Innovative ways of combining teaching ICT with teaching science: video taking and editing by students and teachers

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Abstract: *Science and technology are omnipresent in everyday life and they play a very important role in today's culture. Encouragement is needed for students to study science because, for greater economic wealth, education should aim to attract a greater number of young pupils to study science, so as future scientists and engineers emerge from them. It is also important for school-leavers to have acquired skills such as searching for new information, as well self-educating skills that are consider of vital importance for all citizens in modern society.*
A growing number of schools in Europe already have computer laboratories available. Introductory courses on ICT are already integrated in primary school curricula. Now may be the time, therefore, to revise existing curricula so that they incorporate ICT and become more attractive to the students while avoiding overlaps. We believe that while integrating in the school curricula ICT teaching with the teaching of different subjects, one might attempt at the same time to introduce different learning methods while paying more emphasis to students' own actions and self-directed learning abilities. In the teaching approach suggested, the teacher selects a certain scientific topic deemed suitable for his class and the students are asked to create their own medium. Students choose the content, plan on it, decide which are the important points and which ones have less importance, they develop a teaching "scenario" and thereby act according to it, they learning by their own actions.

Keywords: Science education, ICT education, new teaching methods, teaching science, educational technology, self-directed learning

1. Introduction

Science and technology are omnipresent in everyday life and they play a very important role in today's culture. Because of their pre-eminence, school curriculum should try to comply with these new data. Students should study science and technology:

- Because the economic strength, the progress and the wealth of all modern societies is based on Science and Technology[1]
- Because science is an integral part of human culture and as it thrives on independent and creative thought, understanding science develops one's independent and creative thinking[2].
- Because education should aim to greater depth in pupils' scientific understanding[3]
- Because education should, also, aim to attract a greater number of young pupils to study science, so as future scientists and engineers emerge from them[1],[5]
- To gain knowledge about the material world, simply because it is both interesting and profoundly important – and to feel the sense of excitement that scientific knowledge brings [5].
- Because the understanding of the nature of science is essential if people are to make sense of socio-scientific issues and participate in the decision making process[3]
- Because the ever-growing importance of scientific issues in our daily lives demands a populace who has sufficient knowledge and understanding to follow science and scientific debates with interest, and to engage with the issues science and

technology poses – both for themselves individually, and for our society as a whole[3]

The knowledge on how to search for new information as well as the acquisition of such new information in the course of normal schooling, self-training, or re-training is of immense importance today. Indeed, the ability to acquire new knowledge is a vital skill for all citizens in modern society.

A growing number of schools in Europe already have computer laboratories utilising modern computers. Introductory courses on ICT are already integrated in primary school curricula or soon will be. Apart from that, PCs are present in a continuously growing number of homes, and the age children start using computers decreases continuously. It is about time, therefore, to revise existing or develop new ICT curricula. On developing these new curricula due attention should be paid to the fact that activities such as text editing or painting have already been introduced to the students in primary school. Something different, more advanced, and more exciting is needed, therefore, for the high school (and lyceum) curricula. We believe that one possible course of action would be to integrate in the curriculum ICT teaching with the teaching of different subjects, while at the same time to combine different learning methods by paying more emphasis to students' own actions and self-directed learning abilities.

2. Constructivism in action: the case for self-directed learning

According to **constructivist** theory, pupils cannot be considered as "tabula rasa". They have preconceptions or "alternative frameworks" (according to which they tend to think in order to explain whatever they experience), and which they therefore play an essential role in their learning process. **Constructivism** pays much emphasis on students' ideas, as these ideas represent the raw material that the students themselves are called for to **reconstruct**. Professors and teachers play a supporting role in this process. Meaningful learning demands that pupils construct their own knowledge

Self-directed Learning is a didactic concept where students set their own goals, analyze a given problem, observe their own learning progress, and assess the educational results.

The innovative teaching approach suggested in this paper, aims to help students achieve the goal of self-directed learning. The students learn by their own actions for a change, instead of passively hearing teachers teach. Furthermore, students have to choose the content, evaluate it, decide which are the important points and which ones have less importance, they develop a teaching "scenario" and they execute it. They also have to collect the materials and apparati needed for the experiment to be performed, set the experiment up, make sure that everything works and then start the shooting.

