Physics-an efficient solution for an extremely important problem of now days: electric energy

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ABSTRACT

The issue of saving electric power is an extremely important one for the third millennium and it can be solved by means of physics. Starting with incandescent lamp, this paper presents an educational project, accomplished by students, which can lead to educating population and consequently planet salvage. Within the project, the students proposed a few ways of saving electric power through proper use of electric home appliances; they also made advertising leaflets that are meant to sensitize population in regard with conventional energy sources run-out and the necessity of finding new/ alternative energy sources; last, but not least, the students involved in this project have developed their knowledge and practical skills in physics. They noticed that physics is a key to progress.

Keywords: Energy, Computer, Creativity

This project is an assessment activity that starts in classroom, by defining and understanding the task, and it continues as home activity, within a given time frame. All this time, the student has permanent tutorials with the teacher. This activity winds up in classroom, by presenting classmates a report on student's findings and, if necessary, presenting the product the student has made. The project is an active, participatory form that involves and encourages transfer of knowledge, skills and abilities, facilitates and requires interdisciplinary approaches, and consolidates students' social skills.

Completing a project requires the following stages:

- Identifying a problem, topic, subject;
- Gathering, organizing, processing and evaluating the information connected to the chosen issue or topic;
- Elaborating a set of possible solutions to the problem;
- Assessing solutions and selecting the best one;
- Applying the selected solution(s).

The project can be accomplished individually or in group. The steps are the following:

- Task orientation;
- Outcome awareness;
- Defining key-concepts;
- Task setting;
- Setting responsibilities;
- Establishing assessment ways and criteria;
- Identifying ways of work and access path to information;
- Gathering information;
- Elaborating the product;
- Devising the final report;
- Assessment.

The assessment strategy of the project is holistic, and its rating criteria can be negotiated with the students. The teacher guides students with their tasks, helps them make connections between prior knowledge and newly-acquired information, and creates the appropriate study environment. The teacher must behave so as to be a permanent education model to their students; thus, teachers and students are supposed to be some kind of 'learning colleagues'. The teacher's role is to orientate and coordinate learning. The teacher will not simply disseminate knowledge 'in a nutshell', knowledge previously having been selected by the computer, as it contains the very information a student needs at a certain learning stage, he/ she will also help students learn in their most profitable way.

The incandescent lamp and power saving

In accomplishing this project they started with studying electricity and the light-bulb.

Electricity (electric power) is the orderly flow of electric charge carriers.

The simplest electric circuit consists of an electricity supply, a switch, a consumer and conductive wires.

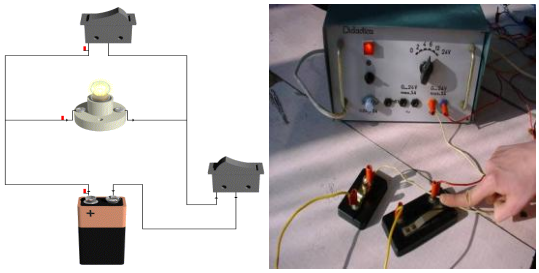

Figure1. The simplest electric circuit

Electricity effects are also studied. The phenomena caused by electricity going through the (electric) circuit are called *electricity effects*.

The magnetic effect consists of an electric field appearing around conductors being gone through by electric power. Electricity also influences the magnetic pointer (needle). The magnetic effect depends in its turn on the sense of the electricity flow the magnetic field is a matter form that manifests itself through its influence on the magnetic needle or on the conductors being gone over by electricity.

Figure 2. The magnetic effect

The sense of the electric flow through the outer circuit is from the supply's positive (terminal) jack/ pole to its negative one.

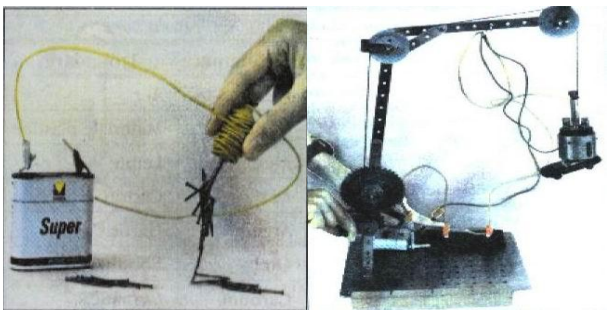

Figure 3. The applications of the magnetic effect

The thermal effect refers to conductors heating up while being gone over by electricity and it does not depend on the electric power sense.

Figure 4. The applications of the thermal effect

Next, the chemical effect of electricity is highlighted.

