Streaming media as an alternative to direct student instruction for performing science experiments

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Key words: *School Lab experiments, Lab instruction, streaming media instruction, educational video clips, instructional video, atmospheric pressure, educational environment, science teaching, students' ideas, constructivism*

Abstract:

In the present paper a ***comparison*** *between the ideas of two groups of students, both of which were taught the same physics laboratory curriculum but using two different instruction approaches is presented. The experimental group was asked to watch some videos including the associated links to Physics theory explaining the phenomena to be observed, gather the information needed and then perform the experiments involved, while the control group followed the traditional lab teaching practice. The aim was (a) to investigate if it is feasible for students to watch a science experiment on a video clip, and then to construct and repeat in the science-lab what they have just watched on video, b) measure the extent to which students that follow this new instruction approach can achieve a similar level of understanding of the scientific topic addressed by the hands-on science experiment, as the students that were instructed how to conduct the school experiment in the traditional way. The final results of this dual educational trial are presented in this paper, while conclusions are presented and discussed.*

1. Introduction

In the present paper a **comparison** is presented between *the ideas* of two groups of students, both of which were taught the same physics laboratory curriculum using two different instruction approaches. A mixed teaching approach (combining instructional streaming video and science-lab) is thus compared to traditional lab teaching practice (having the teacher instruct the students what to do – perhaps with the help of instructions in a lab manual). The aim was (a) to investigate if it is feasible for students to watch a science experiment on a video clip, and then to construct and repeat in the science-lab what they have just watched on video, b) measure the extent to which students that follow this new instruction approach can achieve a similar level of understanding of the scientific topic addressed by the hands-on science experiment, as the students that were instructed how to conduct the school experiment in the traditional way.

If, after the school-lab experiment no significant differences could be observed in the knowledge gained by the students of the two groups, then creating and using video-instructions for school experiments should be considered preferable. (a) Increased consistency in the quality of lab-instruction, (b) the visual immediacy (on how to perform the experiment), as well as (c) the help in time and effort afforded to the teacher acting as lab-instructor, count as overwhelming advantages for the ICT-based method, and represent enough reasons in themselves to tip the balance in favour of the streaming media.

After all, most primary school teachers do not possess enough science to be competent to teach science properly[1]. Despite this, it is within their duties to teach the subject adequately and to also persuade more students to study science and technology, so as future scientists and engineers emerge from them[2,3]. Therefore, properly designed computer-based learning environments can be seen as one of the best ways to achieve correct and efficient lab instruction.

2. The research questions

The research questions were:

1) Will students that follow this new teaching approach achieve (for any reason) a better understanding than the students that were taught the same subject in the traditional way?
2) Is it reasonable to expect a student to watch a science experiment on a video clip, and then to repeat in the science-lab what he has just watched on video?
3) In practical terms, is this activity less time-consuming for the teacher, in comparison to moving around and giving instructions to students in the lab?
4) If this approach saves time for the teacher, does it, as a consequence, leave him/her more time to deal with more elevated things than instructing the students how to perform the experiment? Other such duties could, for example, include devoting more time to each student group, or explaining the theory behind each phenomenon, facilitating the students work, etc.
5) Could this process (i.e. ICT instruction followed by science-lab activity) help the arts-based university students improve their scientific thinking (on the particular topic, covered)?
6) Will students find it easy to follow non-verbal instructions, by simply imitating the examples in the video-clips?
7) What type of reactions would students have towards this new teaching approach?
8) What type of scientific explanation would be best to accompany the streaming media?
9) On a more advanced level, does this didactical trial support the general effort to base science teaching on the use of ICT packages made of an integration of scientifically correct text, combined with pictures, video, sound, and diagrams?

The ultimate aim of the present and still ongoing research effort would be to provide teachers with web-based interactive streaming material. This material, (or alternatively DVD versions of this, in case parents do not wish their children to have net access) could also find use at home during self-study by children wishing to learn more on science topics. Eventually, some (mostly text-based) scientific explanatory material would accompany the streaming material and act as a backbone to tie it together into a learning environment.

3. Description of the research

In this trial some 224 students participated, all 19-year old and training to become teachers. The control group (126 students) followed the traditional way of lab-instruction to perform the experiments, in which the teacher was instructing them on how to do the experiments while they could also use a lab-manual (a leaflet), in which some relevant theory was also contained.

The experimental group (98 students) was asked to watch some videos including the associated links to Physics theory explaining the phenomena to be observed, gather the information needed and then perform the experiments involved. The videos used in this educational trial were created by the researchers. Subsequently the videos were used to teach students, and the educational evaluation took place. All of the videos produced are currently freely available on the web at: http://estream.upatras.gr/ for the English version, while a Greek version can be reached at http://www.elemedu.upatras.gr/science/index.htm. The video-clips themselves are simply presented and contain very little wording, so that they can be used as teaching material and as a way to gain initial student interest, even when they don't understand either Greek or English. This became possible as they were designed to be understood from the image alone. This was a conscious decision because the translation of scientific text, in any other language, has been proven a very difficult task. The scientific explanation of these videos is really simple, and therefore any teacher willing to spent some time searching physics books can provide the explanation. This educational trial is part of an ongoing research one prospective target of which would be to create a computer based learning environment, easy to use and suitable even for self learning. That would necessitate adding some text, images or perhaps further videos, the resulting learning environment offering the scientific explanation of what the user observes during the experiment-on-video

All of the 15 video-clips made and tested herein are of short duration (2.5 minutes at most) and demonstrate simple scientific experiments on air pressure. Conscious effort was made to select science experiments the outcome of which would be surprising (or even startling) to the uninitiated so as to attract student's interest. The equipment used to perform these experiments was selected to be simple, inexpensive, and widely available (e.g. balloons, plastic bottles, glasses, paper, etc.) so that these activities could be replicated in any school lab or even in the class. The target group for the video-clips was both school-children, as well as teachers (young trainees or active teachers during re-training).

The videos were available to the students for repeated consultation as many times as they required during the trial, so as to better comprehend the experimental setup.

