Streaming Media in Education and their impact on teaching and learning

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Streaming Media in Education and their impact on teaching and learning

Educational best practices and some first observations of their implementation

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Streaming Media in Education, and their impact in teaching and learning

Educational best practices and some first observations of their implementation

by

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Preface

This book was written to explain the intricacies of streaming media and their use in education today, as well as to present the results of a major research effort in the field, performed by all members of the e-stream (Minerva) collaboration.

The aim was to be as complete as possible, within the limits of the book's size, because the prospective readers could belong (in principle) to a broad and diverse group: Teachers, researchers, decision makers, media providers, business executives, and even computer specialists interested in education. The only common denominator amongst all those is their interest in streaming, and streaming as used in education in particular.

Given the broad scope of the book (e.g. trying to satisfy the whole spectrum of prospective readers), some of the material presented might seem too elementary at first. The authors ask for the understanding of the readers in such cases, calling them to reflect that what is trivial to them might be most interesting to others. In addition, not everybody might find all chapters covered to be equally interesting. They are there to offer a well-rounded view of the subject of educational streaming.

The first chapter offers a short introduction to the fundamentals of streaming: what it really is streaming, and why we use it in education, as well as a user's guide to the way streaming works.

The second chapter of the book deals (very briefly and superficially) with the technical aspects involved with streaming media. A reader not interested in technology (or alternatively, proficient in it) may safely leave it out and proceed with the rest: this chapter was placed there just to clear out certain misunderstandings that the authors discovered to be almost common, amongst interested educators. Indeed, as the name clearly spells out, it is written for pedestrians!

Chapter 3 presents the major learning theories in education, and their overlap with ICT. In chapter four, the use of Information and Communication Technology in education is dealt with in a rounded fashion, while placing an emphasis in blended learning, and the use of streaming in such school practices. A classification of the software categories used in education is also presented, giving also an overview of all the current trends in e-learning and educational streaming usage.

In chapter 5, an attempt is made classify the various educational activities in which streaming media play the major role. The classification presented is novel and aims to be complete, for the time being at least. While the activity in a particular classroom might be best described as a sequence of two or more such elementary activities (as the ones in the new classification), it is felt that this is the only way to proceed in an orderly fashion within this diverging scene of teaching practices that use streaming media. Each activity within this classification scheme is analysed and, (as most of these were tried out by members of our collaboration in one way or another), the advantages seen and the problems encountered are clearly spelled out every such activity. The technicalities, the intricacies, the problems encountered, as well as the gains to the students when creating new media, make up the rest of chapter five.

Chapter 6 gives specific examples of educational implementation of streaming media. Its various sections are contributed by the various groups of the e-stream (Minerva) collaboration. By reading this, the reader will benefit from the diverse experience all these groups had, while doing educational research on the use of the media in schools.

In chapter 7, the basis of the quantitative educational research performed by the e-stream collaboration is explained, followed by a presentation of the measurements taken (by the various members of our collaboration) until now. These data were analysed by performing a full error propagation computation, in which the total experimental errors were computed for every data point. These results are presented in comparative histograms, together with the respective error bars, also plotted. At the bottom of each such histogram, the relevant experimental observations are made, reflecting the information presented. Educational observations made during the trials are also presented, and are related with research comments reflecting the measurements. At the end of the chapter, the general conclusions from the research performed are given, together with some reflective afterthoughts, emanating from the research conclusions.

Streaming media is such a vibrant and rapidly developing field today, that it was seen crucial to try to get an overview of the developments emerging in the field and to try to estimate (guess, really) their impact in education. This is done in chapter 8, where due to the diversity of the developments presented one would be tempted to suggest that most readers would find something interesting, if not fascinating. Indeed, not all of the foreseen developments are science and engineering developments; some are financial, others industrial-infrastructure related, while others are device marketing trends, others constitute important software developments, while others refer to methods and trends in using ICT. They all make up the intriguing puzzle of the shape of streaming media in education tomorrow.

Not very surprisingly, the final chapter of the book gives a general overview of streaming media in education today and presents the general conclusions of the present research effort in the field of streaming.

Seen overall, from the research performed and presented, as well as the issues discussed, this book attempts to answer to two main questions:

1. Timing: Why is now the tight time to change from analogue videos or DVDs to streaming media? and
2. Availability: Are there any, good quality, and scientifically correct streaming media available in sufficient numbers on the net? Which factors determine quality (educationally and technically)? Is there a mechanism to evaluate any existing (and available) media and to provide reliable help to the teachers?

The book also tries to answer to some less important questions such as:

- Which educational activities could be implemented with the use of streaming media today?
- Which educational goals do these activities fulfil?
- Which educational activities are most beneficial for the student?
- What do students gain in each of these activities?
- What technical knowledge should the teacher have before starting working with the streaming media?
- What technical knowledge should the students have before they start?
- What difficulties the teacher may encounter when implementing streaming media in his class?

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This book would not have been possible without the important educational research performed by all the partner institutions of the e-stream (Minerva) collaboration. Much is due to the fruitful collaboration amongst all groups. Within all those researchers and research collaborators working within these groups, we would particularly like to thank the following:

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1 Introduction

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1.1 The case for streaming media in schools

Searching for new information in the course of normal schooling, self-training, or re-training and the ability to acquire new knowledge are vital characteristics for all citizens of modern societies. Therefore, schools should teach such skills to all pupils[1].

A growing number of schools in Europe already have (or will soon have) broadband access to the Internet, enabling them to take advantage of multimedia resources and new interactive learning methods. The use of web-based video-on-demand in classroom teaching will have an impact on the way teachers prepare lessons, which in turn will affect the way the lessons themselves are conducted. It is expected, for example, to see a major shift towards the use of interactive multimedia content by students working on individual screens, as opposed to having the whole class passively listen the teacher teach. In this didactical paradigm, the teacher becomes the person giving the inspiration and the person facilitating the acquisition of new knowledge[2].

Teaching is a live process and no matter how carefully the teacher has planed the lesson he/she never knows what else might be needed during the course. The reasons extra resources might be needed are multiple: The need might arise from a question coming from a student. Current events to which the students are aware might also prompt interest on a specific aspect of the subject taught at the time. Alternatively, the course of teaching might lead the teacher to show to his pupils "a new way of acquiring knowledge". For all these reasons, it is essential that teachers retain some level of flexibility in their hands, to be used accordingly during teaching. Streaming technology gives this flexibility with its simplicity in use; it brings a revolution to daily educational activities, and it promises much more. It is suggested that there is a real case for streaming video-on-demand media in schools now[3].

Streaming media offer an easy introductory path for schools due to their ***familiarity***! Most teachers have used video before at one time or another (albeit on a different format), and they are therefore at ease with the general concept although not quite grasping the different level of didactic and educational opportunities offered by the new technique[4]. Streaming media also offer to the teacher ***flexibility*** in delivering the lesson, something fundamental for a good teaching approach. Streaming media are ***adaptable*** enough to serve different didactical tactics within the same teaching hour, making the method easy to adopt and to blend with other techniques and approaches. It is easy for teachers to just stop using streaming media and continue conventionally.

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[1] Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: "Interactive Computer Aided Learning"*, Kassel University Press (2004) ISBN 3-89958-089-3

[2] Ibid. (i.e. in the same publication as the previous one)

[3] Ibid.

[4] Ibid.

On the negative side, and despite the fact that streaming video is (additionally) considered one of the best methods for introducing ICT in everyday school practice, there is currently an acute lack of educational research results in the use of (internet transmitted) streaming media for teaching and learning[5]. Why should internet transmitted media be any different (educationally) to old style VCR? It could be argued that this old style video (with sound) is a type of “streamable media”, which has been available in school libraries. This has been tried out educationally for many years with mixed results: most researchers agree that it never had the impact that was expected. This was largely due to the many challenges faced in making effective educational use of video, as well as to some practical problems. Such problems are related to the limitations of the video libraries existing in schools, the fact that the whole class could only use one video at a time, and the practical difficulties faced when trying to integrate the use of video with other forms of teaching.

It should be noted here that it is precisely this effective vacuum in educational research that the e-stream (Minerva[6]) consortium aimed to fill. Various ways of using IP-delivered streaming media in education were tested systematically, and as the tests continue, the impact these methods have on the educational process is being monitored. Various methods of producing new media have been tried out by various members of the collaboration. In the present publication, the experience gained is reported, as well as the difficulties, the problems encountered, and any steps taken to solve these problems.

1.2 The short history of streaming media transmitted from a distance

Historically, the technical capacity to incorporate video to two-way communication grew over the years from its first usage in the 1980’s. Compressed video was then transmitted via satellite and cable and, eventually, it became standard feature in conference rooms. As the internet has progressed and the compression technologies have advanced, the cost of transmitting video and audio fell considerably; inevitably, video-conferencing became commonplace. It eventually found its way to the distance-learning classrooms offering increased level of interaction between instructor and student via video and audio, at broadband speeds and at a reasonable cost, especially using xDSL connections.

Technically, transmission speed, image quality factors, as well as monetary cost considerations made the use of internet protocol (UDP/IP or TCP/IP) networks the standard for video transmission. The presently available infrastructure in most places in Europe is more than adequate to accommodate the transmission of streaming media. In addition, on a pan-european scale, no problem is envisaged with the projected growth of bandwidth demand in the near future, as the technical developments and the deployment of new backbone network lines of ever-increasing capacity far outweigh the projected growth in demand. Major telephone communication networks are presently inextricably moving from today’s “circuit switched” example to pure “packet switching” elegance, offering a further reduction in operating cost in addition to higher effective speed. It is envisaged that it is precisely the transmission of streaming media (of any form), be that for educational or commercial purposes, which will be the prime use of this increased communications capability.

In education, the increased communications speed and the omnipresence of the web have created, in effect, an integrated educational medium. Web-based video streaming technologies experienced a rapid uptake. By utilising ordinary internet browsers, video sequences can be integrated with or linked to slides, in addition to maintaining the more traditional activities like

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[5] Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: “Interactive Computer Aided Learning”*, Kassel University Press (2004) ISBN 3-89958-089-3

[6] eStream – Increasing the use of Streaming media in school education in Europe 110160-CP-1-2003-1-AT-MINERVA-M

text conferencing, whiteboards, video conferencing, etc. This leads to a seamless integration of digital video with other tools to create a Virtual Learning Environment and offers an opportunity to move beyond one-way video to an interactive medium that complements, and adds visual richness, to static text and graphic content [7,8]

It is now considered possible for streaming media to become a ubiquitous form of communication and find application in every classroom. The promise of streaming technologies is finally within our grasp.

1.3 How does video streaming work: a users' guide

Streaming technology enables a video (or audio) file to be played, while it is being "taken" from the internet. We specifically use the term "take" from the internet, instead of saying "downloading", as this latter technical term (i.e. downloading) is the alternative to streaming. Encoding is widely used for the compression of normal audio and video files. While this is not strictly speaking necessary, the encoding process both shrinks files and it allows for more efficient streaming and, practically, it is therefore considered essential[9].

Video streaming means that a sequence of "moving images" is sent in compressed form over the internet, without waiting for the whole file to be transmitted to the desktop computer. Instead, the media is sent in a gradual continuous stream to the desktop computer, and is played as it arrives. The media file is executed but cannot be downloaded onto the desktop computer. The user needs a media player, which is a program that decompresses the data and sends video data to the display and audio data to speakers. A media player either can be an integral part of a browser or could be a separate program (often downloadable from the internet)[10].

In order to play smoothly, video needs to run uninterrupted. Streaming technologies sends the requested media file residing on (or passing through) the streaming server to a "buffer" (part of memory) on the client computer (e.g. the computer displaying the medium). This will start executing as soon as a sufficient amount of the file has been buffered. Only a small part of the video is in the computer memory at any given time and it is erased as it is being played, to make space for the new material[11]

Streaming media technology allows for "live streaming" or, alternatively, "on demand" delivery of multimedia.

VoD Streaming: "Video on Demand" allows the end-user to view pre-recorded material stored on a server (normally a special "streaming" server) archive, ready for access when the user asks for it. Some authors refer to VoD as a "soft-real-time delivery", referring to its function of processing and delivering of media in such short delay of time that, to the user, it appears to be instantaneous. While VoD was originally regarded as a single-viewer technology, there are today systems that can provide "video multicasting on demand". Such multicasting acts like a "private broadcasting" for a limited number of users (see later on in the present section). In VoD, the video material is always available to the potential user "on demand" at any time. The demand

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[7] Thornhill S., Asensio M., & Young C., (eds.) Video Streaming, a guide for educational development, "Click and go video" project, www.ClickandGoVideo.ac.uk, (2002), ISBN 0 9543804-0-1, pp. 10, and 21

[8] Bijnens H., Bijnens M., Vanbu M., Streaming media in the classroom, Austria: EDUCATION HIGHWAY Innovation Centre. (2004), ISBN: 3-9500247-3-5

[9] Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: "Interactive Computer Aided Learning"*, Kassel University Press (2004) ISBN 3-89958-089-3

[10] Ibid.

[11] Ibid.

is simply a request (e.g. a click on the appropriate link) sent by the user to the media server, and the machine then starts sending the video clip to the user's screen.

Live streaming: This is like a live broadcast, taken in "real-time" and transmitted immediately with no file stored in the media server that is performing the task of transmission. This means that it can only be accessed once, which has to be the precise time the event (e.g. a lecture) takes place, as no record of it is stored in the server's hard disk. The user may seem to address a "file" when he calls a stream to play, but this is an illusion: to the streaming-server this "file" represents only the data stream, which the user chose to have delivered. This data stream (captured by one or more cameras and "mixed" afterwards) is generated by an encoder which digitises, encodes, and sends the signal (video and audio) to the server in real time (e.g. instantaneously). The server, having received the data simply passes them to the client (without first keeping a record of it).

The user will see no difference between these two (quite different) systems. Video is constantly being played on his screen; it appears soon after he selects (e.g. clicks) on it and it will continue until the end of the event (or the pre-recorded video clip) unless the user chooses to interrupt the process. It is quite obvious, though, that there can be no "go back" facility when the event is streamed live.

RTSP (Real Time Streaming Protocol) is a client-server application-level (i.e. high on the OSI reference model, see chapter 2) multimedia presentation control protocol, designed to address the needs for efficient delivery of streamed multimedia over IP networks. It has some similarities to HTTP, but it is also different in that (unlike HTTP) it does control the bits streamed between the server and the client. To the end-user, this means that he is offered facilities like a virtual VCR (e.g. pause, forward etc). RTSP also offers multi-session control, choice between UDP and TCT protocols, and some other functions optimising data transmission (see section 2.17).

Unicasting is referring to the situation where, for each and every user requesting from a streaming server for a certain video to be streamed to him, a totally new session for him is started-up inside the media server. A new connection is opened, control commands are transferred, and the user has full control on the clip: Functions such as Stop, Pause, and Positioning, are all possible.

Multicasting is the ability to transmit a session (e.g. the same video) simultaneously to all the users who want to participate, and have specifically requested for the session. Limited resources are used more efficiently through multicasting but users have less control on the video they watch. Users can think of this service as a kind of "private broadcasting", as the starting time of the transmission could be (broadly speaking) one of their own choice, but otherwise (depending on the type of on-demand multicasting scheme) users may have little actual control over the stream.

While a medium is being streamed, the most important factor is to ***keep it being displayed***, and not so much the image quality of what is being displayed! Although streaming using TCP/IP is possible, the nature of the streaming process does not quite fit (in a natural way) with the full TCP/IP checking (and retransmitting) process to be performed, as the video needs to keep playing: there is just no time for that, as the next video frame must appear on time. For this reason, alternatives like UDP/IP are preferred for streaming applications, and specialised streaming protocols are used on top of UDP/IP. Amongst other advantages, these specialised protocols give additional controls to the end-user and ensure the best visual quality at specific circumstances of network congestion. Overall though, due to transmission errors, it is not altogether rare to observe lost frames in video and stutters in audio, and some such degradation in quality is accepted in order to keep the medium coming to the user in a continuous flow[12] (just like a stream).

The visual (and audio) quality of the streaming medium is mostly dependent on the bandwidth (i.e. the connection speed) available, the media content (sudden-motion vs. non-motion), and the amount of data that need to be moved per second across the network. Better quality is possible with higher bandwidths, but maintaining that bandwidth (without significant fluctuations) for an extended period can be a problem, sometimes[13]. The four most important factors for uninterrupted streaming are, the internet connection bandwidth, the computer's processor speed, the amount of memory (RAM) the computer has, and the internet congestion at transmission-time.

The quality can also be affected by the congestion that occurs in switches and routers[14]. Fortunately, the streaming tools are rapidly improving, resulting in increased quality and better access. For example, the latest crop of media players automatically adjusts the streaming parameters as (for example) resolution, to compensate for random drops of transmission speed (for a concise explanation of how this is achieved look in sections 2.14 and 2.17.c). The increasing availability of wide-band connections on a high-performance internet backbone result in increased quality, stability, and reliability.

For reasons of completeness, it should be mentioned here that streaming is not necessarily done via the internet[15]. Although most definitions of streaming media associate them with transmission through the internet, some streaming applications do not use the internet for transmission.

We should also stress here that streaming servers are specifically designed and optimised for "streaming", and that they are different from the other typical web servers (let alone mere file servers). Streaming servers not only house the media files, they also balance the load of delivering streaming files through the network to many users in parallel, by also taking into account network congestion and bandwidth requirements for each stream. The design of streaming systems as well as individual streaming servers is a very involved one; whole monographs (i.e. books) are currently published dealing with such important and difficult subjects.

1.4 Difference between streaming and other types of media delivery

Radio and TV broadcasting are the most common technologies for the transmission of media content[16]. These are not "on-demand", because it is the broadcaster and not the user who decides what and when is being broadcasted. They are in essence "online media" because we receive TV and radio at the exact moment these are transmitted. It is also possible to record a particular program and to display it at any later moment. These ready-made recordings, although not really an "on-demand" medium, they can be considered as offering a type of "on-demand" service (to the final user), with the advent of video rental shops, or public media libraries. The unavoidable delay between selecting the medium and displaying it is deemed unacceptable for the 21st

[12] Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: "Interactive Computer Aided Learning"*, Kassel University Press (2004) ISBN 3-89958-089-3

[13] Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: "Interactive Computer Aided Learning"*, Kassel University Press (2004) ISBN 3-89958-089-3

[14] Ibid.

[15] Ibid.

[16] Ibid.

century, though. We demand information to be available at the speed of a computer "click", and only streaming media can offer this. The media server may be asked to transmit the very same video to many different recipients just because they "clicked" on it, each one a few seconds later than the previous client did. If the service offered is VoD, for each recipient a different session will be created on the streaming server. Therefore, transmission can start immediately, and there would be no delay to gather more users who ask for the same video (as it would have been if the service was "Nearly Video on Demand" multicasting, or "Near Video on Demand", as it is called sometimes).

Streaming is possible from any physical location of the media server to any location of the viewer, while is only restricted by the connection-speed to the internet. The media that are streamed could have the same origin of creation as those of a TV broadcast, while offering the same sound quality as a radio station. On the negative side, at present they do not quite manage to look as good on the PC, when they are streamed. The reason is, partly, because in order to transfer images and sound over an internet connection, these need to be compressed (see sections 2.7, 2.8, and 2.9) in order to get through the limited bandwidth available[17,18], but there are also other technical issues involved (e.g. stream scheduling), as the field is rather complex. Nevertheless, technology progresses rapidly and there are already more precise and more efficient compression algorithms in use, albeit at the expense of some more computing power being devoted to the process. A multitude of other technical advances (see sections 8.1 to 8.6), will only mean that perceived image quality is bound to improve rapidly in the future.

