional approach. It is not the

marks which would build our future, it the understanding in a child's mind which is the real future.

Manthan Educational Programme Society, India is an NGO which focuses on non-formal science communication and we try to use several different medias for communicating science to children & students of different cultures and communities. Through this paper, we would like to share some projects where we try to use toys as one of the main medium of science communication.

Keywords. Outreach, science exhibition, hands-on kits, non formal, toys.



Hands-on Astronomy for Primary School

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Abstract. This study presents a research based on implementation of hands-on activities for the contents Sun, Earth and Moon with in-service primary school teachers. A didactic sequence has been established to the learning objectives of the 3rd and 4th years of schooling and put into practice during a 50 hours education training course. A quasi-experimental study was designed and data collected through questionnaire and reflective portfolio analysis show that teachers of the experimental group achieved a significant improvement on scientific knowledge through the practice of hands-on activities.

Keywords. Hands-on, astronomy.



Hands-on Activities as a Support of Re-Education of Students with Specific Learning Disabilities in Science and Mathematics Education

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Abstract. *Specific learning disabilities are the inability to learn to read, write and count. It is important for the re-education of children with learning disabilities to diagnose which functions are impaired or undeveloped, to what extent and in what combinations. We can use hands-on activities for the re-education and development of these functions in science and mathematics education. They should help children to overcome their difficulties in reading, writing and counting that are a prerequisite for successful learning of science and mathematics. The study is presenting examples of special developed hands-on activities for the re-education of visual disorders in physics education.*

Keywords. Hands-on activities, re-education, science and mathematics education, specific learning disabilities.

Hands-on Experiments in the Formation of Science Concepts in Primary Education

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Abstract. *Science concepts are formed at an early age of children in non-formal education as preconceptions. The risk is the emergence misconception that later complicate the understanding of concepts. Research shows that primary science significantly affects future understanding of science. Therefore building the foundation for future understanding of natural*

phenomena, quantities, principles and research methods is important educational goal of primary science. Hands-on experiments play an important role in the formation of concepts. Using design-based research, we implement hands-on experiments in the formation of science concepts. The study presents examples of hands-on experiments, which should develop science concepts in primary science.

Keywords. Concepts, formation, hands-on experiments, primary science education.

The Impact of Observational Astronomy in First Grade Students: a Study for Symbolic Representations as a Source of Indicators

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Abstract. *The following study consisted in assessing the changes of the graphical representation of the sun, created by first grade students, after a session of solar observation. Three moments were considered: before the session, afterwards and long after. Two conclusions are derived: the representation of the sun evolved from an intangible object, capable of representing symbolic meanings to an observable one, with characteristics of its own, not inherited from something external. Such feature was persistent but not usurping of the previous imaginative version. Moreover, it combined the observational information from two different contexts: the observational session and the day-to-day experience. The image of the Sun was therefore enriched with new possibilities originated in a scientific observation of nature.*

Keywords. Astronomy, impact evaluation, sun observation, symbolic representation.

Genetic Transformation of Plants. A One Week Summer Course for High-school Students

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Abstract. Genetic engineering, the process of manipulating the DNA of an organism often including DNA from a foreign organism, relies on complex molecular techniques. In the program for school students "Universidade Junior", from the University of Porto, we developed a one week-long summer project for 15-17 years old students pertaining the concepts and procedures involved in plant genetic transformation. Students conduct hands-on experiments involving DNA-based Technologies including Agrobacteria-mediated transformation of plants, and observation of fluorescent recombinant proteins by fluorescence microscopy.

The impact of these technologies is discussed enabling students to resolve these controversial issues and justify their decisions on scientific-based balanced appraisals.

Keywords. Agrobacterium, electroporation, genetic engineering of plants, floral-dipping, GMOs, fluorescence microscopy.

Science: 1, 2, 3, Action! How to Teach Science to Primary School Children

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Abstract. This project is dedicated to students of the Primary Schools of our region. During the primary school, the only contact of children with Science is through a subject named "Estudo do Meio" which presents several problems. Therefore, this

project came to cover this gap, with the availability of a set of experimental activities, discussion and debate of ideas. It has been considered interesting and very well received, not only by students but also by teachers, these last ones may eventually be looking at the project as an useful tool of making enthusiasm grow in their students.

Keywords. Children, education, primary school, science activities.

The Role of Optics in Engineering Education: First Year Students

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Abstract. This paper describes and analyzes some specific aspects of our experience in stimulating the interest of the first year students of our Engineering School. They will follow in subsequent years different Engineering Studies, although not Optical Engineering. In general, the first year curriculum doesn't allow a detailed review of the main light properties, least its technical applications. Based on the fact that they have a very basic training in this branch of physics, we have designed a series of experimental demonstrations with the dual purpose of making them understand the basic principles of these technologies, and to know their potential technological applications.

We assemble these experiments in the final days of each course, and invite the students to pass by the laboratory to get to know them, giving them an explanation in which we focused on the possible range of application of each technique. The students who attended the invitation really showed a great interest for the issue, in spite the fact that the demonstrations were basics and not really spectacular. Here the authors analyze the understanding of the explained principles, as well as the degree of awareness in the importance of the Optics in Engineering and then in their education.

Internet technologies make easy for the students to search for information in any scientific field, in particular this of Optics and many questions arise for specific points that awake their interest, leading this to an enrichment of the discussions.

Keywords. Engineering education, optics education.



Hands-on Experiments in Development of Gifted Students

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Abstract. Gifted students have special educational needs. The wide support of students gifted in science is a social necessity. This lecture describes the three main roles of hands-on experiments in the support of gifted students: identification, motivation, and development of giftedness. Crucial areas for the support of gifted students are: education of teachers in identifying and development giftedness, creation of a support system to help teachers and families in the education of gifted students, and setting up of high-quality school facilities for gifted students. Inquiry-based science education is the appropriate educational method for the intrinsic motivation and the development of giftedness.

Keywords. Development, gifted students, hands-on experiments, motivation, science education.



Project Salt Science II: Getting Students Closer to Science through the Study of Sodium Chloride

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Abstract. In this talk we present some activities (centred in fieldtrips) conducted during the project SaltScience II, which is an interdisciplinary study-research network around sodium chloride, commonly known as Salt. The project involves secondary school students and teachers from five Portuguese public schools, the Portuguese Chemical Society and a team of researchers, and other specialists, from the University of Aveiro and the Mãe d'Água.

Keywords. Field trips, secondary schools, science, salt.



Lisbon Cycling Cultures

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Abstract. The city is no longer possible without the car, the city is no longer possible with the car [1]. This emblematic sentence pictures the relationship between the city and the automobile as a dead end, a stalemate, a circular predicament with no solution. Alongside with this almost symbiotic relationship between the car and city, a controversial topic emerges, regarding the consumption of natural

resources and the pollution generated by all the mobility rituals of motorized technology. In this research we use the motility capital concept to compare institutional policies towards cycling (top-down narratives) with the actions and proposals of MUBI cycle activists (bottom-up narratives). Following Kaufmann definition, motility “encompasses interdependent elements relating to access to different forms and degrees of mobility, competence to recognize and make use of access, and appropriation of a particular choice, including the option of non-action”. Semi-structured interviews were applied to policy makers and pioneers of MUBI association, and participant observation during last year in Mubi mailing list and Voca project (the Volunteers of Cycling Academy project has been funded with support from the European Commission under the Lifelong Learning Programme - Grundtvig Learning Partnership). We intend to demonstrate differences between both narratives, discerning the main obstacles to prosecute a sustainable mobility in the city and, at same time, demonstrate the value of scientific social sciences knowledge, namely the storyteller method, to understand our reality and to solve social and environmental health problems.

Keywords. Mobility, motility capital.



Staining Techniques Can Help to Learn about Bacteria: A Hands-on Activity

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Abstract. Laboratory work, in particular the use of staining techniques and optical microscopy to teach about bacterial cell structure, can be successfully implemented by teachers with various levels of expertise to engage students in simple, but

informative procedures, feasible even in school settings with limited resources. In this work we propose and discuss the potential of staining and optical microscopy methods as hands-on activities to advance high school students' (15-16 years old) understanding of bacterial cell biology.

Keywords. Bacteria, laboratory work, microscopy, staining techniques.



Astronomy with Hands-on Data

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Abstract. A starry night is the astronomer's favourite lab. The sky is mankind's heritage and is available to all, for free. This immense lab poses challenges and brings mysteries even to the most skilled and inquiring minds. Ground based telescopes are now at a distance of a click and freely available provided we have internet access and a device capable of handling data. So the next natural questions are: "Can we use this richness of tools and resources for science teaching"? "Are there new strategies to sparkle students interest for science using such possibilities in classroom"? During this talk we will share some examples on how the scientific method is being integrated in school curricula in several countries in Europe, in the framework of projects that are cutting edge solutions to e-learning, community building and online/remote labs.

Keywords. Astronomy, citizen science, data mining, community building, inquiry.

Playing for Science and Mathematics Education: An Experience for Pre-Service Kindergarten Teacher Training

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Abstract. For small children, there is no difference between learning, playing and working. Playing is the most important way how they learn. Even for older children, games promote high levels of attention and concentration that may be applied to learning. This work reports on the experimental approach to a subject matter for university training of pre-service kindergarten teachers, newly developed with the aim of applying the use of games and ludic resources for children's education in science and mathematics. Although the full evaluation of this subject matter must await more data, the present work introduces its methodology and provides results of its implementation.

Keywords. Kindergarten, learning by playing, pre-service teacher training, science and mathematics education.



Autonomous Robot Programed on Arduino to Teach Science in Schools

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Abstract. The idea of this paper is to show school professors how good robots can be to teach students. Many other papers are written by university Professors, but this one's written by a student who learned from a robot and in the future would like other students to have the same opportunity to learn with the help of a robot as I have.

Keywords. Robot, programming, school.

Entrepreneurship in “Sciences”: Mini-Entrepreneurs

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Abstract. The learning of natural sciences requires an active and committed intervention by students in conducting experimental activities. Experiments are inherently of investigative nature. To assume, accepting or even creating their own, new challenges and responsibilities is very important to growth of our students and should be promoted as earlier in age as possible. Entrepreneurship and specially when directly related to science and technology can be a valid way of achieving this. In this communication we report the implementation of a science entrepreneurship project, “Mini Entrepreneurs Project”, promoted in Portugal by Science4you, in the primary school of Gualtar in Braga, Portugal. Our project was aimed to prepare a draft of toy that has both scientific and educational nature. The project challenged the children to work actively and present their ideas on scientific toys or projecting a toy based on their scientific knowledge. In a dynamic and appealing atmosphere this activity sought to encourage entrepreneurship among our youngsters while contributing to the learning and discovery of science by hands-on investigative experimentation. The relevance of this activity is the application of entrepreneurship in the study of the natural sciences, as facilitator of acquiring new skills, through the need to transfer and mobilize the knowledge acquired at school. It was therefore important to establish a clear relationship between entrepreneurship and classroom learning. Children start having contact with entrepreneurship in sciences and technologies early in school. Entrepreneurship appears here as a promoter of science learning by creating a toy based in the application of scientific knowledge.

Keywords. Entrepreneurship, toys, natural sciences.

Fungi Ubiquity. Arousing Curiosity, Astonishment and Scientific Knowledge

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Abstract. Following the training course entitled "The Microbial World around us", promoted by the Ordem dos Biólogos and attended at the Biology Department of the University of Minho, it was proposed to 11th grade students of secondary education the planning and achievement of an experimental research activity related to the presence of fungi in everyday materials and the evaluation of the disinfectant capacity of various substances for common use.

The students accepted the challenge enthusiastically, which allowed them to question reality, training tasks in an investigative context and revealing the results in various communications among school colleagues, other members of the educational community and in scientific meetings for peers.

The initiative was a success, having increased in the students directly involved in the project, their active and critical involvement in other intervention activities in the school community. On the other hand, it allowed stimulating the scientific curiosity of many students from 5th to 12th grades, as well as parents and even other teachers.

This communication aims to show how stimulating activities can promote an education in science and the development of the citizens' critical minds, starting with easily accessible materials (even in a school that does not have well-equipped laboratories). They can also involve the whole community because they aren't restricted to the teaching practice of a subject.

Keywords. Biology, Fungi, hands-on/minds-on project, scientific literacy.



Instructive Fun with Water

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Abstract. A selection of involving hands-on experiments with water is presented, covering a wide range of physical principles and laws. Their possible applications extend from lecture demonstrations and measuring labworks to creative students' research projects and summer camp fun activities. Experiments on 'violated' Archimedes Law, measuring of atmospheric pressure with water containers, water jets used to set in motion toy cars and to measure time intervals, are all about how to develop entertaining demonstrations into instructive accurate measurements. Reflection of surface waves off the walls of water tanks is studied experimentally as well as with computer models designed by the students. Reviewed surface tension phenomena include buoyancy of the bodies denser than water and 'liquid marbles', the amazing powdered drops. Exploration of the three-bend self-starting siphon is an example of a step by step students' inquiry.

Keywords. Hands-on experiments, Archimedes law, measuring of atmospheric pressure, water clock, surface tension, elliptical mirror.



Understanding Growth and Thermal Inactivation of Foodborne Bacteria Using the Pathogen Modelling Program (PMP)

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Abstract. According to the biology curriculum guidelines for the last year of high upper secondary studies, Portuguese students (16 to 18 years old), should be prepared to rationally mobilize and apply knowledge in the analysis of issues that impact society. Amongst the various contents addressed, students are expected to become more knowledgeable about key concepts related to the topic "Food Preservation". In this instructional level, and following current curriculum recommendations, practical work should be regarded an integral and crucial component of the teaching-learning process. In this work, we present an activity aimed at promoting high school students' understanding about microbial growth on foodstuff, and food preservation methods by engaging them in the use of a bioinformatics tool, the Pathogen Modeling Program (PMP).

Keywords. Growth of microorganisms bioinformatics, food preservation.

Preschool Chemistry: A Soluble Story

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Abstract. Will be Chemistry important and understandable in preschool children's development? This question was the inspiration of this activity, where we took in

children's curiosity and willingness to try, a story and chemistry, all mixed together. We used safe and familiar children's material and we followed the course of the activity observing the difficulties and conceptions of them, using the inquiry focused on what was happening with each one and trying connections with their predictions. All the children observed and understood that the colour in the water came from the previous M&M's[®] exterior colour.

Keywords. Chemistry, colours, solubility, preschool.



SAFE: Secagem de Alimentos e Fruta em Estufa. ECO-FOOD: SOD (Solar Oven Dehydration) of Food and Fruit

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Abstract: SAFE is a project that was made by the 12th grade students of Agrupamento de Escolas de Caldas de Vizela, which the objective is introduce the consume of fruit in school community, it means, increase the consumption of fruit among the school community with the access of fruit with an improved texture and flavour, while maintaining all the nutritional value.

This project consists in the construction of a greenhouse/ solar oven for the dehydration of all types of fruit or other kind of food. All of our school community has a part on our project. The greenhouse is completely "green" because the only source of energy is the sun. We intend to built prototypes for drying food and fruit with more technology. These prototypes where build based on papers and research from another country's that use sun energy for this task [1].

Portugal is a producer of fruit and vegetables of high quality so we intended to make a project that promotes small food and surplus valorisation. On the other hand,

there is enough solar energy to dehydrate foods without recourse to other energy sources in part of the year.

This type of food is very unusual in our country and few people will be using this method or cook with these foods. So, we'll create a recipe book to promote the use of this type of fruit.

Concluding, SAFE combines the ecology with health.

Keywords. Fruit dehydration, food dehydration, natural resources, food preparation, solar power, solar drying oven.

chemical (acidity-basicity, red cabbage extract obtained will use to identify acids and bases) properties. In addition, experiments prepared to do at home are also discussed in this work - because of their importance for students and the possibility of using them to increase the student's, their families' and finally the whole society's interest in science.

Keywords. Didactic experiments, chemical properties, physical properties, at-home science.