The present study represents the first trial in which videos depicting science-lab experiments are purposely designed as a means of instruction, produced, and eventually used as a "lab-instructor" for the students. Therefore, the knowledge gained by this experiment has to be assessed by the following direct comparisons: (a) the remaining knowledge at the end of this innovative teaching procedure

(experimental group of students) in comparison to the one achieved using traditional teaching methods (control group), (b) the knowledge remaining to the students when the experimental lab-teaching procedure was completed as compared to the knowledge students had before the lab-teaching, (c) students' reactions towards -and opinion for- this new teaching approach, and (d) time used to fulfil the task. Only the first of these comparisons is presented herein, while the second has already been published elsewhere[4].
The last two of the aforementioned tasks were achieved by educational observation from the researchers conducting the trial. An additional practical observation concerned a comparison between the time taken by students to (repeatedly -perhaps) play the video and perform the lab-experiment (on the one hand), and (on the other hand) the approximate time needed in a traditional teaching in order for the teacher to explain the experimental task in addition to the time needed by the students to perform it.

The primary data taken for the present study concerned the remaining knowledge. To collect these data, all the internationally accepted practices for performing research in science education were followed. The pre and post questionnaires used were carefully designed, with clearly stated questions relevant to the topic taught. Both groups covered all topics, and all questions asked were contained therein. All these precautions were very important in order to avoid biases.

4. Forming the research groups for the trial

In the present study, 19 year old University students studying to become schoolteachers participated, each one of them having different knowledge in physics. It was crucial to split them into two groups with more or less equal level of knowledge. For this, a pre-test was given to all students, a few days before the trial, in order to identify what they already knew about atmospheric pressure, as this was the subject they were going to be taught. The data from the pre-test were analysed. Based on the results on the pre-tests, and after some careful considerations, the students were divided into the 2 groups, the "experimental group" and the "control group". The "experimental group" was instructed for the laboratory with the use of the computer based learning environment, while the "control group" achieved the same with traditional methods.

It was decided that, for the educational trial, the students were best be divided into smaller groups, each one of which consisted of 6 pupils working in parallel and collaborating and communicating with each other. During the educational trial the behaviour of the participants (and the interaction between them) was carefully observed by the researchers working in pairs. One was monitoring the activity and taking notes about the students' behaviour, while the other performed the educational activity for which the number of six students per group was the ideal.

Students were allowed to form the 6 pupil sub-groups by themselves. This often resulted in uneven grouping: the "stronger" students often stuck together leaving the rest to do their best. On the positive side, allowing students to form the teams often results to having most of the members of each group being friends with each other, thereby facilitating communication and accelerating cooperation. In addition, one of the aims of the present educational trial was to allow students to learn at their own pace of learning. Therefore, allowing variations ability (or interest) amongst various groups was not considered a problem in itself, as these forces act in every class around the world. Special care was given to prepare and provide the "stronger" students with additional worksheets (not presented here), so as to satisfy their natural curiosity, and avoid them getting bored by keeping them occupied.

5. The teaching approach followed

As students of the "experimental" group were not familiar with the video-before-action lab-instruction procedure were given an "introduction" from the researchers. During this, the new teaching approach was explained to them, and they were told how they were expected to work. Any procedural questions by the students were answered at this stage by the researchers, ensuring procedural clarity to all.

The trial followed. Both groups of students performed the same experiments, and both groups received the same theoretical explanations regarding the experiment, but the way this information was provided to them was different:

- The control group followed the traditional way of performing experiments. This means that they read the instructions in a lab–leaflet, which also contained some relevant theory.
- The "experimental" group used the computer-based learning environment. They watched the video and followed the links to the theoretical explanations, gathered the information needed and then performed the experiments. The videos were available to the students to consult as many times as they required.

The lab assistants - researchers were present during this stage (for both groups), and they were intervening when needed, giving guidance, posing crucial questions and answering student's questions. Both groups filled the same worksheets. Students are so used to work with predefined tasks that, without the worksheets, they were uneasy as they were unsure as to what to observe.

An open discussion with the researchers took place soon after all the experiments were performed, a procedure followed for both groups. During this step, the basic core of knowledge which the students should have acquired was clarified. The teacher-researcher made sure that this basic core of concepts was well understood by the students. At this stage the researcher poses to the students certain questions (concerning hypothetical experimental or everyday situations) and encourages them to guess what would happen, and support their opinion by utilising the experimental conclusions already reached. Also the teacher could ask students to think of further (real of fictional) applications arising from the newly acquired knowledge.

A few weeks after the activities, the post test was given to the students so as to measure the remaining knowledge. This took an extra hour, but it was necessary, as the only way to evaluate the success of the computer based teaching approach, is to analyse and compare the post–tests amongst the two groups. The evaluation was based on questions testing knowledge that all students should have acquired (both the ones used the streaming media and also the ones learning with the traditional way of teaching).

6. Data collection and analysis

The data of the present study were collected from a sample of **224** students in total, of which **126** followed the traditional way of teaching and **98** followed the computer based learning activity.

Each and every study (or measurement, or evaluation) involves a number of **experimental errors** and the present research trial cannot, therefore, be an exception. All these different errors contribute to make what we call **measurement error**, which is (in general) different for every experimental data-point measured, calculated and finally presented. All such points are, therefore, only valid within the limits of the experimental errors associated with them. This is true for every study, even the so called “qualitative” ones.

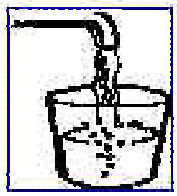
As already mentioned, special care was taken during the experiment to avoid large **systematic errors**, and to minimise any bias. Despite these being small they, nevertheless, need to be measured (in statistical language “estimated”) and subtracted (during the analysis) from the data whenever necessary. The remaining systematic error for the present study was estimated to be **2.0%**, a value considered to be fair (if not on the low side) and which neither dominates the statistical errors, nor is it eclipsed by them.