[17] Thornhill S., Asensio M., & Young C., (eds.) Video Streaming, a guide for educational development, "Click and go video" project, www.ClickandGoVideo.ac.uk, (2002), ISBN 0 9543804-0-1, pp. 49

[18] Bijnens H., Bijnens M., & Vanbu M., (Eds.), Streaming media in the classroom: EDUCATION HIGHWAY Innovation Centre, Austria (2004), ISBN: 3-9500247-3-5

2 Streaming technology: a brief account for pedestrians

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The less technically minded of the readers can safely omit the present chapter 2 (with all its sub-sections) as it is placed for reasons of completeness, and it is only meant as a help to those pedestrians having the ambition to learn to deal with streaming on a more technical level. What follows is, albeit correct and up to date, not even a scratch on the surface of the technical issues involved in streaming. For, even such a superficial treatment of the issues would have required a monograph of quite a few hundred pages, just in order to briefly sum-up a technical field that is already large and expanding rapidly.

2.1 Internet is a "best-effort" network

The main design objective for the internet was to transfer data securely, via a decentralised communications network; this objective (originating from a military brief to keep communicating in case of nuclear attack) still underlines the function of internet even today, after many decades of technical innovations. Any type of data (text, images, sound, video etc), before they can be sent over the internet, has to be divided into a series of many small "packets" of data. Each of these ***packets*** contains a small part of the data, and it carries (on the cover of the packet, as it were) the address of the recipient and a packet-identity number signifying the ordering of the packet within the total message. The individual packets are sent over the internet via communication lines (normally telephone lines); the data-packets are simply sent to find the recipient but neither is a "direct line" connecting the two communicating computers established for their exclusive use, nor is even the exact transport path predefined along the network. Each packet is left free to find its own way to its final destination. Neither the transmitting computer nor the recipient has any control over the path of the packet; this decision (for each individual packet) is taken by the ***routers*** along the path of the packet, and each one of those decides on the basis of the options available at the time the packet arrives. Packets, therefore, are "switched" to follow different routes; they do not arrive to the recipient (also called a "client") in the same order they were sent, and some packets are lost along the way (or take ages to arrive). The reasons for such loss are explained by physics (e.g. bits randomly becoming damaged) or by electronic engineering (e.g. overloaded routers rejecting packages due to lack of resources). Internet protocol (IP) does not, guarantee, therefore, secure transport of individual data packets to the target, but it only guarantees the best possible effort. It should, therefore, be appreciated that internet is just a "***best-effort***" network!

To make up for that, it is possible for each packet received the receiving computer to confirm this fact to the sender, who will alternatively retransmit the missing packet to make up for the loss. As the packets received are in random order, the computer receiving the message sorts them out the ordering being based on the packet-identity number on each packet. This procedure is perfectly suited for non-changing (i.e. static) content such as text messages, HTML pages, or still graphic images. These are called "***discreet-media***", as the information they contain is static over time, or "***time-discreet media***" as they are called sometimes; this means that (quite unlike sound or video) the message itself is meant to be displayed as a whole (i.e. what the computer receiving the message does, will not change with time). This means that (purely because of the nature of the data transmitted) the timing for the reception of the individual data-packets, by the target computer, is not a critical issue.

2.2 Discreet media versus Continuous media; (i.e. time-discreet versus time-based media)

Continuous media (or "***time-based"*** media, like sound or video) are by their nature not time-discreet. If we take the transmission of sound as an example, and if we just assume (for the purpose of explaining the issue) that each "packet" contains a single musical note of the song transmitted, the computer receiving the information still has to place the notes in the right order, and then play them through the loudspeakers. This example should be seen as just a "mental model" of what we mean by continuous media (e.g. non time-discreet) as, in reality, what is contained in each packet is a series of bits (e.g. binary digits) representing the encoding of the "sampling" of the sound-waveform for a number of times. (This is the sampling performed 44100 times a second for CD quality sound).

In any case, to come back to our mental model, how can the client computer be certain that it has all the notes of the song to be played? By waiting, until all the packets arrive and by placing them in the correct order, and then counting them to check if a packet is still missing (in which case he will ask for the missing packet to be retransmitted). There are two reasons why this is an unsatisfactory situation. The first is that we could have to wait for far too long for the song (or more to the point, video) to start playing. The second is that the whole method is wholly unsuitable for a real-time event, like two people talking to each other on an internet-phone (e.g. Voice over Internet Protocol, VoIP), or for a two-way video conference. Each person's message would need to finish, to be sent, and be displayed at a later time, before the reply could start being composed; it will be like sending emails to each other, something quite different to speaking over the telephone.

2.3 Real time delivery versus soft-real-time delivery (VoD)

When transmitting continuous media, therefore, the question of how long one has to wait for the transmission to start does arise. In the previous example (VoIP, video conference etc), there is a generally accepted maximum delay for the reply to start coming back, before people become impatient and confused during *communication*. ***Real-time data delivery*** corresponds to the situation when the reply *must* start, within a pre-defined *time delay*. Less delay is acceptable but no more, and this is the most important parameter for the transmission: we would accept a lower quality in the data delivered (i.e. errors) so that what is sent arrives on time, no matter what. Conflicts between "data integrity" and "timing integrity" do exist, and resolving such conflicts requires defining one's priorities.

When transmitting a pre-recorded video, the quality of transmission (i.e. "data integrity") is more important, than the time-delay before the video ***starts*** flowing, and as long as it ***keeps*** flowing (i.e. "presentation timing integrity") without any problems, while it plays. Such a system is called ***soft-real-time delivery***, and ***Video-on-Demand (VoD)*** is a typical example. Here we would like the video to start as soon as possible, but we would happily accept an unspecified (but short) delay for the starting time, so as to ensure "data integrity" (e.g. no picture distortions), as well as "presentation timing integrity" (e.g. smooth presentation and no interruptions after streaming starts). Here "timing integrity" is not strict (therefore, it is "soft"), other parameters being judged as more important.

2.4 Streaming versus downloading data

Downloading is the most common method of delivering data to a client from an internet server. What characterises downloading is that the entire data object should first be received, and data transmission should be finished, before the video (or other) file can be decoded and played. This is a strict requirement and is independent to whether the client computer uses a memory buffer in addition to the local hard disk drive subsystem, or not. Decoding and playback can be done in the same way as any other data-object in the client computer, as downloading is truly independent from these operations. Downloading works well for many applications but it is clearly unsuitable for continuous media (e.g. video).

The main (and insuperable) problem with downloading is the requirement to wait until the whole video is transmitted before decoding and playback can begin. This requirement may be necessary for discrete data (e.g. still pictures) but continuous media (e.g. sound and video) possess the intrinsic quality that a part of the data could (in principle) have been decoded and played back before the rest of the data was transmitted. For example, a video is made-up from a series of pictures (also called frames) played in sequence. Once the data of a few frames are received, it is possible that (if an alternative transferring model was used) playback would begin.

Streaming is the alternative to downloading; data, in this case, are played back while data-reception is still in progress. The client computer will wait until the first couple of data-packet arrive and will then commence playback, while the next parcel is transmitted to him in parallel, (i.e. data-transfer and playback are “pipelined”, in computer terminology). No data are stored in the client computer as, after their playback, they are erased from the buffer (e.g. local volatile memory) to make space for the next data-packet.

This method is unsuitable for discreet media, as the data cannot be split into fragments that would be of any use to decode and progressively present (e.g. parts of a still-picture are not of much use until the whole is completed). Streaming does have an important ***continuity*** requirement though, in that we must ensure that each and every data-packet (i.e. video frame sequence) is delivered to the client at (or before) their playback time. Keeping up with this tight schedule is a dire predicament for the systems designer, as there are many parameters involved and not even one should be allowed to fail for too long a time, or otherwise the video sequence looses its continuity or it stops playing. Small variations are accommodated using (amongst other techniques) data buffering; quite a few frames can be kept in waiting in the buffer, before the time comes for them to be used. Increasing the size of the buffer is experienced by the user as a slight delay before video-playing commences, but not all problems can be cured by just increasing the buffer size.

2.5 Pipelining

When considering “media-server” design requirements, one of its most important qualities is to be able to serve concurrently many clients. Pipelining signifies, for media-servers, the ability to have multiple concurrent streams of data flowing from the server to the internet. When we have concurrent streams, the transmission bandwidth available for each client is reduced accordingly at the server-end of the network, but this is very rarely a problem as servers have a provision of extremely high bandwidth. Indeed, more often than not, the transmission speed bottleneck is at the client side: the last kilometre between the telephone exchange and the client.

2.6 Difficulties in designing streaming servers and streaming systems

While it is not particularly difficult to design a streaming server that would work reasonably well for a couple of users at a time, and stop operating as soon as some component fails, designing a system that can support thousands of users concurrently and keep on operating even when components fail is totally different. As electronic components fail (often when least expected) it is essential to have some fault tolerance (i.e. capacity to sustain service even under failure) in the streaming server, even if we do not anticipate a great number of concurrent users. This involves those components most likely to fail during operation (e.g. disk arrays, disk controllers, communications controllers, power supplies etc). A large installation would be served by a cluster of fault tolerant systems and would be able to operate even when multiple components fail concurrently.

Overall ***streaming performance*** is the other crucial quality demanded from a streaming server (in addition to ***fault tolerance***). A cluster of servers streaming in parallel does offer increased streaming performance, albeit by further complicating the problem of stream scheduling. Streaming servers balance the load of delivering streaming files through the network to many users in parallel, by taking into account network congestion and bandwidth requirements for each stream. The whole problem is truly complex and subjects like parallel server architectures and especially architectures for multicast streaming are still under heavy investigation.

2.7 Compression methods and encoding methods

Encoding is a general term in computing and it signifies a process in which the original signal is changed into a new different (encoded) one. The opposite of encoding is called decoding and it signifies the process in which the original signal is regained. A codec is a coder and a decoder combined, and it can be implemented either in software (to be used by a CPU) or it can alternatively be “hard-wired” into one or more specialised integrated circuits (ICs or silicon chips). The latter method is normally followed for the more mundane tasks of encoding (e.g. encoding before secondary storage, before transmitting a fax, etc).

Signal ***compression*** is but one category of encoding, and it signifies the case when the coded signal has a smaller size (in binary digits) than the original signal. Not all encoding is done in order to reduce size, e.g. encryption is done for the purpose of safeguarding the information contained in the original signal for reasons of concealment or privacy.

It should be noted that it is quite common for data to undergo multiple sequential encodings (each one achieving a different purpose or using a different method) as long as we keep track of the order the encodings were effected, so as to be able to re-enact the opposite sequence to recreate the original data.

In multimedia streaming systems, compression is almost invariably used to reduce the data rate requirement. This can be easily calculated by multiplying three factors together: (a) resolution (i.e. total number of points making up the picture) (b) Colour depth (in bits) (c) Frames per second. The choice of the right media codec used to reduce (i.e. to compress) the data rate, has a significant impact on the streaming. The choice of codec depends on a multitude of parameters, only some of which (i.e. network bandwidth and media bit-rate) are in any way accessible to a layman.

It should also be remembered that decoding is done (by the client computer) in real time. Higher data-compression is normally achieved at the expense of greater computation complexity. Therefore, inefficient hardware on the client’s side could be the cause of a potential bottleneck to the process. This problem can be grossly exaggerated by choosing a codec unsuitable for the specific task. For video-streaming the use of asymmetric compression algorithms (see later) is essential. Luckily for non-professionals, this choice of codec has already been made for them by experts.

2.8 Lossless versus lossy compression

Lossless compression refers to the compression methods during which all the information of the original signal is retained. This means that encoded (i.e. compressed) data-set is in no way inferior to the original, which can be recover with the utmost precision by performing the opposite process (i.e. decompression). Pioneering work on this field has been performed by extremely famous people in IT; examples of such codes include the Shannon-Fano algorithm, the Huffman coding, the Huffman coding of Images, the adaptive Huffman coding, the arithmetic coding, the Lempel-Ziv-Welch (LZW) algorithm[19] etc. Examples of popular compression packages utilising some of these algorithms and used in personal computers are WinZip, PKZIP, Stuffit, RAR, etc., as well as the PNG (Portable Network Graphics) still-image compression

[19] Welch, T. A., A Technique for High Performance Data Compression, IEEE Computer, Vol. 17, No. 6, 1984, pp. 8-19.

format, or the RLE (Run-Length Encoding) used amongst others in fax machines. Such compression algorithms are used for compressing written text, software programs (they come compressed on CDs), and all occasions when exact recovery of the uncompressed material is vital. These algorithms work very well and they are extremely reliable, but the compression they achieve is not always very high. Nevertheless, not being satisfied with CD-audio, both of today's "high-end" high-fidelity audio formats (representing the next-generation audio distribution) use the higher bit-capacity of DVD disks just to record audio signals (exclusively), and they both use lossless compression algorithms, each one achieving (approximately) a compression rate of a factor of 2 (i.e. half the size). Both standards offer sound quality far superior to CD sound[20]. Indeed, Super Audio CD (SACD) uses an algorithm[21] called Direct Stream Transfer (DST) to write on the DVD. The alternative standard called DVD audio uses another algorithm called Meridian Lossless Packing (MLP) before the data (pure audio) are written on the DVD. Their choice of lossless compression is based on their need to preserve the highest possible audio quality at which these recordings (or transcriptions) were made, and they do achieve their goal.

However, it seems that "not all ears are created equal" while some are "more equal than others", to paraphrase Orwell. Most people do not seem to be able to hear the difference in sound between an original CD recording and an MP3 version of it playing off the internet. While abysmal loudspeakers and miserly amplifiers distort all sound on ordinary so-called Hi-Fi, so that everything sounds terribly similar (and should be the real reason why most people do not distinguish the degradation in sound), part of the blame should be shared by the digitalization of the audio signal (i.e. sampling frequency, word-length, shaping etc), as well as compression methods used.

Lossy compression refers to the compression methods during which some of the original information is lost in the process, while achieving a high compression ratio, e.g. 1000 : 1. Lossy compression is invariably used in video streaming to reduce the data-flow to a lower rate, which can be easily accommodated by modern equipment and internet bandwidth.

Human perception is by its nature finite. We do not hear all sounds (only from 20 to 20000 Hz at best) and do not perceive all aspects of a video image in the same way. The human eye has a finite number of sensors. Although "not all eyes are created equal", it is assumed that the retina has 120 million rods (used to register brightness levels – i.e. light intensity) and are therefore used to induce the contours of objects seen. Retina also has 6 million cones, which are specialising in detecting colour. The difference in these numbers suggests that more emphasis should be given to recording brightness information than recording colour. Moreover, quite clearly, there is not much point in recording or streaming an image (even in the future, when much higher-definition images would be possible) using so many pixels that it cannot be handled by the resolution of computer screens available at that time. Furthermore, as an even more extreme example, there is not much point in recording and projecting at such a high discrimination that it cannot be sensed by the human eye which (as we explained) has an "effective resolution" of 120 million pixels.

On a more superficial level (and therefore higher level), we reach the field of psychophysics, for example psychoacoustics and psycho-optics. In such fields, we learn that our perception of an effect is deemed not to be propositional to the strength of the effect itself but proportional to the logarithm of the effect (Weber – Fechner law). For example, although changing an electrical lamp from a 60 Watt one to a 120 Watt one does produce roughly twice the amount of light, it does not feel like that to us – it only feels slightly brighter! Also our strength of perception (both for sound and light) is highly dependent on frequency – e.g. we cannot hear variations in

[20] Bosi M., & Goldberg R. E., (foreword Chiariglione L.), Introduction to digital audio coding and standards, Springer, Kluwer Acad. Publishers, (2002), ISBN: 1402073577.

[21] Konstantinides K., An introduction to Super Audio CD and DVD-Audio, IEEE Signal processing Magazine, 20, 4 (2003), pp. 71-82

strength of a low 20Hz sound, a lower strength sound goes unheard at such frequency while a higher strength one causes us to panic.

Based on these (and many other) observations we deduce that there are many ways to reduce the information transmitted, without causing an appreciable loss in the perceived quality of image and sound. This is what lossy data compression is all about[22].

When compressing ***still pictures***, TIFF and MNG compressions can use both lossless and lossy methods. GIF compression is a special case, in that although it is a technically lossless compression method, most GIF implementations today are incapable of representing full colour, so they quantize the image (often by dithering) to 256 or fewer colours before encoding as GIF, and colour quantisation is a lossy process by definition.

Standards ***video*** compressions include MPEG2, MPEG4, and H.264 (H.264 is the advanced video coding standard, and is described in Part 10 under the MPEG4 standard).

Using MPEG4[23], one can achieve a higher compression ratio than with MPEG2; by using H.264, one can aim to an even higher compression rate without experiencing much degradation in terms of image quality.

2.9 Symmetric and non-symmetric compression algorithms

Compression and decompression involves some processing to be achieved. How much processing is needed depends on the algorithms used for each process; the more sophisticated the algorithms are the more complicated computations are involved. Very complicated compression algorithms give much better results (both in quality and in compression rate) but they require either much longer processing times (i.e. time-delays) or much higher processing power (i.e. costly computer systems) and often both of these. Some decompression algorithms are the exact reverse of the respective compression algorithms. These are called symmetric compression algorithms, and they require as much effort to compress an image as to decompress it. Some sophisticated compression algorithms are called non-symmetric as they require much smaller effort to decompress (and therefore recreate) the image than in order to compress it. This can be a great advantage, one only compresses the video once, and it is then stored in the streaming server's hard disk array. The decompression effort is done in the client computer, and it has to be repeated as many times as the video is played back, but only a small computing power is needed for that. Compression is harder; to get really good compression special and very clever algorithms need to be used, and these need powerful computers to run. It is, indeed, possible for advanced asymmetric compression algorithms to achieve much better compression rates (i.e. smaller files) while (at the same time) maintaining high image quality, by using very powerful computers (or even supercomputers), and leave them to execute for a truly long time.

2.10 Multiplexing audio streams with video streams to create media-streams

Typical media encoders (e.g. MPEG encoders) consist, in fact, of two independent parts: audio stream encoder and video stream encoder. After the compression of the two independent streams, these two are "multiplexed" together by a system encoder (or multiplexer) to produce one single media stream. The multiplexer does his function by adding presentation "time stamps" to the media stream according to which the audio and video streams are interleaved (as a layman might phrase it) to produce the single stream. These "time stamps" are quite important later on, as they represent specific reference points from which the reproduction might start, if we only wish to play a clip from it. In any case, this single media stream is then sent over the internet in the usual fashion. On arrival, the receiving computer would then use his MPEG

[22] Richardson I. E. G., Video Codec Design: developing image and video compression systems, Wiley,(2002) ISBN: 0471485535

[23] Richardson I. E. G., H.264 and MPEG-4 Video Compression: video coding for next-generation multimedia, Wiley, (2003), ISBN: 0470848375

decoder to first de-multiplex the two streams from each other and then proceed to decompress them. The time stamps will then serve to synchronise the two streams together, during playback.