Didactic Experiments on Science

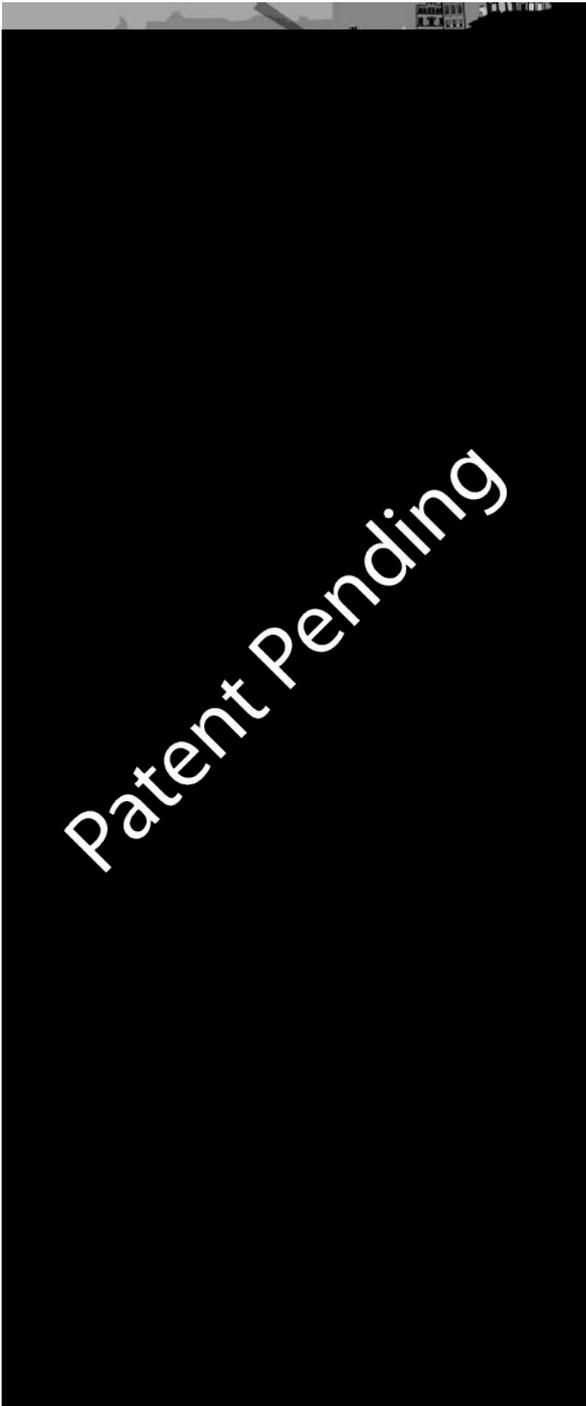
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Abstract. In our daily life we are constantly in contact with chemical substances. All of them intrinsically possess a number of properties which can be used to our advantage, as a society and as teachers. These properties are classified in two general groups: chemical or physical properties. Chemical properties are oxidative or reductive powers, acidity or basicity, etc. whereas states (solid, liquid and gas), shapes, density, and so on are physical properties. When variations take place in the chemical or physical properties of a compound, this compound shows a chemical or physical change, respectively.

A physical change maintains the molecular integrity of the substance, for example the state of matter or the density of fluids changes. A chemical change, however, implies the transformation of a substance into another, with a different molecular constitution. For example, when iron oxidizes or the combustion reactions with oxygen which take place in our cells. In this work, we are introducing some didactic experiments related to both physical (density, water-oil-metal and plastic) and



Patent Pending

Atreve-te!: Dare Yourself to the World of Engineering

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Abstract. *The Engineering plays a fundamental role in our society. Since it's defined as the science which aims to apply scientific knowledge and techniques in order to solve problems found in a society or to improve solutions already proposed to the same problems, it's important spreading among the students what is really the Engineers' role and where we can find Engineering.*

Keywords. Electronics, engineering, high school, additional training.



Scientific Readings in EIDH

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Abstract. *The application of new methodologies in the teaching of experimental sciences can be a facilitator process of acquiring skills in the interpretation of scientific texts and experimental results, which are referred by teachers as gaps presented by the students. In this communication, we present a project developed with students of various levels of education, which aimed at combining playful reading activities with practical activities that sought to materialize the "story" told in readings.*

By being aware of the limitations of the impact assessment of the project that we implemented, we intend to continue it, exploring, more fully, its real potential.

Keywords. Children, education, school, science activities, reading, hands-on activities, non-formal education.

An Exploring in-Service Teachers' Professional Development Activities for Enhancing Students' Scientific Thinking

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Abstract. *This study aims to investigate the junior high and elementary school in-service teachers engaged in the design of hand-on science learning activities and to enhance students' scientific thinking and learning attitudes. Before the county science fair, we hold a professional development workshop in order to regain the teachers' ability of designing suitable for junior high and elementary school students' hands-on science learning units. There were 30 teachers participated in the workshop. The hands-on science learning activities were not only for fun but emphasizes to promote the students' scientific thinking ability. Then teachers finished the preparation of material and provided for a total about 1,200 students from junior high and elementary school participated in this activity. With the simple random sampling, there were 136 students (junior high: 87, elementary:49) filled out the "hands-on science" learning survey questionnaire. The research discussion include: there were 10 set learning units produced by the cooperative teacher, the study generalized the design criteria for hand-on science activities from the workshop instructor's sharing experiences and in-service teachers' viewpoint. The results of analysis show that the hand-on science learning activity can enhance students' learning effectiveness in scientific thinking and attitudes.*

Keywords. In-service teacher, science fair, scientific attitudes, scientific thinking.



O Continhas. Mathematical Activities for Children from 5 to 10 Years Old

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Abstract. We present an extra-curricular mathematical project for children in the first years of school.

Keywords. Cognitive stimulation, contextual learning, creativity, mathematics.



About Science Fairs: Revisiting Alan Ward

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Abstract. Twenty years ago, ten years of experience and some movies watched were meet to an Alan Ward article, "Planning, organizing and staging a school science fair", ... and a new life begin for my students and for me and several mates in our school. Twenty years after, each with (almost) one science fair celebrated, and with experiences in other events-like, several papers and conferences, a wiki about science fairs and after have helped to begin other science fairs-like events, it's time to remember the Alan's article and comment it from my experience, to try of make an improvement of their function as guide to begin and to do a Science fair. Development will show comments about the article but also new questions (and answers) related to science fairs in our schools today.

Keywords. Science Fairs, guide, didactics.



Audiovisual Animations for Teaching the Theory of Special Relativity Based on the Geometric Formulation of Minkowski

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Abstract. We present a proposal to make available the contents of the Special Theory of Relativity (STR), explained through video animations. The ability to advance the teaching of the main relativistic phenomena to previous courses (1 high school and even earlier) was the subject of an investigation conducted as a doctoral thesis.

The inherently visual characteristics of the didactic proposal, based on the geometric formulation of Minkowski, can incorporate all the physical aspects of the STR in spatiotemporal diagrams.

As a result, we propose to participate in the realization of educational animations based on these diagrams to those who may be interested.

A provisional website and a DVD are presented as examples.

Keywords. Animation, Minkowski, relativity, spacetime.



Scientific Literacy and Laboratory Activities in Physical-Chemical Sciences

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Abstract. According to the curriculum guidelines, given by the Ministry of Education, teaching Science Education implies learning based on Science-Technology-Society (STS) activities, looking forward to the development of competences related to the promotion of scientific literacy.

Thus, the teaching of science should create conditions that allow students to develop thinking skills, leading to the (re)construction of scientific knowledge and the promotion of autonomy, through the use of active learning strategies. In this perspective, laboratory activities, as a teaching resource, are likely to contribute to an integrated development of students' skills and competencies.

Keywords. Science-Technology-Society (STS), education, scientific literacy, laboratory work, social scientific interference.



School's Robotics: Improve Teacher Praxis to Promote Science and Technology

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Abstract. Recently the authors, teachers at different school' levels and Portuguese regions, attended, on a lifelong learning program, a training course on 'School' Robotics', organised by the Hands-on Science Network. They were able to learn from the know-how of trainers in Educational Robotics and to exchange experience with trainees of other nationalities. From this acquaintance the authors created a partnership among them since they aim to improve the quality of their teaching practice and to promote science and technology in schools. In this communication we will report on the acquired knowledge and on three practical cases which intend to engage pupils in learning, create robotics clubs, make pupils participate in national robotics competitions and disseminate knowledge among other teachers and schools. We conclude by pointing out the significance of such training for the improvement of our praxis and the holistic view brought to it.

Keywords. Lifelong learning, education, school' robotics, motivation.

Development and Construction of Educational Materials in Physics and Geosciences for High School Teachers Training in the State of Rio de Janeiro

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Abstract. The contents of Geosciences, namely the Geology, begin to be worked in basic education, especially in the sixth year of the second upper elementary school, especially by Geography and Science disciplines teachers, addressing issues related to the internal structure of the Earth, tectonic plates, volcanic activity, earthquakes, rocks and minerals cycles. However, these educators, in many instances, are challenged in transferring these matters to their students. This is a quite complex understanding, as the students need a greater awareness and maturity, because they refer to matters of endogenous activity on Earth. The purpose of this work is to develop and apply skills, techniques and appropriate teaching-learning processes and elements of the geosphere resources, thereby supporting the improvement of the teaching of Earth Sciences/Geology headquartered in public schools in the state of Rio de Janeiro. Research has also approaches aiming at observing and inferring the links between Geosciences/Environmental Education and tentatively with other school subjects, such as Mathematics, Portuguese and Arts with regional realities, which depend on the integration of teachers these disciplines in the process. More specifically we foresee the creation of a Sciences lab at the Municipal School JúlioRabelloGuimarães. The location of this school is of particular importance because it lies next to the Municipal Natural Park of Nova Iguaçu (RJ), which keeps in its area geological and geomorphological features that betray the event of preterit volcanic activity, such as: magmatic cameras, syenitic rocks, pits,

dams, breccias and volcanic pumps, which makes this an important heritage Park. The area contains extensive technical and academic production related to aspects of local volcanology. Furthermore, we propose the creation of a Laboratory for Geosciences practice mineralogical study of rocks in the schools, through the acquisition of collections of minerals, laboratory installations for studies and practices. Concomitantly, manuals for students and teachers to research and study minerals and rocks will be developed.

Keywords. Geology learning, minerals, physics learning, rocks.



Triggering Male and Female Student Questioning through Device Experiments

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Abstract. Device experiments (DE) were short science demonstrations implemented to foster student questioning and to identify gender differences in questioning. The demonstrations were applied to three groups of science, technology and engineering undergraduates, each respectively composed of four female students, four male students, and two male and two female students. Male students in the single sex group posed many more questions than female students in the single sex group, and many more questions than male students in the mixed gender group. However, in the mixed gender group the number of questions posed by female students was significantly higher than that of questions posed by male students in the same group.

Keywords. Gender differences, student questioning, undergraduate students.

IRRESISTIBLE Project - Portuguese Community of Learners: Teachers' Perceptions

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Abstract. The European Union has developed a framework for Responsible Research and Innovation (RRI) to address the growing need to bridge the gap between scientific community and the rest of society. The EU funded IRRESISTIBLE project aims to engage teachers, teacher students and school students in RRI. As part of the project, each of the ten partner countries will establish a Community of Learners (CoL) for the professional development of in service teachers. The portuguese CoL comprises five science teacher educators, four research scientists, one science museum member, and fifty-two science teachers. Results of the impact of CoL on teachers' perceptions regarding the main project domains and on their professional skills will be presented.

Keywords. Community of learners IRRESISTIBLE project.



Ciência na Ponta dos Dedos: Scientific Activities for Children under 10

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Abstract. In the context of the "Projeto" of the 3rd year of "Licenciatura em Biologia Aplicada" it was proposed to develop experimental activities connected with science for 1st to 4th grade students. This

initiative was named *Ciência na Ponta dos Dedos* and was presented in the scope of “Festa da Ciência 2014”, an event of the *Escola de Ciências* of *Universidade do Minho*, which happens every year during May (and lasted this year from 12th to 14th of May).

The first edition of *Ciência na Ponta dos Dedos* was offered to 1st grade students (6-7 years old). A mini laboratory where children could see, try and participate in scientific hands-on activities was created for the initiative. The experimental activities were designed and settled in accordance with curricular guidelines, age [1,2,3] and in the scope of the theme “water source of life” through the development of six different activities where the children, organized in groups, had the opportunity to explore aspects connected with the (i) reaction of an acid with sodium bicarbonate in water, (ii) dissolution of different substances in water, (iii) permeability of different soils, (iv) water cycle through the observation of a mini ecosystem, (v) observation on the microscope of the stoma of the plants and (vi) the colouring of carnations by capillarity using several dyes.

These activities were carried out in such an environment that kids’ eyes had light up as brightly when doing the science lab activities. Children could feel free to express their ideas and participate in the activities to build applicable knowledge in the context of experimental science. This kind of learning comes easier to children if they can touch and make the experiments by themselves, though with a proper supervision, allowing the children to think and to learn that “if I do this, that will happen”, so “in order that to happen, I will have to make this” [2].

In the sequence of these experimental activities, children were asked to fill in an inquiry, previously prepared in order to know their opinion about the activities they performed, including their favourite ones. This survey will also provide some new ideas to improve future similar events.

The present communication intends to present the project and its success near the children and their teachers, as well as to highlight the importance of scientific knowledge. Quoting some children: “the activities were very funny and I learned new things”, “I learned why oil does not mix with

water” and “I learned that the noses of the plants are in their leaves”.

In a developing society it is more and more important that the education system makes science stand out from the early years of school in order to form citizens able to deal efficiently with the challenges and the necessities of the current society [2].

Keywords. Children, experimental activities, hands-on science.

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DNA goes to School

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Abstract. Education has a strong influence on students’ future decisions about the professional field they wish to pursue [1]. As science is the engine of the development of societies, it is of great importance to disseminate scientific knowledge in order to engage new generations in the world of science. The popularization of scientific concepts is also imperative, to make them clearer and more appealing to non-expert citizens, awakening their interest and curiosity for science [2].

The core of science communication and education implies a bidirectional contact between science and society [3]. In this relationship citizens can understand and discuss scientific advances that impact their daily lives, and scientists also obtain useful information from the public. The greater the involvement of citizens, and the amount of experimental activities, the more successful this relationship will be.

To encourage a closer connection between science contents and non-specialist school population, the STOL– Science Through Our Lives team launched the project "O DNA vai à Escola" (DNA goes to School), which was funded by "Agência Nacional para a Cultura Científica e Tecnológica". Although current programs of secondary education include general concepts of molecular biology, which should be exemplified with practical activities, schools still lack several resources to implement such experiments. In addition, teachers also reveal some training gaps at this level, weakening the whole process of teaching and learning. Thus, collaboration between these teachers and researchers/professors of higher education, sharing resources and expertise, could represent a strong strategy to reverse some of these gaps, both by equipping schools with technical and scientific resources and by motivating students to scientific research.

"O DNA vai à Escola" was performed at the "Escola Secundária de Paredes (ESP)" between February and July 2013. In this partnership, students of the last year of the degree in "Biologia Aplicada (BA)" and professors from "Departamento de Biologia" of the "Universidade do Minho" organized several workshops and lectures addressed to the students of 12th grade, and to their biology teachers, at ESP. One of the most successful activities was the set of three hands-on sessions named "O DNA chegou à ESP", which was supported by eight students of BA and presented to 50 students of ESP. The impact of these practical sessions was assessed through questionnaires filled by the student community, the students-supervisors, and the teachers of ESP.

This work will show the main results of this project, highlighting the relevance of this kind of activities, namely those related with the promotion of science education and

scientific literacy. The data collected allowed concluding that, among other aspects, the interaction with students of higher education was one of the most appreciated novelties of these hands-on activities.

Keywords. Hands-on, molecular biology, secondary school, higher education, student-learner, student-supervisor.

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Using Research Projects to Explain Science to Youngsters – Our Experience at MicroLab

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Abstract. *The University of Aveiro (UA) is undoubtedly an active agent of social transformation, linking knowledge production to its dissemination. Activities like “The Open Week of Science and Technology” and the “Summer Academy” target young students enrolled on the secondary or the pre-higher education levels, stimulating their curiosity on scientific knowledge and promoting research as a relevant activity.*

The department of Biology (DBUA) and its Laboratory of Microbiology are aligned with these activities and with its main aims.

