Science Week at IES A Xunqueira and IES de Poio (Pontevedra-Spain)

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Abstract. *During the first weeks of May 2004 a Science Week has been organized at the IES A Xunqueira and IES de Poio (Pontevedra-Spain). This Science Week is an interactive exhibition of small scientific experiments which attempts to arouse an interest and motivation for science via games, fun and simplicity. The students of secondary school will do the many experiments and simultaneously explain them to his classmates. Each experiment goes with two posters: one which explains how to interact with the Hands-on Science Experiment and the other includes the related concepts and its aim.*

Keywords: Hands-on experiments, Physics, Science Week.

1. Introduction.

The science syllabus of many countries has been revised during the last few years. The continual reduction of teaching hours and the optional nature of many of the science subjects has meant that many of the secondary school students are unable to have at least a minimum scientific culture. On the other side, many new concepts have been provided by the fast evolution of science and technology. This scientific culture would provide them with a critical view point of reality, and further enable them to ask why questions, which forms the basis of scientific spirit and evolution and also that of scientific and social development over the years. At times, justifications for non-provision include difficulties in comprehension and assimilation of certain curricular concepts due to the low level of cognitive development and conceptual maturity of the student.

There has been an increasing demand over the past years for providing a closer proximity to science through simple experiments, to cover general science on the whole and physics in particular, such that students from all walks of life are able to understand them. The above demand from citizens has resulted in the appearance of science museums [1]. These interactive centres provide a powerful tool for teaching and an important source of motivation [2,3,4]. These interactive displays are being importing into schools with great success [5,6,7, 8,9].

The aim of this project is to create low cost Hands-on Physics Experiments (HPhysE) that can be easily assumed by schools [10,11], with a view to producing a didactic tool that would show the students and the general public that Physics is not complicated and that simple explanations can be provided to explain everyday phenomena.

To that end, HPhysE with different degrees of conceptualisations have been introduced. Some of these are suitable for the first cycle of secondary schooling while others are suitable for the second cycle and still others for leaving certificate students.

The HPhysE at low cost, to be carried out by oneself or small cooperative group, are presented within the teaching-learning strategies used in the Science/Technology/Society approach, intending to offer a wide and diverse group of people a powerful tool for teaching-learning and diffusion-spreading. Among other advantages, it can be highlighted the following ones [12]:

a) Increasing the comprehension of the scientific and technological knowledge with the aim to attract more students towards these kinds of activities.

b) Developing more positive attitudes towards Science, applying the scientific knowledge to their everyday environment.
c) Showing the usefulness of Science and Technology, promoting their self-confidence to successfully use them.
d) Highlighting the experimental character of Physics and its relation to everyday reality.
e) The concepts, support of the scientific habeas, are acquired, whenever possible, by means of experimentation.
f) They reinforce the creative activity.
g) They establish a connection between the scientific formalism and the real world phenomena.
h) They can help to introduce certain historical perspective on the teaching process.
i) They arouse curiosity and interest.
j) They result to be more effective than the mere audiovisual methods, since they demand a direct involvement.
k) The phenomena are not simulated, but presented as they are.
l) They show experimental work techniques.

2. Science Week.

Science Week 2004 is an exhibition of 32 interactive HPhysE that are easily reproducible. It is based on well-known learning experiences [13,14]. This is a result of the collaboration between the Physics and Chemistry Department of two Higher Secondary Schools of the Pontevedra province namely; "IES A Xunqueira" and "IES de Poio", in collaboration with the Applied Physics Department of the University of Vigo. This activity has been realized as part of the "Hands-on Science" project of the European Commission, through the Comenius/Socrates program, project number 110157-CP-1-2003-1-PT-COMENIUS**-C3.**

Although the main idea of this project was taken from the above mentioned departments, other departments at both Higher Secondary Schools have also contributed to enrich this project contributing to the interdisciplinary nature of the same, such as those related to: technology, automobiles, wood work, electronics, biology, geology, and plastic arts education.

Science Week 2004 was inaugurated at IES A Xunqueira on the 3rd of May, with the honourable presence of the Mayor of Pontevedra and that of the General Sub-Director for Educational Innovation of the Department of Education at the Xunta de Galicia (Regional Government). This has had a great social impact since the event was covered by media personnel from the local and Regional TV stations and press, thereby providing wide press coverage [15].

Figure 1. Press at work.

The exhibition was also held at Poio on the 18th of May, where a total of 51 experiments were displayed and included not only HPhysE but also 6 experiments from biology and 12 experiments from technology.

Figure 2. People at "work".