Electrolytes are those substances that, when liquid, conduct electricity. The liquid state can be obtained using certain solvents (e.g. water, alcohol, ammonia) or by melting at high temperature. The separation process of ionic substances in a solution, into positive and negative ions is called *electrolytic dissociation*. This dissociation can be obtained in the absence of electricity as well. Electric field is a matter form manifesting through actions upon electrically-charged bodies. *Electrolysis* is the phenomenon of guiding ions towards electrodes and their transforming, through neutralization, into atoms or radicals. An electrolysis installation is made up of the following: an electrolytic pot, electrolyte, electrodes, a power supply and a switch. The electrode connected to the positive pole of the generator/ supply is called an *anode*, and the one connected to the negative pole is named a *cathode*.

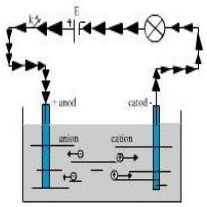

Figure 5. The applications of the chemical effect

When the switch is on, an electric field appears between the two electrodes. The chaotic flow of the positive and negative ions is then overlapped by an orderly flow, imposed by the electric field. Under its action, the positive ions – also called *cations* – move towards the negative electrode, and the negative ions – called *anions* – move towards the positive electrode. When reaching electrodes, the ions are neutralized. The chemical effect depends on the sense of electricity flow.

After understanding the electrolysis phenomenon, students then proceed to study its laws.

The first electrolysis law: mass *m* separated from an electrolyte is proportionate to the electric charge, *Q*, carried through the electrolyte: hence m = k*I*t. The proportionality factor k = m/ Q is called *electrochemical equivalent*.

The second electrolysis law: the electrochemical equivalent of a substance, *k*, is proportionate to its chemical equivalent *A/ n*. A = atomic weight of the substance, n = substance valence, F = 96400 C/ gram-equivalent; *F* represents Faraday's number. The mass in a substance expressed in grams, that equals A/ n is called *gram-equivalent*.

Based on Faraday's laws, Helmboltz acknowledged, in 1881, the existence of an elementary electric charge carried by the mono-valence ion.

Students are requested to identify a few applications of electricity effects and to perform simple experiments to emphasize these effects. They are also requested to specify how certain electrically-powered home and industrial appliances work.

Students have checked out the electrolysis laws using a device consisting of the following components: charcoal from an exhausted battery, conductors (wire), a glass, $CuSO_4$ solution, a switch and a valid battery.

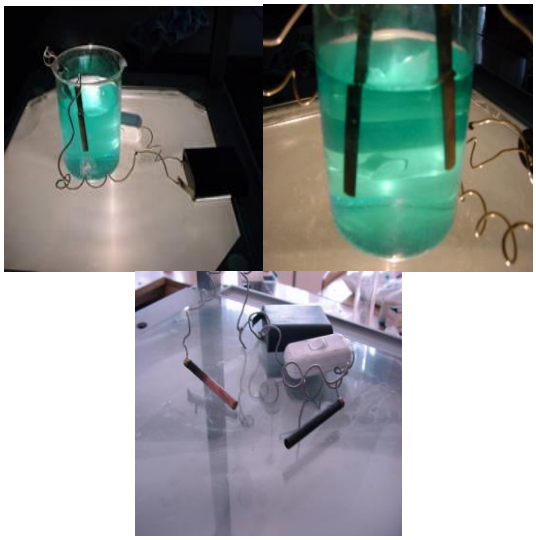

Figure 6. The electrolysis device

After that, a few important uses of the light-bulb and some of Thomas Alva Edison's biographical data are presented.

Thomas Alva Edison (11^{th} February 1847 – 18^{th} October 1931), gave people, in 1879, the power of creating light without fire: he devised the electric bulb, also inventing the threaded socket. We owe him many of today's common-fact things we use: the radio, the film, the television, etc. He is considered the greatest inventor of all times, as he obtained 1,903 patents in the US only. The technical and commercial success of his inventions brought him worldwide reputation, thus being called "The Wizard of Menlo Park". During the night following his funeral, the Americans turned the lights down, as a final homage paid to the man who 'lit up' the whole world.