Microbiology co-exists with human daily life in many facets – human nutrition, health, biotechnology, among others all are deeply influenced by microorganisms, their actions and their interactions. Nevertheless, the general awareness of the society to the diversity and richness of the microbial impacts on human life is low and often restricted to the adverse effects that microorganisms may exert (e.g. antibiotic resistance of bacteria and its consequences, pathogenesis, and other related phenomena).

As researchers, microbiologists can give a suitable contribute: in fact, microbiology is a field of research where several fundamental biological questions can be posed and linked to ordinary day life. The young students we receive in our laboratory in the context of the activities previously mentioned, show very broad motivational levels and quite different histories of exposure to science knowledge in formal or non-formal environments.

Taking the previous considerations into account, we try to bridge with students that visit our laboratory, posing problems that are raised by our research activities and to which the researchers of the group aim to answer. The use of simple questions, using everyday situations, places the students in situations where they can try to solve

scientific problems: how bacteria became resistant to penicillins, why is the cork oak dying or if the bacteria from Berlenga’s beach are harmful.

In this context, the students have the opportunity to participate in scientific activities such as, for example, cultivating microorganisms (bacteria and fungi) - allowing them to, in a very simple way, recognize the extraordinary diversity of microorganisms; interpret simple protein electrophoresis experiments - allowing students to realise that microorganisms interact with their environment expressing new molecules; detect enzymes produced by bacteria and fungi – understanding that these microorganisms produce molecules that are used in their lives.

This communication presents simple examples of these activities, gives a description of their execution, and at same time tries to interpret successes and difficulties.

Keywords. Microbiology; high school students; hands-on-science.

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Entertaining Scientific Activities with Drama: Cases of Yozgat and Its Districts

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Abstract. With changing curriculum and adopting constructivist view of point, there has been inevitable tendency from teacher-centered system to student-centered system. As a result of this tendency, Drama Method has been used in schools.

In this study, it has been aimed to enhance primary school students' conceptual understanding using drama method with entertaining scientific activities. In this context, six drama activities were presented. In these activities, topics related to curriculum such as "surface tension of water, state of matter, expansion, conduction of heat, pressure, and chemical reactions" were handled. All activities were done by actors who were expert in their domain. Besides, primary school students were attended to those activities vigorously.

The other aim of the study was to service the society because of planning to go to province of Yozgat and its districts to be able to implement entertaining scientific activities. With these aims, 16 drama demonstrations were held in the city of Yozgat and its districts. This study included all districts of city of Yozgat. Whilst 3 of 16 the drama demonstrations were held in the city center, the rest of them were held in the 13 districts (Akdağmadeni, Saraykent, Sorgun, Aydıncık, Çekerek, Kadişehri, Sarıkaya, Çayıralan, Çandır, Boğazlıyan, Yerköy, Şefaati and Yenifakılı). The samples of the study were primary school students who are in the 7-8 grades. The study consisted of 1089 primary school students. Case study was used as methods. The data source included Conceptual Achievement Test (CAT). The result of this study analyzed using SPSS-16 program.

The result of this study showed that students had better conceptual understanding in terms of the concepts studied. Besides, it is thought that entertaining scientific activities

enhanced students' attention and motivations towards science.

Keywords. Science education, drama, entertaining scientific activities.

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Microbes: Where Are They? Are They Harmless? Are They Harmful?

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Abstract. Education for scientific literacy has many challenges in its mission of contributing to the promotion of informed, aware, critical and committed citizens. According to several authors, scientific education should begin as early as possible, and in the form of experimental activities, thus communicating science and raising children for critical observation and scientific thinking [1].

This work describes a hands-on experiment conducted with preschoolers and dealing with Microbiology. Following the training course "Science from 3 to 11 - Experimental Activities on Biology and Environment" of the Pri-Sci-Net project [2], three of the teachers enrolled in the course designed and implemented in their classrooms small experimental activities in the field of Microbiology, applying some of the concepts acquired in the aforementioned training course. Pri-Sci-Net is an FP7 funded project within Science in Society which promotes inquiry-based learning in science education (IBSE) at primary level.

The human being is surrounded by a large number of microbes which are present in the air, water, food and in every object of daily life. The experimental activities developed allowed children to have a first look into the invisible world of Microbiology, and to learn that microorganisms, some harmless others harmful, are everywhere, colonize all habitats and multiply rapidly if appropriate conditions are provided. One of the main objectives was to check and to alert children to daily hygiene habits at different ages, stressing its need and importance for a healthier life. To achieve such goal, samples were collected - inside the mouth, in the armpits, and on the hands and feet of participants - and spread on the surface of Petri dishes with a suitable culture medium. Microbial growth was then observed, compared, recorded and characterized during a couple of days.

In the present work we describe the experimental activity and its evaluation, which was developed in two parts: the first through observation of children participation, motivation, interactivity and involvement and secondly by using questionnaires (before and after the hands-on activity) to check learning progresses after completion of the activity.

Keywords. Microbiology, hands-on, pre-schoolers, learning.

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Hydrobots: An Educational Marine Project

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Abstract. *Hydrobot is an international Project developed by the MIT Sea Perch Lab, provided to Greek Secondary Education by Eugenides Foundation. It aims to introduce the involved students to the fundamental scientific principles and applications of modern Technology by constructing their own AUV (Autonomous Underwater Vehicle), the Hydrobot. Hydrobot measures marine's temperature, pressure, depth and luminosity, through a set of sensors based on Arduino Open Source Platform (Hydrosensor) in order to update an online data base designed for this purpose, part of Crowdsourcing's process. Students of our school, which is located in Elefsina a city in the northernmost end of the Saronic Gulf, have been involved in this Project, assuming the responsibility for the construction of the vehicle, for the regularly data collection and the programming of Arduino platform; processes that introduce them to the scientific approach by performing a series of experiments in realistic conditions. In order to programming the Arduino platform, students had used S4A which is a Scratch modification that provides new blocks for managing sensors and actuators connected to Arduino. The project Hydrobot / Hydrosensor involves various learning methods (such as constructivism, outdoor activities and collaborative work) using ICT, Technology, Mathematics etc, triggering students' abilities and skills. It offers fun and challenge, combines engineering and technology in the classroom, giving opportunities for collaborative learning, inspiration and professional orientation. Design of ships and submarines, Electricity and electrical circuits, Ergonomics, procedures for taking measurements (depth, biological samples, light, etc.) can be some of the subjects students can acquainted with.*

Keywords. Educational robotics, hydro-bots, arduino, scratch.



Representations of the Role of Citizens in Science among Scientists and Communication Professionals: A Study of Portuguese Universities

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Abstract. *The objective of this study is to analyse how Portuguese universities have involved citizens in debates on science and how important public engagement with science is to those institutions.*

Over the last two decades, multiple scholars have studied the implications of applying a dialogic model to public communication of science. Further to considering that public participation is the best guarantee to avoiding public resistance and mistrust regarding higher education institutions (HEIs) and science in general, some advocate that citizens' judgments, knowledge and competencies are just as reasonable as scientists. It is believed that through public participation it would be possible to renegotiate responsibility in deciding the political objectives of S&T and in supervising their fulfilment. Public engagement is expected to contribute to a commitment of society in the application of scientific breakthroughs, as well as to increased accountability.

However, achieving effective public participation in science has proven to be a rather complex objective. In Portugal, only a few HEIs have considered the potential of communication for stimulating a more regular involvement of citizens in science. Most science communication activities have been confined, at least until early this century, to a top-down format that is not dialogic.

Based on document analysis and interviews, we analyse the activities that HEIs have been promoting to engage society in

debating science and the processes involved in defining such strategies of communication. This study will also look at dominant conceptions, among scientists and communication professionals, of what citizens' involvement should be like.

Preliminary analysis suggests that science communication initiatives conducted by universities do not follow any formal science communication strategy. They are led by researchers rather than by communication officers and mostly involve low intensity public participation, such as seminars or talks. Contact between scientists and communication officers mostly revolves around the goal of disseminating results via the media at the end of the research process. Regarding the potentialities of public participation, scientists believe that public disclosure helps fulfilling previously defined objectives, such as increasing accountability, improving citizens' scientific literacy, generating consensus and enhancing public trust in science or awareness of the importance of science. Despite this potential, scientists feel that public participation has some limits and constraints, most of which are also associated with the deficit model. We identify the main obstacles to the development of more participatory initiatives and discuss the roles that the scientific community and HEIs could have in stimulating public involvement with science.

Keywords. Public engagement with science, public participation, science communication, universities.



High Abilities: A Project for the Training of Teachers with Children and Adolescents Who Enjoy Learning

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Abstract. *The present paper reports an experience which has been developed over the last 3 years with undergraduate students of Biological Sciences at the Pontifical Catholic University of Minas Gerais (PUC Minas, Belo Horizonte, Brazil). The pedagogical project of the undergraduate program predicts a degree based on teaching, research and extension, enabling the contact between future teachers and different realities and policies that favor, among others, science education and social inclusion. In this context, the subject Science Workshop IV is offered every semester to second-year undergraduate students. The module provides educational practices and technical, scientific and didactic transposition, integrating all subjects of the semester through the promotion of interdisciplinary and project's pedagogy. For the development of these activities, we opted for an approach that would provide built-in dialogue with the community outside the university in a process of combined learning, in the perspective of university extension.*

The project High Abilities: children and adolescents who enjoy learning (Altas Habilidades: crianças e adolescentes que gostam de aprender, in Portuguese) was identified for a partnership. This project is directed to children of primary education in public and private schools. The initiative project of the Pro-Deanship of Extension at PUC Minas, through the Center for Human Rights and Inclusion, consisted of creating learning opportunities at the university for children and teenagers who demonstrated interest, especially those with a high-ability profile. The public policies that include students with this profile in Brazil and rather recent and, thus, restricted and not yet consolidated. With this path defined, other subjects offered in the same semester –

Psychology of Education, Didacticism and Environmental Education – were integrated with the proposed work with children and teenagers of the project, for special planning, monitoring and evaluation of the work. In about 12 weekly meetings throughout the semester, undergraduates developed the planned activities. These activities were organized based on the children's interest in investigating different themes of biological sciences through collectively constructed methodologies. Every semester, around 15 students of private and public schools of the city, aged 7-15, are involved. As many participants remain involved for more than one semester, 44 students were contemplated until the present moment. Among undergraduates, an average of 40 students is involved each semester. At the end of every semester the results of the work and research projects developed by the children under the guidance of the undergraduate students, are presented to the community with the participation of the students' parents.

Different methodologies are employed in several areas of the University used for the development of research projects: library; computer and photography laboratories; zoology, botany, genetics and human anatomy laboratories; Museum of Natural Sciences; the university woods and others. Among the products are didactic models and mockups, presentations using different media, brochures and prototypes.

The process, which is enhanced each semester, has positive reviews of all the involved: professors and undergraduate students, teachers and students of elementary schools and their families. By focusing on curiosity, discovery and collective construction of knowledge, the work contributes to the development of skills, attitudes and values that enable quality of science education, the construction of a view for teaching science in association with a cultural formation of students and a human-centered discussion of values.

Keywords. High ability students, science teaching, scientific education.

A Functional Hand-Made Model of Jules Verne's Nautilus

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Abstract. *This work presents the results of a project made by a group of secondary level students, coordinated by the physics teacher. The goal of the project is to construct and study a functional model of the submarine described by Jules Verne in his works.*

Based on the roman of the writer, we gained the technical data's of the Nautilus. The technical data's obtained by the students were compared with the data's described by Wier and constructed our hand-made model using a proportional scale-reducing of approximate 50:1. The poster presents our submarine and the technical solutions for advancing or going backward, for turning to right or left and for sinking deeper or coming to the surface. All this manoeuvres are controlled by two remote controls gained from two remote controlled car toys.

On the other hand, we didn't respected the weight data's given by J. Verne, because as you will see on the poster, with the weight given by J. Verne the submarine wouldn't be able to sink even in usual water. In the salted water from the sea, where the submarine would be in usual case the situation would be more worth.

At the end on the poster we present the issues we would like to perfect and other ideas for the future.

Keywords. Functional model, Jules Verne, Nautilus, remote controlled, submarine.



An Interdisciplinary Educational Project: Mitochondrial DNA and Megalithism in Sever do Vouga Community

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Abstract. *The development of molecular techniques for the analysis of DNA led to the emergence of new disciplines Archeogenetics and Paleogenetics with applications in the fields of Anthropology and Archaeology.*

In particular mitochondrial DNA (mtDNA), which is maternally inherited and with high copy number per cell is a valuable tool for the investigation of old (archaeological) material.

Megalithic manifestations such as dolmens (or antas) are frequent in Portuguese landscapes.

Based on former interaction with local high school from Sever do Vouga (region of Aveiro, Portugal) we propose an interdisciplinary project based activity where students from communities with archaeological vestiges may integrate their cultural heritage with an understanding of the scientific use of mtDNA to better understand their ancestral history.

The project includes Lab activities (extracting DNA, separating fragments and comparing data) along with work in history classes exploring issues such as the study of inherited and infectious diseases in past populations, reconstruction of past population movements, origins of modern humans and the relationship between humans and other primates.

Keywords. Genetics, mitochondrial DNA, megalithism, interdisciplinary.



Hunting for Asteroids at Portuguese Schools

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Abstract. *In the autumn of 2007, one Portuguese school in Cascais began searching for asteroids, with one teacher and one student, in collaboration with International Astronomical Search Collaboration (IASC) represented in Portugal by NUCLIO – Núcleo Interativo de Astronomia. Since that time till now about 60 Portuguese schools and 500 students participate in IASC asteroid search campaigns.*

Using the same techniques as professional astronomers, students learn how to detect asteroids using real images made by big telescopes, received by email and analyzed with free software Astrometrica. Students send their Astrometrica written reports to IASC with their discoveries and observations. IASC Data Reduction Team evaluates the reports and forward them to MPC (Minor Planet Center). After discovery, confirmation images are taken and more measurements made.

In addition to asteroid discoveries students make important measurements of Near Earth Objects (NEOs). These objects can pass near or even cross Earth's orbit so they can pose an impact hazard. Till now 30 asteroid discoveries and hundreds of observations were made by Portuguese schools. Participating in this project helps students to develop an awareness of global citizenship.

Keywords. Asteroid, Astrometrica, global citizenship, International Astronomical Search Collaboration, NEO, search for asteroids.



A Young & Unique S.O.S. Platform for a Sustainable World: Children Summit on Hands on Science and Environmental Education

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Abstract. *The 1st Children's Summit on Hands on Science and Environmental Education (HSCI-EE) was initiated within the frame of 9th International Conference on Hands on Science at Mediterranean University, in Antalya, Turkey on October 20, 2012. It was the first of its kind in Turkey. Two years later, the 2nd Children's Summit followed the first one. The 2nd Summit was hosted by ÇEK 3 Mart Educational Institutions in Bursa, Turkey on May 17, 2014.*

The theme of the two Summits was 'Hands on Science and Environmental Education' and they were aimed at acting as forums in which children's outlooks on their own local environments and species were expressed through their brand new sets of imaginative approaches and views that were put forward.

The mission of these Summits was to contribute in creating an environmentally concerned community of children, their families and teachers for the well-being of our Planet. Gatherings of children, from different places and backgrounds in Turkey at these unique platforms built strong energetic fields in which informations and resources were presented, hands on practices were demonstrated and exchanged. The inspirations were then taken back to their homes, schools and their communities.

Initially, the thought of creating forums in which children could come together and make proposals for solving environmental problems they had encountered was the ultimate goal for Save Our Species (S.O.S.) Project since its first implementation in Turkey in 2005.

Save Our Species,(S.O.S.) is an ongoing environmental project, whose context has continuously been developed in years, involves primary school children mostly from different parts of the country and it is carried out by using scientific processes both in schools and on field trips to natural areas during the academic year.

This presentation will outline the developments of the 1st and 2nd Children Summits on Hands on Science and Environmental Education recently held in Turkey and the samples of hands on activities that were demonstrated and exchanged as part of S.O.S. Project's curriculum in these forums.