The video-editing phase follows and any corrections needed are performed. Students are asked to evaluate their own work, and if the end result does not satisfy them they may decide that the process should be repeated. Alternatively, they may decide to just alter the narration (boring voice) etc. Students develop abilities such as judging their own work and finding arguments to justify their opinion. They learn to hear their classmates and evaluate the arguments presented. All these abilities are considered essential for a modern citizen. Apart from that, the teaching approach suggested offers a very strong motive to the students. Their work will remain at school for other students to use it in order to learn, (or perhaps it may be uploaded via the internet to a streaming server so that other schools may have access to it. Students can also visit their own school page and show to their friends and relatives their own product. In case the same procedure will be performed in parallel in different classes or different schools, a competitive spirit will be easy to take hold. Teachers may also wish to cultivate such a constructive situation by splitting their class into two or more groups and institute a procedure in which all groups take turns in presenting their work. This way, students are given a stimulus to try to outperform the other groups.

In the process of doing so, students learn to collaborate with other members of their group, to evaluate their own work and to make the best of the assets they have available. Students, therefore, learn to develop collaborative characteristics, such as helping each other and to develop their social competence in working as a team. They learn by themselves and by taking into account the opinion of their friends and co-workers on their project. This whole procedure is also bound to enhance their mutual and social skills (group interactivity).

3. Innovative ways of using ICT at school

We have already explained the didactical merits of the innovative learning approach advocated, namely that it allows students to develop their collaborative spirit, learn to help each other and achieve social competence in working as a team. The practicalities of such an endeavour will now be expanded.

Digital video cameras and digital cameras (offering the possibility of limited video capturing) are nowadays cheap and common enough (even mobile phones have such capabilities nowadays). We believe that it is about time to start using media-editing application software in the classroom as a good new method for introducing ICT in everyday school practice.

The teaching approach suggested in this paper is part of an ongoing research, contributed by a number of the authors to the e-stream (Minerva) research effort. Several different didactical projects are currently running in parallel, involving students of different ages (from primary school students up to twenty-year-old ones). The main aims are (a) to find the difficulties faced by students of different ages, interests, and socio-economic backgrounds, and (b) to evaluate different teaching activities in order to find the most appropriate ones for students of different ages. Overall, this approach should have considerable impact on the way teachers prepare their lessons, which in turn, will modify the lessons themselves.

To help along these lines, we present some teaching scenarios for combining ICT (developing of media) with other school curricula. In the present paper, the emphasis is in combining teaching Science with teaching ICT, and therefore the examples are from science teaching.

As the media content is concerned, these can be categorised in 4 major categories as follows:

A) Scientific experiments with the use of computers (sensors/actuators). These have two subcategories.

A.1 The teacher performs the experiment, the capturing, and the editing. The product is then used in class. As sensor equipment is not yet available in all schools, the cooperation of a TEI (Technological Educational Institution) or a University is (for the time being) essential for the shooting.

A.2 A certain experiment is assigned to the students. In this case, the procedure might take place in the school lab a university or a TEI (Technological Educational Institution) might lend the necessary equipment and perhaps a researcher to help if necessary, or it may be combined with one or more visits to a university/higher education training centre that has the equipment for the shooting

The scientific experiments using sensors that were recorded and subsequently used in this educational trial were designed developed and performed in the Department of Physics, Chemistry & Material Sciences at the TEI (Technological Educational Institution) of Athens, and were financially supported by the research program “Archimedes”.

B) Scientific videos: e.g. physics experiments, or instructions on constructing a device requiring a certain level of technological skill. This one has two sub categories.

B.1 The teacher performs the experiment the capturing and the editing and he/she uses the final product at his/her lesson

B.2 A certain experiment is assigned to the students. They should study the scientific topic decide on the “narration”, collect the material and apparati needed, test them, perform the experiment, do the video capturing and proceed with the video-editing.

These two aforementioned categories (A) and (B) are considered to contain a high educational value. This is even more the case, when students are asked to create their own medium. Students will be responsible, in this case, for the end result. The teacher will be, of course, the one that will select the scientific topic deemed to be suitable for his class. In both these cases, (still under investigation):

- The students are asked to investigate and find the theoretical background.
- They will design and plan the content of the video.