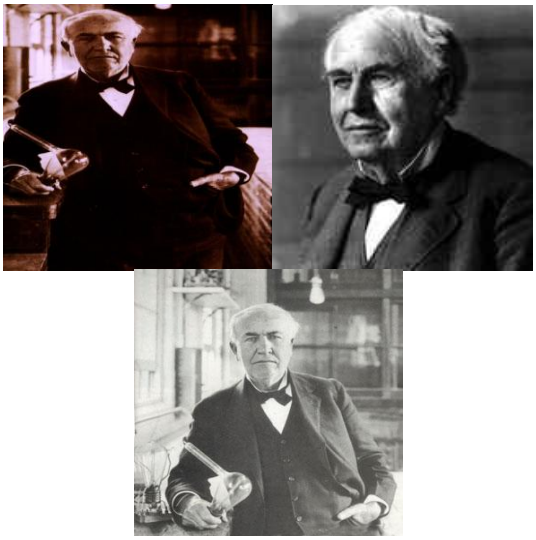

Figure 7. Thomas Alva Edison

Afterwards, the students are presented the structure of the light-bulb.

Figure 8. The light-bulb

An assembly of circuitry items (of the same type), connected among themselves through conductive wires, is a group of circuit elements. It is shown that bulbs can be grouped *in series*, *in parallel*, or both, after which live and virtual experiments are performed.

A group of bulbs connected one to another, so that they be gone over by the same electric flow is an ‘in series’ group.

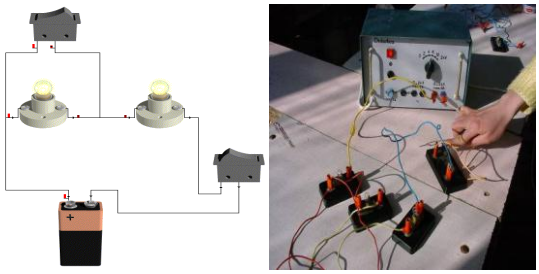

Figure 9. The light-bulb connected ‘in series’

If the bulbs have their electricity entry poles connected together and their electricity exit poles also connected together, the bulbs are grouped ‘in parallel’ then.

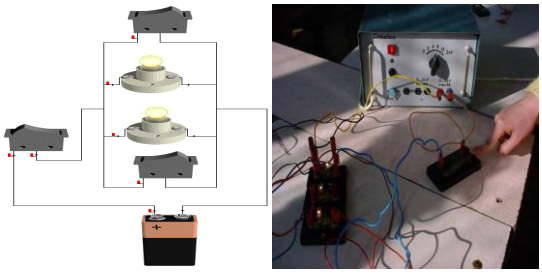

Figure 10. The light-bulb connected ‘in parallel’

Any time an accidental (or non-accidental) contact is performed between two normally insulated points of an electric circuit, a *short-circuit* takes place. If there is a consumer or generators between the two short-circuit points, we say that element has been short-circuited. A short-circuited light bulb no longer lights up. The electricity still goes through the wire, but it doesn’t go through the bulb’s filament any more.

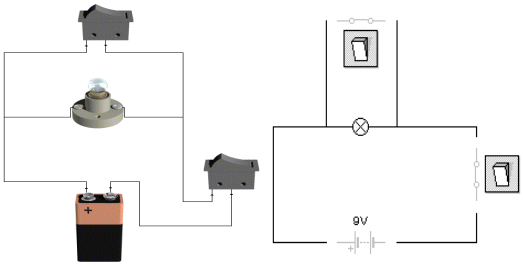

Figure 11. The short-circuit

If one of two ‘in series’ bulbs is shorted, the latter lights up more brightly. If one of two ‘in parallel’ bulbs is shorted, the bulbs not brightly. If the battery (supply) is

directly shorted, all bulbs go out and the battery gets heated up.

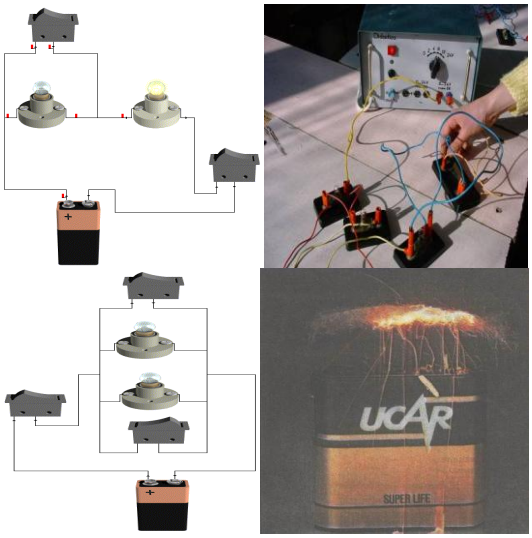

Figure 12. The short-circuit experiment

If the power supply is an accumulator, when a short circuit occurs a bunch of sparks can be seen. A short circuit is always dangerous! It deteriorates power sources and causes conductor heat-up, thus leading to fire. The use of fuses can also avoid short circuits.