Keywords. Children's Summit, Save Our Species Project, hands on science, environmental education.



Non-Formal Science Education: the Role of Outreach Programs, Science Centers and Science Museums





Audiovisual Participatory Content for Science Communication

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Abstract. The need science centres and museums feel to renew their languages and means of communication opens opportunities to the development of new interaction and media solutions.

In this paper, participatory contents in science centres and museums and a practical use case, developed in a Ciência Viva science centre in Portugal, are discussed. The guidelines of the research were focused on the cooperation on knowledge communication among visitors and their engagement in the production of audiovisual (AV) content. The goal of this project was to present a participation model where collaborative science videos can be produced with the contribution of the visitors. With the aim of identifying different levels of participation and participatory models that could be adopted, this work started with the analysis of some use cases with similar goals. It was followed by the development of different prototypes that propose different levels of participation.

The study was designed taking in consideration, the main interests of users and their enthusiasm towards AV content. Therefore, a "Participatory Design" approach using bidirectional techniques was adopted: visitors were invited to watch and produce their own scientific explanations in video. Four stages of observation were implemented to evaluate the categories of preference of the audience (children). Each stage was structured into sessions targeted at various classes from different schools for two months. The prototypes included the presentation of concepts/questions about science complemented with options that allowed to evaluate the target preferences for: an active role (answering), a passive role (viewing answers from other children or scientists (male or female) or making

questions. These prototypes were presented on a computer. The analysis and adjustments on the prototypes were made between sessions. The set of participations has shown that children tend to prefer by this order: answer, hear the explanations of scientists (male) and finally to make their own questions. The preference was always towards video content.

It was concluded that there was collaboration and mutual support among peers. Children showed total willingness to participate, specially to answer, being however curious to hear the other presented options. Based on the analysis of the results a proposal for a participatory model was developed, involving visitors in providing and receiving audiovisual contributions to help clarify science concepts. The proposal also offers some relevant indicators for a potential implementation in a Ciência Viva science center.

Keywords. Audiovisual contents, science exhibitions, knowledge communication, collaborative production, participation.



How a Sustainable Way of Collecting Bivalves Becomes Unsustainable: Case Study in Ria de Aveiro

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Abstract. Ria de Aveiro is a popular place where professionals and the population who lives nearby go to collect bivalves (the population does that as an economic complement). The species collected are: cockle (*Cerastoderma edule*), grooved razor shell (*Solen marginatus*), pullet carpet shell (*Venerupis senegalensis*) and grooved carpet shell (*Ruditapes decussata*).

This work study is based on the observation which has been carried out for the last 10 years in the area and concludes that:

The legislation applied to this activity was and is thought in order to keep the sustainability of Ria de Aveiro. In this context, the majority of the capture of these bivalves is being performed by hand or with small tools, according to the law. Although the impact is thought to be almost none (both in the environment and with the species), compared to some other capture techniques, the reality shows that these bivalves are being collected far below the legal size by adulterating the tools used in the process. Also, some legal tools are not the best to use in the collection of bivalves because they cause damage to the intertidal bottom of Ria de Aveiro. Both situations endanger the sustainability of the biodiversity of bivalves in the area.

Keywords. Collection cockle, bivalves, clam.



Hands on Science: The Case Study of Pedra do Sal Interpretation Center

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Abstract. Pedra do Sal Interpretation Center offers an original experience, and the possibility to observe and touch all of Avencas beach fauna and flora, once it is equipped with a touch tank, representative of a rocky shore tide pool. In 2013 the Municipality of Cascais developed and installed the permanent exhibition "Cascais, from Land to Sea" and adjusted all of its scholarly activities to this theme. Since the opening of the exhibition, the number of visitors of Pedra do Sal Interpretation Center has been increasing and is currently four times higher than in the past year (2012 vs 2013).

Keywords. Cascais, coastal zone, hands on sea experiences.

New Color Pencils, for a New Drawing

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Abstract. This short essay attempts to summarize a dedicated, courageous, passionate and comprehensive work by a young engineer in the Environment City of Portugal, seeking that it can be just as inspiring to more and better work (and does our country need it!). Keeping in mind the citation recorded in memory: "A Country without the participation of young people, is a bankrupt country", this is also a work by, for and with Young. More competitive cities will also give a better, fairer and more balanced country, in defiance of a complete experience.

Keywords. Joy, environment, creativity, passion, persistence.



Ponds with Life: a Hands-On Environmental Education Campaign on Ponds Conservation

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Abstract. "Ponds with Life" - Researchers at School is a science communication project that aims the conservation of ponds for biodiversity, raising the young public awareness and encourage interest for careers in the area.

The project was applied to 8 high-school groups of students, allowing the direct contact with the conservation scientific research through a set of scientific and pedagogical activities, contributing to the knowledge, aware and engagement with ponds.

The two-phase project evaluation is being applied and already showed a poor previous contact, interest and knowledge about ponds as well as negative attitudes towards biodiversity that this project aims to change.

Keywords. Conservation, evaluation, informal education ponds.



How Illegal Capture of Glass Eel (*Anguilla anguilla*) Affect Biodiversity in Tagus River

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Abstract. *The eel is a catadromous fish that grows in rivers and spawns in the sea. Every year, between November and the end of March, when glass eels migrate up river, illegal nets catch them in the Tagus River (downstream of the estuary, in Portugal). Every day, authorities organise policing actions to capture illegal nets placed in river specifically intended to capture glass eels. Usually, the seized nets are filled with glass eels and other species, since the net is very narrow (1-2 mm); it therefore captures everything. The mortality rate caused by these is huge and affects the eel's preservation and the river's biodiversity.*

Keywords. Eel, glass eel, illegal nets, policing actions, biodiversity, Tagus river.



Hands-on-Science in the “European Research Game” Project

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Abstract. *Present day teaching and learning paradigms acknowledge proactive and curiosity driven attitudes as crucial for the development of competences at cognitive, intrapersonal and interpersonal levels. Skills for the 21st century often refer non-cognitive skills as fundamental, such as critical thinking, problem solving, collaboration, effective communication, motivation, persistence and learning to learn. Projects such as the European Research Game (ERG) were developed to fulfil such need. ERG is a European project developed under partnership between Italy, Portugal, Turkey, Germany and the UK. It aims to engage students in the methodology of scientific research through an Internet-based Serious Game.*

The game was divided in two phases, the first consisting of a hands-on-science approach with an experimental project and the second an online competition. The experimental project was developed within the field of Biodiversity and supervised by the mentor (played the teacher). This project required the application of the scientific method, namely the identification of a research question and the ways to reach answers. The project results were communicated and shared on the project platform with the other participants, in English, using video, a poster, or any other suitable means.

A total of 35 teams from 8 European countries participated in the Game, of which 14 teams and close to 100 students from Portugal, aged between 11 and 18.

The teams were given freewill to implement any experiment to apply the principles of the scientific method. The University of Aveiro project team in collaboration with the science centre Fábrica Centro de Ciência

Viva de Aveiro, implemented two experiments to support the mentors, one focusing on invertebrate soil diversity and the other on effects of different light wavelengths in plant photosynthesis.

The students could readily apprehend the various steps of the scientific method as well as the advantages of sound experimental design, the use of controls, replication and avoidance of confounding factors. The reporting of the work allowed them to train presentation skills and the use of media. Video presentations were preferred by many teams and the involvement of the students and mentors was visible on the quality of the work submitted. Learning-by-doing and mentorship played a crucial role in the acquisition of new knowledge and overall in the way the Research Game intended to engage the participants.

Keywords. Learning-by-doing, biodiversity, serious games, scientific method, 21st century skills.



CIIMAR at School: Hands-on Activities in Marine and Environmental Sciences

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Abstract. *Hands-on science activities provide a lively effective approach to introduce school students important topics related to marine and environmental sciences.*

The project CIIMAR at School combines an offer of specialized talks and experimental activities, aimed at developing interest and curiosity about these themes and improve scientific literacy. The activities were taken to five high-schools in a novel approach allying the collaboration of university students.

Anchored on CIIMAR researchers and technicians, the university students performed the activities with their high-school colleagues helping to enhance

curiosity about the scientific activities. The youngsters were very receptive to their presence and their experience as university students. The experience suggests this interaction may bridge the gap between high-school and university education, and encourage interest for careers in these scientific areas.

Keywords. Experimental activities, marine and environmental sciences, high-school and university students, interplay within the educational system.



Linking Science Garden to School and University: Teacher Education, Research and Dissemination

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Abstract. *Science Garden [SG], located in the Department of Education at University of Aveiro [UA], is a non-formal science education context designed to promote children's explorations (4 to 12 years old). It offers challenges and outdoor exhibits focusing on key themes of Science – Forces and Motion, Light and Water. This communication aims to clarify SG's strands: education and dissemination of science and technology; research in science education; and teacher education.*

Keywords. Education and dissemination of science and technology, teacher education, research in science education, articulation between school and a non-formal science education context.



HoloNet: Hands-on Holography

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Abstract. *Holography is an experimental technique based on optics and photonics. It involves different topics on physics, such as waves, interference and diffraction. These subjects are include in the curricula of formal education.*

We believe that holography can be an important strategy, for science education and outreach programs, based on hands-on activities and problem solving. Holograms can be a contextualise way to promote scientific culture and technology.

In this sense, we have developed the HoloNet project, which is dedicated to experimental teaching of physics and science communication. This project involves a framework with two main purposes: scholar teaching and public engagement with science.

All activities developed and implemented at Schools or Science Centres use two types of holographic systems. The advanced holographic system with better equipments and materials which allows the production of different type of holograms and bigger holograms. And the portable holographic system which allows the production of smaller reflection holograms. The advanced system is based on 20 mW He-Ne laser, spatial filter, first surface mirrors, beam splitter and breadboard optical table. The portable system is based on 5 mW semiconductor laser with lens and metal base.

During the last years, we have developed outdoor activities dedicated to general public and schools. These activities have the goal to popularize holography as a state of the art technique for 3D imaging. These activities involve one hologram exhibition for a Science Centre at Cape Verde and one holography interactive exhibition dedicated to shopping centres and schools.

This paper will present in detail all equipments, materials and setups used on experimental holography. The educational

program, activities and contents will be explore and discuss. All results obtained will be present and analyse. Exhibitions and different holograms produced will be present and final conclusions will be drawn.

Keywords. Science outreach, science communication, physics education, optics, holography.



Advanced Courses: A Novel Strategy in the Teaching of Advanced Science Concepts to High School Students and Teachers

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Abstract. *The Instituto de Educação e Cidadania (IEC) is an institution that works closely with schools, the municipality, research institutes and the universities of Coimbra and Aveiro. The IEC is an interface to facilitate the interaction between these institutions. The IEC developed an advanced studies program for schools including practical courses in the sciences, seminars, and promotes the organization of Science clubs in schools. The advanced courses are taught by young scientists from research institutes and facilitate the transfer to schools of advanced concepts and experimental approaches. The IEC is mobilizing the community around schools in the Bairrada Region, in Portugal.*

Keywords. Experimental science, advanced courses, engagement in science, non-formal education.



MicroBio 12: from the Lab to the Classroom

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Abstract. The project *microBIO 12 – from the lab to the classroom*, funded by *Ciência Viva* in the context of the program *Escolher Ciência*, aims to promote learning of biology-related issues, through the implementation of experimental activities in high school.

Topics addressed in the course of this project include antibiotics use, antibiotics resistance and sunlight exposure habits. In the activities proposed, students perform basic microbiology procedures; interpret and discuss experimental outcomes; develop scientific knowledge and creativity skills; strengthen the ability to understand and position themselves critically with regard to the topics discussed; and become familiar with a number of useful concepts for their academic and personal life.

It is expected that these activities may foster other hands-on science initiatives.

Keywords. Experimental activities, high school, microbiology, science education.

Visiting Science Museums

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Abstract. To improve science and chemistry learning in our society it is necessary to think about different educational approaches. In this sense, visiting a science museum nearby is also an excellent opportunity for primary school students and secondary school students as well as their families. There are two museums we have

successfully worked with in the past to the benefit of secondary school students. The Museum of the History of Pharmacy at the University of Barcelona located inside the Faculty of Pharmacy and the Barcelona Perfume Museum. It is important that young students comprehend that drugs, medicines, perfumes and scents are chemicals. Visits to a science museum are usually preceded by preparatory work in the classroom, imparted by science secondary school teachers. To make the students do some preliminary work on the subject by Internet at home is also discussed in this work.

Keywords. Medicines, perfumes, science, secondary school.

Reading Stimulus in Science Center Visits

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Abstract. This study, developed at the Science Center Exploratório – *Ciência Viva*, aimed at observing, describing and verifying the visitors behaviour (in terms of learning) during a school group visit to a science exhibition in a non-formal learning environment, but also at testing the effectiveness of exhibit labels Reading Stimuli. To conduct this study, we selected two interactive exhibits in the exhibition “Keeping fit... with science”. To achieve our objectives, a study was made (with students from the third cycle of basic education) based on questionnaires, observation grids and a Reading Stimuli as instruments of data collection. Despite the exploratory nature of these studies, results indicate that in response to the Stimuli tested, many visitors read the exhibit labels in the search for the answer.

Visitor-based studies are intended to contribute to the improvement of the relationship between the school and the

Center and to improve the quality of the visits to Exploratório – Ciência Viva.

Keywords. Hands-on activities and texts, museums and science centers, non-formal learning of science, reading stimuli, science communication.



PmatE – 25 Years at the Forefront of Education

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Abstract. “Projecto Matemática Ensino” (PmatE) was created in 1989, by the Department of Mathematics of the University of Aveiro. Bearing in mind the weak outcomes in Mathematics, PmatE introduced new methods for the study of this scientific area, namely online games and competitions for all degrees of education. These competitions and games were recently extended to other scientific areas. In order to accomplish the goals initially projected, PmatE developed specific software, the Question Generator Models (QGM). This software is the basis of all computer games and competitions that take place, each year, among Portuguese students through the projects’ online platform.

Keywords. Competition, education, question generator models, science.

Keeping Fit... With Science

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Abstract. This presentation describes the main permanent interactive exhibition “Keeping fit ... with science”, associated with the second stage of the new Exploratório Ciência Viva, in Coimbra, Portugal and reveals the theoretical framework of its development. The name of the exhibition is deliberately ambiguous, to encompass the various dimensions of the aimed objectives. Health and Medicine, as well as Sport, – under a science perspective – are among such dimensions, but this is, above all, an exhibition that uses Health and Education for Health as a context for the exploration of fundamental scientific facts and concepts.

Keywords. Health, interactive exhibition, non formal education, public involvement with science.



Coordination Chemistry: a Bridge over Troubled Waters (or not) in a Wonderful World (or even better)

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Abstract. Coordination Chemistry appears in chemistry programs or text books as a chapter of “Inorganic Chemistry” being taught like that and in general no one gives it the enormous relevance this subject has in modern chemistry. This work intends to present coordination chemistry as a bridge towards the majority of the “other” chemistry chapters, and try as well to demonstrate its capacity to link chemistry to biology, biochemistry, health sciences, new materials, energy generating devices, and

environmental solutions, just to list a few possibilities. In today's scientific world, interdisciplinarity is a major education goal and, in our opinion that can be reached using coordination chemistry.

Keywords. Bridging sciences, modern chemistry in today's world, coordination chemistry, interdisciplinarity.



Time to Plant Science. A Choosing Science Project in the Botanic Garden of Coimbra

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Abstract. "Time to Plant Science" is a project developed by the Botanic Garden of the University of Coimbra, in Portugal, approved by the program Choose Science supported by Ciência Viva, the National Agency for Scientific and Technological Culture. This project is being developed in collaboration with the secondary school of Quinta das Flores (Coimbra, Portugal) and the Department of Life Sciences of the University of Coimbra since September 2013 and will continue until December 2014. The main aim of the program Choose Science is to provide secondary students with opportunities to contact with science and scientific research in university centres, in order to stimulate the option for choosing scientific courses at the university.

Keywords. Botany, choosing science, non-formal education, plant evolution, secondary students.