Using an alternative method, the video-stream and the data-stream can be sent independently in the network, bypassing the multiplexer. In this more advanced streaming-server setup, the server inspects the data, and after it discovers the timing information, sends them in such a way as to arrive at the same time so as to synchronise audio and video playback. While this method requires more processing at the streaming-server end, it has its advantages, especially when using ***multi- rate-encoding*** to achieve "***adaptive data-streaming***" (see section 2. 14)

2.11 Redundancies exploited for achieving high compression ratios:

Video streaming is associated with lossy compression achieving high compression ratios. Each of the following image redundancies are presently used to achieve this (altogether) high ratio.

1. **Spatial (i.e. space-based) redundancy (within the same still-frame image): I frames**

Also known as ***intra-frame coding***, the spatial (i.e. space-based) redundancy refers to redundancies correlating adjacent pixels within the same video frame (i.e. still picture). The compressed video frame which is produced from such process is called an "***I frame***". The important thing to remember is that an I-frame can be decoded independently from other frames.

2. **Temporal (e.g. time-based) redundancy: P frames and B frames**

A moving picture is composed of a series of still frames taken at high rate (e.g. 25 or 30 fps). Assuming that we have a continuous sequence of frames, if we think in terms of pixels, it is very likely that the next image-frame is very similar to the previous one. The idea behind time-based compression is, therefore, only to record the part of the still image (i.e. frame) that is different from the previous still image (- in fact it is even cleverer than that, as it will be explained). This way we save a lot of information that is repeated, at the expense of only being able to recreate this resultant frame in direct reference-relation to the preceding frame (which might be related to the frame preceding that, etc). Therefore, frames that have been created by exploiting temporal redundancies are not independent from each other; as a result, when creating a video-clip from such video (e.g. using a virtual cutter - see section 5.11 for an explanation), these frames cannot be used as starting-frames for the reproduction process.

In MPEG image compression, there are two distinct types of such so-called "inter-coded" frames: ***P-frames*** (i.e. predictive frames) and ***B-frames*** (i.e. bidirectional predictive frames). The procedure to create a ***P-frame*** is called "motion estimation" and starts from a proceeding ***I frame,*** (see figure 2.1, in which time flows from left to right). The frame chosen to become a P-frame is not adjacent to the original I-frame, but a few frames apart.

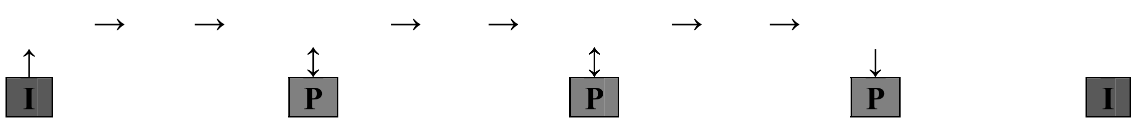

Figure 2. 1

Both the original I-frame and the new frame (the one that will become a P-frame) are analysed to find similar blocks of pixels that might have been moved (often just slightly) in the new picture. After the end of the search, only the contour (i.e. the perimeter line) of the block that moved is recorded, as well as the exact direction (i.e. the vector) of its movement. In addition to this, any errors to the prediction (on individual pixel level) are also recorded and this makes up the total information recorded for the P-frame. When

moving the camera sideways (panning shot) the same principle is used, to determine that the whole image-frame has moved, and only to record the small part on the side as a supplement.
In terms of bits (i.e. binary digits) the information recorded for a P-frame is substantially less than the number of bits used to record the I-frame. This first P-frame is then used to predict and encode the next P-frame, and so on until the next I-frame is found.

The ***B-frames*** are frames located *between* I-frames and P-frames, or just between P-frames, and they are "predicted" from those frames located before and after them (see figure 2.2).

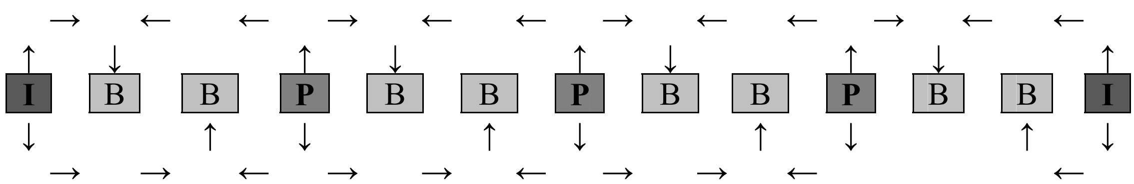

Figure 2. 2

B-frames are called bidirectional predictive frames, precisely because this "prediction" is done from both directions, and it is in effect an interpolation for the movement of the "blocks" as described for the creation of the P-frames. Within the same video-stream, B-frames would normally need fewer bits to represent, than either I-frames or P-frames.

It is obvious that although the decoding of I-frames can be done totally independently (as if it were a still picture), for the decoding of P-frames and B-frames this is impossible. For the decoding of a P-frame, it is essential that the preceding I-frame (and possibly the preceding P-frame, as well) should have arrived in the video-stream, and have been decoded by the media-player. For the decoding of the B-frames, (the procedure being bi-directional), both the preceding "anchor frame" (e.g. either I or P frame) and the one following the frame to be decoded, should have already arrived and been decoded. To perform this action the decoder needs a buffer (i.e. local memory) at his disposal. The buffer will contain information for many frames, something necessary for the decoding process to be successfully completed. Please note that it is not necessary to transmit the frames at precisely the same sequence, as the one they will be placed in the stream flowing from the decoder. Some CODECs re-order the sequence of the frames transmitted, to allow more time to the decoder to complete its function. All frames are reassembled at the correct order afterwards, before playback time.

3. **Entropy encoding**

The term refers to ***lossless compression***, essentially. As defined in the JPEG standard, entropy encoding is a lossless procedure, which converts a sequence of input symbols into a sequence of bits such that the average number of bits per symbol approaches the entropy of the input symbols. One typical example of such compression is the RLE (Run Length Encoding), in which all repeated symbols are replaced by one special symbol, and a number denoting the number of times it is repeated. Another example is "statistical encoding" in which frequent symbols are replaced by short codes. Another example is a CLUT (Colour Look-Up Table) in which the colours actually used are defined in a table and then the code of the position in the table is stored (or sent) instead of the colour characteristics.

2.12 Lost "packets", quality degradation, and Group Of Pictures (GOP)

As already explained, internet network is not always reliable and it is quite possible for some individual data-packets to get lost on the way. When video-streaming, it is generally not possible to recover such lost packages (due to lack of time as well as transmission protocol). The resultant video image will therefore suffer a degradation in quality (- albeit on a small and acceptable scale). The worse problem occurs when the data-packet lost contains a part of an I-frame (described earlier). In this case, all the other P-frames and B-frames near to this I-frame will also be affected, as they depend on the information contained in it for their reconstruction (i.e. decoding). To make things easier, the video encoder decides (at fixed periodic intervals) to encode frames as I-frames, although this is to the detriment of the overall compression ratio. This is done in order to alleviate the problem of loosing a whole chunk of the video-stream as non decodable.

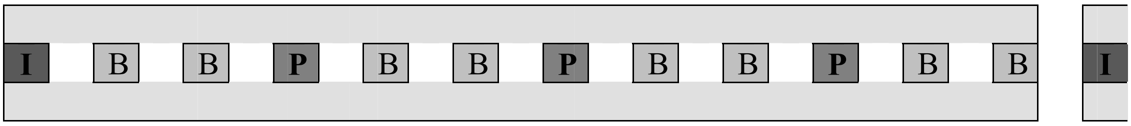

Figure 2.3: a Group Of Pictures (GOP), and the beginning of the next GOP

For example, in the video depicted in figure 2.3, a new I-frame is introduced every 12 frames overall (or 11 predictive frames). If the information of the preceding I-frame is corrupted in any way, it is obvious that all 12 frames will be effectively lost. Nevertheless, as videos normally play at a rate of 25 to 30 frames per second (fps), these 12 frames would translate to half a second gap in the continuity of video reproduction. This becomes noticed to the viewer as quality degradation but it is acceptable, especially since the video decoder makes its best to send something (even the previous sequence) to be displayed. Regrettable though it is, this is experienced as just a flicker in the resulting video image, and anyway the problem is contained to last for only a very short time.

An "I-frame" together with all the subsequent predictive frames (and before the next I-frame comes alone) is called a Group of Pictures (GOP), as depicted in figure 2.3. This is a self-contained entity of information, as all these frames depend on the I-frame initiating the decoding sequence. A stream is, therefore composed of a series of GOPs transmitted one after the other. The shorter the length of the GOPs is, the smaller the probability of a major disruption during playback becomes, but at the same time, the smaller the average compression rate we could finally achieve. It is, therefore, a question of balance, as this will result in a higher bit-rate requiring a higher bandwidth to transmit properly. The length of the GOP, as well as the distribution of P-frames within it, can normally be configured manually when encoding the video. More advanced encoders do this job automatically as well as dynamically: the length as well as the structure of the group changes with time. Such encoders always introduce a new I-frame when we have scene changes in the video, in effect aligning the start of the GOP with the video content, resulting in higher perceived quality overall. Similarly, when sensing long sequences of similar frames, they lengthen the group to increase compression rate. Ultimately, this whole process is a question of risk management, the risk in this case being the loss of quality or loss of picture altogether.

2.13 Constant-bit-rate (CBR) versus constant quality (VBR) codecs

As it has been explained, there are three different types of video frame encoding (I, P, and B-frames) each one capable of describing one video frame, but in doing so, each type of frame-encoding producing substantially different amount of bits to be transmitted. Therefore, the demand for video bit-rate does vary quite substantially across subsequent frames of the same stream. These variations in demand of network resources could potentially create problems.

An encoder can be designed to try to smoothen out any bit-rate variations, not (of course) on a frame to frame basis, but from one GOP to the next. Such an encoder is called ***Constant-Bit-Rate*** (**CBR**) encoder –decoder (codec, in short).

An alternative type of encoder is the one called ***constant quality*** encoder, and not surprisingly, it ends up transmitting a signal of *variable bit rate*. Such encoders are, therefore, also called

Variable Bit Rate (**VBR**) encoders. It should be understood though, that we are talking of variations of a long frequency scale (minutes or longer), and not of a timescale of less than a second. The reason for the existence of such constant quality encoders becomes obvious if one consider the nature of the scene one tries to compress. If it is a rapidly changing scene (e.g. a car chase, or filming from inside a car moving fast) one can expect that there is going to be large differences in the content from one frame to the next. There is, therefore, little temporal (i.e. time-based) redundancy to be exploited there, because of the very nature of the scene. If we try to maintain quality, we should either use less P-frames and B-frames or have many bits to be corrected within such frames. Either will end up increasing the bandwidth requirement for such a scene. In contrast to that situation, a CBR encoder has a different primary goal, and when faced with such predicament it will simply accept a loss in image quality and it will try to make the best use of the bit-rate imposed upon it.
Constant quality (i.e. VBR) encoders are the best choice for quality, but (as their bit-rate is variable) they do impose additional strain on the whole system transmitting such VBR media. (This problem is beyond the level that could be fixed by simply increasing the buffer size!)

2.14 Real life choices: encode for the lowest client bit-rate, encode multiple versions, or choose multi-rate-encoding

After encoding, the media are stored on the hard disk-array of the media server, waiting to be streamed to the prospective client. The problem arises from the fact that not all clients have the same resources (e.g. some have ultra broadband at their disposal, others ADSL connections, while others make do with a lot less than that). If the video is encoded at high quality, this will only reproduce properly for some clients and not at all for others. If, on the other hand, one encodes in accordance to the lowest bit-rate for the potential user (i.e. sacrificing quality), users with better connection will receive video of a much worse quality than the one they are capable of streaming. One solution to this problem (effectively, matching the media bit-rate to the bandwidth available) is to encode multiple versions of the same video and store them all in the same server. This solution is laborious to achieve, and it takes up hard disk space on media servers, but it keeps users satisfied as they can decide which version they can use. Alternatives to this “multiple encoded versions” solution do exist, (they are sometimes collectively called “multistream” or “Multiple Bit Rate” and should not be confused with VBR explained in the previous section), and they are used for “***adaptive data-streaming***”. All such alternatives are very involved and highly technical. We will briefly mention two types of ***multi-rate encoding*** (each with its own advantages), which are the following:

1. **Video transcoding**

   A video transcoder is capable of converting a high quality high bit-rate compressed video stream into a lower bit-rate video stream by a process that drops some information from the original stream. The process is a controlled one and the output bit-rate is continuously adjustable. The transcoding techniques used to achieve such an effect are: ***(a) re-quantization***, ***(b) spatial downscaling***, and ***(c) temporal downscaling***. Modern transcoders can use a combination of all the above techniques to achieve the desired effect, optimising their use according to how much reduction in bit-rate is necessary (or is desired). Such reduction could be quite substantial, even down to just a 20% of the original rate, albeit imposing a corresponding loss in image quality (something unavoidable anyway).

2. **Layered video encoding**

   When using the layered video encoding, the original video is encoded into one “base layer” (of base quality) and a number of “enhancement layers”. While the base layer provides a minimum of video quality (requiring a minimum of bandwidth), the progressive addition of each of the enhancement layers improves video quality (at the expense of a higher bit-rate, if the end-user has such resources at his disposal). The media-server senses the user's connection speed and automatically adjusts the number of layers to be transmitted according to the bandwidth available.

2.15 Interoperability of streaming media components

Streaming media systems are composed of many components (e.g. Media Players, Streaming Servers, Encoders/Tools); all these must share some common mechanisms to be able to operate together. Encoders and content-creation tools should be able to produce and store media-content in such file-formats (i.e. types) that media-servers can handle. Streaming servers should be able to stream media-content using protocols with which media-players are compatible. Encoders (and other tools) should also be able generate (i.e. encode) data-types which will be of a type that could be decoded (and eventually played) by the media-players. Figure 2.4 is helpful[24] in order to visualise the connection amongst these components.

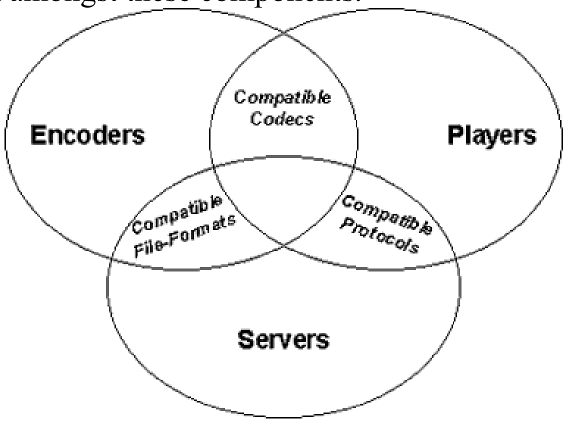

Fig 2.4

2.16 Streaming over TCP/IP and UDP/IP

It is essential to have at least a superficial understanding of the OSI reference model (Open Systems Interconnection), in order to be able to appreciate the discussion about communication protocols (Fig. 2.5). In this model, the different layers are based on each other, a higher layer always relying on (and making use of) all the lower layers for the more mundane tasks. For example, the network cables form the "physical layer" transporting the physical signals (i.e. the bits and bytes), whereas the top layers (e.g. the "application layer") makes use of all the layers below it. The power of the model is based on the independence of the individual layers. An internal modification of a component belonging in one layer does not result in a need to modify all others. For example, it does not really matter to all the layers above if the signals are transmitted via wire or fibre optics. The "transport layer" could be either UDP or TCP, all the layers above should simply care is their ability to interface with it.
Having all the above in mind let us face the question of whether or not it is possible to transmit streaming media the "normal way", i.e. using Transmission Control Protocol **TCP** or, to be more precise, HTTP/TCP/IP. (Please note that in this last notation we specify the layers from the higher to the lower.) The answer to the above question is yes we can, but despite various advantages, such streaming will not be smooth enough (for reasons all relating to the type of media these protocols were designed to handle).

Application Layer Services to user applications (e.g. HTTP, RTSP, FTP, etc)
Presentation Layer Network communication services

[24] RTSP, frequently asked questions, http://www.rtsp.org/2001/faq.html, downloaded May 2005

(e.g. compression, encryption)
Session Layer Node-to-node communication control (hardly used)
Transport Layer Reliable end-to-end network communication (e.g. TCP, UDP, RTP)
Network Layer Initiation and termination of end-to-end network communication (e.g. IP)
Data link Layer Logical link and access control
Physical Layer Point-to point physical data lines (e.g. wire, cable, fibre optics, satellite links, network interface cards etc)

Fig 2.5: The OSI reference model

In modern "media players", there is in fact an automated procedure to relieve the users from having to specify the transfer protocol they want to use. Various combinations are tried out automatically, and if all other attempts fail, the last option (before giving-up totally) is, in fact, HTTP/TCP/IP. The main reasons that faster and more suitable protocols (discussed in section 2.17) sometimes fail to operate, is the use of (incompatible) firewalls and proxy servers and other such security measures.

A second type of transport layer protocol is the User Datagram Protocol (**UDP**), which is far simpler than TCP. UDP does not attempt any flow or error control like TCP does, and therefore it does not have the overheads associated with it. As it does not introduce such delays, it is more suitable for continuous (i.e. time-based) media. The lack of such functions by the UDP has shown the need of another layer of streaming protocol on top of UDP, which in this case is simply used to deliver the data and the control signals. Such specialised protocols are discussed below.

2.17 Specialised streaming protocols

HTTP is well suited for transfer of web pages. However, because HTTP is entirely based on TCP, which enforces reliability without regard to timelines, it is not suited for use in multimedia presentations with timelines. Furthermore, TCP throttles the client-server connection based on the availability of bandwidth, and not on the needs of the media involved. HTTP has only rudimentary mechanisms for random access to files, and thus is not suited to time-based seeking. Finally, TCP is not at all suited to multicast. The following independent but interconnected protocols, are a proposed standard (not approved yet) but a lot of effort has beep put in those and they seem to be able to work with the foreseen future developments in computer networks.

(a) Real-Time Streaming Protocol (RTSP)

The Real-Time Streaming Protocol **(RTSP)** is an application level protocol, designed to work with continuous media (or time-based media)[25], such as streaming audio and video, as well as any application where application-controlled, time-based delivery is essential. RTSP does not deliver data (it needs RTP for that) but is designed to control multicast delivery of streams, and is ideally suited to full multicast solutions, as well as providing a framework for multicast-unicast hybrid solutions for heterogeneous networks like the internet. In addition,

[25] Huuhtanen J, Real-Time Streaming Protocol (RTSP), Helsinki University of Technology, http://www.tml.tkk.fi/Studies/Tik-110.300/1998/Essays/rtsp.html, (1998).

RTSP using "streaming commands" and has mechanisms for time-based searches into media clips, with compatibility with many timestamp formats, such as "time-codes". This means that RTSP provides stream-control functionality such as "pause", "fast forward", "reverse", and absolute positioning, just like a virtual VCR (Video Cassette Recorder) somewhere in the internet.