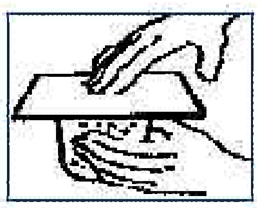
During data analysis, **full error propagation** methods were used. All statistical results presented herein were calculated using specially constructed (by members of the Science Laboratory) software, interfaced with a popular computational and plotting package. The statistical error was calculated independently for each and every point of the data-set taken, as this is both a function of the sample as well as the actual answer given by the students. The **statistical variance** was computed and the **Bessel-corrected standard deviation** was calculated for all data points presented. The **total experimental error** was then computed by adding in quadrature the systematic with the statistical errors, as these two errors are by definition independent.
In some of the questions in the questionnaires, students could choose more than one answer. In these questions it is possible for the sum of the percentages to add-up to something above 100.

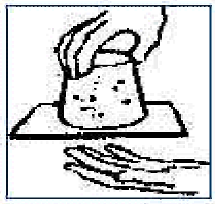
The data are presented here in double histograms, depicting the percentage of students (of each group) which hold a particular idea. The data-points marked by a red triangle represent the control group, whereas the data-points marked by a blue circles represent the research group. The error bars on each point of the histogram represent one total standard deviation on either side of the point, as computed for this single point. The numerical values of the data are denoted staggered on either side of the data-points on the histogram. For the computer based learning environment -blue circles- these are on the left side, whereas on for the traditional teaching -red triangles- they are given on the right).

6.1 Question 1

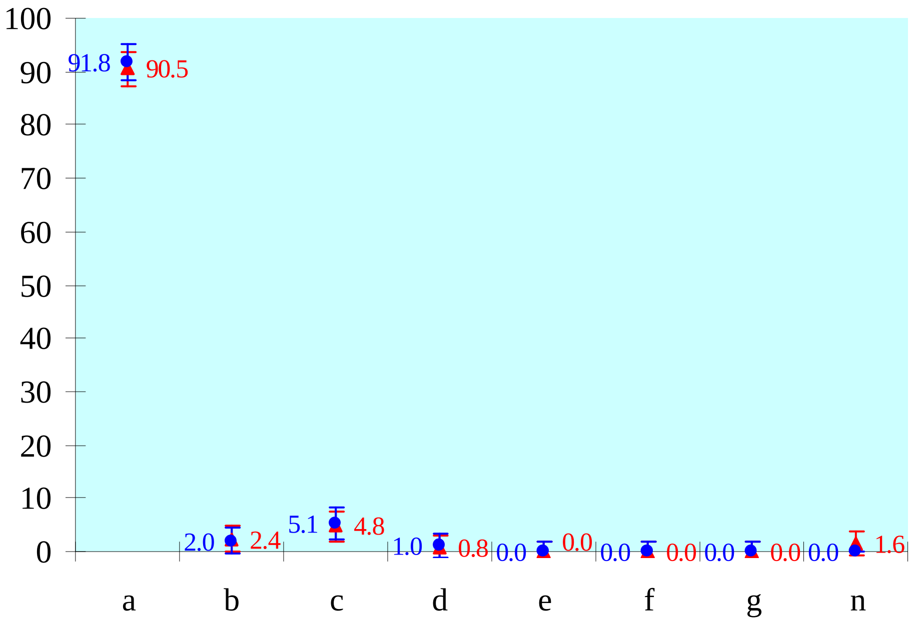
Fill a glass with water, and cover it with a piece of cardboard. Turn it upside down, as shown in the picture. What will happen if we stop holding the cardboard?







(a) If the glass is completely full of water, the cardboard will remain in place due to air (atmospheric pressure).
(b) The cardboard will fall and the water will pour out due to hydrostatic pressure
(c) Surface tension will keep the cardboard and the water in place for a few seconds. Then the water will pour out.
(d) The cardboard will fall because gravity is greater than the affinity forces between cardboard and water.
(e) If we move our hand very quickly, the cardboard will remain in place because of inertia.
(f) We will simply get wet.
(g) Earth attracts all objects. Cardboard and water will fall to the ground as soon as we remove our hand.



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

Figure 1.

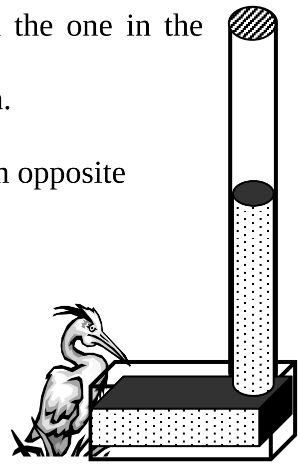
As it is shown in figure 1 there are no significant differences between the two groups of students. Both groups of students answered the question equally well.

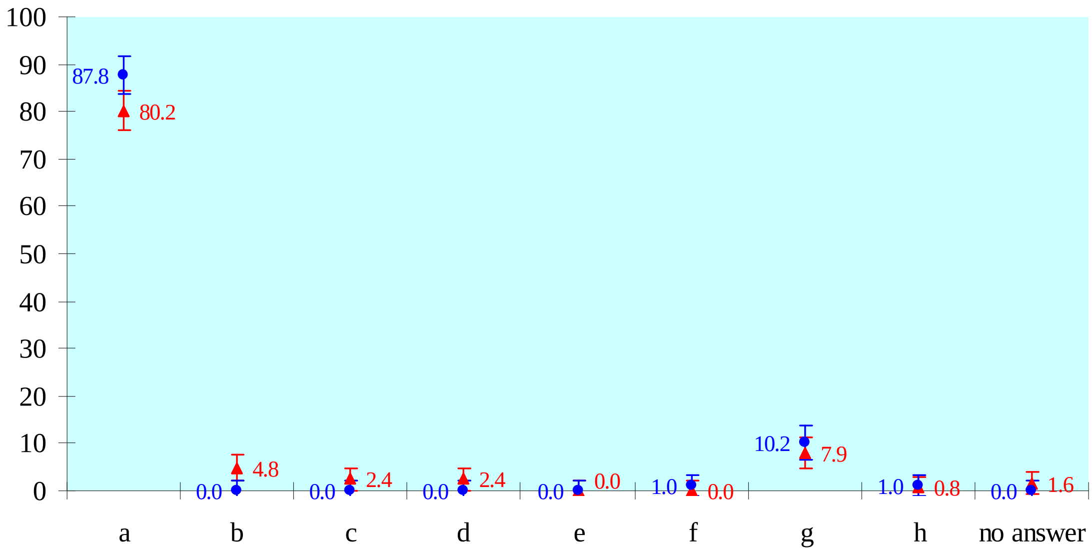
6.2 Question 2

The bird watering trough is a plastic transparent cylinder. The upper end of the cylinder is closed, and the lower one is open. The cylinder is full of water. The lower part of the cylinder is positioned in a small basin full of water. The bird drinks water from this basin. The water from the cylinder goes down to replace the water drunk or evaporated.