The attendants were asked to reproduce the HPhysE and provide a scientific explanation for the same and to provide answers to questions related to the HPhysE. They were encouraged to pull, push and poke all kits. The aim was to explain daily phenomena through interaction and games. Small scale easily reproducible HPhysE, using simple available materials were to be carried out with an understandable concept which would permit extrapolation to more complex systems that were difficult to reproduce in a laboratory. The employed material is commonly found in the students´ everyday surroundings or found in the typical science laboratory classroom. Expensive or hard-to-get elements have been avoided. Designs are simple avoiding unsafe materials and high voltages, in such way that they can be employed without supervision. In general, all of them can be completed by one or two persons. This was thus an attempt to exhibit HPhysE that were self-explanatory and easy to carry out. Another prime objective was that of arousing interest and motivation towards science, especially in primary and secondary school students by introducing them to eye-catching and surprising events.

Figure 3. General view of the interactive room at IES A Xunqueira (top) and IES de Poio (bottom).

The objective of this exhibition was to introduce science and its applications to day to day activities. There was no attempt made to stress on either the theoretical, practical or the manipulative aspects of science. Many of them present only qualitative aspects but sometimes the taking of numerical data is involved. In fact, the posters were very qualitative.

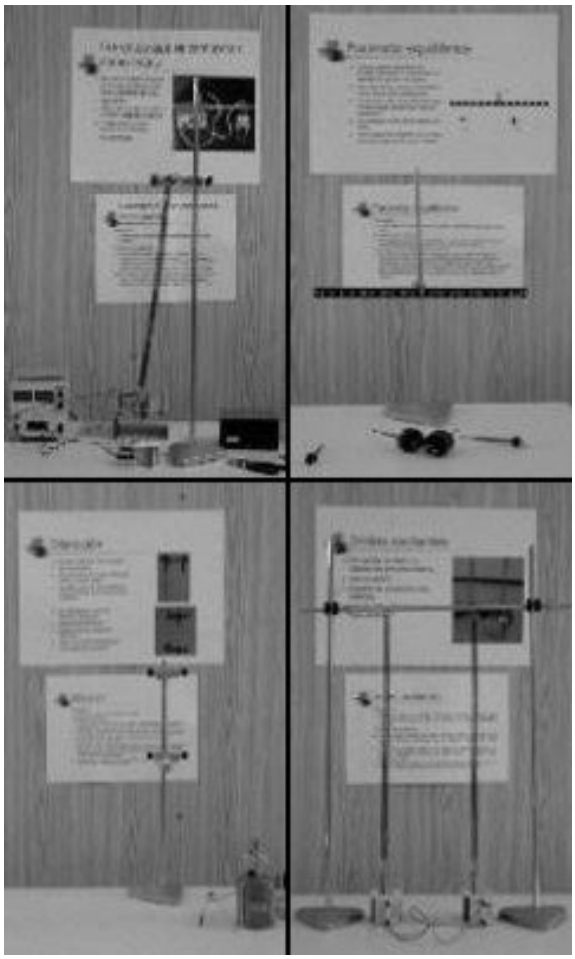

Figure 4. A selection of HPhysE.

There are a number of HPhysE that can be found in the literature however, these are not always easy to carry out even for teachers with an ample experience on the subject. The present project tries to provide HPhysE that can be easily reproduced by any teacher. Each HPhysE is composed of two explanatory panels. In one of them, one can not only find pictures of the experiments but also information on how to interact with the materials provided, ask related questions and seek answers for the same. The other poster explains the didactic objective of the HPhysE in terms of physical concepts and the theoretical basis of the same, doing so in a simple and qualitative manner. This structure

shows the two science dimensions: concepts and process, where in this case the "process dimension" is stressed.

Today modern society not only demands a collection of knowledge based facts but also, and especially the skill for finding information and analysing it. We have tried to promote activities in which students become involved in a voluntary manner and use experimentation and information seeking techniques that have been quite successful in the science museums. We feel that such HPhysE must be widely carried out in order to increase scientific awareness levels of our students and society which will enable them for a better democratic participation in decisions which could affect their lives, namely those related to environmental, bioethical, problems, etc.