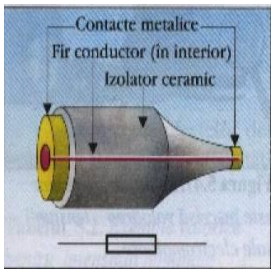

Figure 13. The fuse

Next, students perform a number of experimental activities and then they proceed to the project itself.

Look for new information on electric bulb and power: the amount and colour of light supplied by the bulb depends on the temperature of the incandescent filament; the whitest light is obtained at a filament temperature of 2700^0C. The project was carried out in group, so each student had a clear-cut responsibility. Not only did students bring in new information on this topic, but they also made up lots of problems, pointing out the keys to them, as well as crossword puzzles, photo albums and they made interdisciplinary links with biology, chemistry and countless computer applications. To carry out this project, students used CD-ROM encyclopaedias and search engines. Thus, they completed and diversified their knowledge. They also exchanged opinions with other students worldwide through e-mail. They analyzed the similarities and differences between the Romanian education system and the one in other countries. Communication through the Internet allowed the teacher to answer students' questions and guide them into project completion, even when they were not at school. But this way of communication cannot be used by all students, as not all of them have an Internet-connected computer, or are able to use the computer well enough. The materials made up by those having used modern technology were much more interesting than the students having used the books in the library only. The former students also made up advertising leaflets to draw people's attention to the necessity of power saving.

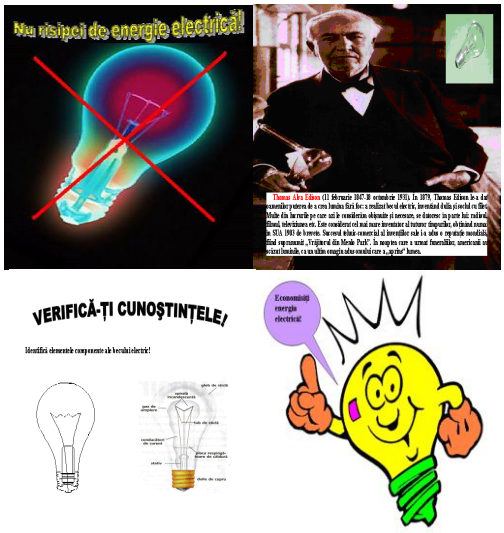

Figure 14. The students' projects

In order to consolidate their knowledge, students made concept maps. 'Concept maps reflect cognitive and emotional networks formed throughout a lifetime in regard with certain notions." (Horst Siebert)

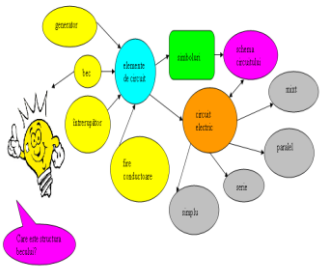

Figure 15. The concept map

By means of these maps cognitive networks can be reconnected, new ideas are included into a cognitive structure, and previous items of knowledge are rearranged. The new ideas pay off within the frame of existing cognitive patterns, too. Concept maps are a visual presentation technique of information structures describing the way concepts in a certain field interrelate. A thorough learning of new concepts depends upon prior concepts existing in the student's mind and on the establishing relationships between these two kinds of concepts. More specifically, learning new things makes sense when finding prior basic ideas to build up new acquisitions in the learner's mind. The concept maps pay major importance to making links among concepts during a learning process. In other words, not *how much you know* is important, but the *relationships set* among the acquired pieces of knowledge. Performance depends on the way the student organizes their own experience, ideas, and on integrated structures and their applicability. By means of concept maps, the student learns actively and consciously.

Since students are not really willing to quit modern-day technology, it is then imperative to find modern ways of saving energy and the fuel necessary to produce the former. The students came up with a few alternatives: water, solar, wind and nuclear energy.

Figure 16. A few alternatives energy: water, solar, wind and nuclear energy.

Several extracurricular activities should also be performed with students, so that they spend more time outdoors, practice more sport, and consequently save energy.

Students also wrote essays entitled 'A Day with No Electricity'. These essays enhanced their imagination and creativity, and students tried applying what they had written, but it was rather difficult.

All this experience got students to both appreciate our forerunners' and contemporaries' discoveries and to reflect on the future, from the perspective of conventional energy sources extinction. This also made them understand they had to learn not to waste electricity. Students proposed a few measures of saving it by appropriate use of home appliances. It can be therefore concluded that the project attained its goal to sensitize students towards necessity to save electricity!

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