Motivate to Learn: Other Ways of Learning Biology, Maths and Other Sciences

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Abstract. The development of teaching and learning strategies that effectively assist in the understanding of scientific knowledge is an ongoing challenge. Doing experiments outside the classroom, one of the recommended approaches, presents some risks, because students can divert their attention from the pedagogical objective of the activity. However, experts agree in considering that learning outside the classroom can be used to facilitate Education. Providing students with learning activities in relevant situations beyond the walls of the classroom is vital for helping them to appreciate their experiences from a variety of different perspectives. Furthermore, experiences outside the classroom provide opportunities to practice skills of enquiry, values analysis and clarification, as well as problem solving in everyday situations, thus enhancing learning.

A preliminary analysis of the results suggests that the initiative boosts the curiosity of students, especially in what concerns some particular details like the information about the brain, the amount of produced fluids and the size of the digestive tract. Students used different numerical representations and performed calculations to figure out if they had the "perfect" Vitruvian body measurements. Students of the 9th grade were specially engaged within this task, powering the "vanity" in their perfect measurements. The aim of the present work is to assess whether this activity, clearly exciting and motivating for students, also contributes to make school syllabus more relevant and meaningful for

them and to promote the overall quality of their education.

Keywords. Hands-on, students, motivation, learning, exhibitions.



Citizen Science as a New Strong Form of Social Engagement with Science

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Abstract. Citizen science is emerging as a new form of interaction between society and science, allowing for social participation and involvement with scientific activities. It has a great potential for social engagement with science, which is still very little explored. Most of the initial citizen science projects were directly associated with environmental education, and this tendency has been maintained, although recently projects in other areas have appeared and developed, namely in astronomy and health. This has raised the question of whether citizen science is just a form of education, or whether through it citizens do really participate in the scientific enterprise. I will make a case for the second. I report here the case on the involvement of the Science Museum of Coimbra University in a large scale international citizen science project. The project involved dozens of schools and other groups such as senior academies, which actively participated in analysing data, as a scientist would. The results of the interactions with the project, including discussion sessions with the scientific leaders of each experiment revealed to be extremely engaging. Also, participating citizens referred that they understood the tasks in which they participated, understood better what is to do science and felt involved in the process. I also discuss the various levels of engagement of citizens in citizen science projects, and how important it is to make this clear and explicit.

Keywords. Citizen science, social engagement with science, science education, citizen engagement with science.



Art and Science in the Park: Disseminating Science in Public Space

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Abstract. Science dissemination in Brasil has been boosted during the last few years and one can observe an increase number of science museums and exhibits being installed in different regions of the country. However, these actions take place mainly in spaces located in universities and museums, and the visits are predominantly organized by fundamental and intermediate levels schools. These characteristics, on the other hand, inhibit the great majority of the population that does not have any connection to an educational system to participate. Another reason for the low attendance is the still existing myth that science is for “educated and intelligent” people, therefore, not for the general public. One action that can modify the above situation is to take these spaces to the population, without the formal aspects of a museum or alike. With this objective in mind, a group at the Institute of Physics of the University of São Paulo started, in March 2007, a project named Arte e Ciência no Parque, partially supported by the Program of the Ministry of Science, Technology and Innovation in Diffusion and Popularization of Science, aiming to reveal aspects of science and technology in our daily life that can be understood by lay people.

The strategy was to present simple experiments that could be executed by the public and several demos in public parks in the city of São Paulo. During the first 2 years, the group took to 8 parks, about 50 experiments of physics, biology, mathematics and challenge games. Assistance and explanations were given by students of University of São Paulo (USP)

from different courses, coordinated and supervised by 3 lecturers, 2 from the Institute of Physics and 1 from the Institute of Biomedical Sciences. Similar activities also took place in 4 public fundamental and intermediate levels schools. During the first year, 4 artists collaborated with musical and performance activities involving mainly children.

As the number of requests of activities by the public schools was increasing and as the group is small, never more than 15 people (including some volunteers) and basically formed by students from the University, the target public was shifted from the general public to the primary and secondary schools pupils and teachers, from 2009 onwards.

Apart from the exhibits and hands-on experiments, workshops on production of simple devices to be used in demos and experiments were introduced, both for the teachers and the pupils. These activities take place in the schools and an inclusion program offered by USP to students from public schools during the second academic semester.

One week courses on specific topics of optics, sound, biomechanics and construction of simple experimental devices were offered to physics and science teachers during their school vacations. All 10 courses were attended by approximately 300 teachers from different towns.

During the last 5 Annual Condense Matter Meetings, Arte e Ciência was invited by the Brazilian Physics Society to present its exhibit to the schools in the towns where the event was held. This group also participated in other scientific events in São Paulo and cities in other parts of the country.

From 2007 to 2013, about 40 students from different courses at USP were trained as monitors in science exhibits, 20 fundamental and intermediate public schools in São Paulo and neighboring towns were visited, exhibits were presented in 15 scientific events and fairs and 8 public parks, and an estimated 90,000 visitors participated in these activities.

Although these figures show that the approach adopted is feasible, a few challenges still need to be tackled and these include: adequate languages to communicate with the different publics, improved training of the monitors, how to

involve the schools and their teaching staff and evaluation of the result or impact of these activities in the different publics.

This project proved that it is possible to introduce a culture in science to the general public, especially children and youngsters in school age, through simple experimental activities that show the connection between daily life phenomena and science, as well as instigating their curiosity towards science and scientific activities. These actions can be improved if school teachers are involved by incorporating similar practices adapted to the needs of their classes.

Keywords. In-formal learning, science.



Astronomical Caravan: Scientific Spreading in the Interior of Minas Gerais

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Abstract. The project "Astronomical Caravan" is a mobile Science Center, Planetarium, Observatory roving and more. Is a project approved by the CNPQ and Fapemig (funding Agencies of the Brazilian Government and the State of Minas Gerais) and has the goal of spreading the Astronomy in twelve different cities in the interior of Minas Gerais, in the period from July 2010 through August 2012. Happens in cities of Minas Gerais in the Southeast region, where the teaching of Astronomy is deficient or non-existent. It is performed by the Astronomy and Astrophysics group of the Museum of natural sciences of the Pontificia Universidade Católica de Minas Gerais and Interactive Science Learning Center "Experimentário". Before the event, are sent, by e-mail, to the municipality, the roadmaps and service capacity, activities, images and details about the necessary infrastructure.

The cities that receive the Astronomical caravan are responsible for mobilization, lodging and meals from the team and provide space and necessary structure for

installation of equipment and development of the activities. Are actions of the Caravan: (a) planetary sessions; (b) astronomical observation; (c) Workshops and demonstrations; (d) lectures; (e) sessions plays. Instruments for assessing the effect of the actions on the participants learning are still applied.

So far, the "Astronomical Caravan" was in the municipalities of Arcos (600 participants), Serro (1600 people), Pitangui (200 people), Guanhães (1100 participants), Brumadinho (200 people), Santana dos Montes (500 people) Barbacena (1000 persons), Esmeraldas (400 people), Contagem (on two occasions, 700 persons), Manhuaçu (1000 persons) and Maravilhas (1200 people), spreading the Astronomy for a total of 8500 people.

90% of this audience is composed by the school community, most of them students; however occurs the participation of teachers, employees of schools and parents of students, in addition to the general population. The actions are very well accepted by the population of the municipalities and testimonials from participants suggest that the event could happen more times in a year and also in more municipalities. Reports of young people, without professional perspective before the event, suggest a change in behavior after that: "I know what I'm going to be ... astronomer" or "scientist". A brief analysis of maps of concepts shows that learning occurs in all actions carried out in the caravan.

Keywords. Dissemination of astronomy, scientific spreading, cities of the interior, Minas Gerais.



Atractor: Interactive Mathematics

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Abstract. Atractor is the Portuguese word for attractor and it was the name chosen for a non-profit association created in April 1999 in Portugal for the popularisation of mathematics. Its purpose is to attract people to mathematics at different levels, trying to reach the broadest possible cross-section of the public.

To this purpose Atractor uses interactive physical modules or virtual exhibits. In the last years, its efforts have been focused essentially in the virtual part, although Atractor still keeps a physical exhibition on display in the Rectory building of the University of Porto – the exhibition "Symmetry playing with mirrors" (a slightly enlarged version of an exhibition with a similar name built at the University of Milan). In what concerns the virtual part, Atractor has developed several mathematical games, which can be downloaded from Atractor's website: <http://www.atractor.pt/>

The program Atr Mini, which can be used by primary school students, has proved to be successful in engaging small children for Mathematics. Another program, GeCla, helps students to find symmetries and to classify patterns/friezes/rosettes. In 2013, using GeCla's competition mode, Portuguese and Italian students of two High Schools were involved in the first International GeCla competition – Portugal x Italy and this year a similar experience was carried out with two Portuguese schools.

Atractor's website also provides a big range of mathematical materials, which include many interactive applications: applets (more than 750), swf movies and more recently, CDFs (a format for the web, which uses the Mathematica technology underneath).

Following the recent developments in stereo technology, which led to the introduction of 3D televisions/monitors in the market, Atractor has recently converted many of its 3D contents - applets / images / movies - into the 3D-televisions format and has produced new contents for that purpose.

Most of these stereoscopic contents visible in 3D TVs are accessible from the website.

Keywords. Atractor, exhibition, GeCla, virtual exhibits, Atr Mini, mathematics, Atractor's website, applet, swf movies, CDFs, 3D technology.



Ciência Viva Network: Hands-on Science at National Scale

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Abstract. *Ciência Viva is the Portuguese Agency for the promotion of scientific and technological culture. It was established in 1996 and it works as an open program, promoting alliances and fostering autonomy in action. Ciência Viva mission has three main goals: the promotion of experimental teaching of science and science education at schools, the implementation of a National Network of Science Centres, and the implementation of national campaigns for science communication and science promotion, providing direct contact with scientists. Since 1996, several programs, dedicated to hands-on approaches, were implemented in Portugal. One example, with important results, is the National Network of Ciência Viva Science Centres. This network have a collaborative framework, based on hands-on activities, interactivity, problem solving and inquiring based contents. Science Centres involve several types of contents, such as exhibitions, labs, projects, shows, workshops and others. In this talk, the Network of Science Centres will be presented and explored. Some cultural and regional contexts will be discussed and the scientific programs will be analysed with focus on "doing" and on hands-on activities.*

Keywords. Hands-on, science centres, science literacy.



CSI and Prenatal Diagnosis to Teach Molecular Biology. Lab-it: Itinerant Laboratory

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Abstract. *Molecular biology and genetics are two research lines that evolved rapidly during the last decades, in a way that also emerged in our day-to-day life. Currently there are several routine decisions and interpretations that depend on molecular biology techniques. For this reason it is important to provide tools to high school students in order to promote their capacity to understand the applications of molecular biology, form independent opinion and contribute to later make decisions consciously. However, the basic knowledge and techniques associated to these concepts are not easy to fully understand without practical courses. Molecular biology courses and practical training are common at the university level. But to be able to reach a wider public it is mandatory to bring these practical courses to the high school level (particularly to 11th and 12th grades). However, most of the equipment and reagents to be used in these courses are expensive, require specific expertise to be used adequately and thus not usually available in high schools.*

Here we present a project developed specifically for the high school level, with the objective of bringing a molecular biology laboratory to the schools without requiring additional work or expertise from the teachers but working in collaboration with them to provide high school students a hands-on experience. For this we developed an itinerant laboratory, fully equipped with micropipettes, centrifuges, vortex, PCR machines, electrophoresis apparatus and others to be able to implement a practical course on a high school. Our main goal is to provide laboratory experiments where we can explore subjects such as DNA extraction, PCR, electrophoresis, heterozygosity, genetic diversity, and molecular mar-

kers, DNA mutations and genetic diseases, among others. We have also noticed that some of these concepts are much easier to understand if we implement and explore them on a realistic or attractive scenario. For that we developed several experimental settings associated to different scenarios that the teacher, together with their students, will choose before the practical course. Two of the most popular scenarios are: (i) the application of molecular biology techniques in a crime scene to answer specific questions. And (ii) a scenario of prenatal diagnosis related to genetic pathologies. Both forensic and medical applications are sure to drive students' attention.

On both scenarios we perform DNA extraction, PCR screening for two molecular markers, electrophoresis of PCR results, visualization on ultraviolet lightbox, and finally interpretation of the results.

All the experiments are performed by the students, which at the beginning of the course are divided in small working groups. Each group will do all the techniques proposed, with different samples in order to have multiple results for comparison at the end of the experiment.

This project was funded by the National Agency for Scientific and Technological Culture and also supported by the local government education offices (Câmaras Municipais), and ended in 2013. Due to its enormous success and support from all teachers, schools and students involved, we aim to find new/more financial support to continue to provide this service to all high schools from Algarve region, and open the collaboration and participation to other institutions to reach general public and society. A collaboration through Centro Ciência Viva de Lagos is emerging.

Keywords. Heterozigosity, molecular biology, PCR, practical course, prenatal diagnosis.

Fábrica Ciência Viva Science Centre: 10 Years of Hands-on Science

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Abstract. *Fábrica Ciência Viva is a Science Centre (FCVSC) that belongs to the Portuguese Network of Ciência Viva Science Centres. This project started in 2004 and it resulted from a partnership between University of Aveiro (UA) and the Portuguese Agency Ciência Viva.*

The Science Centre has 3.000 m² and it involves 12 scientific contents, based on 3 exhibitions, 3 labs, 2 workshop places, 1 children's room, 1 maths' room, 1 auditorium and 1 media room. All science contents derived from ideas and research projects of UA and they were developed by the team of FCVSC. During the last 10 years, several activities were implemented to different types of public. Fábrica's goal is the promotion of science and technology, through an annual program that contains 4 main topics: indoor, outdoor, media, and products.

Indoor activities involve 12 spaces at science centre and are related with physics, chemistry, biology, geology, robotics, holography, maths, nanotechnology and engineering. Types of activities are based on exhibitions, labs, workshops, shows, science cafés and storyteller.

Outdoor activities are implemented all over Portugal at other entities, such as museums, libraries, theatres, companies, shopping malls, or in open air, such as gardens, parks, city centre, beaches, mountains, rivers, plazas and streets. Activities can involve several areas of science and technology. Types of activities are based on lab sessions, demonstrations, workshops, science shows, science in the summer, field trips, talk sessions, maker sessions, science fairs, night science sessions, science adventures, training and storyteller.

Media contents are develop to TV channels, radio broadcast, press and web platforms.



These products are dedicated to different publics, dealing with several science topics and in different types of narrative.

Product development, construction and commercialization is an area of great investment at FCVSC. During the last 3 years we started the development and construction of exhibits, kits, books, DVDs, thematic rooms, labs, interactive exhibitions, touch screen displays and a Interactive Science Centre at Cape Verde.

Each year 70.000 people are involve in our Science Centre, where 50% are visitors of exhibitions and the other 50% are public that participate in outdoor activities.

The itinerary project was developed to bring science closer to the public, to take science into non-traditional places, to show science in day life society and to promote social inclusion.

The annual program is constructed promoting links between schools and Fábrica and foster connections with society. Science education projects are organized with schools to involve teachers training and workshops with students. A science and society project was organized to include contents that were prepared in cooperation with partners, and to implement activities for the general public.

All these program and projects are built for science communication with focus on “doing”, “make”, hands-on, problem solving and inquiring base learning.

In this talk all scientific contents, exhibitions, labs and other rooms are present in detail, with focus on types of activities and implementation with public.

The annual framework and outdoor program will be analyzed, highlighting the political engagement, sustainability and interaction with society.

Outreach programs and results obtained will be present with focus on hands-on strategies, scientific topic and activities with and for society.

Keywords. Science center, outdoor activities, outreach programs.



