THE CONQUEST OF ENERGY – THE PHYSICAL PROPERTIES OF MATERIALS

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1. Introduction.

The National Institute for the Physics of Matter (INFM) during the last few years has included among its objectives the dissemination of scientific culture and the didactics through the production of multimedia courses, with a particular attention to the physics and technology of the matter.
One of the aims of these challenging undertakings is to face the decline of the inscriptions to the physics university courses, a common trend since many years in Europe, with a consequent deficiency of scientists and skilful technicians, today more than ever necessary to our society.
As far as the school engagement is concerned, INFM has realized, using the latest modern informatics instruments, various courses addressed to the teaching of physics and technology, with virtual laboratories, animations, interactive simulations and games, tests of auto-evaluation.
The results have been positive and encouraging, with national and international prizes and recognitions; two courses of ours [1, 2] have obtained a financial support from the European Union in the Fifth Programme "*Raising Public Awareness*" [3].
On the second front, the dissemination to the general public of the scientific and technological culture, INFM is active with several initiatives, of which it worth to remember: (i) the production of travelling exhibitions, like "Imparagiocando", which have been visited by many Schools and common people; (ii) the organization of scientific exhibitions, above all the Science Festival; (iii) the realization of "*Archimedes*", a multimedia project (partially supported by the MIUR) which aims to the popularization of some of the main issues of contemporary science [4].
Through the projection of animations and simulations, we shall illustrate two multimedia courses realized by INFM as new opportunities for learning and to communicate the physics charm to young students.

2. The Conquest of Energy.

This multimedia course is devoted to stimulate the understanding of how men won and exploited energy during the past and which are nowadays problems and outlooks in the management of this fundamental resource. It mostly addresses to teachers and students of compulsory school, but also to anyone whishing to enlarge his/her cultural horizons on a subject of social and economic relevance.
It consists of three parts: (i) The energy in the history of mankind; this is mainly an historical and technical/scientific section, describing the most important step in the conquest of energy. (ii) The energy sources and the renewable energies; here is presented a roundup of the different sources of energy. This help us to understand not only when they have been discovered, but also how they are still now exploited, which are nowadays problems and outlooks. (iii) Energy, environment and energy saving; this section aims to give us a general summary about the benefits and the environmental costs related to the exploitation of the different kinds of energy, paying attention to energy saving.
A good part of a material is also suitable for children in the first years of (Italian) primary school, even if they must be driven by the teacher. Other sections, like closer looks and historical notes, are more suitable for students towards the end of their compulsory schooling, or higher. Some sections are for teachers too, so to give them a complete picture of the subject, and it can be useful also for people whishing to have a general summary about the development of energy resources that are at the material base of our society.
It is always a difficult task to find relevant experiments, so we have put some "role games". They provide the opportunity to involve the young students in the subject. Playing the role of some

character the child has to consider critically the problems pointed out by the game and the weak and strong points of different positions.
This introductory multimedia, rich in images, animations, interactive games and simple experiments, provides a suitable mean to introduce the concepts starting from every day experience.
It is presented in two version, on CD ROM (for both PC and Mac) and on line at the site http://informando.infm.it/energia2/ [5].

3. The Physical Properties of Materials.

The course [6] is addressed to teachers and to students of the High Schools and is available on CD ROM (for both PC and Mac), and it deals with the atomic structure of matter, the basic concepts of modern physics and the main physical properties of materials. It has been carried out within the "Agreement" between INFM and MIUR and offers a good example of the possibility of cooperation among University Institutions, Schools and Ministry, in the field of didactics.
The project, indeed, is the result of a collaboration with a group of teachers of the graduate schools, which, at a Seminar (Genova, 2000-2001), have contributed to its structure, contents and evaluation. The idea was not to create something that will replace the textbook, the lecture or the direct experience, but a new mean that can integrate the traditional lecture and the school program of physics and that can help to deepen the physical and technological aspects that usually are not taken into consideration.
It is composed of seven parts : (i) The materials around us; (ii) The structure of materials; (iii) The atomic structure of matter; (iv) Mechanical properties; (v) Electrical properties; (vi) Magnetic properties; (vii) Optical properties.
Each part consists of principal cards, with many images and animations and enriched with closer looks and suggested experiments. Several historical notes and curiosities and a large introduction on the use of different materials during history and in art, allows a multidisciplinary use. Moreover there are tests to check the comprehension level of the students.
Some sections are accessible, under the guidance of the teacher, to students of the first years of the High Schools, other ones are suitable for the students of the last years.