Can you explain why the water into the cylinder is higher than the one in the basin?

(a) It is due to atmospheric pressure on the water in the basin.
(b) It is due to the principle of interconnected vessels.
(c) It is due to the osmotic pressure of the water which has an opposite direction to the hydrostatic pressure inside the tube.
(d) It is due to the specific design of the watering trough.
(e) It is due to the affinity forces between the water and the plastic.
(f) It is due to buoyancy which raises the level of water in the tube.
(g) It is due to hydrostatic pressure.
(h) It is due to buoyancy.





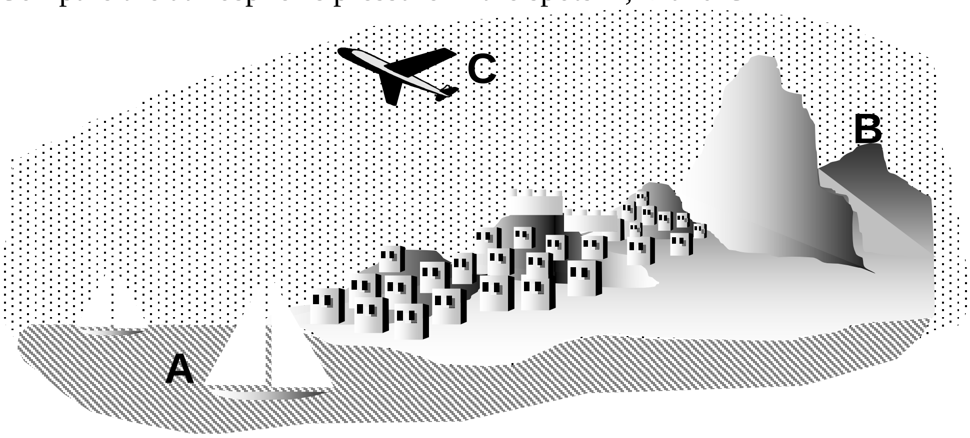
Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

Figure 2.

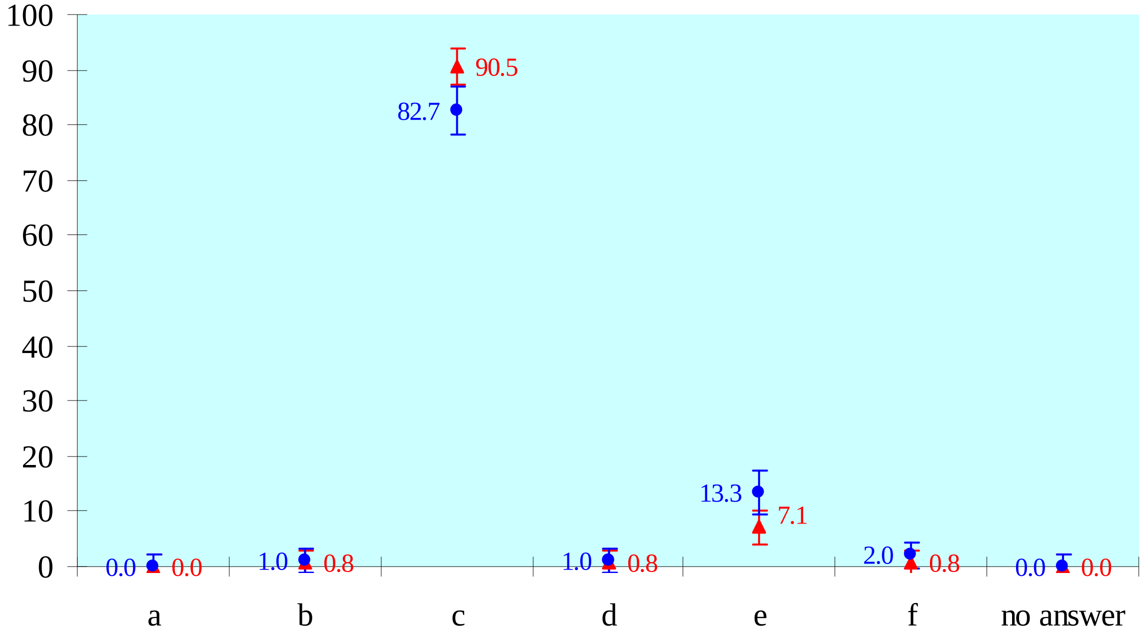
We observe that the research group was marginally better, though there are no significant differences between the two groups.

6.3 Question 3

Compare the atmospheric pressure in the spots A, B and C



(a) Atmospheric pressure is greatest at B, because it is in the mountains.
(b) There is no difference between the atmospheric pressure of points A, B and C (A=B=C).
(c) The atmospheric pressure at A is greater than that at B and the pressure at C is the lowest.
(d) Pressure B > pressure C > pressure A
(e) Pressure C > Pressure B > Pressure A
(f) We can not compare the pressure at these 3 points because the temperature is different.



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

Figure 3.