Instituto de Educação e Cidadania (IEC): An Interface between Schools, Universities and Research Institutes to Engage Young People in Science

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Abstract. IEC is a private non-profit institution, in a rural area in the center of Portugal, and constitutes an interface between the close by universities/research institutes of Coimbra and Aveiro and local schools. The IEC takes advantage of this proximity to facilitate the transfer of knowledge and educational expertise from the academic media to the schools. Thus IEC, in collaboration with members of the academia, developed an Advanced Studies Program of science courses, lectures and science clubs which brings young scientists in close contact with students and teachers in the schools. The concept of Advanced Studies refers to intensive hands on teaching of selected interesting concepts of modern science and technology, and how this knowledge is obtained. The Advanced Studies Program goes beyond the regular school curriculum, and students and teachers adhere to the program on a voluntary basis. For students in the 1st and 6th, IEC has generated a program of experimental sciences. This program is linked to another program of reading and writing in which students improve their skills by reading and writing about their observations in the laboratory and also by interpreting the details of the life stories narrated in the biographies of great science personalities. The reading of the biographies is done in parallel to the participation of students in the science courses of Biology, Chemistry, and Physics. For the secondary and high school, IEC also developed a program that intervenes to create modern school laboratories and facilitates the visits

of students and teachers to research institutes and science museums. Each course in Physics, Chemistry, Biology and Social Sciences lasts ten weeks, three hours per week, and is taught by young active scientists who interact in the laboratory with students and teachers. We have observed that engaging students in the disciplined practice of Science automatically generates a friendly and collaborating spirit among the students. This approach has influenced positively the school environment, the student's appreciation for Science, develops new social relations between students, and contributes to more informed and assertive choices by students. Moreover, high science capital may be the basis of science careers aspiration, and probably also influences positively several personality traits.

This work was supported by FCT, FEDER and COMPETE (SFRH / BPD / 81509 / 2011, SFRH / BGCT / 52116 / 2013), Ciência Viva and Câmara Municipal de Oliveira do Bairro.

Keywords. Engagement in science, interface between schools and universities, advanced courses, non-formal education, science capital.

Literature and Science: Hands-on Storytelling

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Abstract. Storytelling can promote curiosity and interest on techno-logical and scientific knowledge and on literature. For all ages and at several places, such as school libraries, science centres, city gardens, Reading/Telling Performances can become peculiar science communication acts. After capturing attention with "once upon a time" eternal enchantment or with an expressive reading moment of a selected variety of texts, storyteller leads audience to surprise, while unveiling a certain scientific concept, principle, phenomenon that literary text hides inside.

Single voice and gestures are used to share literature and explore science. Classical or modern literature, oral narrative or published authors, well known authors or unknown ones can introduce basic or frontline science subjects.

"The Turnip", a classical fairy tale collected by Grimm brothers, gives way to a scientific humorous point of view that discloses very simple notions on biology, chemistry and physics behind the plot. As an upshot, an invitation: everyone can come on stage to take part in an experiment that confirms one of the scientific statements.

Keywords. Narrative, science communication, spherification.

Mathematical Circus

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Abstract. The Mathematical Circus is a project that aims to promote the general curiosity and the like for mathematics, through a varied set of attractive and recreational activities. All the activities of the circus are mathematical in nature, despite motivating playful and entertaining experiences. We wish to spread, itinerantly, the wonder and fascination of mathematics basing our inspiration on the usual circus. Thus, the magic, the surprise, the wonder, the clowning and the jokes associated with the circus will be the means used by the Mathematical Circus team:

<http://www.ua.pt/dmat/PageText.aspx?id=15173>

Every show has a host, a magician, a contortionist, a clown and a DJ. The activities use different materials and mathematical areas: the magician guesses your birthday or a hidden playing card using binary codes; the contortionist unravels joined ropes or turns inside out the reflector vest of a handcuffed driver using topology; the clown takes advantage of an unfair division of sweets misusing arithmetics. Altogether, these and other tricks, spiced

with the DJ's musical choices, enchant and amuse the audience for about one full hour. After two years of itinerancy, the Mathematical Circus of Aveiro has reached over 5000 spectators, most of which aged 6 to 18. It is hosted by the Department of Mathematics of the University of Aveiro.

Keywords. Mathematics, recreational activities.



MoBIDiC. Merging the Edges between Scientists and the Public

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Abstract. In June 2014, CIIMAR launches officially an online platform for biodiversity monitoring, relying on a collaborative model between researchers and the public. Since 2005 MoBIDiC - Intertidal Biodiversity Monitoring and Ocean Sciences Dissemination - worked exclusively with schools getting students and teachers involved in field trips to rocky shores in the north of Portugal. Now MoBIDiC opens to a wider public allowing different levels of participation and data acquisition.

Through an online registration participants introduce data from their field observations. The data is then integrated in an open-source database, co-created by citizens and scientists.

In this communication we'll present the process of construction of the database, including the selected parameters for sampling each intertidal taxonomic group and also the levels of monitoring according to the degree of citizens' knowledge and the forms of data validation.

It will also be addressed to the evaluation scheme of MoBIDiC project dealing with three dimensions: i) social - assessing the skills developed by the public in their participation; ii) scientific - evaluating in what extent and how the citizens' data is used by

the scientific community; iii) institutional - assessing MoBIDiC impact in other marine research institutions, national or European. MoBIDiC is supported by a number of technical and pedagogical resources providing tools to empower the citizens to go on with a monitoring scheme autonomously. These resources, specifically designed for the project, take an online format and include sampling protocols, field guides as well as audiovisual documentaries. Some of these resources will be presented in HSCI 2014 conference.

Keywords. Intertidal biodiversity, monitoring, citizen science, outreach.



Photography: When Science Meets Art

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Abstract. Arts and Sciences are often regarded as separated disciplines. However collaboration between science and art may provide an interesting interdisciplinary approach. Through photography, science may influence artistic thinking and arts could be a tool to communicate science.

"Ciência em Flash" is a scientific photography contest promoted by Fábrica Ciência Viva Science Centre and University of Aveiro. The contest aims to allow the public to communicate a topic of science through photography, and to increase their interest in science through art.

During the last years, two photography contests were promoted: one dedicated to chemistry "Química em Flash" and other dedicated to maths "Matemática em Flash". The former was part of a set of activities carried out throughout the International Year of Chemistry (2011), and was directed at photographs showing any type of chemical phenomenon, or reflecting the importance of chemistry in any aspect of the daily life. The latter was part of the celebration of the

Mathematics of Planet Earth International Year (2013) and aimed obtaining photographs that show the role of math on Planet Earth.

The target audience of these contests was adults (general public) and students of all ages. Participants could apply individually or in groups (in case of students). Each participant could submit up to two photographs under one of the different categories. Categories were defined as adult or, in case of students, according to their school grade. Submitted photographs were assessed by a jury and the top three in each category were awarded.

In “Química em Flash” 150 photographs were submitted while “Matemática em Flash” had a total of 256 participant photos, both with an international scope.

Selected photos were showcased at the University of Aveiro, Fábrica Ciência Viva Science Centre and a local shopping center. The success of “Ciência em Flash” may lead to believe that people’s interest in different scientific areas can be nurtured through photography.

Keywords. Science, art, scientific photography contest.



Potential of Science Club Networks for Public Understanding of Science and Technology Communication

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Abstract. *The paper defines the dynamics of science clubs as robust platforms for communicating science and technology aligned with several local level considerations. This is in the context of the fact that people need to understand the pervasive nature of science and technology today more than ever before, as these two aspects influence all aspects of life. In all democratic forms of government an increasing number of people are involved in decision making at the local and the national*

level. Such scientific and technological issues as nuclear energy, global warming and climate change, preservation and conservation of biodiversity, genetically modified crops, etc., dominate the development mosaic and need to be debated before national policies are formulated. To generate meaningful and effective debate, the public needs to be well informed and updated on information so that informed decisions can be made. The debate should not remain confined among elite groups but emerge with the direct involvement of people from all walks of life. A robust decentralised approach to enhance public understanding of science and technology is therefore essential.

Currently, several approaches and media are tried with equal emphasis in developed and developing country contexts. . Every form has its own significance, utility and limitations as well. Such institution as science museums, science cities, satellite and cable TV and radio, specialised agencies for S&T communication, and both government and non-governmental organisation play their role quite effectively in taking science to people. These approaches are however capital intensive and are based on the deficit model of S&T communication.

For example, India’s manifold diversity including cultural, social, religious, linguistic and regional is unparalleled in the world. Importantly nearly 65 % of population are rural and a significant part of the population is not literate. The reach of mass media, except radio, is still limited. These ground realities present a formidable challenge to a science communicator. In such a scenario, any centrally planned strategy employing modern means of communications does not stand much chances of success. Any strategy to be effective should be “participatory and in the local language through the familiar channels of communication”.

Across the world, a variety of science clubs and networks of science clubs are active. These clubs are supported by national governments and even such international bodies as the UNESCO. Some networks of science clubs have significantly long histories since beginning of nineteenth century. Some such networks of science

clubs worth mentioning are from f America, Canada, , STEM clubs of UK, Federation of Young Farmers Clubs, VIPNET, and Eco-clubs in India. They have also supplemented formal science education under various circumstances. Their potential as decentralised centres of social transformation centred on S&T communication is concern, is however yet to be explored.

Over the past decade, Vigyan Prasar, an autonomous institution of the Department of Science & Technology body of Government of India, attempted to involve all existing and newly-formed science clubs to create a network of these entities namely the VIPNET (Vigyan Prasar Network of Science Clubs). Initially the network members were motivated to take up scientific activities to help fulfil the goal of achieving a scientifically oriented and empowered society in the country. Presently about 12,000 clubs are involved from all States across the country. Members of the network have been involved in some of the major campaigns built around celestial event like solar eclipses, biodiversity, water, etc., that has proved the role the clubs can play in taking science to the people. These involve debates, surveys and demonstrations, performing experiments, and answering the queries of citizens at the local level. Over the years VIPNET club activities have been transformed essentially into people-oriented activities. They are not confined to formal classroom or laboratory experiments, nor do they provide any bookish or theoretical knowledge; rather they invite and involve people to see, do and learn things by themselves and find out the truth. Science club activities have accordingly established a strong link between science and the community.

A decade of experience with science clubs and societies, including analyses of reasons for their survival or otherwise has shown that the members and functionaries of the clubs sometimes find it extremely difficult, after a couple of years, to sustain the zeal and excitement with which the clubs were formed. Either they lack new ideas or activities, or fall short of active members or minimum funds to carry on with anything meaningful and educative. A series of meetings and brainstorming sessions with

clubs and stakeholders have resulted in the formulation of a road map for the science clubs movement.

The present paper highlights the basic philosophy, current status, and developments as a result of the consultation meets in recent past to sustain the zeal and excitement among the clubs so that they continue to act as centre of social transformation by creating much needed scientific outlook. These will be useful for initiatives in comparable circumstances to mainstream synergies across institutions and beneficiaries of science and technology communication interventions.

Keywords. VIPNET, science communication.



Science Show. Light my Fire!

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Abstract. This Science Show aims to reveal the chemistry behind some “magic tricks” involving fire. During the show the concept of magic will be demystified, with scientific explanations, by using chemistry as background. The show will begin with a classic science demonstration, the Cartesian Diver, to break the ice and to introduce the concept of “magic”. The other experiments will all involve fire. These will include a demonstration of an exothermic reaction which will start a spontaneous combustion and coloured fire revealing most of the rainbow colours. The show will end with a volunteer whose hand will be set on fire with nitrocellulose. The main question will always be: “Is it magic or is it science?”

Keywords. Science show, chemistry, nitrocellulose, coloured fire, exothermic reaction, magic tricks, fire.



Snails4all

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Abstract. We will present some examples of an Educational Project we aim to implement at Centro Ciência Viva de Sintra for 2014/2015 school year. We will use snails as a starting material for the study of different scientific fields: biology, mathematics, physics and chemistry.

Our main goal is to bring to schools different activities programmed by the center and explainers, who will work closely with the teachers and students of local schools. Starting with the snails themselves we will study anatomy, physiology, locomotion, chemical needs, physical boundaries, ability to detect special chemical compounds, environmental impact, and many more. We want to promote students' interest in science and technology through inquiry based learning, using low cost materials, with connection to real life organisms, easy to maintain and keep in a classroom. We want to promote students' active participation in class, promote team work and critical thinking. The idea is not to take a "key in hand" closed context activity, but rather develop it with each school class and teacher, adapting to each environment a tailor-made activity.

Keywords. Biology, chemistry, mathematics, physics, snails.



Studying Archaeology at the Natural Science Museum of PUC Minas

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Abstract. The Natural Science Museum of PUC Minas (Belo Horizonte, Minas Gerais, Brazil) houses an important Paleontological collection about the Pleistocene (2.6 Ma to 11 thousand years), composed of giant sloths and other examples of megafauna that lived at the time. This collection is composed also by so considered as archaeological pieces on display, like a replica of the fossil skull of Luzia (the oldest ever found in Brazil) and the reconstitution of this, besides skeletons, skulls and human fragments of Lagoa Santa (designation for the human fossils similar to Lucy, found in Lagoa Santa, Minas Gerais, Brazil), in addition to lithic instruments and reproductions of cave paintings that record their interactions with the environment skills, and landscapes. The Museum PUC Minas annually receives an average of 50 thousand visitors, 70% of the audience being made up of schoolchildren. Among the educational activities geared to schools is the "Educator's Space", now reserved for the interaction between the formal (school) and informal (Museum). In these meetings, teachers and Educational staff of the Museum building, together, the scripts of the visits for the students. The scripts include mediation of the contents of the exhibitions and the development of didactic tools that stimulate the acquisition of various and complementary skills, based on hands-on learning processes – learning by doing.

Starting the year of 2014, due to demands of teachers for teaching archaeology in the PUC Minas Museum, scripts were built for development of scientific processes inherent to the area, as well as practical activities that allowed the expansion of students' knowledge and clarification as to the differences and interactions between archaeology and Paleontology. In addition to the mediation of the contents of the exhibitions together with students,

educational practices were held, workshops of excavation, touching original fossils pieces and rock painting workshop.

The results of the development of such roadmaps indicate that the active involvement of students enables them to enlarge their vision with respect to the environment as a whole, promotes the encouragement of research, provides social relations by group working job, and otherwise de-mystify misconceptions and valuing primitive's knowledge.

Keywords. Teaching archaeology, science museum, practices.



Tasty Glass

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Abstract. Not so long ago kitchens were transformed in laboratories as a way of science outreach. From biology, chemistry and physics, with food almost everything can be explained in the light of science. More recently, even molecular biology was brought into kitchen's laboratories. There are distinct compounds which allow us to explain molecules properties and Isomalt is an example. This sugar alcohol is obtained, by two chemical processes of beet root sucrose. Isomalt became very popular due to its properties of noncariogenicity, practically insulin-independent metabolism and its reduced caloric value. Moreover, items that contain it can be labelled "sugar free". It is commonly used in commercial food manufacturing, but mostly in sugar sculpture and decoration, and its preference is because it will not crystallise as quickly as sucrose, forming translucent sculptures mimicking glass.

In the last four years Centro Ciência Viva de Lagos has been using isomalt at science fairs as demonstrative compound, as well as in molecular cooking activities developed for schools and general public.

Here we present some isomalt properties and some hands on science applications of this peculiar sugar.

Keywords. Hands-on experiments, biology, chemistry and physics.



Waking Up to Science with Hands-on: Science Activities in the Kindergarden and in Primary School

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Abstract. It is now widely accepted that a complete citizenship requires basic scientific literacy. In spite of some good projects and practices, there is still a lack of science education activities in kindergarden and in the early years of primary school. This fact may be the reason for difficulties and aversion to science in later years. To overcome this problem it seems necessary to promote better science training of educators and teachers. An increase of familiarity with science will enable teachers to offer their students a variety of hands-on experiments. These may be done with very simple and affordable materials, as it was shown by the Portuguese "Ciência Viva" project documented in the book series "Playing Science" (published by Bizâncio). In this project all sections start with a question, whose answer is achieved by doing an experiment. Parents may also contribute to develop the engagement of their children, since all these activities are feasible at home. Children are certainly not the problem: they are very curious and get easily involved whenever they are asked to perform science activities with objects they can touch and play with. Science education may and should, therefore, start in a ludic way. Even in later years, an excitement element in science learning may be provided by scientific toys.

Keywords. Scientific literacy, hands-on, training of teachers.