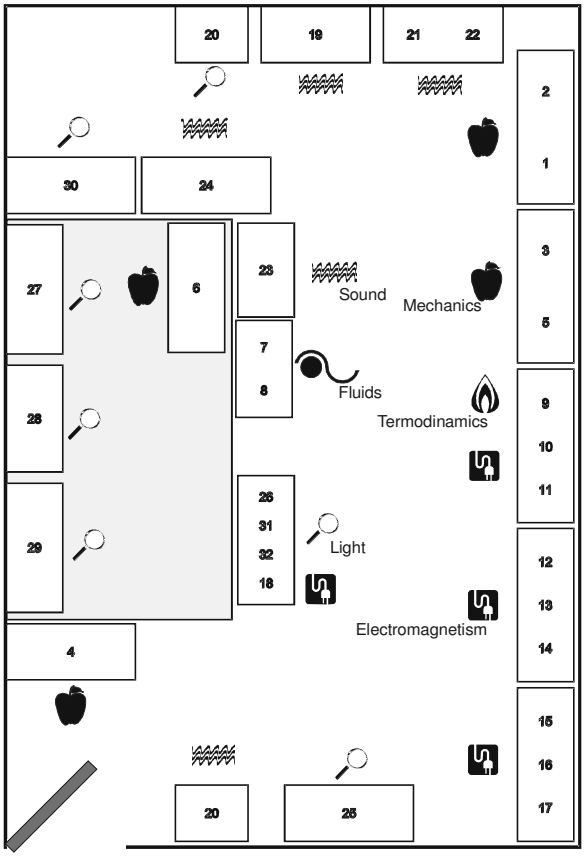

Figure 5. HPhysE distribution at IES A Xunqueira.

The exhibition is aimed at parents and students studying at these schools and those studying at primary schools in the area.

To that end, one hour duration visiting time-table for the exhibition was made and groups attended the same based on available free time. One whole morning was made available in Pontevedra and one whole evening in Poio to facilitate visits from other schools from the area and the country.

3. HPhysE.

The HPhysE that were set up at IES A Xunqueira can be broadly divided into six groups as explained under and their lay out can be seen in the attached map. Proper information about the employed HPhysE can be found in the literature. Each HPhysE is followed by proper references where are given for similar HPhysE can be found.

Mechanics:

1.- A free fall ball race [16, 17 p. 124].
2.- Air as a hindrance to free fall [18, 19 p. 126-6].
3.- Ball race [20, 21 p. 65].
4.- The archer who always hits the bull's eye [22, 17 p. 125, 19 p. 84-5].
5.- Balancing [23, 17 p. 116].
6.- A toy with a reaction [24, 17 p. 130, 19 p. 122, 21 p. 33-4].

Fluids:

7.- A submarine that sinks and surfaces [25, 16 p. 109, 19 p. 137-8, 21 p. 96-7].
8.- Please, blow [26, 17 p. 90, 19 p. 249-51].

Thermodynamics:

9.- Expansion of Bodies [27, 17 p. 141-2].

Electromagnetism:

10.- Human battery [19 p. 570, 21 p. 147].
11.- Induced Current [28, 19 p. 625-6].
12.- Currents that behave like magnets [28].
13.- Oscillating magnets [29, 18 p. 630-1].
14.- Current generation [30, 17 p. 181, 21 p. 170].
15.- Electric motor [17 p. 162-3, 17 p. 182].
16.- Oersted's experience [17 p. 169, 21 p. 157-8].
17.- Foucault currents [32, 21 p. 167-8].
18.- Plasma lamp [19 p. 49-50].

Sound:

19.- An organ with water [17 p.135, 19 p. 412-3].
20.- Telephone without lines [33 p. 76].

21.- Resonance with two tuning forks [19 p. 379, 33 p. 75-6].
22.- Beats with two tuning forks [21 p. 144].
23.- Synthesizing music with an osciloscope and a wave filter [34].
24.- Voice analysis [35].

Light:

25.- Lose or gain weight without dieting [36].
26.- Periscope [17 p. 194, 19 p. 444].
27.- Optical table [37].
28.- Fountain light [19 p. 443, 21 p. 181-2, 33 p. 98-103].
29.- Diffraction using a CD [38].
30.- Polarization and stress [39].
31.- The astronomical telescope [40].
32.- Galileo's telescope [17 p. 199].

4. Conclusions.

Several Hands-on Physics Experiments have been mounted during Science Weeks organized at IES A Xunqueira and IES de Poio (Pontevedra-Spain). Each one was designed to be eye-catching and to occupy a person less the five minutes. They reinforce classwork, show everyday examples in action or point out novel technological applications. Employed materials range from low cost everyday items to more sophisticated laboratory apparatus, being in any case adaptable to all ages and backgrounds. The activity can be considered a success as the public use it. It seems that the public believes that the interactive room is valuable, as it increases their understanding, but proper evaluation should be done in order to check it. In any case some measurements about number of times by experience, acceptation, etc… should be given.

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