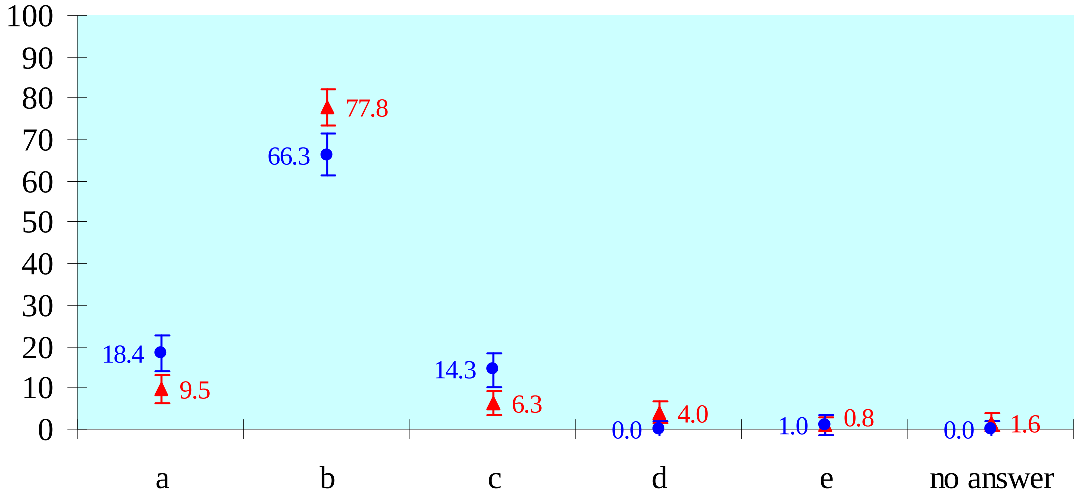
No significant differences between the two groups can be observed.

6.4 Question 4

Question:

Why do we feel our ears blocking when we are up on a mountain?

(a) Because the pressure on the outside of our ear is greater than the one in the inside of our ear.
(b) Because the pressure in the inside of our ear is greater than the one outside of our ear.
(c) Because the pressure outside of our ear is equal to the one inside our ear.
(d) Because of the altitude.
(e) Because at this altitude there is less oxygen in the atmosphere.
(f) Other, please specify: ....



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

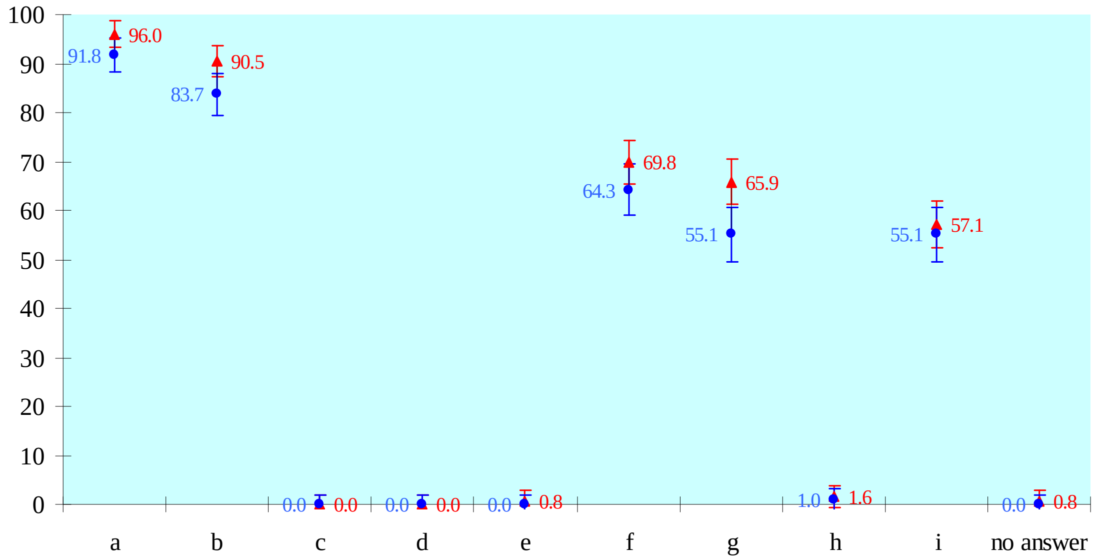
Figure 4.

We observe a small difference between the control group and the experimental group. Only 66.3% (±5.2%) from the experimental group gives the correct answer. For the control group this percentage is 77.8% (±4.2). A 18.4% (± 4.4%) of the experimental group selects answer (a), something that obviously means that these students have not clarified whether the air pressure goes up or down as we climb the mountain. This might indicate that more emphasis should be placed in stressing this particular point in the instructional videos, and in the accompanying text.

6.5 Question 5

Which of the following are used for measuring pressure?

(a) Atm	(d) Newton	(g) Newton/m^2
(b) Pa (Pascal)	(e) Kilograms	(h) Newton • m^2
(c) m/sec^2	(f) mm Hg	(i) mb (millibar)



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

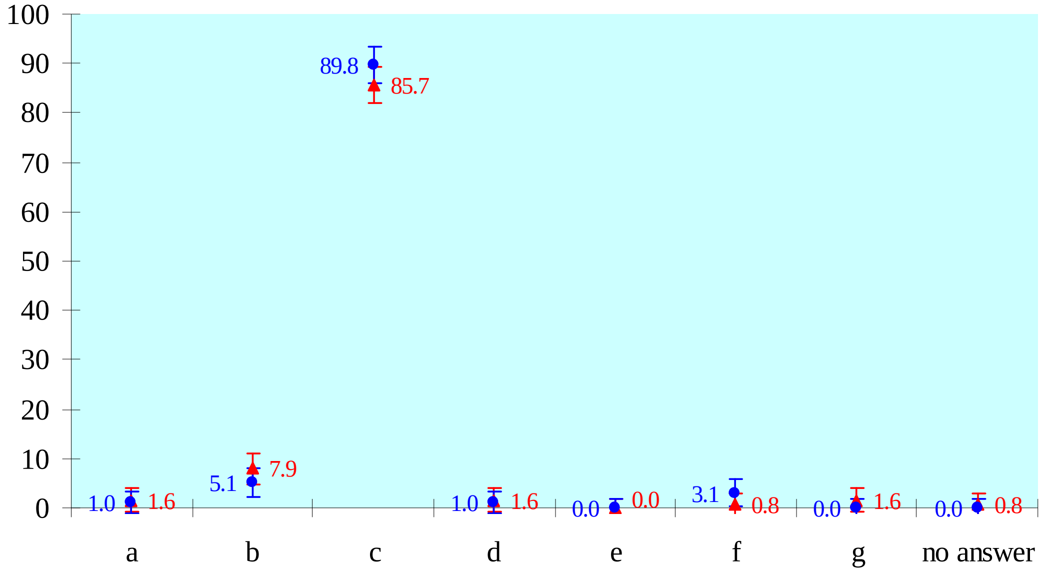
Figure 5.