- They will decide (roughly or even vaguely) for the narration that may also appear as text.
- They should collect the necessary equipment/materials and test them in an experimental setup before perform the shooting.
- They perform the video shooting.
- They perform the video editing.

C) General knowledge video: the presentation of a well-known monument (there are plenty of such places in Greece e.g. Acropolis, Olympia, Delphi, a certain town) and its history.

This should be considered of contain a medium-level educational value. The quality of the video is an important factor to the success, in this case. In the present paper, we will not deal in depth with this category, as we believe it requires a very different approach that presents its own didactical challenges and all that warrants a new and separate study.

D) Videoing real time events to record (and) reproduce the information it is contained. This real time event might derived from one of the following:

a) Lectures: The lecturer and the topic he chooses are the factors that determine the educational value of the media. Seen in this light, the educational value of this approach does not differ much from attending the same lecture on a TV program. There is not much difference even from listening to this lecture on the radio since very little information is on the visual part. For some people reading the same lecture from a book, be that an electronic or a printed one, might be preferable. And this because they can stop and search for an unknown word, or re-read a paragraph that it was not clear enough. In this case, the quality of the video is not, really, all that important. The important information is to be found in the content, while the information contained in the image is of lesser value, and in certain cases the image might be even distracting (jewellery, clothing, gestures etc.)

b) A real time event such as a song competition, a sport event, students presenting something etc.

c) A school event such an excursion of a ceremony etc.

Normally such videos have limited educational value, as they only serve as an object to exercise and perfect the ICT-video capturing and editing proficiency of the students who take the video, while the real educational value is limited to that. The medium can be used for discussion about the subject e.g. the music, the presentation etc. The quality of the video is again of lesser importance as the details do not play such an important role. In this case, only some limited video editing is normally necessary. The medium is almost ready to use in the first place.

Such activities require the cooperation of teachers of different “specializations” and skills. The Science (or History) teacher is called to cooperate with the ICT teacher. There are reasons to believe that such activities make the learning process more interesting and, finally, the percentage of the knowledge remaining to the students is higher.

Activities like these can be performed after the normal class hours in a daylong school, at the “free activity zones” or in locations that students can visit at any time (as, for example, “houses of knowledge” or “science museums”).

Students can work in small groups. Working in small groups is, of course, most beneficial for the students because they learn to work in teams, to develop collaboration and communication skills, as well as to practice self-learning techniques. This approach encourages teachers to use information and communication technologies as well as collaborative tools, in order to widen the students’ opportunities while facilitating the interaction with each other and with distributed information resources. However the pedagogical challenge is to choose and assess the technology available and to use it in ways that are pedagogically appropriate and relevant to the learners.

4. Difficulties in using the new approach

In order to reveal the difficulties that would be faced by a teacher attempting to use this teaching approach, the decision was taken to organise and perform various teaching activities to test these tasks in practice.

1. Materials and equipment to be used in the experiment had to be collected and tested beforehand. This step is considered crucial. Multiple sets of the materials/equipment that will be used are absolutely necessary (e.g. batteries, lamps, materials that might be cut down, burned, or destroyed during the experiment, experimental tubes etc.)
2. The video-shooting equipment should be tested in advance, and the person using the camera should have pretty good knowledge of the capabilities and limitations of the camera. Using the camera manual and performing experiments in front of the camera will increase dramatically the time needed.
3. Special care should be paid to small details such as the background of the experiment, the surface on which the experiment takes place, but also to the hands of the performer (rings, watches, long nails with strange colours etc.) may attract the "eye" and shift the viewer's attention from the experiment to something irrelevant
4. Normally the LCD screen on the video camera shows a slightly smaller frame than the one stored on the tape/PC. Connecting the camera to a personal computer is considered necessary, especially if we are dealing with small objects in scientific experiments. If we do not do so, things irrelevant to the experiment will appear in the video and will distract the child's attention. A video editing program can be used to crop "noise" but this increases the time and the effort devoted to the editing phase. This step should be omitted for outdoor shooting due to safety and mobility reasons (moving around with a laptop that operates, connecting with a camera)
5. The camera should be kept very steady, especially when videoing scientific experiments. A "professional tripod", a heavy and steady one, is recommended for this purpose.
6. The camera is best to be operated via remote control, due to several practical reasons

a) If the tripod used is not a professional one the final image will suffer greatly as it would allow small movements and vibrations during the time of video capture (even if we handle the camera with care)

b) If the performer and the "shooter" is the same person it allows him to start/stop the camera easier,