(b) Real-time Transport Protocol (RTP) with Real-Time Control Protocol (RTCP): (RTP/ RTCP)

The Realtime Transport Protocol (**RTP**) although it is -strictly speaking- located in the transport level, it is really a sort of "middleware protocol" placed above proper transport level and below the application protocols[26]. RTP is used for the delivery of continuous media, including streaming audio and video. RTP is used by many standard protocols, such as RTSP, H.323, SIP, and SAP/SDP. It provides the data delivery format for all of these protocols.
RTSP uses RTP as a means of actually delivering the multimedia data. This data-level compatibility results in efficient gateways between the protocols, since only control messages need to be translated. RTP and RTSP together support multicasting, and because of this they will probably be used together in many future systems, but either of these protocols can be used without the other.

The Real-Time Control Protocol **(RTCP)** is a part of RTP, and helps with lip synchronization and Quality of Service (QoS) management, among others.
The **RTSP/RTP/RTCP** protocols can work either over **UDP/IP**, or using **TCP/IP.**

(c) Proprietary streaming protocols

The RTSP/RTP/RTCP protocols have received increasing support lately, and they are becoming some type of a standard (although not yet one, officially). As already mentioned, these work either over UDP/IP, or over TCP/IP, and they are used as such by various major manufacturers of important commercial systems. Such software companies are offering products ranging from software for the creation and encoding of media to the (final) media players. Such manufacturers have proprietary streaming protocols (constantly evolving), each one different to the one supported by the other. Luckily, they now all support RTSP/RTP/RTCP protocols in addition to their own.

Unfortunately, for the time being at least, these major manufacturers keep some advanced features of streaming media only for their proprietary protocols. Such features include some important ones, like the multi-rate-encoding (briefly discussed in section 2.14). It is reasons like these that keep the proprietary protocols still in use, and prevent "media players" from becoming commodity items (i.e. each one playing equally well all type of media coming from all type of media-servers).

In any case, as already mentioned, the various modern "media players", have an automated procedure today (technology is constantly changing), to relieve the users from having to specify the transfer protocol they want to use. This "protocol rollover" is convenient for the average user. Various combinations of transfer protocols are tried out automatically one after the other, depending on the type of final encoding streamed from the streaming server. In case the RTSP/RTP/RTCP protocols are being used, the first attempt made is to play them over UDP/IP, (i.e. as RTSP/RTP/RTCP/UDP/IP, as it were) and failing that over TCP/IP. As a last choice, most of current "media players" will finally abandon RTSP altogether, and will revert to HTTP/TCP/IP, which might be able to deliver some streaming but the image will probably not

[26] Tanenbaum A. S., Computer Networks, 4th edition, Prentice-Hall, (2003), ISBN: 0-13-066102-3, Section 7.4, pp. 701 -741

be very stable and the overall perceived image quality will probably deteriorate in the eyes of the user.

3 Learning Theories and Learning Styles

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3.1 Introduction

One of the main aims of Science is to study aspects of the physical world, its nature, and its functions, while one of the aims of the Arts is to study ways to express one's ideas, feelings and collective experience about the outside world, as well as to study the meaning of such mental products. One of the main aims of the School Science is also to facilitate students' understanding of the world, to reveal to them the Science's approaches for this study, and therefore to develop their knowledge about the world. This has happened, albeit not exclusively, through a cautious evolution of the perspectives about learning and teaching throughout the schooling history. These perspectives are also connected with the different views of the nature of science itself. In the Arts as well, a similar evolution of perspectives occurred. It may be noted here that in the present we shall deal mostly (but not exclusively) with science education theories, as ICT implementation in teaching practices is more advanced for the science-related and mathematics-related subjects as opposed to the arts subjects. The reason seems to be the greater familiarity of ICT amongst science teachers, as well as their interest in using new technological resources.

Ideas about how knowledge may be acquired have ranged from an empiricist view on the one hand to a radical constructivist one on the other. Supporters of the former stance have affirmed that it is merely necessary to observe the 'real world' to obtain knowledge about it, whereas constructivists maintain that we have no *direct* access to the world as-it-really-is. Any knowledge that we have, they claim, has been actively built up over time. Thus the 'world-as-we-know-it' is regarded as one viable model of reality based on experience and not as discovery of 'what is' (Holding[27], 1987).

3.2 The empiricists' view

The most simplistic view of the scientific enterprise is, perhaps, the empiricist's, which holds that all knowledge is based on observation (Driver[28], 1983). This view that the mind *passively* acquires knowledge of reality has been analysed by Piaget[29] (1936):

> *Empiricism is primarily a certain conception of experience and its action. On the one hand, it tends to consider experience as imposing itself without the subjects' having to organise it, that is to say, as impressing itself directly on the organism without activity, of the subject being necessary to constitute it. On the other hand, and as a result, empiricism regards experience as existing by itself and either owing its value to a system of externally ready-made 'things' and of given relations between those things (meta-physical empiricism), or consisting in a system of self sufficient habits and associations (phenomenalism) (Piaget p. 362).*

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[27] Holding, B., Investigation of Schoolchildren's Understanding of the Process of Dissolving with Special Reference to the Conservation of Matter and the Development of Atomistic Ideas, Unpublished Ph.D. thesis: The University of Leeds, School of Education, Leeds (1987)

[28] Driver, R., The Pupil as Scientist?, Open University Press, Milton Keynes (1983).

[29] Piaget, J., The origins of Intelligence in Children (transl. M. Cook), W.W. Norton, New York (1936/63).

Doubts about the empiricist view and its 'certainty' were also raised by Heisenberg's Uncertainty Principle that he enunciated in 1926. It led to a (mistaken) lack of confidence in the idea that physical concepts (e.g. position, momentum etc) correspond to an objective reality. It would seem that profound scientific progress such as quantum mechanics, takes considerable time to be popularised, distilled, and digested correctly. George Kelly[30] (1970) considered that there was an epistemological problem in acquiring any direct knowledge of 'things-as-they-are' in the real world:

> *Neither our constructs nor our construing systems come to us from nature. It must be noted that this philosophical position of constructivism alternativism has more powerful epistemological implications than one might at first suppose. We cannot say that constructs are essences distilled by the mind out of available reality. They are imposed upon events, not abstracted from them. There is only one place they come from; that is from the person who is to use them. He devises them (Kelly p.13)*

.

3.3 The 'transmissive' model

An expression of empiricism has been applied to some educational systems. A hypothesis made concerns the learning of science, for example. Pupils are supposed to learn by presenting to them the scientific concepts, theories and laws in a clear and interesting way. This is supported by demonstration of experiments that verify the discussed issues.

This tradition is based on a view of learner as a passive absorber of information. Teaching is considered as the transmission or passing on of knowledge. Learning, in this case, is an inductive process and an accumulation of knowledge.

Hypotheses of the transmissive model

- ❖ Science is a rigid body of knowledge
- ❖ Science is stored in school books
- ❖ The teacher is the one who transfers the knowledge from the books to the students' head
- ❖ The learner receives passively the knowledge and fills his previously empty head
- ❖ The teacher by demonstrating the experiments falsify or verify Science laws and persuades students
- ❖ Learning is an inductive and accumulative process

3.4 The discovery model

An alternative teaching perspective of school-science curriculum development has adopted the heuristic method. This was prompted by the admirable concern to allow children to experience something of the excitement of science – 'to be a scientist for a day' (Driver[31], 1983). Gradually educators recognized the pitfalls of putting this approach into practice in classrooms and laboratories. Secondary school pupils are quick to recognize the rules of the game when they ask 'Is this what was supposed to happen?' or 'Have I got the right answer?' (Wellington[32], 1981). The intellectual dishonesty of the approach derives from expecting two educational outcomes from pupils' laboratory activities, which are probably

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[30] Kelly, G., A Brief Introduction to Personal Construct Theory. In D. Bannister (Ed.), *Perspectives in Personal Construct Theory*, Academic Press London (1970), pp.1-30.

[31] Driver, R., The Pupil as Scientist?: Open University Press, Milton Keynes (1983).

[32] Wellington, J. J., What's supposed to happen, sir? Some problems with discovery learning, *School Science Review*, 63, (1981), pp. 163-73.

mutually incompatible. On the one hand, pupils are expected to explore a phenomenon for themselves, collect data, and make inferences based on it; on the other hand, this process is intended to lead to the currently accepted scientific law or principle.

This is due to one of the empiricists' view about the nature of science, that all knowledge is based on observation. Scientific laws are reached by a process of induction from the 'facts' of sense data (i.e. sensory input). Taking this view of science, observations are objective and facts are immutable. In addition, such a position asserts that science will produce a steady growth on knowledge: like some international game of 'pass the parcel', the truth about the natural world will be unwrapped and gradually more will be revealed.

The inductivist position (whose application in education the discovery model is), was criticized when it was first suggested by Sir Francis Bacon nearly 400 years ago. Nevertheless, it has reasserted itself during early 20th century in the heuristic movement and later in some of the more naive interpretations of the discovery method adopted by the Nuffield science schemes in the UK. For a long time philosophers of science and scientists themselves have recognised the limitations of the inductivist position and have acknowledged the important role that imagination plays in the construction of scientific theories. In this alternative constructivist or hypothetico-deductive view, theories are not related by induction to sense data (i.e. sensory input), but are constructions of the human mind whose link with the world of experience comes through the processes by which they are tested and evaluated.

Hypotheses of the discovery model

- ❖ Science is mainly a process
- ❖ Scientific concepts and laws can be discovered
- ❖ Students working on laboratories and doing experiments discover by themselves scientific concepts and theories
- ❖ The teacher organizes lab work and supervises the class
- ❖ Learning is an inductive and discovery process

3.5 The constructivist view

The adoption of a constructivist epistemology has implications for the ways the teachers views the process of learning (in both individual and social contexts) and for the way in which it construes the nature and status of scientific knowledge. This tradition argues against a view of the learner as passive absorber of information (Driver & Bell[33], 1986, Millar & Driver[34], 1987). Instead, learning is viewed as an active process, whereby each person makes sense of the world by continually constructing mental models that are used to anticipate and interpret events. Already existing models are used to make links with, and make sense of, new experiences.

Such mental representations or models have been the subject of investigations by researchers in fields other than Science, like in the fields of reading (Anderson[35], 1984;

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[33] Driver, R. & Bell, B., Students' Thinking and the Learning of Science: A constructivist View, *School Science Review*, 67 (240), (1986), pp. 443-456.

[34] Millar, R. & Driver, R., Beyond Processes. *Studies in Science Education*, 14, (1987), pp.33-62

[35] Anderson, R. C., Some Reflections on the Acquisition of Knowledge. *Educational Researcher,* 13(9): 5-10, (1984).

Shank and Abelson[36], 1977), problem solving (Greeno[37], 1978; Larkin[38], 1983) and human reasoning (Rumelhart & Norman[39], 1981; Osborne and Wittrock[40], 1985).

Kelly's[41] Personal Construct Theory (1955) with its central metaphor of "man as scientist" also supports a view of the learner as an active, sense-making individual.

> *"According to Kelly, each person creates for him or herself a representation model of the world which enables him/her to chart a course of behaviour in relation to it. This model is subject to change over time, since constructions of reality are continually tested out and modified to allow better predictions in the future."*
>
> (Pope & Gilbert[42], 1985, p.20)

Rumelhart & Norman[43] (1981) argue that such representational models are context dependant; and thus we may hold different models for different situations.

> *Our ability to reason and use our knowledge appears to depend strongly on the context in which the knowledge is required. Most of the reasoning we do apparently does not involve the application of general-purpose reasoning skills. Rather it seems that most of our reasoning ability is tied to particular bodies of knowledge."*
>
> (Rumelhart. & Norman, p.338)

Much of the focus of past work in cognitive science has been on the individual's personal construct of the world. More recently, however, the importance of social processes in learning has received the attention of psychologists such as Norman[44] (1981).

> *"Human cognition exists within the context of the person, the society, the culture. To understand the human requires understanding of these different issues and the ways in which interactions among them shape the cognitive process."*

Communication and language play an important role in cognition. In applying this perspective to science classrooms Solomon[45] (1987) notes that, as well a seeking to make sense of the world in terms of their personal internalised schemata, humans are drawn by a need to integrate their internal models of the world into a socially constructed picture.

> *"We take for granted that those who are close to us see the world as we do, but, through social exchanges we seek always to have this confirmed. This continual reaffirmation of social notions makes them very resistant to change."* (p. 67)

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[36] Abelson, H. & diSessa, A., Turtle Geometry: The Computer as a Medium for Exploring Mathematics, MIT Press, Cambridge, MA (1980).

[37] Greeno, J. G., A study of Problem Solving. In R. Glaser (ed.) *Advances in Instructional Psychology. Hillsdale*, N.J.: Lawrence Erlbaum Associates (1978).

[38] Larkin, J. H., The role of Problem Representation in Physics. In D. Gentner & A. Stevens (eds.) *Mental Models,* Lawrence Erlbaum Associates, N. Jersey, Hillsdale (1983).

[39] Rumelhart, D. E. & Norman, D.A., Analogical Processes in Learning. In J. R. Anderson (ed.) *Cognitive Skills and their Acquisition*, Lawrence Erlbaum Associates, N. Jersey, Hillsdale (1981).

[40] Osborne, R. & Wittrock, M., The Generative Learning Model and its Implications for Science Education. *Studies in Science Education*, 12, (1985) pp.59-87.

[41] Kelly, G. A., The Psychology of Personal Constructs. W.W. Norton & Co., New York (1955).

[42] Pope, M. & Gilbert, J., Theories of Learning: Kelly, In Osborne, R. & Gilbert, J. (eds.) *Some Issues of Theory in Science Education*: University of Waikato. Hamilton, N.Z. (1985), pp. 19-41.

[43] Rumelhart, D. E. & Norman, D.A., Analogical Processes in Learning. In J. R. Anderson (ed.) *Cognitive Skills and their Acquisition*. Lawrence Erlbaum Associates, N. Jersey, Hillsdale, (1981).

[44] Norman, D. A., *Perspectives on Cognitive Science*. Lawrence Erlbaum Associates, N. Jersey, Hillsdale, (1981).

[45] Solomon, J., Social Influences on the Construction of Pupils' Understanding of Science, *Studies in Science Education*, 14, (1987), pp. 63-82.

Edwards & Mercer[46] (1987) support this view, seeing the classroom as a place where meanings are shaped through discussion and negotiation between peers and between students and the teacher.

If the view that knowledge is both personally constructed and socially constructed is accepted, there are profound implications for the development of school science curricula, and for the teaching and learning of science.

Firstly, if knowledge is seen as being individually constructed, then it is necessary to adopt a particular perspective in relation to how learners are seen. It must be recognized that they cannot be regarded as passive recipients of knowledge, but rather as being actively involved in the learning process, drawing on prior knowledge in an attempt to make sense of their classroom experiences. Learning does not only involve students in taking on board new ideas, but may require them to modify, develop, or change their prior conceptions. Such a view has implications for teaching: the role of the teacher becomes that of facilitator, organizing experiences that provide opportunities for learners themselves to restructure their ideas. Further, if teachers take on board that science itself is socially constructed, then this might also have implications for the ways in which is taught.

Hypotheses of the constructivist model

- ❖ Science is knowledge and process and communication
- ❖ Science is accepted as instantly true (historically)
- ❖ The teacher organizes appropriate activities to question students' prior knowledge
- ❖ The learner constructs his/her own knowledge
- ❖ Learning is the result of the learner's interaction with the classroom environment
- ❖ Learning is a reorganisation and developmental process

From a constructivist perspective therefore, the science curriculum becomes much more than simply a list of facts or concepts to be taught by the teacher and learned by the students.

An alternative picture might be that of a program of experiences that are designed to encourage students to restructure their views of the world. Furthermore, it should be noted that neither teacher nor students are outside this curriculum. Rather, both form integral parts of it. The teacher plays a part in shaping the curriculum through his/her ideas about both the science content and the teaching/learning process, and through the ways in which these views are translated into pedagogy. Students also have prior expectations of school, and of science lessons, and these two will contribute to the total experience, which is the curriculum. Such a perspective implies knowledge of students' pre-existing conceptions and this led to a research movement, focusing on the characteristics and qualities of students' thinking inside and outside the classrooms. This demanded the involvement of teachers taking the role of researchers. It has also raised arguments that researchers of "human systems" (i.e. systems composed of many humans) need to keep in mind their own interference (be that positive or negative) to the phenomena they try to analyze, which in turn contributes to their own constructions of the system being investigated (Steier[47], 1995).

[46] Edwards, D. & Mercer, N., Common Knowledge: The Development of Understanding in the classroom. Methuen, London (1987).

[47] Steier, F., From Universing to Conversing: An ecological Constructionist Approach to Learning and Multiple Description. In L. P. Steffe & J. Gale (eds.) *Constructivism in Education.* Lawrence Erlbaum Associates, N. Jersey, Hillsdale, (1995).

If taken to the extreme, this situation might, in effect, lead to self-fulfilling prophesies from the part of the researcher. On a totally different level, an experienced scientist will not fail to detect the similarity between the predicament described above and quantum mechanics. Indeed, one focuses on the interaction of the researcher with what he is trying to measure: the researcher needs to illuminate the object studied, but the photons disturb the small object causing it to change momentum. Science is very precise in describing how much disturbance the measurement procedure causes, and it sets numerical limits to the precision of any measurement, or combinations of measurements of different physical quantities. In education research though, setting a number on the disturbance caused by the measurement can only be estimated, and taken into account in the determination of the systematic error of the experiment, at best. Furthermore, this effect is common to all educational measurements, and although such effects (e.g. of sizeable systematic errors) are bound to increase when one deals with “human systems” as opposed to individual students, it is not apparent why such effects are only discussed under such a perspective. Indeed, careful experimenters (as opposed to those lacking any foundation in error theory and statistics) have been pointing out to the existence of serous systematic effects[48,49] for quite some time now.

3.6 An action research perspective

Many arguments have been put forward for the active involvement of practising teachers in the development of the curriculum and the classroom quality. Argyris[50] (1980) proposed a model for action research consisting of:

A naturalistic diagnostic phase
An intervention phase

Alcorn[51] (1985) elaborates on this model, proposing a cyclic plan of action for action research, and identifying a number of key features that she considers should be present (Fig. 3.1).

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[48] Ioannidis G. S., Garyfallidou D. M., and Vavougios D. G**.,** Teachers’ ideas on computers after some initial Information Technology training. In: Valanides N. (Ed.), *Proc. 1st IOSTE Symposium in Southern Europe Science and Technology Education: Preparing future citizens* Paralimni, Cyprus , (2001), ISBN 9963-8519-2-4, Vol. 2, pp. 244 – 258

[49] Ioannidis G. S., Garyfallidou D. M., Panagiotakopoulos C., and Vavougios D. G**.,** Ideas on computers as held by arts students, after a course on Information and Communication Technology (ICT). In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: “Interactive Computer aided Learning, Experiences and Visions”*, Villach, Austria , Kassel University Press (2001), ISBN 3-933146-67-4

[50] Argyris, C. *Inner Contradictions of Rigorous Research.* New York: Academic Press (1980).

[51] Alcorn, N., *Action Research: A Tool for School Development*, Centre for Continuing Education, University of Auckland, N.Z. (1985).