4. Common features.

The general lines of these multimedia take care of the suggested policies of the National Project on Scientific and Technological Education (SeT) and in particular about the recommendation to link science with technology and to give a multi-disciplinary character to didactical projects.
They, indeed, provides also many starting points for other disciplines. The historical and reinforcing sections give numerous multi-disciplinary links and can readily provide topics which can be covered in collaboration with other teachers (in history, geography, art education, etc).
Moreover, the suggested experiments can be carried out with cheap recyclable materials and quite often involve the construction of simple scientific toys. They can be set up in a laboratory or in a classroom or at home. We suggest experiments which can lead to a qualitative analysis (not a quantitative appreciation) of physical phenomena. The supervision of an adult is required in just a few cases. Experiments and outside visits provide a special opportunity to start from observations in the real world, not on a computer screen but in the classroom, at home, or even in other places near to the school.
To allow teachers to customize and to choose the subjects suitable to their own lessons we add also a "*path configurator*".
The implementation of both multimedia was performed by Infmedia srl

5. Conclusions.

New multimedia technologies are showing their potential in terms of promoting a big step forward in teaching and spreading the knowledge on scientific and technological subjects. Interactive multimedia tools with simulations and movies are more effective than textbooks in giving a first intuitive approach to physics and technology concepts.

Nevertheless, one of the main problems to be faced in supplying the schools with a multimedia educational tool is to overcome the diffidence of the teachers and to guarantee them their irreplaceable role. We do not believe that these instrument can replace the front lesson and the individual study of a traditional text book, or that a simulation or a virtual lab are as effective as it is a real lab experience. Animations can only introduce, in intuitive and attractive way, a concept that must be deepened in the lesson and in the individual study; the virtual lab shows the frame of the experiences that must be done in the real lab (if the school is sufficiently equipped).
In order to guarantee the teacher's role, and at the same time to allow students to sail independently, with a direct personal involvement and a good level of self learning, we tried to organize the contents on two levels. An easier one, rich in images, animations, simple tests with multiple answers, that the student can do alone, and a more complex level, that needs the teacher guide and that, in part, should be a help for teachers too, in order to widen the acquaintance of the argument. This point is important in the primary school, where some teacher do not have a specific knowledge due to their own curricula.
In this type of formulation we have been helped by the suggestions of the teachers that have participated to dedicated courses organized by the Ministry in which our group and the teachers have interacted to study and detect the characteristic, the strategies and the skilfulness of a real useful multimedia on physics, and more generally on science.
Several facts confirm that INFM took the right way and that the educational instruments realized have reached the aim for what they are projected: to help Italian students and teachers (and in other European countries) to approach science and technology and to promote their better comprehension. Further confirmations came from the schools experimentation (just finished). Although the Italian sample is still limited, it shows that teachers as well as students agree on the benefit of these courses. More data came form Spanish and, above all, from English schools and also from other European English speaking schools, which have used the English and Spanish version of the first multimedia.
At the same time, we think this will improve the image of science and research in society with the objective of creating a favourable environment for research and technological development.
We must admit, however, that the main problem we are now facing is the diffusion of our work. The distribution through the Editors reaches relatively few people, while the diffusion via internet works only as far as the potential user is aware of the availability of the product. A great help could come from proper information from the Ministry to the schools, as proven with the distribution to 1500 Italian compulsory school of our latest multimedia "*La conquista dell'Energia*" [5].

6. References.

[1] – R.Fieschi, R.Roncaglia, "*Dal Silicio al Computer*", multimedia course about semiconductor physics and technology, 2000. Also available on-line at URL: http://informando.infm.it/dsac .
[2] – R.Fieschi, M.Bianucci, "*L'energia e le sue trasformazioni*", multimedia course about energy and its transformations, 2001. Also available on-line at URL: http://informando.infm.it/energia .
[3] - INFM, "Archimedes, archivio multimediale su Scienca e Tecnica nell'Italia contemporanea"; http://informando.infm.it/archimedes
[4] - See for instance: http://informando.infm.it/EUprojects .
[5] - M.Bianucci, P.Bussei, R.Fieschi, S.Merlino, A. Del Rosso, *"La conquista dell'ENERGIA"* – Progetto SeT, progetti pilota MIUR – 2002; http://informando.infm.it/energia2/
[6] - M.Bianucci, R.Fieschi, S.Merlino, "*Le proprietà fisiche dei materiali*", 2002