The first observation is that none of the participants chose any of the totally wrong answers like m/sec^2, Newton and kilograms. The control group's percentage is higher but is within the experimental errors.

6.6 Question 6

The term "pressure" means:

(a) Force multiplied by distanced travelled
(b) Force multiplied by surface area
(c) Force divided by surface area unit
(d) Force multiplied by velocity
(e) Strong force
(f) It is an alternative way of expressing the term "force"
(g) Other, Please specify: ....



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

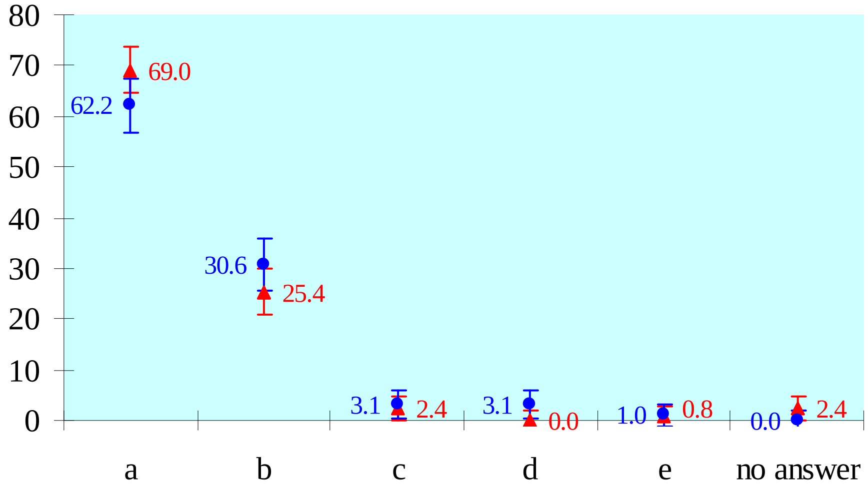
Figure 6.

The percentages of the two groups are compatible.

6.7 Question 7

What is the function of the diaphragm when we inhale?

(a) Muscles push and move the diaphragm downwards. This produces a low pressure environment that forces the lungs to expand and fill with air.
(b) Muscles push and move the diaphragm upwards. This produces a low pressure environment that forces the lungs to expand and fill with air.
(c) The diaphragm does not move. We inhale solely because lungs expand.
(d) The diaphragm does not move. We inhale solely because lungs contract.
(e) The diaphragm has a completely different role. Please specify: ....



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

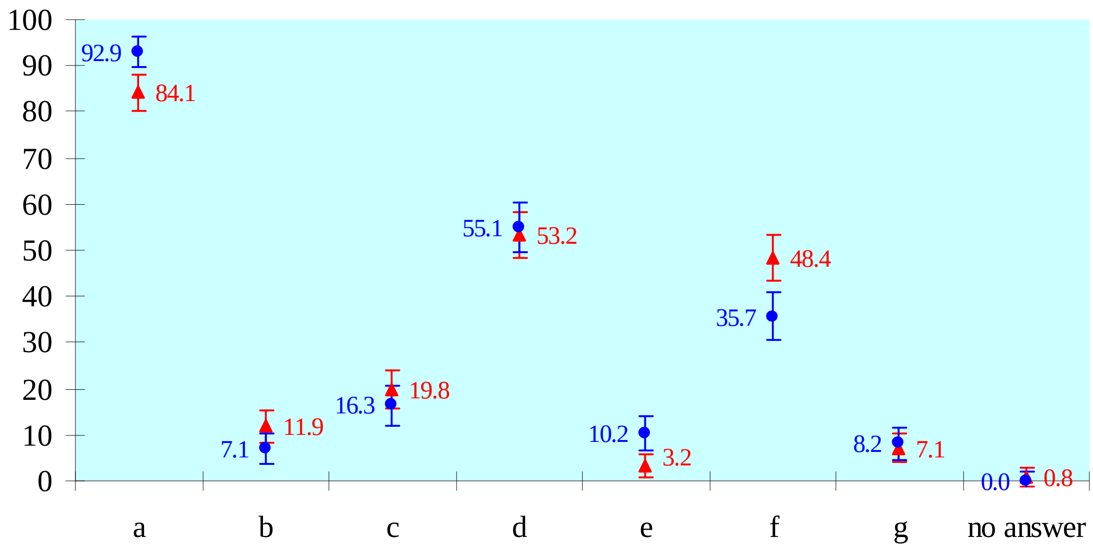
Figure 7.

Again there are no significant differences between the two groups.

6.8 Question 8

Select “true” or “false” for each of the following questions.

a)	On the moon and on the planets without atmosphere we cannot transfuse liquids using a siphon.	True	False
a)	It is easier to transfuse liquids using a siphon on the moon and a planet without an atmosphere than it is on earth.	True	False
b)	The barometer measures the weight of a liquid.	True	False
c)	Air pressure in a certain place remains unchanged 24 hours a day.	True	False
d)	Air pressure on a high mountain (e.g. Everest) is very high.	True	False
e)	High air pressure means good weather.	True	False
f)	High air pressure indicates being very far above sea level	True	False