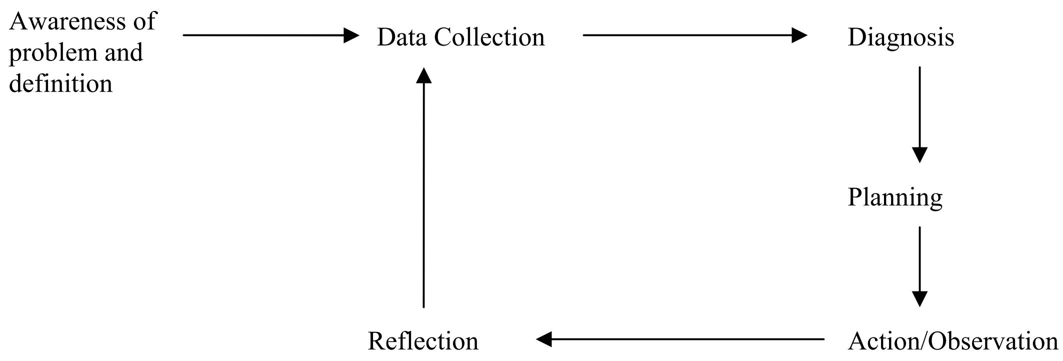

Fig.3.1 A model of action research

Firstly, she states that action research "takes place within actual complex social situations and is geared to an understanding of, and improvement in, practice in specific situations". She also considers the relationship between researchers and teachers involved in action research to be "collaborative and participating". Finally, she concludes that: "Action research is action oriented… without implementation there is no action research." This model matches well with a constructivist model for curriculum development (Fig. 3.2) proposed by Driver and Oldham[52] (1986).

Schemes like the one above, dealing with the development of teaching materials and suggesting ways of teaching intervention can also apply and be very useful for the design and implementation of the computer aided learning and teaching. For example, "the design of learning strategies/materials" with the use of the computer technology has to be based on the "information of students' ideas" and is related to one's "views of learning" and "decisions on content", but also to "teachers' craft knowledge".

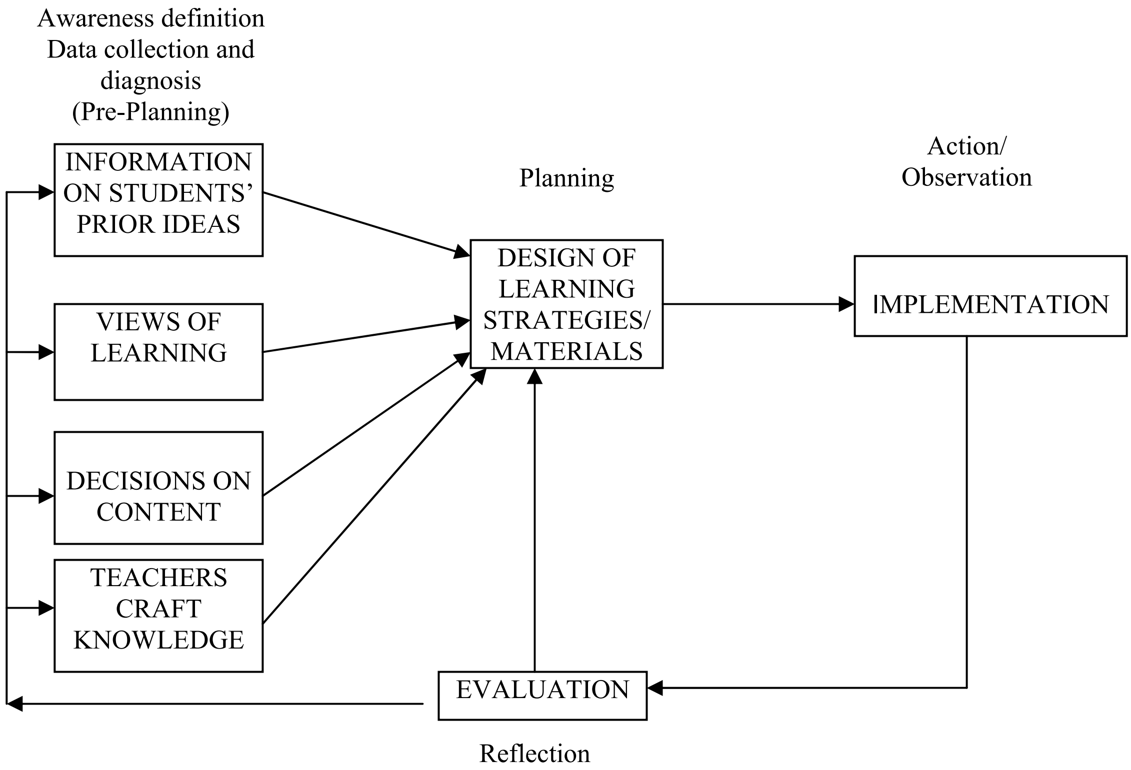

Fig. 3.2 A constructivist model for curriculum development

[52] Driver, R. & Oldham, V. A constructivist Approach to Curriculum Development in Science. *Studies in Science Education*, 13, (1986), pp.105-122.

The designed strategies and materials have to be implemented and tested in real classrooms situations, and be evaluated in order to have the necessary feedback for a better understanding of the relevant fields and improvement of our designs (Phillips & Hollingsworth[53], 2005). This is involved in teachers' new role and is supported by the action research premises and the development of communities of practice (Altrchicher[54], 2005). Action research is also applicable with the Web-based environments for the enhancement of distance learning instruction (Lamaster & Knop[55], 2004).

3.7 Reflexivity, social constructivism and sociocultural approaches

Current research approaches seek for "reflexivity", which means slightly more than being aware that your involvement helps to create the behaviour you wish to study. (Thompson[56], 1995). Reflexivity in research also entails reflecting on the following:

- your sense of your research domain
- how that sense is expressed in your researching actions
- the contributions your actions make to the behaviour you wish to study, and
- how your observations of behaviour influence your sense of the research domain

This means that the research on students' thinking and learning has influenced our research action, the realities of the people participating in our investigations, and our sense of the research domain. All these, together with the advances in technology have changed our perspectives and research emphasis. Instead of being focused on individual's learning in the traditional sense, it now focuses on the individual in relation to the others placing importance on the socially constructed knowledge. Reflexivity, also, focuses on discussions of social interactions and learning from multiple perspectives. The personal success of generating accepted contributions (either by the teacher or by any other student), or of arriving at viable constructions, rests on both the participants' active engagement in the social practice of learning as well as on the qualities of this social interaction. Applying the social constructivist perspective can lead towards an understanding of the classroom processes as a kind of "culture". Culture only exists through living interaction amongst human beings. However, such kind of interactions have to be intentional and to form an integral part of learning activities planned and questions concerning the value of "situated learning" have been explored (Billet[57], 1996). The cultural and pedagogical aspects of this have been recently the focus of a global e-learning program involving over 150 countries (Selinger[58], 2004).

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[53] Phillips, R. & Hollingsworth, S. From curriculum to Activism: a graduate degree program in literacy to develop teachers as leaders for equity through action, Educational *Action Research*, 13(1), (2005), pp. 85-102.

[54] Altrchicher, H. The role of the 'Professional Community' in Action Research. *Action Research*, 13(1), (2005), pp. 11-26.

[55] Lamaster, J. K. & Knop, N. Improving Web-based Instruction: Using action research to enhance distance learning instruction. *Action Research*, 12(4), (2004).

[56] Thompson, W. P., Constructivism, Cybernetics, and Information Processing: Implications for Technologies of Research on Learning. In L. P. Steffe & J. Gale (eds.) *Constructivism in Education.* Lawrence Erlbaum Associates, N. Jersey, Hillsdale, (1995), pp. 123-132.

[57] Billet, S., Situated learning: Bridging socio-cultural and cognitive theorising. *Learning and Instruction*, 6(3), (1996), pp. 263-280.

[58] Selinger, M., Cultural and pedagogical implications of a global e-learning programme. *Cambridge Journal of Education*, 34(2), (2004), pp. 223-239.

3.8 Learning theories and ICT

Taking into account learning theories to help in the design and development of new learning media and environments is a complicated task, as there are many factors involved (e.g. the subject taught, the presence or not of a teacher facilitating learning etc). Indeed, the important maters are in the details here: learning has to do with the content of educational media (software or video), the method it is presented, and the method we implement it in the school environment, as opposed to the use of ICT in the first place, or if one uses streaming media or not.

Coming to the problem of creating new teaching material, research supports the view that new design discourses are necessary, if interactive learning resources are to combine effectively the skills of all members of the development team. Research also suggests the importance of conceptualisation of the learner's role as an active participant in the learning environment, for the resultant product to be engaging and meaningful (Hedberg[59], 2004).

The role of computer technology in education has altered during the past years; this changing role and its relation to the models of learning and teaching is discussed in the next chapter.

4 Information technology and education – Visions of implementation for streaming media

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4.1 Educational impact of technological developments

[59] Hedberg, J., Designing multimedia: seven discourses. *Cambridge Journal of Education,* 34(2), (2004), pp. 241-256.

We can divide human history into three segments: ***pre-literacy tribal***, ***modern***, and ***post-literacy*** societies. The movement between segments is characterized by transitions that our sensibilities undergo as technological advances are made and as the tools are incorporated into everyday life. The printing press divided the pre-literacy and modern; the computer divides the modern and the post-literacy (Henrickson[60], 2000).

In the move from the pre-literate to modern society, there were few technological advances and the speed of development of new mechanical devices was slow as well. The sensory shift occurred between an emphasis on the hearing (e.g. use of the ear) in the oral society, to the visual (e.g. use of the eyes) in the modern literate society. The few technological innovations and their slow pace of adoption ensured that individual and societal reactions to innovation were delayed and absorbed over a considerable amount of time. People were able to develop new competencies, as changes occurred with a potential to destabilise already existing organizations.

This is not the case in the current (in most countries of the world) move from modern to post-literate society. Electronic tools instantaneously extend our capabilities in a 'global embrace'. Action and reaction times occur simultaneously and there are many more tools available. If we are to successfully adapt and absorb such a pace of change, without any major breakdown in world economy (to say the least), a major change in the way we view technology and we incorporate new technological tools in modern education is truly essential. Furthermore, as the skills required from a person are viewed as rapidly loosing their value and becoming redundant at least once in his lifetime, the very essence of education is in need of a major shift, as most of us will become "eternal students". Education in a post-literate economy should provide: (a) technological competence so that information (and knowledge) can be accessed at will, on a just-in-time basis, and, (b) the person should learn the skill assimilating the information available thereby transforming information into knowledge. ICT plays, therefore, a crucial role in such educational shift, and teachers should also accept their new role (which is yet to be clearly defined) and adapt to it.

It is a most interesting fact that the latest developments in ICT, (like UDP/IP and TCP/IP streaming, GSM, GPRS, UMTS, etc.) all take the emphasis away from symbol-based (i.e. letter-based) written communication and back to image-based and oral-based communication of the early pre-literacy tribal society communication model. Despite the fact that we now have a real choice to either use letters or images and videos, it would seem that our "natural choice" or "default choice" is to abandon symbols and choose instead oral and image-based or video-based instant communication (or even as archives to be used instead of books for teaching or just safekeeping). Is this not a curious global "déjà vu" of many centuries ago?

4.2 Computers as used in Education

Computers have been proved to be important and widely used tools in all activities of our society, because they are cost effective aids to problem solving in business, government, industry, education, and in many other areas. Concerning education, the structure of the overall field of application of computers in education is presented below. As indicated in the diagram (Fig. 4.1), the field can be divided into three main parts (Moursund[61], 1990).

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[60] Henrickson, L., Communication Technology and Personal Identity Formation, *Educational Technology & Society*, 3 (3), (2000).

[61] Moursund, D., *Computer-Integrated Instruction In-service Notebook: Secondary School Social Studies*. Oregon: International Society for Technology in Education, (1990).

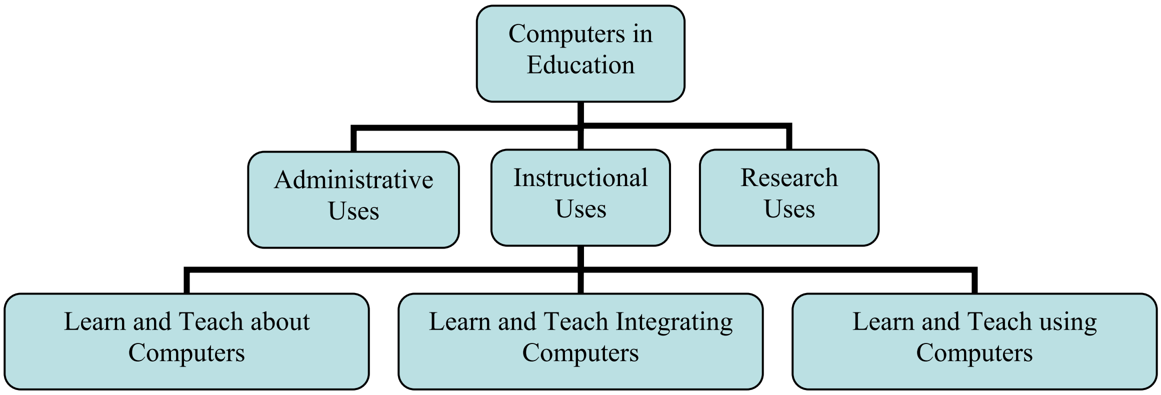

Fig. 4.1 The fields in which computers are used in education

A few words are due for the use of ICT to "**teach and learn about computers**", as this is a very special (and crucially important) educational use of computers. From an educational point of view, when trying to distinguish between the terms (a) Information and Communication Technology (**ICT**) **education** and (b) **education using ICT**, we conclude that the main difference (between those two) is in the educational aim. The aim of ***ICT education*** is to provide schoolchildren with basic skills as well and knowledge about computers, which comprises what we generally call "computer literacy" (Ioannidis & Garyfallidou[62] 2001). It is quite clear that without emphasis on ICT education as a pivotal element in our teaching (at all educational levels), all attempts to endow individuals with enough skills to succeed (or even survive) in post-literacy economic environments, are doomed from the very beginning. For, without a deeper understanding of the tools of knowledge - acquisition (and the development and potential transformation of such tools), and of information retrieval, education is facing a dire predicament. It could all too easily regress from the age of enlightenment to a neo-dogmatic era, where private individuals have to accept information "mysteriously" (even mystically) passed on to them as unquestionably correct, this being the new dogma for the large masses. The learned few would form the new "priesthood" of technologically enlightened, essential to perpetuate ICT development, these forming, in effect, the new literate classes.

The main interest in the present publication focuses, nevertheless, on "***education using ICT***" which refers to the use of ICT in the teaching of subjects other than ICT, where ICT is used as a mere tool and not as an educational target in its own right. This could be split in two categories: **"learn and teach using computers"** and **"learn and teach integrating computers"**. Under the first use, the computer plays the role of an instruction-delivery device. This type of computer use is often called computer-assisted instruction, computer-based instruction, or computer-assisted learning (CAL), which is in line with a constructivist and phenomenography perspective (Marton & Booth[63], 1997).

CAL is sometimes divided into categories[64] such as drill and practice, tutorials, and simulations or microworlds. Most CAL systems include a recordkeeping system, and some

[62] Ioannidis G. S. and Garyfallidou D. M., Education using information and communication technology (ICT), and ICT education: categories methods and trends. In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: "Interactive Computer aided Learning, Experiences and visions"*, Kassel University Press, (2001), ISBN 3-933146-67-4

[63] Marton, F. & Booth, S., *Learning and awareness.* New Jersey: LEA, (1997).

[64] Ioannidis G. S. and Garyfallidou D. M., Education using information and communication technology (ICT), and ICT education: categories methods and trends. In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: "Interactive Computer aided Learning, Experiences and visions"*, Kassel University Press, (2001), ISBN 3-933146-67-4.

include an extensive diagnostic testing and management system. Thus, computer managed instruction is sometimes considered to be a part of CAL.

Initially, most CAL material was designed to supplement conventional classroom instruction. For example, elementary school students might use drill and practice science materials for ten minutes per day. However, as computer hardware costs have declined and more CAL materials have been developed, there is some trend towards implementing substantial units of study and/or entire courses, to be used in a self-taught study manner. In some cases, it has been much more cost effective to make such courses available through CAL than through a conventional, teacher taught, modes.

CAL has been heavily researched over the past 40 years. It should be noted, nevertheless, that (due to the extreme educational importance of Graphical User Interfaces (GUI), as for example "windows", all older research conducted on character-based computers is now rendered to be largely irrelevant! As this pivotal change is no more than 10 to 15 years old, and schools were often slow to adopt changes, and research takes time to conduct and to publish, ***all publications older than a few years*** (as from now, that is) should be approached with ***extreme caution***. The evidence, nevertheless, strongly supports the educational value of using CAL in a wide variety of settings. The success of CAL may be explained by three factors (Moursund[65], 1990). First, students using CAL on the average spend more time on task. Because learning correlates well with time on task, students on the average learn faster using CAL. Second, CAL materials allow students to work at their own levels and at their own pace. This individualisation is a considerable aid to some students. Third, CAL materials can incorporate "good practices" of instructional and learning theory.

From the point of view of the designer (as opposed to the user) of the software, all software used for CAL purposes fall in either of the last 2 categories presented in the next section 4.3. The best of the software (at least in its scope) is real educational software (e.g. category C, below) while the rest is really presentation software with some content (e.g. electronic books etc.) We strongly believe that there is a great deal of difference between these two categories of software used in CAL and that investigation as to the educational impact would be much better served by separating them in research as their sophistication is quite different. Mixing them simply blurs the issues under investigation.

Under the second use, the **Computer-Integrated Instruction (CII)**, the computer plays the role of a productivity tool, of a sort. One orientation focuses on general-purpose application packages with such generic names as databases, graphics, spreadsheets, word processors, and telecommunications. Each of these application packages is widely used in business, industry, and government. In education, each package can be applied at any grade level by being utilised in a variety of courses of increasing specialisation. For example, word processing is a generic computer application tool in the sense that is applicable across the entire curriculum at all grade levels.

An alternative orientation focuses on the development of application software for a specific skill. For example, there is a great selection of software packages available, which can help a person compose music. There is, also, a substantial amount of Computer-Assisted Design (CAD) and other graphics artists' software. All software used in the CII manner can be classed as "programs lacking educational target, per se" or "class A", as in the classification presented in the next section 4.3.

[65] Moursund, D., Computer-Integrated Instruction In-service Notebook: Secondary School Social Studies. Oregon: International Society for Technology in Education, (1990).

The educational use of **streaming media** can fall in either of the above-mentioned categories. If we deal with a case of streaming video used in education, this falls into the category of **"learn and teach integrating computers"** in teaching, even in the case when the student actively searches (on the web) one (or many) data-bases to discover a video appropriate to satisfy his interest to learn something on a particular topic. If, on the other hand, we have the case of a specialised computer program that may invoke a streaming medium to teach a specific point during a lesson, this is now the case of the **"learn and teach using computers"** category. The same is true for the case where the streaming video contains a recording of a teacher teaching a particular topic (as ICT is used as an instruction-delivery high technology device). A special sub-category of the use of streaming media is the case where the students themselves (with the help of the teacher) create their own videos and they then transfer it to a computer, edit, and compress it to fit their purpose. This is mostly an activity that falls into the "**Learn and Teach about computers**" as the basic skills exercised are not so much content related as they are method related skills

4.3 Software categories used in Education: How do streaming media fit in the picture?

Under the general title "software used in education", we include a very varied selection of software. This software has been classified by Ioannidis and Garyfallidou[66,67, 68] (1998, 1999 and 2001) in three major categories. The analysis of the educational use (and the limitations) of each of these software categories is beyond the scope of the present publication and can be found elsewhere. The software categories are briefly mentioned here in order to assist in the clarification of the position of streaming media techniques in the whole picture of ICT in education.