7. Images.

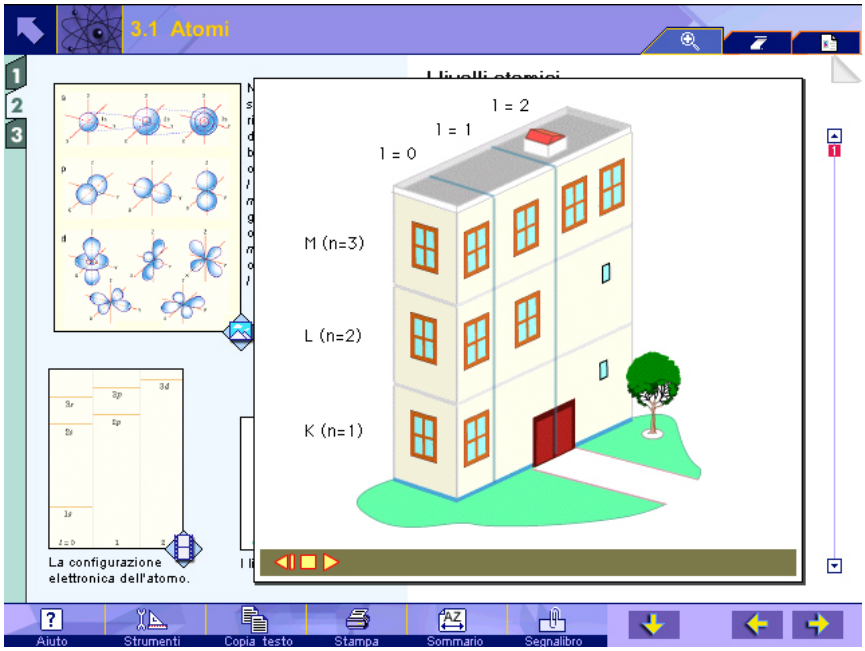

Fig.1 - Caption:
Often we try to introduce difficult concepts by the means of analogies; here is illustrated the one describing the "atomic orbital levels" extracted from the multimedia course "The Physical Properties of Materials".

Fig.2 - Caption:
Here is represented an example of "Historical Note" from the multimedia course "The Conquest of Energy"

Fig.3 - Caption:
An example of "Experiments" children can do, extracted from the multimedia course "The Conquest of Energy"

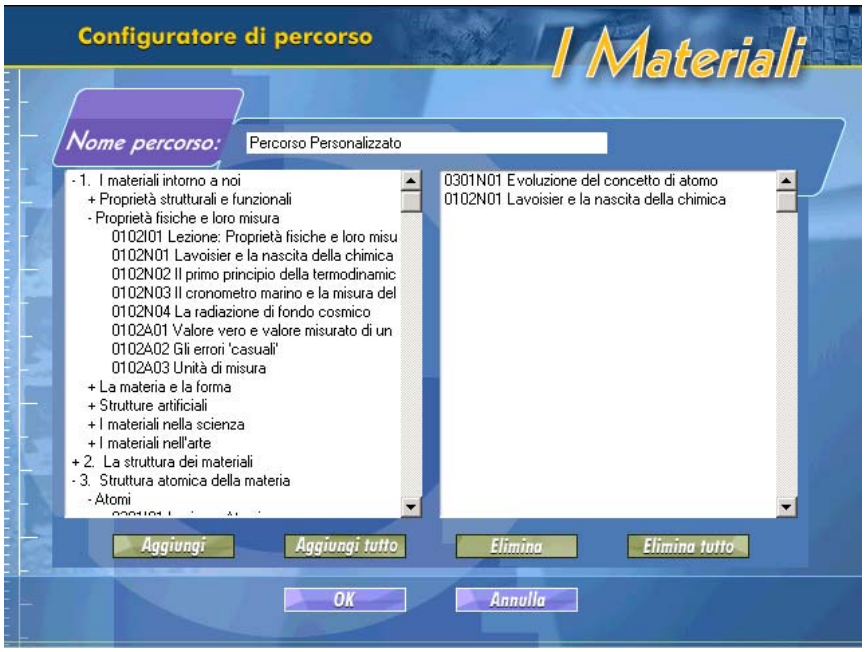

Fig.4 - Caption:
Screenshot of the "path configurator" tool extracted from the multimedia course "The Physical Properties of Materials". Also the multimedia "The Conquest of Energy" has the same tool.