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

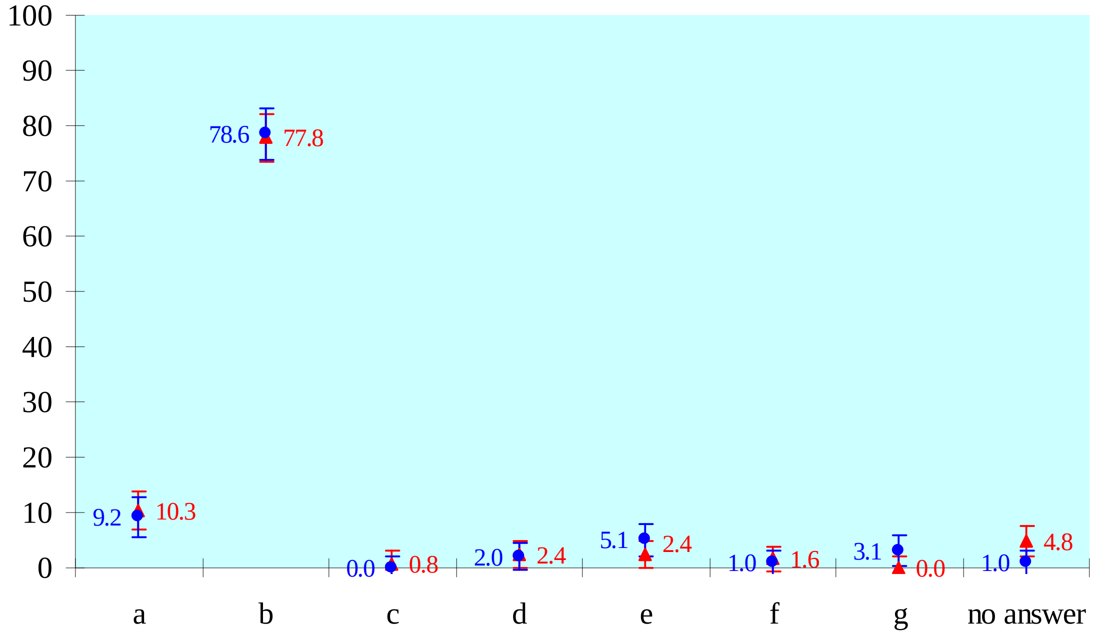
Figure 8.

The numbers represent the percentage of students who had considered “true” to be the correct answer to each respected question (from a to g), irrespective of whether this was the scientifically correct answer or not. We observe some differences in answers (a), (e) and (f). A 92.9% (±3.3%) of the research group considers sentence (a) as correct, while only an 84.1% (±3.8%) of the control group does the same. As this is a complex and quite involved question, these numbers are hardly surprising, but they point out to a need to keep stressing the distinction between different physics concepts –a task for which ICT is much better equipped in order to handle. A 10.2% (±3.7%) of the research group considers (e) as correct while for the control group the percentage is 3.2% (±2.5%). A 35.7% (±5.3%) of the research group considers (f) as correct, while the percentage for the control group is 48.4% (±4.9%). We see that the experimental sample did slightly better on the last 2 sentences as compared to the control sample. On the other hand it seems to be that students’ understanding of the physics behind question (e) leaves a lot to be desired. Therefore more effort should be paid to this topic.

6.9 Question 9

When using a mercury barometer, what does the mercury level read at sea level?

(a) 76 m
(b) 760 mm
(c) 2 m
(d) 9.81 m
(e) Mercury is exactly at sea level
(f) Mercury reading does not change.
(g) Other factors influence the reading. Please specify: ....

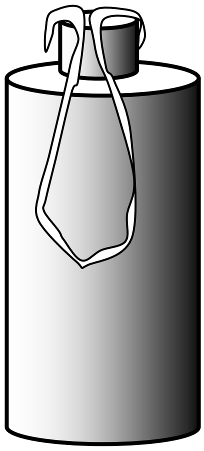


Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

Figure 9.

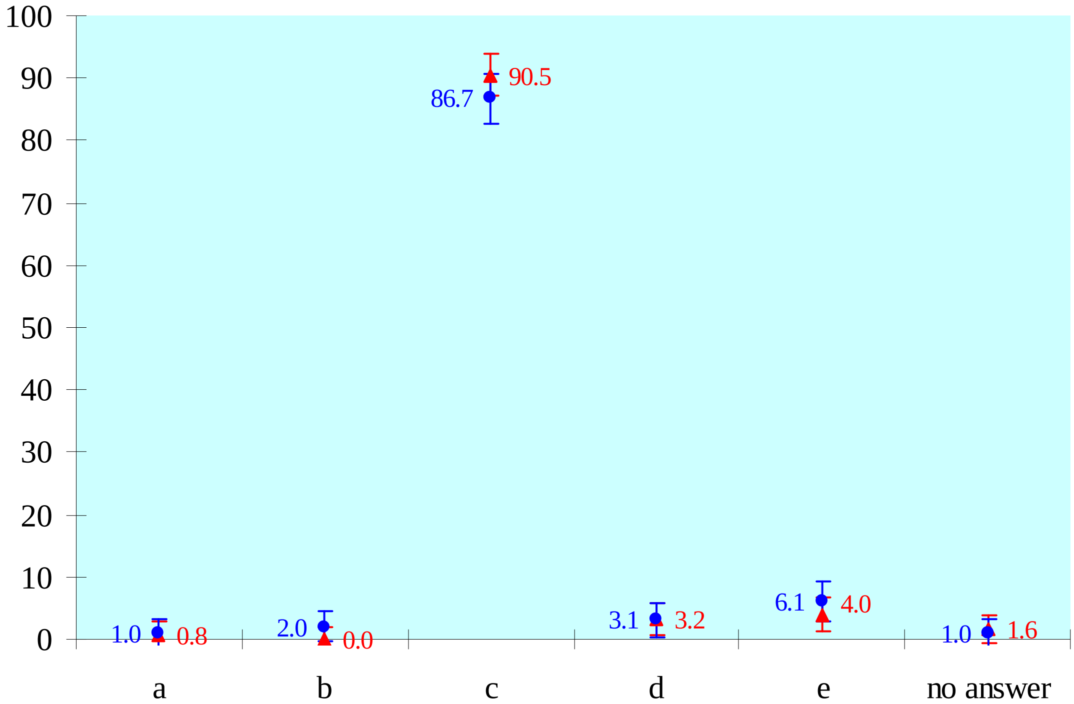
There are no significant differences between the two groups of students.

6.10 Question 10



Little Helen places a balloon inside a bottle. She folds the opening of the balloon around the bottle neck (so as no air can get in or out of the balloon). Then she tries to inflate the balloon, but in vain. What of the following is happening? The balloon does not inflate because:

(a) The balloon has a hole.
(b) The bottle has a hole.
(c) The balloon can not be inflated because the air inside the bottle suppresses it and does not allow it to inflate.
(d) There is not enough space for the balloon to inflate.
(e) Other. Please specify...