A. Programs lacking educational target, per se (category A)

These programs were conceived and constructed primarily for quite different purpose than to be used in education (they are general-purpose application software). Although they can also be used in education, they mostly lack educational content, meaning that *what* is to be taught as well as *how* is that to be taught is not included in the software. Sub-categories of such programs include: (1) Word processors; (2) Spreadsheets and programs used to perform statistics; (3) Data Base Management Systems (DBMS); (4) Encyclopaedias, dictionaries, geographical atlases, and thesauri; (5) Internet browsers; (6) Media Players.

The ***Media players***, an important piece of software for the use of streaming media has been elevated to this category quite recently, mainly due to the fact that all common players are now effectively mutually compatible in their specifications. Therefore, they have become a kind of "commodity" software, like the browsers, in that if one chooses to create his streaming video using one particular codec, this would not alter the way the video will appear to the user, who can (in most occasions) even select a player of his own choice for reproduction.

B. Presentation software (category B)

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[66] Ioannidis G. S.: "New technologies in education", in *Proc. 1st Greek conference in Science Education and the use of IT in education,* Thessaloniki, round-table contribution, proc. supplement published in Greek, (1998), pp. 15-20

[67] Ioannidis G. S. and Garyfallidou D. M., Education using information and communication technology (ICT), and ICT education: categories methods and trends. In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: "Interactive Computer aided Learning, Experiences and visions"*, Kassel University Press, (2001), ISBN 3-933146-67-4

[68] Garyfallidou D. M., & Ioannidis G. S Educational software, multimedia, and internet – a comparison with traditional teaching methods,., *Proc. 1st International conference in Science Education*, Cyprus (1999) (ISBN 9963-0-9062-1), published in Greek, pp. 281-296

Such programs (in the form they are bought) also lack educational content. This category includes software with a wide-variety of presentation capabilities. They range from the simplest packages up to the complex authoring tools such as (1) MS-PowerPoint, (2) Toolbook (now by Sumtotal), (3) Macromedia Authorware, (4) Macromedia Director, etc. These packages can help the teacher plan his presentation for next day's lesson. They could also be bought together with some educational content in the form of an "electronic book". A specific characteristic of this category of software is that the presentation package that is used defines (and ultimately set limits to) the shape and form of the final presentation.

C. Educational software (category C)

The fully-fledged educational software category contains programs that have been designed specifically, in order to be used in teaching and learning. These programs are created using high-level languages, which allows to the designer total freedom of function for the software. In the past, subcategories would have included descriptions like (a) Drill and Practice, (b) Tutorials (c) Educational programs and educational games, (d) Simulators. Today, modern programming techniques allow software designers to include many or all of the above functions into a single software product. In effect, the designer can choose a different method of approach to fit the specific educational objective. A verbal explanation (tutorial) can thus be followed by a simulation, which can be then followed by an educational game or a set of questions and answers.

Specialised educational software can be (under certain conditions) easier for the teacher to handle and includes more information about the subject taught. It also presents some practical *problems*[69]:

1) Many of the educational programs available are now quite old and, therefore, they cannot be expected to take full advantage of the capabilities of modern technology.

2) Many programs are, really, nothing more than electronic questionnaires.

3) In many of the existing programs, the curriculum can be extremely limited. These programs teach very well (in depth) something so small in width that their impact to students' understanding of the subject taught is (in effect) negligible.

4) Many programs cannot possibly be expanded and upgraded to cover other topics (of a similar context) other than the original one.

5) Many programs sold for educational uses are only electronic books written solely in the form of "hypertext". That means text with "links" and possibly the inclusion of a few pictures. The "hypertext" context is in itself a very valuable contribution to the development of written language in general.

6) Ultimately, some specialised educational software tends to be rigid in both the knowledge offered and the way it allows the student to learn. Flexibility in teaching and learning has to be designed in the software from the very beginning, and not to come as an afterthought.

It should be mentioned that some older educational research confuses programs under category **C** (i.e. real educational software) with those falling under category **B** (i.e. glorified electronic books). The term CAL used in some education research sometimes refers to the use of programs in either category, although in terms of software sophistication (as well as in terms of the final educational impact), categories C and B are radically different. This mix-up is the outcome of a misunderstanding (by the educators) of the way these software packages are designed and produced, coupled with some wishful thinking that, somehow,

[69] Ioannidis G. S. and Garyfallidou D. M., Education using information and communication technology (ICT), and ICT education: categories methods and trends. In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: "Interactive Computer aided Learning, Experiences and visions"*, Kassel University Press, (2001), ISBN 3-933146-67-4

advanced educational effects can be achieved via the use of authoring tools[70]. This mixing of products of such radical difference in sophistication ends in confusing the educational issues involved, by placing in the same bucket (as it were) educational research data from different categories of products. It also unwittingly promotes the use of products that are impossible to be combined with other such software, to be extended, or to be reused as "educational modules" (see section 4.7, later on).

Streaming media techniques have not yet progressed to the level of integration necessary for specialised "proper" educational software. It can be assumed that this will come with time. The streaming media techniques are just currently being tested educationally, while the incorporation of the methods into educational software requires them to be properly assimilated.

In the ***future***, either the whole or only a part of the program may be delivered as a streaming medium. As a first example, the whole program may reside in the streaming server, and it may be delivered to the user in educational blocks each with a different function. Alternatively, the main core of the program may already reside in the hard disk of the user's computer and the software may be programmed to call upon a specific internet address where one or more interesting media are offered. In this second example of software design, the streamed medium could be a video but also an encyclopaedia (or a dictionary), or an educational simulation etc.

4.4 New tools in education: new practices

It is evident these days that there is a trend, investment, political will, and sometimes a rush, towards using computer and network technologies in education with the hope that this will raise the quality of teaching and learning carried in schools. In addition one hopes that the "close encounters" of students with ICT (specifically) will raise their proficiency and their understanding of science and technology in general, thereby improving their future productivity and general competence. After almost two decades of ongoing activity in the field, a number of fundamental issues are still prominent:

- What kind or combination of expertise is necessary for the design of computer based educational activities? What are the boundaries between technicians and educationalists in software development?
- Why is it so hard and expensive to produce good quality educational software?
- How can technology contribute to evoking deep educational reform? What is the nature of the problem of using technology for deep systemic educational reform?
- How can technology be used for infusing innovative practice and attitudes?
- What kind of standards for tools, activities, support, and educational practice are we in the need of?
- What are the idiosyncrasies of the educational, school community? What is their reaction to technological innovations?

Fullan[71] (1982) states that, in the educational context, "change involves 'change in practice'" and he mentions several difficulties. One kind of difficulty, which also tries to

[70] Ioannidis G.S., Garyfallidou D.M., Panagiotakopoulos C., & Vavougios D.G., Ideas on computers as held by arts students, after a course on information and communication technology (ICT) In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: "Interactive Computer aided Learning, Experiences and visions"*, Kassel University Press, (2001), ISBN 3-933146-67-4

[71] Fullan, M., The meaning of educational change. Teachers College Press, New York (1982).

answer to the first category of questions, was discussed by Roschelle[72] (1998). He argued that today's technology is expensive, easy to break and inflexible, while a good catalyst for change would be low cost, reliable, flexible, and available everywhere. Educational software is viewed as 'bad', as it is based on a wrong economic model: a) produce stand-alone application islands, b) big project teams, c) distribution controlled by a few huge companies. As a possible solution, it is suggested a 'right' economic model, which would be based to a) component-based technologies, b) incentives for small developers, authors and c) web-based, open distribution. He suggested that it is the right time for a number of innovations, like

- Java: a common platform
- Web: coordinate distributed work
- Handhelds: components at very low cost
- Standards
    - Labelling for search (metadata)
    - Plug & play, mix match
    - Linked representations

Therefore, Roschelle proposed as a solution for the educational software the philosophy of 'components' and gives as an example the Educational Object Economy. This is the name of a global community for web-based tools in Java, which joins educators, researchers, software innovators, and businesses working together.

In effect, what Roschelle (as well as others) have proposed is not much different to the general consensus regarding software design: Reusable software modules, written in high-level computer-languages and as much object oriented as possible. In a sense, he just advocated the application of the general rules to educational software. Proper software written today conforms to most of this doctrine although not all rules of object orientation are adhered to, in a fanatical manner. It could be said that today's languages are mostly "object based" and some are "object oriented", and that the final package (more often than not) ends up being written in more than one high level language.

Change is difficult. Educational change is difficult to imagine, difficult to plan for, difficult to implement, difficult to manage, and difficult to measure. This is even more difficult when we talk about attitudes and education. However, it is generally agreed that technology can be a powerful catalyst for:

- *New level of engagement*
- *New content*
- *New pedagogy*

Technology can create opportunities for reforming:

- *The curriculum*
- *The pedagogy*
- *The Teacher Professional Development*

It is argued here that, for the second category of the initial answers, the major role is played by the teacher. No change can happen without the teachers' involvement, no reform without teachers' efforts. New practice means new ways of thinking about science, about learning and about teaching. The change conceptually is less a matter of discarding than augmenting ways of thinking. Moreover, the new ways of thinking require computational

[72] Roschelle, J., Henderson, B., Spohrer, J., & Lilly J., Banking on Educational Software: A Wired Economy Unfolds. Tecnos, 6 (4), (1997) pp.23-28.

tools, just as modern astronomy requires telescopes, and biology requires microscopes (Kaput[73], 1998).

All these new educational technologies have led to new research explorations. Visual ethnographers, for example, increasingly use hypermedia for research, representation, teaching, and learning. These uses, for example, are discussed by Pink[74] (2004), by reflecting on "visualising ethnography", a teaching and learning 'gateway' web site containing and interlinking the visual aspects in the ethnographic process, housing interviews, authored works, exhibitions, introductory texts and offering further links. In this research, she compares the web site with other visual-anthropology web sites, discusses key characteristics of hypermedia for teaching, learning, and representation. She also analyzes how authors constructed their contributions as well as the site-users' responses. The way prospective web sites might link with each other in the future, to interrelate each other's material is also discussed, together with the effect such interlined sites might have in teaching and learning.

4.5 Digital media promises, versus established analogue-media educational practices

Seen from a technical point of view, there is a profound difference between analogue and digital media. Analogue media refer to films and conventional video recordings, as well as to still pictures all gathered through many decades of careful production and development of the techniques of cinematography and presentation practices. Digital media are new but they are quickly gaining pace, one important factor of the increase in speed being the much greater facility in operating the latest equipment, while another is the radically different cost in production and digitally editing the new media. Digital production and digital editing are much cheaper and are done much faster. An equally important factor in favour of digital media is the (almost totally automated) facility of turning older analogue material into digital. Digital can be encoded in various methods and using various (mostly lossy, see section 2.8) compression algorithms, so that the same basic material can be shown using different screen sizes, and displayed at different screen analyses. Furthermore, in case of transmitting these media over distance, the transmission quality can be dynamically altered, resulting in a mostly reliable transmission utilising the best possible image that could be displayed on the device at that time, at least in theory. An additional advantage of digital media is the (ultimately) lower cost of the display devices, as well as the lower cost for the distribution of digital media.

From the point of view of the educator, the view is radically different. For education, a video remains a video no matter if it is analogue or digital. It is all the other factors associated with streaming, which may make a difference in education, and these advantages have to be explained and demonstrated. This process is just starting (e-stream being a part of this process) and for this reason, the take-up of digital media in education remains a future promise as opposed to being a present reality.

Future educational promises of digital media are based on the following:

1. Lower distribution costs due to increased bandwidth (using UDP/IP or TCT/IP protocols) available on a European and (later) universal scale.

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[73] Kaput, J. Technology as a Transformative Force in Education: What Else is needed to Make it Work? Paper presented in the Workshop*: "New tools in education. New practices?"*, Computer Technology Institute, Athens (1998).

[74] Pink, S., Making links: on situating a new web site. *Cambridge Journal of Education*, 34(2), (2004), pp. 211-222.

2. Lower administration costs (potentially) as only the maintenance of a media server is required as opposed to a hierarchy of (human) administrators distributing the media.

3. Instant delivery of the medium (on demand), in the case of internet transmission.

4. Searching for an already existing medium can (potentially) be done in an orderly and systematic fashion, by consulting data-bases over the internet.

5. Convenience in displaying the medium (digital media are easier to handle and computers and displays are omnipresent nowadays).

6. Digital display devices are so easy to handle and to use that students can be left to act by themselves, to exploit all the possibilities (e.g. repeating parts of the medium at will etc.)

7. The sequel to the last three points (above) is that the student is not anymore a passive receiver or information but rather an active exponent seeking new knowledge.

8. Convenience as expressed by the ability to distribute a single digital medium with a multitude of languages used in narration and/or subtitles (very important issue for Europe today). Users can select the language to be used while watching it.

9. The proliferation of inexpensive and easy to use digital video recorders, as well as the easiness of transferring the videos to computers and subsequently editing them, raises the possibility of teachers and/or students to create (and distribute) their own videos.

10. By utilising streaming media using UDP/IP and TCP/IP techniques, there is a hope that intellectual rights issues can be resolved in a way that each user will be charged a "trickle charge" for every viewing. Alternatively, the issue can be solved by a yearly charge from a "consortium of data-bases" offering the media (and supporting the multiple parallel media servers to provide such service).

11. The possibility to use low cost display devices in classroom allows educators to experiment with novel teaching approaches involving students working in groups to achieve an educational goal.

12. There is a promise of future "individual wireless portable display devices" that could be used on a one-per-student basis. This would blend much better in ordinary classrooms and in mixing traditional teaching practices with ICT convenience and capabilities.

An experienced educator would not fail to notice that in all these points made above, there are more of signs of future opportunity than present possibility. Indeed, the following observations are true: (a) The educational and didactical trials to reap these benefits are just at their infancy, and much more of these are needed. (b) Intellectual rights legal issues do not yet seem to have been solved, this issue being further complicated by translation issues. (c) The availability of educationally worthwhile digital media, for easy viewing over the internet is sadly lacking in numbers, this being the most important sticking point at the moment. (d) It is not easy to translate text in a way that the true educational benefit is not lost in the process, let alone to plan and create new valuable educational material.

All these issues will be discussed in much more detail in the appropriate chapter, later on in the present publication.

4.6 Exploratory learning

Educators are increasingly interested in providing students with computational tools that support exploration and experimentation. Doing it well requires intertwining many different threads of thought (Resnick[75], 1995).

[75] Resnick, M., New Paradigms for Computing, New Paradigms for Thinking. In A. A. diSessa, C. Hoyles & R. Noss (Eds.) *Computers and Exploratory Learning*. NATO ASI Series; Series F: Computers and Systems Sciences, Vol.146, Springer-Verlag, Berlin (1995).

One thread involves the *understanding of the learner:* What are the learner's preconceptions and expectations? How will the learner integrate new experiences into existing frameworks? In what ways can learners construct mew concepts and new meanings – and in what ways can new computational media provide scaffolding to support this process?

A second thread in the design fabric involves the *understanding of domain knowledge*. If a new computational tool, or activity, or even streaming medium is intended to help students learn about a particular area of mathematics, or science, or any other subject in fact, the designer should have command of that area of mathematics or science, or any subject he wishes to teach. However, there is a deeper point. The best computational tools don't simply offer the same content in new clothing; rather, they aim to recast areas of knowledge, suggesting fundamentally new ways of thinking about the concepts in that domain, allowing learners to explore concepts that were previously inaccessible. A classic example is Logo's turtle geometry explorations (Papert, 1980; Abelson & diSessa, 1980) which can be useful for children up to 8-year old, but no more. The design of such tools requires a deep understanding of a particular domain, and the above serves as just an example of software tools suggesting fundamentally new ways of thinking about the contents they try to teach.

4.7 E-learning: The case for Object Oriented Programming (OOP)

The world of the Internet offers us a huge amount of information and poses new questions concerning the identification of the appropriate information, and the quality of this information. Therefore, despite many factors lining up in desirable directions, huge challenges face all stakeholders in the educational technology enterprise (Roschelle[76] et all, 1997). For example, teachers find existing products fragmentary, incompatible, and closed to customizations necessary needed for their specific classroom situations. Government agencies spend a lot of money on successful demonstration projects, but too few of them transfer into mainstream teaching and learning or scale into systemic reforms. These problems have been taken under consideration by a community of people and their research finally led them to the formation of a so-called "Educational Object Economy" (EOE), which can dramatically enhance the impact of innovative educational software. The traditional approach was that every lesson would be built by the same software company to fit its unique formation of a series of activities for a specific curriculum. Using the "object oriented" software architecture, the software "component" can be reused. Once the first components are built, they act as a kind of "template" or tool on which different components can be built using the previous component as a paradigm. Tools are chosen and build by each consumer according to his/her own needs.

This is the theory. In practice this is already happening but not in a very strict manner. It should be understood that there are a number of pre-requisites to being able to do that. These are:

1. Software produced should be available as free-source software. This means that all intellectual rights are waved by its creator, in the interests of the advancement of science and the "fine and gentle art" of computer programming. In practice, this can only happen if the programmers are financially supported by other means (e.g. grants etc.) There are a surprising number of those people, and the free source software movement has come a very long way in recent years.
2. For the user to be able to build a component to fit his needs, would mean that in school practice a teacher should also be a programmer, and we are implying programming in an

[76] Roschelle, J., Educational Software. Components of Tomorrow, Paper presented in the Workshop: *"New tools in education. New practices?"*, Computer Technology Institute, Athens (1998).

object-based high-level language. Not all teachers are so proficient in programming, and this means in practice that groups need to be formed (often ad hoc) to produce the software.

3. Programming a computer is a discipline, and as the name implies this means training to think in a disciplined way. Real object oriented programming necessitates a higher level of disciplined thinking. In direct contrast to the so-called "quick and dirty" programming often available in some high level languages (not so suitable for component building work) object orientation requires clear and disciplined thinking. This, in turn, implies training. As a trained programmer is not very often a trained teacher, the formation of groups of people to achieve the final objective is almost essential.

In practice, the techniques used in programming are more object-based that object-oriented (which might be something a lot more powerful and a lot more elegant but it requires an even higher level of programming skill). This is due to practical reasons outlined above. The level of reusability offered by such object-based techniques is, nevertheless, impressive. Anyway, to be pragmatic, forces of a much higher strength than those available in the educational field have already decided that this is the way of the future, in general. No matter which way it will implement it, education has no other choice but to follow this higher-level decision.

Frameworks based on learning objects have been explored, in terms of their effectiveness in tailoring learners' knowledge to their educational background and their needs. Atif, Benlamri, & Berri[77] (2003) reported that although the general learner-modelling alternative is an intractable problem, learning objects constructs could be used as building blocks to root out individual learning deficiencies. They also provide an algorithm to construct individual learning routes that are adjusted to learners' profile as well as an open implementation to accommodate their integration of various learning sources.