Walking on Top Trees”: Changings on the Environmental Perception of the Educators of the PUC Minas Natural Sciences Museum

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Abstract. *The PUC Minas Natural Sciences Museum counts on trainees who take the role of educators in guided tours, they are from different areas such as: History, Biological Sciences, Tourism Management, Public and International Affairs, and others, This makes the Museum a place with different positions and points of view regarding the environment.*

The way each individual sees the environment varies according to their beliefs, customs and values, as well as how that deals. In this sense, a formal Environmental Education often slightly educates, because it uses recurring topics that do not establish link with the needs of each individual, becoming inefficient. The Environmental Perception then becomes a way to better understand and enhance the interaction of the individual with the environment.

In order to understand how each the educator of the PUC Minas Museum sees and interacts with the environment, a diagnosis was made through questionnaires containing questions about the environmental perception their own. Given the results of this diagnosis, it was decided to perform a series of actions aimed at environmental education with educators (experiences, dynamics and workshops) in order to improve their environmental awareness and assist them on the integration between the pairs and the environment where they live.

In this work there will be presented the reports of the Museum educators who took part in two dynamics at the PUC Minas Woods: "Web of Shares" and "Walking on the top trees".

The first is a dynamic adaptation of the Web of Life, widely used in Environmental Education and experienced by authors in training courses. Consists of carrying the participants to an open spot, forming a circle and, with a string, everyone in turn, speaks two good things they do for the sake of the environment and plays the string to the next, so that when the last one ends, is formed a web. After the web is formed it is requested to each participant to say something that he or she fails doing for the environment or something that harms the nature. As each speaks the string is cut out where he or she holds it, so that in the end, there is no more web of good deeds and the debate begins. The second dynamic was adapted and invites the group to walk a trail with a mirror at the chin level, so they look directly at it and have a broad view of the treetops and the sky. The main goal is the observation of the environment for rarely noticed angles. The results obtained the expanded perspective of educators regarding the current environmental issues, their interaction with nature, their notions of preservation areas, the perception of ancient ways, vision of the need for change and the increased awareness about human as part of the environment.

Keywords. Environmental perception, educators, dynamics, science's museum.



What Does Science and Biology Teachers Seek in Science Museums?

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Abstract. *This work has as axis the relationship between museums and school, with a proposal to present an overview about the goals and expectations of the teacher when looking for not scholar environments of science or biology teaching tools. The teacher plays a key role in the transmission of knowledge, because he makes the connection between the student and the scientific knowledge. In this context, the school and the teacher have a key role in the training of students, because globalization and new technological advances bring, for education, new responsibilities, being necessary to break through certain paradigms, enlarge the vision reflective of the new school and educators seek alternatives capable of an interaction between the educational traditional knowledge and scientific knowledge. According to the national curriculum Parameters for the teaching of Sciences, it is necessary to form critical and reflective citizens involved in the social, cultural and economic processes.*

Science museums are conducive environments for the dissemination of scientific culture, considered as an essential element in the reformulation of the teaching-learning process. These spaces are sought after by teachers from public and private schools with goals, among others, to provide cultural elevation, complement the content studied in the classroom or for the development of projects, interdisciplinary curriculum. Marandino (2001) describes a recurring speech in the speech of the teachers, to justify such a search: They expect these spaces to provide opportunity for the students, to experience situations impossible to be reproduced at the school for lack of material, physical space, etc. The

present study was carried out at the Museum of natural sciences PUC Minas, Brazil, from data collected during the "Educator's Space" – meeting of training for teachers who choose the PUC Minas Museum for visitation with their students. The research took place in the first half of 2014 and sought mainly to meet the goals, expectations and issues that the science and biology teachers intend to develop when looking for an non formal space for the popularization of science. The PUC Minas Museum has no scripts nor fixed tracks for development of visits with schoolchildren. These scripts are defined in conjunction with teachers, in the space of the educator. This research also raised the main scripts defined by science and biology teachers together with educators from the Museum. So far, 74 teachers participated in the "Educator's Space", being 18 elementary school science (6th-9th grade), one of biology (high school) and 19 in Regency of Class in elementary school (1st to 5th year). The latter providing other disciplines of basic education, in addition to the sciences. The main objectives targeted by the teachers was the content completion, followed by development of projects before and after the visit. The evaluation of the data allowed us to know that the exhibitions more chosen by science teachers and biology was the treating of Archosauria, located on the first floor of the Museum. In second place was the exhibition on the father of Brazilian paleontology, the Danish Peter Lund and third were the exhibitions about the ice age (the great extinction) and the Cerrado. In addition to the exhibitions, the teachers participating in the space may opt for workshops and interactive activities for students. The most chosen by science teachers and Biology were those of excavation, rock painting and ecological path. The evaluation on the contribution of "Educator's Space", most teachers reported having expanded his vision about the space of the Museum, adding new knowledge and offering new possibilities that could guide them in the planning of the visit, promoting greater interaction between the Museum and understanding of exhibitions, collaborating with the learning of their students. The work of the educational sector of the Museu PUC Minas, presented a great

initiative to carry out the training of teachers in the "educator's Space", since the construction of the scripts along with teachers favored the relationship-Museum teacher, promoting the interaction between them, using the museums as a complement and helpful tool for theoretical classes.

Keywords. Science museum, school, teacher, objectives.



A Digital Platform to Share Knowledge Between Schools and Scientific Community

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Abstract. *In today's world, information flows swiftly, almost immediately, through many channels at the same time. This fast paced reality is reflected in the way science is produced in research centres and how it is shared within the scientific community. Faced with this demanding rhythm, researchers sometimes feel lost when asked to participate in outreach activities. If science does not start from scratch each time and is instead built "on the shoulders of giants" why should the dissemination of science be different? By helping researchers to share successful outreach experiences with each other, we hope to increase the opportunities for the scientific community to engage with society. In addition, these science outreach activities designed by active researchers will be available to other interested parties. Research centres in Portugal have been active in science outreach for many years. But often the knowledge and experience of what constitutes a successful activity is concentrated in a small number of researchers. With the high turnover of researchers in institutions, this continued experience, as well as all the educational tools produced over time, is sometimes lost. By promoting the concentration of resources within each research centre and by adapting these resources to the new digital platforms,*

institutions that produce knowledge exert their responsibility to provide reliable scientific information to the public, which is often faced with the difficulty of navigating through chaotic, dispersed, and often wrong online contents.

Keywords. Science communication, science outreach, public awareness of science, science education, digital platforms, collective memory.



Laboratório Aberto: A Model of How Make Science

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Abstract. *The science and communication science have been an enormous influence to increase the public science literacy, especially in young people. Enrich citizens with scientific knowledge is encourage the doubt and consequently explore one answer. At any age or life condition, contacts with news and different experiences, endows new Human skills, many times for them unknown. How much early starts, more the society will be evolved. This social intervention is equally revealed in Horizon 2020 program, which has three pillars - Scientific excellence; Industrial lead and Societal challenges. In accordance of this, it is crucial for educational system that exist one complement more practice, direct and informal, which connect the research centers with community. In this sense and due to the extensive and intensive contacts from school community, to develop experimental lab activities, in 2007 born the Laboratório Aberto (LA), a project with collaboration of Oporto city hall, Ciência Viva Agency and supported scientifically by Ipatimup – Institute of Molecular Pathology and Immunology of the University of Porto.*

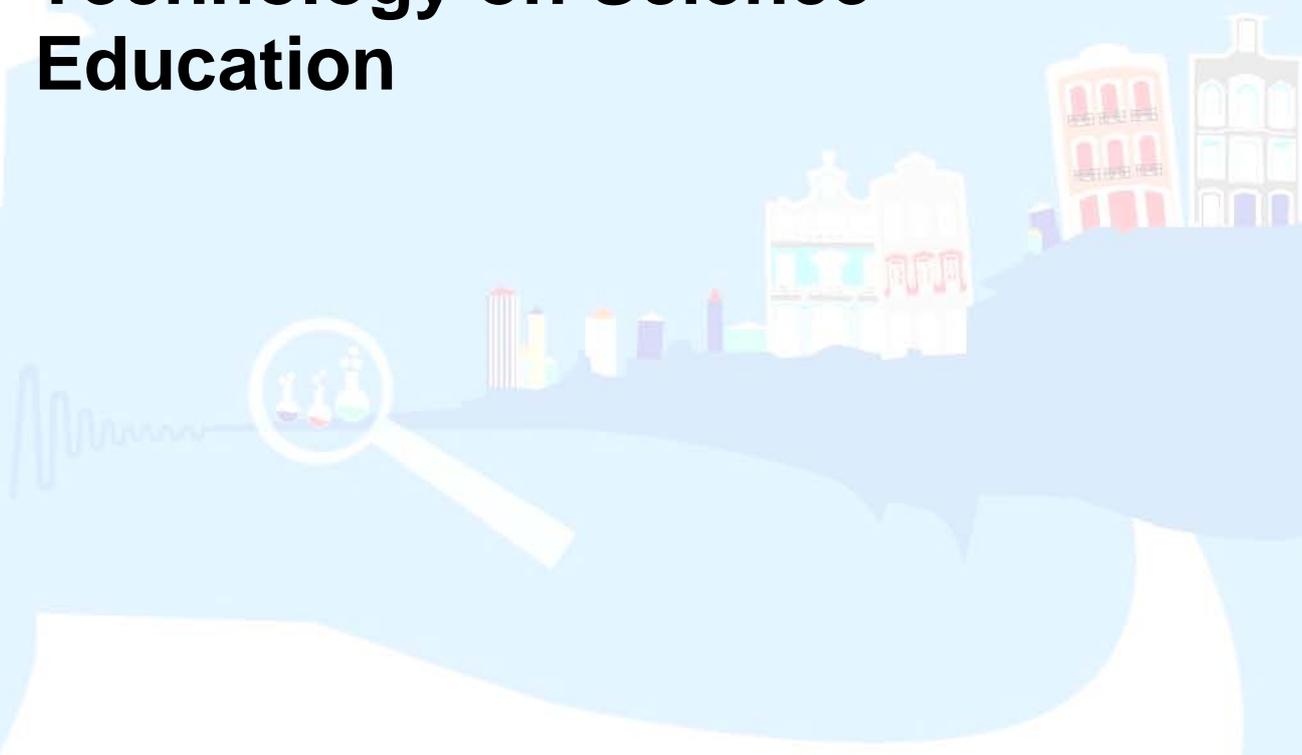
In seven years, approximately 35 000 visitants worked on the LA, to realize activities. Because of the LA localization (Oporto city), 84% (29 815) of the visitants are from the North of Portugal. The other 16% are distributed by Center (15% - 5 141) and South (1% - 262).

In conclusion, all the activities developed are in accordance with the Portuguese educational program, which lead us a huge demand. LA contributes to the curriculum enrichment of a massive student's number, giving them scientific and techniques skills and provides the contact with experimental sciences.

Keywords. Science communication, experimental activities, science.



Technology on Science Education





A Newton's Cradle Model for Science Fair Events

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Abstract. Most commercial models of Newton's Cradle are too small for exhibitions and science fair events. Some bigger models developed for that purposes are not easy to carry and store, which may be a problem between exhibitions. This paper describes a Newton's Cradle which is big enough for science fair events but easy to assemble and disassemble. Its volume becomes substantially reduced after being disassembled.

Keywords. Newton's Cradle, principle of conservation of linear momentum, principle of conservation of kinetic energy, science-fair events.



Environment-Friendly Slot Cars Circuit

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Abstract. This paper presents an environmentally friendly cars system that does not require batteries or the mains to power the cars. Instead of simply using energy from those sources, players have to pedal bicycles in order to keep their cars running. The faster a player pedals, the faster his car runs. The system parameters were adjusted so that a considerable physical effort is required in order to make a car run. Associating electric energy generation with considerable physical effort is pedagogical and makes this system very suitable for science fair events.

Keywords. Electric energy, electric generator, science-fair events, slot cars.

Using ICT and TwinSpace for Knowledge Construction

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Abstract. In 2010, I was the coordinator of an eTwinning project named "ICT, You and Me". Schools involved were from Romania, Poland, Spain, Greece and Latvia. This project won the second place in the European eTwinning Prizes 2012 competition, 12-15 age category. This project aimed to improve pupils' skills in Information and Communication Technologies, Science, Maths and foreign languages. In this paper I will present modern technologies used in this eTwinning project which made the lessons more attractive to everyone.

Keywords. Collaboration, knowledge construction, eTwinning, ICT.



Web-Based Builder of Digital Educational Resources

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Abstract. The goal of the web-based builder of digital educational resources for educators is to provide capabilities for solutions to a wide range of science education tasks using a set of web-services and a library of media objects. There are basic set of digital educational resources related to modern science and technology and these include pictures and photos, videos and animations, 3D models, interactive models and interactive schemes,

tests and simulators and virtual practicum in the web-based builder. For ease of use these web based resources for educators contain web-service for work with media resources, web-service for building own lectures and presentations and web-service for building own tests.

Keywords. Web-based builder, digital educational resources, e-learning, ICT.



Research Centres and Industry as Stakeholders for Innovation Using Nanotechnology. A Social Change

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Abstract. Nanotechnology is a reality that is growing tremendously, creating and redefining added value products. Presenting an opportunity to revitalize and innovate industries and, consequently, for a more productive, entrepreneur and innovative society. Despite the developments in this scientific area, there are still several constraints preventing a broader use of it by the industry sector, namely, the lack of information and uncertainty related to human's health and environment impacts. To overcome the latter, awareness of the potential applications and limitations by the industry agents is of great importance, in order to implement an objective strategy, based on dedicated knowledge and an effective and entrepreneurial interaction with the stakeholders. This paper presents the methodology applied to develop an assertive dissemination plan to enhance the connection between research centres and the industry sector in the nanotechnology area.

Keywords. Applications, human health, environment impacts, nanotechnology.



e-Lab: Implementation of an Online Course for High School Students

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Abstract. This article aims to analyze the results obtained after conducting an online e-lab course (e-lab is a real remotely controlled lab available in <http://elab.ist.eu> and free) for about 20 students of Physics of the 12th year from a secondary school in Lisbon, Portugal (Escola Secundária Padre António Vieira).

The course was conducted using the e-learning platform Moodle containing all documents and references enabling students to undertake the course independently and lasted for two weeks. The results were very satisfactory and the next step will be to conduct a pilot study with teachers of physics and chemistry.

Keywords. b-learning, e-lab, e-learning, online course.



Use Open-Source Hardware for Classroom Research

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Abstract. The main objective of this project is to study ways to build open-source hardware sensors that can be used on science classes. By searching on the community of open-source hardware users we intend to develop small electronic equipment with practical use in science classes [1]. The use of open-source platforms enables fast learning and knowledge sharing. Based on this information, we tried to identify projects that

could be used in schools. We built a humidity and temperature sensor very simple and inexpensive that can either be used independently or connected to a computer as a data logger. This equipment allowed measurements of temperature and humidity in our solar oven for fruit dehydration. This equipment can also be used in experiments monitoring of abiotic factors and growth of plants, in practical activities for measuring humidity and temperature of the exhaled air, on field activities, on the study of thermal efficiency of buildings, ... The project involves learning skills in electronics, computer science, programming, biology: we may say that it is interdisciplinary.

Keywords. Open source hardware, Arduino, sensors, experimental work, research in the classroom.



The Use of Computational Modeling in Teaching Optics to High School Students

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Abstract. The following paper presents a detailed account regarding the use of computational models, created in Modellus, a freeware, in teaching high school students optics concepts and its results. This work aims to evaluate if models can achieve their ultimate goal: improving students' comprehension of physics. Therewithal, it discusses their employment in class. Supervised by Alan Machado in "Jovens Talentos" scholarship program, the other two authors, also high school students, developed models that represent optics concepts and allow students to interact with them. The models were introduced to the students, who gave their opinions about using such technology in class.

Keywords. Computational modeling, high school, mirrors, Modellus, optics, physics, technology.



Tele-Loucuras: Hands on Telecommunications Engineering Sciences

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Abstract. The Telecommunications Engineering Sciences are presented as an embracing field of studies with central importance on both scientific and technological development, and cuts across many areas of knowledge, such as maths and physics. Recognizing this value, the project "Tele-Loucuras" was designed and implemented among hundreds of high school students. Following the main goal of spread the scientific knowledge on Telecommunications Engineering and implementing the philosophy "hands on the mass", the results obtained through an inquiry were evaluated proving the importance of these kinds of initiatives to the students' additional training.