7. If the performer and the "shooter" are different persons and the video shooting is an indoor activity that is going to take place in a small area, a second screen will be needed to allow a full view of the shooting area to the performer.
8. For shooting scientific experiments professional lighting equipment is required to increase the amount of light available and in doing so to increase the depth of field of the image taken. It might be proven that setting up the lighting (avoiding shadows etc,) is a time consuming activity
9. The camera should be set to the mode that allows saving the video to the tape and simultaneously sending it to the PC. That means that 1 PC file and a tape file are produced at the same time (redundancy).
10. The camera should have a high resolution and the connection to the PC should be through a firewire exit. This produces a much higher resolution video in the PC than a USB connection. The resolution can be dropped at the final step (editing and compression) but the only way to add details, is to re-shoot the experiment.
11. It took us about 2 hours to set up the lights, PCs, Tripods, Cameras, find the right shooting position etc.
12. The videotaping could not go on one take (i.e. one shot). The possibility to get the narration recorded correctly while shooting is very low. The probability to also get the narration right might be higher if the text for the narration is prepared in advance and a second person reads it on an external microphone (if the camera allows it) while the experiment is being performed. We, therefore, need multiply takes (shots). Video editing is

needed afterwards, of course. For the video editing a modern computer is recommended (The more the RAM it has and the more free disk space it has, the better. A second disk for the video is recommended)

13. If the video includes several steps, it is recommended to shoot it step by step and gradually store it in a different file. This ends up in editing smaller pieces, and putting them together at the end.
14. Moreover, finally yet importantly, we should mention that this procedure is time consuming. It took us 3 hours for about 8-15 minutes of row video.

Decision such as which video editing program will be used, which analyses etc should be used must also be considered.

The next step is video editing and synchronisation with the narration.

5. Conclusions

While the economic strength, the progress, and the wealth of all modern societies are based on Science and Technology, it is also well known that Science seems to be the most difficult, and the least interesting subject for most students. Considering its true size and its importance, Science is the single major subject in which only minimal amount of hours are devoted in the school timetable. Research has highlighted that "proper" (e.g. laboratory activity – based) science - teaching or such as the science teaching advocated in this paper, is extremely time consuming. Therefore, the first challenge is to find more teaching hours for science.
We also mentioned that introductory courses on ICT are already integrated in primary school curricula or soon will be. Therefore, new teaching approaches more advanced and more exciting could be considered for possible implementation. Techniques such as video capturing become easier and more common. We believe that by combining tasks in the way shown in this paper, will prove to be very beneficial to the students.

This teaching approach helps students to develop collaborative spirit, and to improve their self-learning skills. Students also develop their own judgment as to what is important and what is not, while learning to elaborate arguments to justify their opinion. These are important characteristics of adult people to have. Finally, students also acquire some (often quite considerable) technical expertise.

Another advantage of this approach is the following: Certain events (e.g. the Olympic games, or a school excursion to a certain place such as a centre dedicated to environmental education, or an art exhibition, or an event paying homage to an important artist or a famous author or poet) do not occur every day. Certain events might be rare or even unique and, in addition, they may carry an important educational message worth to be kept as a record. The emotional importance, to the students, to the effect that they themselves record something important or unique, should not be underestimated as it generates excitement.

In the case of recording laboratory experiments, it should be stressed that some such experiments cannot be performed in a normal school-lab. This is because (a) they demand very expensive equipment which can only be found in places where schools go for a visit and (b) experiments may be too difficult to perform at school due to several reasons (e.g. too dangerous to carry out or they demand a tutor with specialized knowledge to perform it). In these cases, the material developed by the students might be useful to the other classes who may be interested to watch it and learn from it.

The ultimate challenge faced by this type of teaching approach is to design activities that are suitable to different age-group students, as well as to students of different interests and abilities.

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