4.8 E-Learning: Synchronous and asynchronous content delivery

Synchronous e-learning refers to the educational setup in which the teacher is present during the time the e-learning is taking place. In the case of web-based tele-learning this would mean that the teacher is available either in the actual room where the teaching takes place or, alternatively, he is available on the web in real time, when the student is using the e-learning module streaming media etc. In some circumstances both the tele-teacher and an on-site (e.g. on location) teacher are available simultaneously. The function of the teacher is to facilitate the learning process by supervising it, and answering to practical and educational questions, as well as by offering encouragement and psychological support to the students.

Resent research efforts in this field focus both on learning theories and on information technology. For example, Yang & Liu[78] (2005) explored the use of a web-based virtual on-line classroom that is composed of two parts: "instructional communicating environment" and "collaborative learning environment". The first provides learners with learning material, lecture videos, and interactive environment, etc. The second supports active learning by providing the environment with learning tools, learning materials and contextual discussion for learners. The environment designed incorporates event-based synchronous strategies and e-learning technology standards. Teachers admitted that they are accustomed to communicating and teaching face to face, but they hope they could master the ability to control teaching and learning process and to observe learner's behaviour like in the

[77] Atif, Y., Bentamri, R., & Berri, J., Learning Objects Based Framework for Self-Adaptive Learning. *Education and Information Technologies*, 8(4), (2003), pp. 345-368.

[78] Yang, Z. & Liu, Q., Research and development of web-based virtual online classroom. *Computers & Education*, (in press), (2005).

traditional classroom. Learners, however, seem to love to use such tools as chat-room, BBS (i.e. Bulletin Board Services), etc., to control their learning pace.

Asynchronous e-learning refers to the situation upon which the student accesses the e-learning material in his own free time, or even at normal school hours. In asynchronous learning there is neither a teacher supervising the activity nor a tele-teacher who might be able to answer to students' questions immediately (e.g. in real time, while the student waits) or to make a suggestion, an educational comment etc.

Educationally, there is a whole world of difference between the synchronous and the asynchronous teaching approach. The advantages of asynchronous e-learning include factors like cost, the convenience for the students to work at their own schedule (very important for mature students having jobs) and also an element of improvisation and active involvement of the student to find and access information on the web. In the disadvantages of asynchronous learning we should count that it asks quite a lot from a student (especially the younger one). An amount of self-discipline needs to be present for the student to give up consistently his own free time to study from the net, with little immediate encouragement. We should remember that the asynchronous e-lesson can always be postponed and this may be done very often or for long periods of time, during which the student forgets most of what he has been taught during the previous e-lesson. In addition, strong will and a commitment to learn must be present from the part of the student for him to check on the web for the answer to the questions he has posed to the (asynchronously available) tele-teacher. The educational pitfall of the asynchronous approach is that, quite literally, while waiting for the answer, the student may forget what the question was! The student might lose interest in his question while he is still waiting for the answer, and not log-in the system to check and find the answer to his enquiry, until his next tele-lesson. This would essentially mean that the student did not afford himself the time to assimilate the previous lesson (free from all queries). This situation could quickly deteriorate to a state of (conventional) educational apathy amongst students (e.g. superficial understanding, no questions asked, minimal motivation to learn).

It could be argued (quite rightly) that this is not much different from what is happening in the traditional teaching methods, where the teacher takes the students' papers home to correct them and he returns them to the student the following day or even later. By the time the students receive the corrected papers, they are probably only interested to know their final result[79] (score). In reality, though, although traditional teaching (in large classes) routinely practices asynchronous assessment of students' progress, asynchronous e-learning takes the game half a step further: it does not even allow "synchronous" interruptions during teaching (or during experimental lab-practice) to ask a straight question to the teacher.

It is quite clear that the asynchronous learning is best suited for mature students with a strong commitment to learn. For younger students it is best to reserve this approach for after school hours learning, in order to give an opportunity to the brightest (or the more inquisitive) of them to satisfy their curiosity in an educationally productive way.

[79] Ioannidis G. S. and Garyfallidou D. M., Education using information and communication technology (ICT), and ICT education: categories methods and trends. In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: "Interactive Computer aided Learning, Experiences and visions"*, Kassel University Press, (2001), ISBN 3-933146-67-4

4.9 E-Learning: Mixing synchronous with asynchronous, and streaming class practices

In practice, some experienced teachers might prefer to mix various techniques during their classroom hours, depending on the special circumstances, each technique lasting for a limited period of time. As already mentioned, the element of improvisation in searching for the information on the web, and the active involvement of the student in this process are valuable educational tools, and are well supported by the constructivist approach to learning. In order to tap these advantages, teachers may ask their students to act by themselves, for a (predefined) limited period of time, to search for the information sought. The teacher is still present offering encouragement. This activity may take the form of a competition amongst groups of students: all groups searching for the same information, each one in their own way and while there may be more than one source to this sought after information.

Alternatively, the teacher may assign to the various groups different (but interrelated) tasks, each group searching for a different aspect of the object or entity studied by the whole class.

After the end of the activity, it is considered most important that the class reunites and compares what they have found, each group presenting this to the others, the best way they can. During this phase, the teacher supervises, guides, and intervenes didactically.

All these approaches are valid and they may be used in different educational circumstances as the nature of the particular subject taught (or investigated) allows. These approaches are best suited for teaching using streaming media, as the web is potentially our richest source of collective information waiting to be didactically exploited after careful educational investigation. One of the aims of the E-stream collaboration is to attempt to perform the first active research in this field.

4.10 Blended learning

What do we mean when we say blended learning? In fact, blended learning often means different things to different people. The concept of "blending" grew out of the successes and failures of e-learning. Although some instruction is appropriate for online delivery, there are still many contexts in which it appears that learning is best served by some combination of classroom teaching, web-based training (WBT), synchronous online delivery, or the use of other electronic resources (Douglis[80], 2005).

The question concerning how students behave, when they are offered the opportunity to choose between either teamwork or individual study, has been investigated in the context of an English Literature course (van Eiji, Pilot, & de Voogd[81], 2005). In that course, students worked intensively using a virtual learning environment, and they attend classrooms: a blended learning environment. Students had the choice of working on the course assignments in small teams or individually. The students who opted for collaboration were mainly those who gained high grades in a previous course that had a similar pedagogical design. This notwithstanding, statistical analysis showed that collaboration resulted in significantly higher grades.

Blended learning is suitable for synchronous e-learning delivery from the web, and the advantages of this combination include:

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[80] Douglis, F. (2005) *Blended learning: Choosing the right blend.* In B. Hoffman (Ed.), *Encyclopedia of Educational Technology.* Retrieved May 9, 2005, from http://coe.sdsu.edu/eet/Articles/start.htm

[81] Eiji, van J.P., Pilot, A., & Voogd, de P., Effects of Collaborative and Individual Learning in a Blended Learning Environment. Education & Information Technologies, 10(1-2), (2005), pp. 51-65.

- Motivation -- focuses the energy of group and encourages students to keep up with their peers and continue with their study
- Tele-presence -- helps create a feeling of community and classroom cohesion
- Feedback -- rapid feedback foster consensus-building in group activities
- Pacing -- helps keep students up-to-date with the course (Mason[82], 2000).

How do we figure out what is the right "blend" of instructional and delivery methods in a given situation? The same decision components that should be considered for any instructional design should be carefully examined for blended learning solutions. The illustration below suggests a number of components to be considered. Some of these are audience analysis, course content, learning objectives and outcomes, and situational context (Fig. 4.2). In addition, when considering technology-based delivery of instruction, it is best to determine whether there are any barriers to implementation. For instance, is there sufficient bandwidth? Is the organizational climate supportive of technology-based learning?

Guidelines for success

Each unique learning situation will require a fresh approach. However, the guidelines below can help designers determine whether what they are considering represents a truly blended solution.

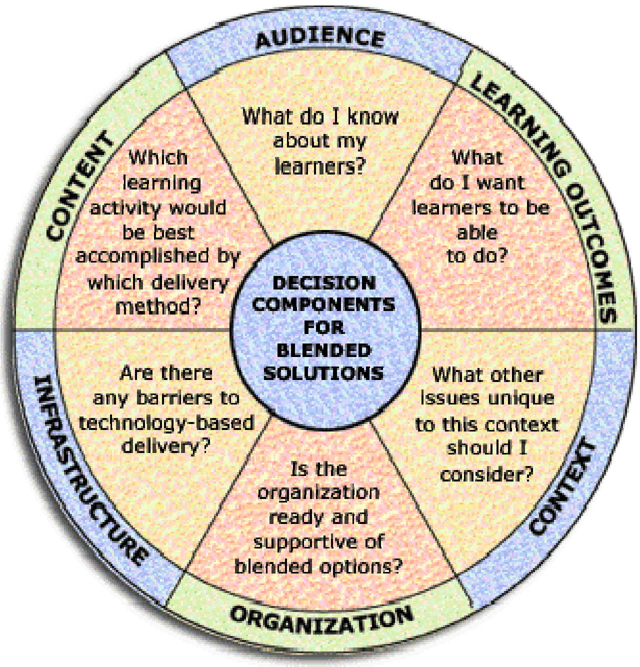

Figure 4.2. Decision components for blended learning

Completely integrated instructional design

A blended solution works when all the instructional components are considered holistically. What is less successful, for instance, are e-learning modules just "bolted on" to existing instructor-led training. A plan for blended delivery should include conducting the up-front analysis necessary, and ensuring the inclusion of these key components of successful instruction: interaction, instructional goals tied to performance, and learner engagement.

Each method delivering its best

Each delivery method should be chosen for what it can deliver best (Zenger & Uehlein[83], 2001). For instance, online training can often effectively provide learners with factual knowledge about a specific skill. However, the content and the desired learning outcome should determine whether the practice of that skill can be appropriately accomplished online, or if it is best done in a classroom, or authentic context. One should also consider whether, in a given situation, performance support and online resources might be more effective than any type of instruction as a "blended solution."

Flexibility and Variety

[82] Mason, R.D., *Synchronous Versus Asynchronous Distance Education.* In B. Hoffman (Ed.), *Encyclopaedia of Educational Technology.(* Retrieved November 29, 2000), from the World Wide Web: http://coe.sdsu.edu/eet/Admin/Biblio/index.htm

[83] Zenger, J., & Uehlein, C., Why Blended will Win, Training & Development, 55 (8), (2001), pp. 54-60.

The choice of whether to offer alternative delivery options for the same instruction, or combine delivery methods will depend on a number of factors. Learners can often benefit from multiple delivery methods that accomplish the same learning objective. Barriers to access are eliminated, and learners have more choice on how they learn.

Extending the blended learning experience

Blended learning is a continuous process, rather than just a "learning event." Providing blended solutions allows flexibility, not only of multiple delivery methods, but for learning to take place over time. For instance, learning activities can start with Web-based modules that offer "pre-work" preceding a classroom-training event. Online peer communities or e-mentoring can extend well past the live event, along with web resource availability for learners. Blended learning offers great potential and attraction for those designing, delivering, and learning. Staying riveted to teaching and learning outcomes, when one is in the process of determining the "right" blend, is the key to success.

4.11 Epilogue

Information and Communication Technology (ICT) is a part of our reality today. It should also be a part of school's reality and of pupils' life. The way that this is going to happen, depends on a number of parameters, which must be taken into account. Teachers can only depend on the facilities already existing and exploit their own knowledge and creativity. A constructivist perspective of learning and teaching seems to fit better the teachers' personal construction of the new classroom culture as well as the pupils' personal construction of a higher quality of knowledge. Action research is necessary for the creation and improvement of new practices and of a new learning culture. Rigid software that will cover every detail of the lesson in every classroom environment seems not to be possible. New technology tools that can be easily used in the classroom situation and appropriate teaching strategies which will be chosen by the teacher, seem to be a viable solution. New learning media are not always easy to be used, nor useful and profitable unless the teacher has first searched, and then identified the appropriate pathways, in order to be finally able to guide his/her pupils. There is no way to use new computer media in classroom unless the teacher has developed an awareness of the consequences of using them, of designing and implementing them in the lesson's plan and in the classroom environment.

This, nevertheless, seems to be the only logical form of action for education to take next, hopefully in the immediate future. From the ICT implementations in education, streaming media seem to hold a special value. They seem to be the ICT application most familiar to the teachers, while at the same time they are the easiest form to blend in ordinary teaching practice, as used today. We always wanted learning to be fun, and especially blended learning with streaming media should really be fun; fun for pupils, but fun for teachers as well.

5 Teaching approaches: great opportunities and some pitfalls

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In the present chapter, we deal with the various types of educational activities centred on streaming media and the way education providers could plan their streaming activities. The existing pedagogical advantages are dealt with, together with the possible disadvantages, to avoid possible problems during (or after) implementation of such activities.

Joan Solomon (1992) says[84]: Teaching and research have always lived uneasily together, with the researchers worrying continually why it was that teachers did not welcome their ideas and put them into immediate action, and the teachers maintaining a withdrawn silence. The impasse is probably due to at least four factors.

- Professional distrust or blame between and teachers and researchers,
- Lack of communications (teacher/teacher and teacher/researcher),
- Uncertainty about modelling the teaching - learning connection, and
- The different kinds of knowledge about the learning process that teachers and researchers possess.

In simple words, if we want teachers to accept our research results and adopt the new teaching approaches we should be honest with them, and present together with the benefits that the students would have from the new method, the difficulties they will face.

5.1 Advantages and disadvantages of using streaming media in education

Moving picture technologies started being used in education almost a century ago: film, television, videotapes, videodisks, digital desktop video, CD-ROM, multimedia, interactive TV, and web-based media, all of them finding some (limited but increasing) use in education.

Since the late 1980's, we see the gradual introduction of some type of so-called “interactivity” in teaching and learning using media. This started with the introduction of videotapes, videodisks, digital desktop video, DVI, CD-i, and culminated by the use of specialist software using multimedia. Using the first few of these delivery systems the user can only control the parts of the video to be shown, to pause, to rewind, and to move forward, but even that is arguably significant, especially if it is done under direct control of the individual learner. With the introduction of DVI and CD-i, ***real interactivity*** with the user became possible, as he was now able to click and select or to move objects appearing on the screen, or to pass through doors to different environments etc. This has led (through a natural development process) to the modern computer games, which are wonderfully realistic, although most people would find it very hard to argue as to the educational advantages of most of the game software currently available! The possibilities and the

[84] Solomon J., *Getting to know about energy - in school and society*, The Falmer press (1992), ISBN 0 75070 018 1, pp. 116

technology are all there for the creation of some truly valuable educational software using true virtual reality techniques, or even total-immersion VR techniques. What is currently lacking is proper (and sustained) funding, and the will to relentlessly pursue this goal by forming large working groups of qualified researchers; such groups should be consisting of hardware experts, analyst/programmers, appropriately-minded research-educators, and teachers.

Moving images are a simpler matter: They may have (or even might have) an educational value by themselves, if their content is suitable and if properly recorded; furthermore, they can offer some added educational value by allowing the user an easier and more controllable access to the material presented, via direct video control. The learner, in this case, has direct control on the choice of the content material as well as on the general pace (and time) at which it is delivered. He or she can choose the parts of the video to be shown, to pause, to rewind, and to move forward whenever necessary, independent of the time or the geographical location of the educational activity, all as if he was operating a normal video-cassette recorder. Video is still just a presentation tool, but if the learners have such a direct control on the data-flow, this goes along some way to satisfy them. As Thornhill, Assncio and Young[85] (2002) explain though, moving images add authenticity and reality to the learning context, and can bring the course content *alive*.

5.2 Using streaming in the classroom

In a classroom, if a single display device is available, data-flow control is normally in the hands of the teacher. Everyone watches at the same time the same sequences, as chosen by the teacher. This relinquishing of the flow-control can be overturned if more than one image-delivery device is available in class: The students can be split into groups and tasks may be assigned to them. Ideally, each student could have access to his own independent display device (a computer of some sort) which means that the control of the data-flow is back in his hands even in the context of classroom teaching. In the future, some already existing portable self-contained media-playing devices may proliferate, as it is certain that they will improve technically (or they might even merge into mobile phones). If prices fall, teaching scenarios utilising one “personal” media-player per student might end up being considered quite normal.

However, and despite the multiple educational advantages of an interactive media-enhanced environment, the widespread use of these media was always limited by media production costs (which remain high despite recent technological advances) and, most importantly, media delivery difficulties. This is where the value of the internet becomes apparent. There is, on the one hand, a need for frequent updates to already existing video libraries, and the distribution of the media as well as the logistics of the process cost time, effort, and ultimately money. The increased internet bandwidth, on the other hand, as it is rapidly becoming available even in small European villages, appears as an opportunity to solve some of these problems, while at the same time presenting itself as a great promise for education. Production costs for media may remain high, but at least it can now potentially be distributed to a wider market, thereby (at least in theory) reducing the cost-per-view to a much lower number.

Internet has not only facilitated the distribution of content, but it has also added another interesting potential use for video in class, namely “integration” as it is called by Thornhill, Asensio, and Young[86] (2002). The idea is that learners can view a video on its own, streamed from the web, or alternatively this can be interlinked with other learning materials,

[85] Thornhill S., Asensio M., & Young C., (eds.) Video Streaming, a guide for educational development, “Click and go video” project, www.ClickandGoVideo.ac.uk, ISBN 0 9543804-0-1, pp. 10

[86] Ibid., pp. 6, 10, and 13

such as slides, supporting texts, chat, discussion groups, references, quizzes etc, which are didactically related to the streamed video. Streaming videos together with these other materials constitute a “***Virtual Learning Environment***”. This integration of digital video with other tools extends its potential use.

In effect, if the video we are talking about is a mere video clip playing for example for less than a minute, viewing it can be followed by a choice of possibilities for the user. This form of interaction elevates the clip into a dynamic medium offering true interactivity.

Using media off the internet (and using steaming technologies in general) should not be considered as a labour-saving alternative method to teach and learn, and this is especially true at the time of the introduction of the new techniques. On the contrary, both the teacher and the student need more time to adjust themselves to the new technique and to develop a way of working with it.

The teacher should search through one or more different media libraries find potentially useful media and decide which ones might be useful for his/her class. He may decide that for his next lesson he would like to show a part of a certain medium (from the 10th to the 15th minute for example), plus an additional 3 minutes from another medium. There may or there may not be additional material accompanying the video, and this may or it may not be suitable for the purpose the teacher has in mind as a use of the video. In either case, the individual teacher is the one responsible both for the content and for the way this will be presented in the class. It is his job to prepare the lesson. Watch the media with a critical eye, decide which parts to avoid as irrelevant and which are useful, and also prepare notes and worksheets for his/her class.

In addition to what the teacher has to do, students will also need time to familiarise themselves with the new learning method. Besides, there are potential time-scheduling problems[87] involved. If students do not have access to broadband internet from their home, there would be the need for them to stay extra hours in the school lab, in order to view the material and finish the task (e.g. worksheet, presentation etc) that may be assigned to them.

5.3 Classification of media activities: use what is available and capture your own

To state the obvious, the media that can be used educationally could either be:

I. **already existing media**, that is media produced by an outside provider, or

II. **media** that can be **produced from within the school environment** (i.e. teachers or students themselves)

It is quite apparent to most educators that although the second source of media (school production) offers immediacy and generates student interest, the real educational impact of streaming can only come from the first source. It is not only that in terms of image quality these videos are (or should be) better in general, it is also that in terms of sheer numbers, what one individual teacher (or a class) can produce is limited, due to lack of time. Furthermore, making a video of acceptable quality is (as we shall explain) not as simple as it first seems – short clips, though, are far easier to tackle.