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

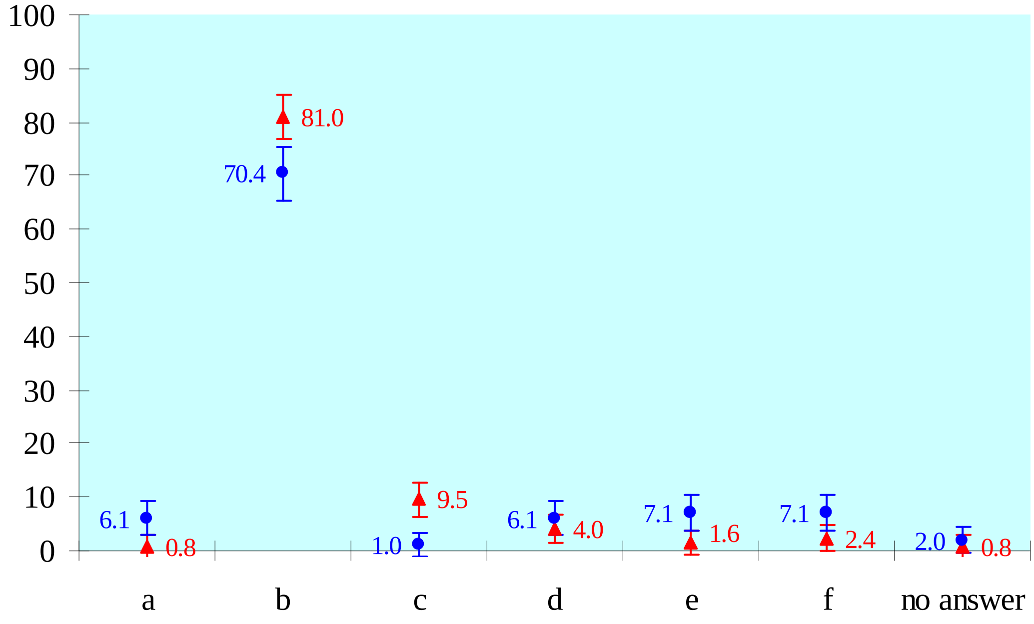
Figure 10.

No significant differences between the 2 groups are observed.

6.11 Question 11

We half – fill an empty plastic bottle with hot (boiling) water. We cover it and we cool it. What will happen?

(a) Because of the expansion effect the hot water will cause the bottle to swell.
(b) The bottle will shrink because of the low pressure in its interior.
(c) The hot water will heat the air inside the bottle which will expand and cause the bottle to swell.
(d) The steam inside the bottle raises the pressure inside the bottle and the bottle swells.
(e) As soon as the water inside the bottle cools down, regardless of the expansion and shrink effect, the bottle will regain its original size and shape.
(f) Other, please specify...



Red triangles represent the control group (traditional way of teaching) and
Blue circles the research group (computer based learning environment).

Figure 11.

The control group managed better in this question, a higher percentage of which selected answer B. Their percentage was 81.0% (±4.0) while the experimental group is slightly lower only 70.4% (±5.1%) from the experimental group offers the correct answer.

7. Discussions and conclusions

The research results support the view that the mixed teaching approach (instructional streaming video and science-lab) tested has been a great success. In most of the questions there are no significant differences between the two groups. Students that followed the new teaching approach mixing video-clip instructions and real science-lab experimental work appeared to respond well to it. They were able to follow the instructions given to them on the video and to perform the experiment without difficulty. We, therefore, conclude that if the digital videos are well designed (as these apparently were), they can be used to instruct students how to perform science experiment.

We have reasons to believe that the educational trial of the final product, where these videos will be combined with scientifically correct texts, selected pictorial material, sound, and diagrams, the results will be even better.

The new teaching approach requires relatively small groups of students to be working together in order to accomplish a certain task. This way, students learn to collaborate with other members of their group, as well as to evaluate their own work and to make the best of the assets they have available. They learn to help each other, and to develop their social competence in working as a team in order to fulfil the task assigned to them. They learn to hear their classmates and evaluate the arguments presented. This whole procedure is also expected to enhance their mutual and social skills (group interactivity).

All these are bound to prove important in their professional life. Finally, on top of acquiring the handling skills normally associated with using the (mechanical) lab apparati, students naturally acquired some technical expertise in handling the devices (hardware and software) as, for example, those deemed essential for the reproduction of the digital video on their computer. It is obvious that the acquisition of all these abilities would not be achieved instantly, but over time.

At the begging, students may need time to familiarise themselves with the new method. Also, easy-to-fill worksheets might be essential at the beginning; otherwise students will be confused, and would not know what to do. If the worksheets are not provided by the learning environment itself, then the teachers wishing to follow this method should spend some time to prepare them. Therefore, at the beginning this method is time consuming.

The videoed lab-instruction approach, as soon as the students are familiar with it, saves teacher's time and it therefore allows him/her to devote more time to each group of students (it is envisaged that many such groups will be working in parallel in the school-lab). He can use his time more creatively as, for example, to answer students' questions, to explain the theory, to facilitate students work, or even to pose questions to the students allowing them to think a bit further.

As already mentioned the video clips used in this educational trial were produced by the authors themselves, and the main reason that initiated this exercise was the profound scarcity of suitable (and available) video clips. One question answered by this exercise is if it is practical for an individual teacher, or even a group of students, to produce their own media. It was shown that the difficulty of the exercise depends highly on the type of educational video clip that one is trying to produce[5]. It was observed to be a lot more difficult to video-record small-scale objects or scenes (such as recorded in scientific video clips), than large-scale objects as (for example) a building, or an overview of a town seen during a school-trip.

We believe that it would be worthwhile if more digital videos were to be developed in the future, videos which will cover other science-lab aspects. These could be incorporated in a computer-based learning environment. Incidentally, these video clips could be delivered over the internet to any school-lab using streaming media technology. They should be either freely available or at a very small cost so as the school budget could afford it. The educational density of such videos should be high[6]. When, as envisaged, much more video-stream based material becomes available, it would also be most helpful for the teacher, if there was some prior information or some sort of guidance given to him, or if there was some other procedure to test such educational material before it reaches schools. This "proofing process" would cover not only the scientific rigour of the material presented, but also the educational approach, as well as the technical suitability. It is hoped that, as both teachers and students familiarise themselves with this new teaching approach, the emphasis in education will shift towards a more student-centred learning approach. This would also cater for the needs of students of different interests and abilities.

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