LEARNING ELECTROMAGNETISM IN INFORMAL CONTEXTS

Electromagnetism at the cinema

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1 LEARNING ELECTROMAGNETISM IN INFORMAL CONTEXTS: ELECTROMAGNETISM AT THE CINEMA

It is well known that media have a strong influence on the students, on their scientific ideas and knowledge. Due to a little growing of public knowledge on dinosaurs in the last years (comparing with other scientific subjects) the European survey *Eurobarometer* 2001 explains "Could it be that the large number of documentaries and fictional items on these topics in recent years has helped to clarify people's knowledge?" [1].

Is it possible to use videos as an educational source? The proposal of this paper is to suggest their use as an educational informal tool.

Of course there is a strong suspicion and distrust by teachers and scientists on the films and videos: television, films and videos are generally considered as a pure entertainment in fully opposition to education: it is mainly because a scientific subject in a film is very often developed on the edge between what is really possible or true and what is only pure fictional; pseudoscience more than science is the real protagonist in films, because it is more dramatic. And the more dramatic is the film the more will be the success.

But we have to take into account that television is still the main source of information about science and technology; quite all Europeans (97.6%) watch television; films and documentaries are the most seen programs (84,3% and 61,6% respectively); more than 2/3 of the people watch DVDs. This is especially true for young people, under 25 years, and this is the part of population for which the use of the computer and of the WWW is growing at a high speed. And we have to consider also the main reasons of the disaffection of young people from scientific studies and careers: the lack of appeal of scientific studies at school (67.3%), the difficulty of these subjects (58.7%) and young people's lack of interest in scientific subjects (53.4%), just to cite the European surveys among the several papers on this topic [1].

So why not to use an informal education methodology to help the science teaching to be more successful in term of involvement of the students (and, why not, in term of results)?

There are already formal recognitions (as the one of the American National Science Teachers Association, see www.nsta.org/about/positions/informal.aspx) and successful experiences (among the others see [2], [3]), so let consider the use of films and videos as an informal tool for education on topics in electromagnetism.

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First, how about the sources? Thanks to our annual *Vedere la Scienza* event – a scientific film and documentary festival for students and the public that we have been carrying on in the past 11 years (www.brera.unimi.it/film) - we experience how science, its methodology and protagonists are highly shown in a lot of productions for the cinema and the television across a large number of genres: documentaries, films, animation, docu-drama, science-fiction, shorts and videos, some of them having a high scientific level, suitable for students of different levels. The whole history of the cinema and the television offers a large quantity of titles on science/scientists or inspired to: among the sources the text by Martinet [4] deserves to be mentioned. *Les rayons Roentgen* (F, 1898), *The story of Alexander Graham Bell* (USA, 1939), *Edison the Man* (USA, 1940), *Young Tom Edison* (USA, 1940), *Ben and Me* (USA, 1953), *Antonio Meucci, cittadino toscano contro il monopolio di Bell* (I, 1970), *Tajna Nikole Tesle* (YU, 1980), *Benjamin Franklin* (GB, 1984), *Einstein's Big Idea* (USA, 2005): these titles represent only a short suggestion list linked to electromagnetism; there is a large number of sources for informal education with videos on electromagnetism - or any other item in science - including films for the cinema or television, videos for the Web, videos for home-distribution.

It is possible here to cite only a few examples but before to go in them it is essential to specify what to search for and what to use the videos for. In our opinion, films as an educational informal tool can be effective face to three main areas of interest: experiments and experimental apparatuses, theories and laws, people.

We have experienced that one of the main problem of teaching electromagnetism is that most phenomena cannot be observed directly so that models and analogies play an essential role helping students to deeply understand the matter and overcome difficulties. The reproduction of an experiment or of a model, with the powerful help of moving images, demonstrates to be useful and stimulating.

Moreover, it appears quite often that several students consider the scientists, laws and experiments as extraneous, unrelated with the normal life. Students (and some time teachers too) mostly know scientists only because of a law name: this is true for minor as well for major names, like – speaking of electromagnetism - Ampère, Hertz, Faraday, Maxwell and so on. It appears also as a consequence of a spread style of education in which physics is taught as a succession of laws and experiments on done subjects, with little or without any attention to the historical, social, political contexts, without any attention to scientific debates, and finally without any attention to the normal scientists' life and the scientific institutions development.

Face to these questions a great example of a help comes from the docu-drama *Einstein's Big idea* (USA, 2005), which explores the lives of the people who helped develop the concepts behind each term in the $E = mc^2$ equation: among them Michael Faraday for term E and James Clerk Maxwell for term c (see the website http://www.pbs.org/wgbh/nova/einstein/). One of the interesting sequences of the film shows Faraday – appointed as Davy's assistant – discussing with their

colleagues on the nature of electricity, replicating the Oersted's 1821 experiments which just led him to see how an electric current passing through a wire can deflect at a right angle the needle of a compass near it. The electricity as a sort of fluid flowing through a pipe, shared in the scientific establishment of that time, is very often also a concept of a student learning (with difficulties) electromagnetism today. More, as shown in the film, Faraday met difficulties on the concept of the lines of force as often appears to a student today (see also [5]). So the student seeing the sequence can "share" similar difficulties with an authoritative scientist of the past and can receive an emotional stimulation to overcome them by means of the experiments shown, the discussions arose, the concepts developed. With a same strategy other sequences, as the one in which Faraday invents the electric motor, could be useful to deeply involve the students on how concepts, which seems to be abstracts, give life to objects which are part of their everyday life. Among the several, a last deserving example from this film is included in the sequence in which the young Maxwell is explaining to the old Faraday how, thanks to an advanced mathematics, he finally came to his model of the light as an electromagnetic wave, starting from the Faraday hypothesis (for which Faraday had to struggle with a large scepticism in his time): the power of the clip is in the ability to show to the student how an achievement in science is the result of a critical process and not a statement.

A good example of models and analogies that could be effectively used with students learning electromagnetism comes from the documentary *QED* (Germany, 2006, www.sciencemotion.de). With a mixture of language, images, music, models and puppets *QED* help the viewer to more easily learn about light, matter and the void. Taking the example of a mountain landscape as a model a sequence explains us what is the electric field and helps to better visualize the electric field, the curl field, the gradient field. Using the model of a moving rocket for an electron another sequence shows why electric and magnetic phenomena can be both described by a unified theory.

Of course the use of sequences from films as a help in the education process could be helpful and effective if accompanied by the discussion with the teacher. It is especially true in the case of blockbuster films which are, very often, cause of misunderstanding of scientific concepts. We can cite here, as an example, a sequence (interval time 23:02-24:53 of the DVD) from the film *The Core* (USA, 2003) in which the protagonist explains the interior structure of the Earth and the reason of strange terrestrial magnetic phenomena, such as the growing of aurora phenomena. As the whole film, the sequence is a mixture of correct and incorrect information of the Earth interior and Earth's magnetic field but the students are normally not able, by themselves, to distinguish the ones from the others ([6]). Taken into account that films are one of the favourite products of entertainment for young people the rationale for the use of sequences from popular films arises also because it is not only a help in the education process but also a way to help the students to distinguish science from pseudoscience, to involve them and to

promote their critical skills, to spark curiosity and engage interest in the sciences during school years and throughout a lifetime.

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