Keywords. Electronics, engineering, high school, additional training, telecommunications.



The Use of Modellus Applied to Studies Regarding Alternating Current Generators

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Abstract. Describes a teaching experiment and applied learning of a group of high school students using the educational

software “Modellus”. After simulating the behavior of an AC generator, used in hydroelectric plants, the students had a significant improvement in their understanding regarding such subject, thanks to this work. Through that computational model, the students were able to vary some parameters that influence the AC generator system and observe the effects instantly. Nevertheless, the model enhances the interactions between the students and the teacher and between the students themselves, inciting questions and suggestions, while stimulating the students, unlike the conventional abstract learning.

Keywords. Computational modeling educational software, learning.



Technology and Mathematics

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Abstract. The evolution of our world from an industrial society into an information society, placed a mark on all of its subsystems, imposed through its new technological support. In this frame, the education system must rethink everything, from methods, contents to structures. This step needed the introduction of Informatics and ICT in the school curriculum for teaching different disciplines. This way, teachers are using the computer, not only as a didactic material but more as a complementary system in the teaching-learning-evaluation process. In this paper I will present some methods for teaching and learning Mathematics using the new technologies.

Keywords. Mathematics, technologies.



Numbers and Elementary Concepts for Biology Students

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Abstract. The validation of hypotheses in order to explain natural phenomena requires data. Many biological phenomena have been discovered and explained on the basis of qualitative analyses, but new insights often follow when they are revisited in quantitative terms. Without a quantitative description, there is no discovery at all. A parameter variation due to changes on environmental conditions is usually detected by measurements on apparatus developed according to certain physical-chemical principles. The knowledge of fundamental principles underlying the techniques used is essential for good understanding of the phenomenon in question and so it is necessary to insist on basic concepts consolidation.

Recalling the properties of water and using mint leaves as biological material, spectrophotometry and tensiometry are two measurement techniques that allow us easily gathering a lot of data. The analysis of the information obtained by these two methods on similar samples may promote internalization of natural phenomena, related to the frequent mixtures of living or dead organic matter in water.

In this work it is proposed an experimental activity addressed to pre-university and first year graduate students. The first step of the activity is to prepare three batches of mint leaves (biological material easy to obtain) to make an infusion, a suspension and an extract of chlorophyll from their leaves. The preparations are analysed by spectrophotometry and tensiometry. The results obtained by each technique allow us to compare some properties of the three types of samples. Although not being related a-priori, the combined analysis of the parameters measured by the two techniques provides some insight on natural mechanisms.

The main goal of this activity is that students

recognize the importance of elementary concepts from different scientific areas, enhancing the relevance of interdisciplinary towards the consolidation of scientific knowledge.

Keywords. Interdisciplinarity, parameters, mint, spectrophotometry, surface tension.



Determination of Thermodynamic Parameters of Glycine Acidity Equilibria Using Potentiometric Techniques. A Video Project to Learn Physical Chemistry

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Abstract. *The main objective of this work was the elaboration of a multimedia project by a group of students enrolled in Physical Chemistry for the Life Sciences (PCLS), a course that takes place in the 2nd semester of the 1st year of the degrees of Biotechnology and Biochemistry of the University of Aveiro. The project here reported is the first exploratory step towards the set up of a wiki for the course that is meant to be expanding continuously from here on. The starting theme, the determination of thermodynamic parameters of the acid-base equilibria of an amino acid, was chosen for its relevance and interdisciplinarity. The work was performed by a small group of volunteer students, supervised by the teacher. The different phases (planning, research, writing, production and publication) were scheduled, coordinated and carried out by the students. The final result is an interactive video with complementary calculations and content related documents, as well as links to suitable sites on the web. The project will be presented using a MS PowerPoint show.*

Keywords. Active learning, acidity constant, higher education, multimedia, physical chemistry, student-created videos.



Video Making as an Active Learning Project for 1st Year Physical Chemistry Students

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Abstract. *The main objectives of the research now presented were to ascertain the expectations of the students regarding e-learning contents and to investigate the potentialities of a multimedia project as a motivational and pedagogical tool. The first goal was assessed by a questionnaire administered to all students enrolled in the course. Next, the pedagogical benefits of student created multimedia resources as a motivational booster and an aid for active learning Physical Chemistry in a first-year university course was evaluated. To that aim, the exploratory multimedia project was carried out by a very small number of volunteered students and presented to the other students of the class.*

Keywords. Active learning, collaborative work, e-learning, higher education, physical chemistry, student-created videos.



Science Teachers' Views on Robotics Applications in Science Education: A Case of Yozgat

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Abstract. *In recent years, innovations in technology have made a great contribution to science education as well as the other areas of life. Technological applications in*

education are used in many different teaching methods. Robotic applications in education are one of them. Robotic applications become widespread day by day and started to implement in Science lessons. Although there have been considerable information on robotics applications in the literature, there have been rarely information indicated science teachers' views on robotics. Therefore, this study aims to determine the teachers' views about the robotic applications in science education. Case study method was used in the study and Semi-structured interviews were used as data collection method. The interviews were conducted with 10 science and technology teachers who work in different schools of Yozgat and data were analyzed by descriptive analysis methods. According to the results of the study, teachers stated that robotic applications have positive contributions to science and technology education, creative problem solving and cooperative learning. Moreover, they indicated that it is necessary for science and technology education in Turkey to extend these robotic applications.

Keywords. Robotics in education, science and technology lesson, teachers' view.



Using Power Light Emitting Diodes (LED's) in the Laboratory of Optics and Physics

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Abstract. After lighting homes, streets and buildings for over 100 years, the incandescent bulb created by T. A. Edison, will soon become a relic of the past. Many countries have taken steps to replace it to another more efficient light energy source. Additionally, the incandescent bulbs have been gradually replaced by fluorescent bulbs that are more economical and, currently, in residential lighting, their compact equivalents. However, this type of

lamp is beginning to be replaced and the alternative that presents itself is the power LED. In Optics laboratories teaching is common to use several types of light sources, from a simple candle to semiconductor lasers. Thus, in experiments involving Geometric Optics and light polarization, among others, it is common to use traditional sources such as incandescence and low pressure gas. In experiments involving the phenomenon of light interference, it is easier to use sources of high grade of coherency, such as gas lasers and semiconductor lasers. The purpose of this paper is to present, in a simple and didactic way, a source of light that uses a LED power and show that it can replace, with many advantages, the light sources traditionally used in many optical experiments.

Keywords. Teaching optics. white light, cold light, power LED,



Exploring a "CSI Effect" Using Forensic Sciences to Boost Young Student's Motivation to Learn Sciences: Evaluation and Perspectives of a 14 Years' Experience

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Abstract. The "CSI effect", where television series influence society perception of forensic issues can be explored in order to boost young student's motivation to learn sciences. Since 2000, by participating in the University of Aveiro's Open Week of Science and Technology, the Applied Genetics Lab of the Department of Biology developed several initiatives under a Forensic Genetics programme. After 14 years of experience with particular regard to the Ciência Viva Internships for Students, promoted by the Ministry of Science and Technology, it's time to evaluate students participation and their expectations and

resulting impact of these activities in their academic and professional future along with an evaluation of constraints (funding, logistics) and way of foreseeing a model for future developments.

Keywords. "CSI effect", Forensic Genetics, Ciência Viva.



Science Race

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Abstract. *PmatE is an investigation and development project born in 1989 with the mission of developing resources and information technology tools in various fields of knowledge. Celebrating its 25th anniversary in 2014 the project has kept faithful to the use of technology, its starting goal. In addition to this, it performs other important tasks like developing resources, organizing events towards academic success and promoting scientific culture.*

As intervention areas, PmatE focuses mainly on science communication, international cooperation with developing countries and school intervention projects.

Due to the growing involvement of schools, what, at the beginning, was a local project spread nationwide and eventually crossed borders to reach other Portuguese speaking countries.

Partnerships grew stronger as several external entities stepped forward and supported the project. Consequently, this helped to widen goals and increase intervention areas which in turn lead to new ways of publicizing science and made it possible for PmatE to keep up with the fast development of technology throughout the years.

It is PmatE's philosophy to comprise numerous features as scientific and didactic certification, pedagogic adaptation, reusing and reducing costs, while securing equity in its dissemination and criteria of usability and access. Starting with Mathematics and spreading to other knowledge fields such as

Portuguese, Biology, Geology, Physics and recently to Financial Education and Chemistry, turning into a creative and daring cross curricular project.

The core of this project is to make learning objects, question generated models and digital multimedia contents or resources, available through a computer assisted learning platform that, at present, is only accessible via the Internet and covers all year groups, from primary school to university.

Within this perspective, the workshop SCIENCE RACE intends to demonstrate that science is everywhere. PmatE team wishes that the proposed activities are cross covering syllabus of various curriculum areas always allying technology to its interventions. Thus, the proposed activities are designed for a school aged audience.

The SCIENCE RACE invites its participants to solve a number of problems and challenges in 60 seconds. In each of the four steps participants will test their skills in terms of handling laboratory equipment, conducting experiments, problem solving and decision making, use of logical thinking and teamwork – always in time trial.

The experimental activities are conducted with the Mobile Sciences Workbench, covering the areas of Physics, Chemistry, Biology and Geology, and the challenges include mathematical and educational games impregnated with PmatE's characteristic competitive spirit.

Keywords. Competition, education, science, science race.



Endocrine Disruption Made Easy. The Use of Imposex to Illustrate Endocrine Disruption in the Wildlife

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Abstract. *Imposex is considered as the best documented example of endocrine disruption and it is characterized by the superimposition of male characters (penis and vas deferens) into female gastropods. This phenomenon, which results from the interference with the normal hormone action, is a consequence of tributyltin (TBT) exposure, a biocide used in antifouling paints formulations until 2008 to prevent biofouling on the ship hulls. The association between the occurrence of these anomalies and the presence of TBT is well established, and imposex is used as a specific biomarker of pollution caused by this compound. Due to its high specificity, imposex is used in monitoring programs of TBT pollution throughout the world.*

The assessment of imposex levels is a simple and easy task that allows the achievement of rapid and reliable results. With a minimum requirement for biological specimens and equipment (stereo microscope and dissection instruments), it's also a low cost technique.

Therefore we propose the use of imposex to explain to high school student's endocrine disruption in the wildlife. In the present work the necessary methodology is described and recommendations for teachers and students performed so that this procedure can be conducted at any school. This approach will allow students to learn in a simple and straightforward way the complex issue of endocrine disruption.

Keywords. Biomarker, endocrine disruption, imposex, gastropods, tributyltin.

Hands-on Simulation: Spectators Entering Soccer Matches

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Abstract. *Active, hands-on learning activities have shown to be effective in enabling students to better grasp lectured concepts. Often, students not only learn better by practicing instead of merely spectating, but also become more proficient in skills.*

This work presents a hands-on activity, concerning simulation, performed out of the classroom. In Industrial Simulation, a course lectured to Industrial Engineering and Management students of the University of Aveiro, simulation concepts and tools are introduced. Among other active learning activities, students are encouraged to apply simulation to real-world scenarios, and draw conclusions.

For the case of spectators entering soccer matches, a simulation study was performed by students. Results of this study, and of the learning experience, will be presented and discussed in this work. Moreover, the use of 3D animation in the Arena® software may allow the general public to have a better understanding of simulation concepts.

Keywords. Simulation, hands-on activity, Arena software.



Virtual Laboratory of Nuclear Fission

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Abstract. This report focuses on the hardware-software complex “Virtual Laboratory of Nuclear Fission” as an example of incorporation of current scientific data into the educational process. The physical process of spontaneous fission has been selected, and performed modeling and visualization of all the stages of preparation of the experiment, taking of data and their analysis.

Keywords. Physical experiment, virtual laboratory, nuclear fission, scientific equipment, data analysis, ICT.



Industrial Engineering Students Learning Simulation Concepts

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Abstract. Simulation is probably one of the best engineering tools to analyze the performance of complex industrial systems. Since the main task of industrial engineers is to analyse, design, evaluate, and control those systems, simulation tools enable them to capture the dynamic nature of their systems and to test and evaluate different scenarios through the analysis of a wide set of performance measures.

The course of Industrial Simulation of the Industrial Engineering and Management undergraduate programme at University of Aveiro (Portugal) aims to prepare future industrial engineering professionals to accomplish the abovementioned objectives when solving real-world problems. Teaching simulation is a complex task that relies on the growing utilization of modelling techniques, software tools and experiential / active learning approaches.

This work describes the contents of the Industrial Simulation course as well as teaching approaches used during the classes (e.g., developing computer simulation models using the well-known Arena® software) and how they are perceived by students. Both teaching strategies and learning activities are presented and discussed.

Keywords. Simulation, Arena software, industrial systems.



Hands-on Simulation: The Café Industry

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Abstract. This work presents some results of a hands-on activity concerning simulation, performed outside the classroom. Possibly one of the best engineering tools to analyze and test the performance of complex systems is simulation. In the Industrial Simulation course of the Industrial Engineering and Management undergraduate programme of the University of Aveiro (Portugal), simulation concepts and tools are introduced to students.

Active, hands-on learning activities may play an important role in facilitating the development of students' knowledge and skills. In the abovementioned course, students were encouraged to apply the learned concepts to model real-world systems. The café industry was chosen due

to being widely widespread and corresponding business activities easily understood. Results of the study may also benefit a wider audience, as 3D animation of the system (using the Arena® software) allows showing to the general public how simulation tools may benefit a correct planning of services, in this case, café-related activities.

Keywords. Simulation, café industry, Arena software.



Real Observation Versus Simulation Study Case: Moon Phases

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Abstract. *The phases of the moon are the result from the revolution motion of the Moon around Earth and depend on the relative positions of Moon, Earth and Sun. Due to its position relatively to the Earth, in approximately 30 days, the moon phases change from New Moon (when no Moon is visible), to Waxing Crescent, to First Quarter, to Full Moon (when the entire face of the Moon is visible) and back to New Moon inverting the sequence.*

As the periods of translation and rotation of the Moon are almost identical the Moon always shows the same face to Earth.

In this workshop, we can simulate the shape that the illuminated portion of the Moon shows to an observer on Earth using Stellarium, which is a software that allows you to view the sky in real time.

This subject is part of the Portuguese official program of the 7th grade in Physics and Chemistry discipline, to address the concepts of motion in the Solar System. Building a paper model of the Moon-Earth-Sun system, students can better relate what they see in the sky with the relative positions of the 3 celestial bodies.

The model is made in several phases in each of them we can work on different concepts: build the Moon-Earth-Sun seen by an outside observer, explain how the moon always shows the same face to the Earth and understand why the Moon is in the sky at different times during the day according to the phase of the moon.

Manipulate a 3D model allows a better understanding of abstract concepts. Assembling and manipulating the paper craft model is an interactive exercise that integrates abstract subjects like the relative positions of Sun-Earth-Moon and the real observation of the Moon in the sky.

Sun and Moon eclipses are also possible to simulate.

Keywords. Eclipses, moon phases, paper craft model, revolution period, rotational period, software Stellarium.



Connecting Science Teachers in Europe Using Online Meetings

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Abstract. *Scientix, the European Commission's community for science education provides different services for STEM teachers. The SOMR is a service to facilitate the exchange of ideas between the different stakeholders and is available for science education projects financed by the European Union under the 6th and 7th Framework Programmes, the Lifelong Learning Programme and by other national and international initiatives. In this paper we discuss the benefits of online meetings and how the Scientix Online Meeting Room (SOMR) is being used by science teachers across Europe. We also explain how different stakeholders can take advantage of online meeting depending on their needs.*

Keywords. Science, teachers, online.



Le@rning as Development

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Abstract. *The paper aims to explore Virtual Learning Communities (VLCs) as a form of organizational communities that can develop creative processes and offer new possibilities to the local development, through the rise of cognitive work and cognitive pattern in organizations. Creative processes, in our perspective, can be developed in the social territory of the Web, and through activities of the virtual learning communities developed in Web-based environments.*

Keywords. Virtual learning communities, cooperation, creativity, resilience and development.



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