[87] Antonopoulos S. G., Garyfallidou D. M., Ioannidis G. S, Sianoudis J. A., Sotiropoulos D. J., Tsiokanos A. C., Innovative ways of combining teaching ICT with teaching science: video taking and editing by students and teachers, In *HSci2005 – 2nd International Conference Hands-on Science: Science in a changing Education*, (2005), ISBN 960-88712-1-2, pp. 63-69.

In terms of ***media usage*** in education, we can class the ***activities*** as follows:

I. **<u>Already existing media</u>**

- ***i.*** Streaming short ***video clips***
- ***ii.*** Streaming ***longer videos***: explanatory documentaries, tutorials, etc.
- ***iii.*** Searching to find educationally useful streaming media
- ***iv.*** Consulting an online library of educational learning resources

II. **<u>Self produced media</u>** (by teachers or students)

- ***i.*** Capturing an educational event and producing a streaming medium
- ***ii.*** Capturing an external real-life event and producing a streaming medium
- ***iii.*** Capturing short clips (produced for the purpose of being recorded)
- ***iv.*** Make short clips by editing longer videos
- ***v.*** Producing long educational streams
- ***vi.*** Adding in the "virtual library" of freeware videos: teachers and students sharing their own resources

The emphasis on work in the second class (according to the above classification) is on ***producing and capturing***. From the point of view of the media *user* (for education), the important consideration is if the particular medium is available to him or not. For him, there is little difference between a professionally or semi-professionally produced video and a "shareware" school video, as both types will be discovered by performing activities ***I.iii*** or ***I.iv***. The school videos (product of a different school) would have been produced (at an earlier time) by performing activity ***II.vi***, in which the video is given out as "shareware" or "freeware". The end-user will probably experience the difference in the "quality of filming" (assumed to be higher in the professional product) and in the cost (school productions will presumably be available for free) but for him the question is if the video is good enough for his purpose. He does not care who has produced the clip, the school next to him or a professional cinematographer on the other side of the world. He just wants to use it if he can.

5.4 Streaming already existing short <u>video clips</u>

(This represents category ***I.i*** in our classification of section 5.3)

Educationally, the real difference between streaming a video clip and streaming a longer video is in inherent educational planning. Obviously, a short video-clip cannot contain in itself (i.e. inherently) any short of educational planning, precisely because it is so short. Therefore, the teacher has to provide his own planning, and in this case, this means, in a practical sense, to decide when and how he will use the clip during his normal teaching. Clips can be easily accommodated during normal teaching. In effect, it is the "movie equivalent" to a stationary exhibit, like a still picture. A clip is therefore used educationally to "make a point" by illustrating it.

5.5 Streaming already existing <u>longer videos</u>

(This represents category ***I.ii*** in our classification of section 5.3)

Educationally, the real difference between streaming a longer video clip and streaming a video-clip is in its inherent educational planning. Any video-film longer than (say) 10 - 20 seconds and spanning into minutes of viewing time, simply has to have some educational planning built into it: if not is worthless educationally, literally representing a waste of time for the students. Such a non-educational film represents potential raw material from which a couple of short video clips can be produced (see activity class ***I.iv***, above, discussed later), but in itself it is not educationally usable material, as it stands. It should be made perfectly clear that media that are (effectively) nothing but concealed adverts, or media presenting "biased" opinions (as those coming from pressure-groups of any kind) etc. should be relegated to the recycle bin without mercy or any second thoughts.

This very reasonable argument brings us to face the question of **what constitutes educational material** or not. The answer to that has to be with the teacher: he decides the suitability. On the other hand, it would be very helpful if some guidance were also available: there is none at the moment. It is not simply a question of whether or not the (particular group of) students gain something by watching the particular stream. The truly hard question concerning video stream suitability has to take account of the *time spent, while watching it*. If the teacher judges that the "***useful educational density***" of the film is too low (i.e. too much time for too small a gain), the stream should be sent for recycling, as unsuitable.
On the other hand, students might also loose something by watching a video originating (for example) from a pressure group in that, it is bound to conceal biased unscientific pseudo-information; concealed propaganda, really. A more subtle approach taken by creators of pseudo-educational media is to present on par the scientifically valid opinion and the one originating from a dubious source (e.g. a religious heretical sects etc) as being both valid and on equal grounds; this biased presentation only serves to bring confusion to the students. It also makes a mockery of the scientific process (based on hard experimentation and on mathematical reasoning providing the proof of the arguments) and degrades it to supposedly being a matter of free choice of the individual (i.e. to choose what to believe).

As it happens with any type of educational material, it is the teacher who decides when it is the appropriate time to use it. The teacher also decides the best way of using the medium. Aggelopoulos, Garyfallidou and Ioannidis[88] (2004) describe the following ways of introducing streaming media in the classroom.

a) The teacher can select a single video and the whole class sees it at the same time, during the lesson. Students may use the same screen or students may be sitting in individual screens, or in small groups. The video will contain certain information and then the students would
   - Discuss the subject presented.
   - Have to answer some questions.

Alternatively, the video may contain instructions for a certain experiment, or lab construction; the students after watching the medium, would visit the school science laboratory, and perform the experiment / construction they have just seen.

Of course, an experienced teacher may devise activities combining creatively the aforementioned ways e.g. have a class discussion and then a construction etc.

Continuing the methods of introduction in the classroom, the teacher may also decide to use an existing medium:

b) Before the class to prepare students for classroom discussion and practice
c) After the normal class hours, as a review of topics already covered in class, or in place of a class for those of the students who (for any reason) missed class
d) As self-study for self-learning

These cases (b), (c) and (d) can only take place if either the students have broadband access to the net from home, or if they have access to the computer lab after school hours. If any (or both) of these pre-requisites is fulfilled, the teacher can then suggest one or more appropriate videos, and:

88. Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: "Interactive Computer Aided Learning"*, Kassel University Press (2004) ISBN 3-89958-089-376

The students can work either individually or in small groups following their own pace. Each group of students could have the same aim, but will be free to can select how many of the videos they will use, how many times they will repeat it, etc. In the end, worksheets will be filled-up. The presence of worksheets is considered crucial, at least at the beginning, because it will force the students to focus on specific parts of the video. These will be indicating where, according to the teacher, the most useful information is located.

e) For free zone activities:

In this case,

- The teacher could suggest some thematic areas e.g. these videos are good for History, these for Physics and so on and each student (or groups of two) can decide what to see in order to answer the questions on their worksheet.
- The teacher suggests a number of topics and each group selects one according to their interests, that means that there is no common subject to be studied from all students. The students work on a topic they choose and they should find certain info and present it to the rest.

All of the above-mentioned ways of introducing streaming media in a class can be implemented by students working individually, but for some of them group-working is preferable. The optimum number of students working in front of a computer is 2 the reasoning for this is in section 6.8 “The Science Laboratory: Implementation of streaming media in school 1”. Working in small groups is, of course, most beneficial for the students for reasons that will be explained in section 5.16 “Teachers and students constructing their own media: What students gain”. Apart from that, if students work in parallel in different classes or different groups within the same class we often have a certain competitive spirit produced. If students are asked to make a presentation of what they found or to explain to their classmates the topic they choose, a competitive spirit will be easy to take hold. Students try hard to understand the subject and make the others to understand too. This way, students are given a stimulus to try to outperform the other groups.

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, we should stress here that such ICT activities are time consuming. If we consider science education we, again, face the well-known problem: teaching and learning science takes its time, but the time devoted to science is always limited. Therefore, even with these new tools and methods it may be difficult to persuade schoolteachers to use the new method. It might be more beneficial to the students (instead of the safe chalk and blackboard teaching approach) but if it is seen as more time consuming teachers will decide that it does not get the job done: the job in this case being the completion of curriculum requirements within the limited number of hours allocated. Such is the power of tradition: While it is well known that, there is no learning involved if the student does not really understand what the contents of the curriculum are, the chalk and blackboard approach achieves a much higher rate of delivery (of the contents). The student would then memorize what he did not quite understand, and as the exams are on a superficial level (testing memorizing), everyone appears satisfied with the exception of true educators. Breaking out of this vicious circle can only start with a deep understanding of the nature of it!

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.

In some existing video-documentaries, a much higher proportion of the contents can hold some higher educational value. Such films are called ***edutainment videos*** (the word simply meaning education and entertainment). In this case, the greater proportion of the video can be used educationally as opposed to just keeping a video-clip out of it. The editing should be done in a wise and well-judged manner aiming to increase educational content per minute of watching the film. A general caveat emptor should be made here, warning all educators and prospective users of long streamable media. How objective is the "information" offered by some of these video-films is a big issue. In reality, quite a few of these videos offer ready-made opinions, as opposed to information from which the listener will draw conclusions and form his own opinion. Some of these films are deliberately misleading, by giving only half the facts (biased information), or even plainly wrong facts. Their aim here is to form a consensus of public opinion, and this is the doing of the numerous "pressure groups" offering their dubious services to the powerful interests of the time. Of course, it is true that the primary function of the mass media (like TV) is to entertain and not to educate. While it can also be argued that one of its aims should be to "not misinform", unfortunately they often unwittingly do precisely that, as well as offer biased data, or just their opinion instead of data, as their audience is relaxing at that time. By, effectively, advertising their opinion to their audience, they "pass the idea" to the conforming public, just like any other advert. While all this is for the mass media within the accepted rules of the game, this is not exactly the function of education! It is perhaps for this reason that educators enjoy (often unwittingly) a higher credibility to the general public than advertisers do. Although the wisdom of such practice is sometimes dubious, one would only but hope that a professor (or a teacher) still holds a higher prestige (and his utterances hold a higher credibility) than a television presenter or an advertiser.

Educators and teachers in general should be very worry about the material they use (especially if it is longer than a 10-second clip. Points to be included in the evaluation for such videos are:

(a) The quality of information contained (if it exists) from a scientific point of view, and the absence of ready-made opinion.
(b) The educational approach inherent in the video film.

The total object of such evaluation is far-reaching and the process is complex (especially as it involves many other aspects to the ones outlined above). Consequently, some of the research-educators active today should perhaps re-evaluate their stance as to whether or not it is below their dignity to deal with such mundane matters as educationally evaluating already existing videos. A group of such research-educators, each one with his own speciality, should be able to do a much more through job than any individual would ever hope to do.

Videos (professionally) planed and produced specifically for educational or training purposes are of an even higher standard than documentary material described above. We are referring to a vast library of training and education videos and films produced since the 1950 in numerous countries. The production of his material was funded by various organizations and governments and the older (often extremely good) material has been digitised already, and is available in various forms but not necessarily over the internet.

5.6 Searching for the elusive media: they exist but how can one get them?

(This represents category ***I.iii*** in our classification of section 5.3). In the present section we deal with media that can be used educationally as they stand, and be used for their full length as they were intended, paused for explanations, be repeated in parts etc. The subject of media that can be "recycled" and reused (in parts) comes under category ***II.iv*** of the classification, and is discussed later in this chapter.

Educational streaming media (especially full-length streams) are few and (unfortunately) most of them do not exist in minority languages (e.g. any language other than English and to a lesser extent German or French). The reason to this should be searched is the cost (in both time and money) necessary to complete the difficult task. Local authorities that normally finance such efforts consider a translation to other languages as a waste of money and time, although by doing so they enlarge the target market for the medium. This attitude should change, especially as now we are part of European Union, even if it means to just add subtitles (i.e. captions) under the image.

We should mention here that if we speak about a non-scientific video e.g. a video about a monument, a certain town, or country, the translation task is fairly easy, because this type of media do not make use of scientific ant technical terminology.

Scientific videos are a completely different subject. Every word carries a certain meaning; therefore, terminology is an important factor. It was revealed during this project that translating a scientific text is a task that cannot be fulfilled by just an ordinary professional translator. This is even worse if the translation is from e.g. German to English and from English to Greek. The translation of scientific text should be done by someone with good command of both languages, but also with excellent knowledge of the subject. In fact, we had to turn for help to people (university teaching staff) which had obtained a degree in the other country.

Another problem faced was related to copyright issues. It is obvious that these solutions require secure mechanisms for the management of authors' rights, and this issue should not be forgotten.

5.7 Consulting an online library (of learning resources)

(This represents category ***I.iv*** in our classification of section 5.3)

As more and more of educational material will become available in the future, the problem will shift to ***finding an appropriate educational medium*** or to ***detecting a part of the movie that may be of some educational use*** and making a (short) clip out of it, discarding the rest. It is expected that (normally) only a very short sequence of such video-films will be suitable to be useful educationally. This searching, evaluating, and discarding process, has to be done in a systematic way, and is (unfortunately) a laborious and time-consuming process. If such clips are properly described, (as in an abstract of the content of the clip – the MPEG7 standard if applied is meant to solve those problems in the future), and if they become available in increasing numbers, these will (presumably) become part of wide variety of video libraries (either real or virtual, localised or distributed). (Some additional reasons for the creation of educational databases are given in Chapter 8). Students (or teachers) can then be expected to search the index of such a library and /or the abstracts of the clip itself to find something suitable for their purpose. What cannot be expected from the individual teacher to undertake is the searching (by viewing) into long archives with the hope of finding something for the next day's lesson. This is impractical as it takes too much of his time. His main job is to plan the lesson and to concatenate some video clips already prepared and made available. During actual school time, either he could access the streaming media library for a demonstration in his class, or he could help his students "discover" appropriate clips. It is possible that, in the future, media searching could become automated "google-style" using search engines. Before this concept materialises though, video description standards should be followed on a wide scale, so that searching can be achieved instantly; it should be understood that the job of labelling appropriately the videos could conceivably be automated through some type of pattern recognition.

The educational advantage here is in the process of searching the online libraries to find what one wants, (while at the same time to be careful to be critical and evaluate the information contained). It is implied here that it is of great advantage to students to learn the process of searching to find what they need. This skill the students gain, by experimenting this way, is thought to be of high value, as from now on it is thought that people will need to re-educate themselves so as to be able to radically change what they will do for a living, two or more times in their lives.

5.8 Capturing an educational event and producing a streaming medium

(This represents category ***II.i*** in our classification of section 5.3)

Events or lectures can be captured and broadcasted on the internet and/or they can be stored in an online archive where they can be viewed later on-demand. A sense of direct involvement and “physical presence” is built in the class. Furthermore, “virtual” guest lectures from outside experts are made possible regardless of time and geographical constraints. A recording can be used in more interactive ways by, for example, assigning tasks to the students that refer to certain fragments of it.

Normally such videos could have limited educational value. 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. Hearing (i.e. listening carefully) this lecture on the radio would have much the same educational effect, since very little information is on the visual part. For some people reading the same contents from a book, be that an electronic or a printed one, might be preferable. As they can stop and search for an unknown word, or re-read a section that it was not clear enough. In this case, the quality of the video image 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, in certain cases the image might even be distracting (jewellery, clothing, gestures etc.)

5.9 Capturing an external real-life event and producing a streaming medium

(This represents category ***II.ii*** in our classification of section 5.3)

In this situation, streamed materials provide access and depth to real-life events that happen, by their very nature, outside the classroom. The purpose of this application is to be able to view an outdoor action that cannot be physically brought into the classroom: political recordings, sports events, wildlife, linguistic samples, a fashion show, or a dramatic performance. When these real life events are brought into the context of the formal classroom, they can be observed, analysed, interpreted, and discussed. Live recordings of outdoor scenes also belong to this category.

Only videos dealing with an event that happens outside and cannot be brought in a class (flowers blooming, wild animals, star movement etc) can be considered of great educational value. Such videos normally cannot be created by the teacher or the students, these are videos created by experts and used in the classroom.

Any other videos (e.g. recordings of political events, sports events, a fashion show, or a dramatic performance) have very limited educational value. Though this approach serves very well as an object to exercise and perfect the ICT-video capturing and editing proficiency of the students who take the video, the real educational value is limited to just that. Some care should be taken so as to ask permission for the event to be recorded and used educationally (it should be easy to arrange). 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 as it stands in the first place..

5.10 Capturing short clips (produced for the purpose of being recorded)

(This represents category ***II.iii*** in our classification of section 5.3)

This short clip is just an illustration. It is a simpler undertaking to capture a few-second clip than to capture a lengthy event or an experiment, simply because a clip lasts shorter time (i.e. in length). Less planning is needed too. Otherwise, all the notes in section 5.11 (for longer streams) apply here too.

5.11 Making short clips by editing longer videos

(This represents category ***II.iv*** in our classification of section 5.3)

This is a process by which we "separate the wheat from the hay", increasing the ***educational density*** of the finished product. By the term educational density, we understand the "amount of educationally effective information over the time taken to watch the stream". For example if the student has to watch a 15-minute stream simply to gain the information contained in a 15-30 second clip, density is low. If we edit the original to create that 15-30 second clip, this is a vast improvement. A new product is really created here, by discarding useless material. It should be seen that more often than not, only a small extract of the film will be used educationally at any given time (e.g. a 5 - 10 second clip out of a hour's video production). This worthwhile job can be achieved in either of two ways:

The first method involves getting ***hold of the original film in digital form*** and using a real ***editor*** (i.e. a specialised video-editing software package). A collection of already existing video materials (often in digital form) could be made available to all the various educational institutions, as they may not be of much use to the owner any more. The educational use of these media could be very different to the one envisaged originally. That is to say that they could also find some additional use in lessons (or in courses), that were not in the original scope of the media production. For example, a geography video about Africa could also include video images of elephants, which can be used in a zoology lesson.

Such (high quality) video material could be (for example) the one already produced and made available by the various European national broadcasters or other news organizations (e.g. the "national geographic" springs easily to mind, as well as other similar European organisations). All this material is video-recorded using experienced professionals who use professional quality recording equipment (and it is therefore of high technical standard). The subject they deal may include documentaries or simply the news. Such material can is made available so that it can be re-used in education.

The second method bypasses the question of video film donation, and it performs a "video film scavenging" by using a ***virtual editor*** or a ***virtual cutter***. Here is how it works: the original video stream still resides in the streaming server, somewhere (and we assume that it stays there). Using the virtual cutter one can select a clip from within that stream and record the beginning and the end of the virtual clip. His new "clip" is simply a product of computer instructions, instructing the opening of the particular stream, the move to the new "virtual starting point" at some place inside the stream, start playing, and at some new point later on to stop playing the stream. A virtual editor can do all that, but it can also concatenate (i.e. join) two clips, originating from either the same or even from different streams. Various other video effects are also possible using such software. It is obvious that if for any reason the original stream becomes unavailable, or if it is moved to a different address, the final product of ours ceases to function.

5.12 Producing long educational streams

(This represents category ***II.v*** in our classification of section 5.3)

These videos are purely instructional, i.e. they demonstrate the process of something concrete, the procedures, and the different stages. Examples include language learning materials, laboratory experiments where there is a potential safety risk or role-playing situations where the students can experiment with different roles and behaviours. The purpose of these materials is to make complex processes understandable and/or to motivate students. A lesson in history or in art could also be produced by going around and taking a video of a historical site or a monument. In the accompanying audio track one can explain the important points to notice, as if the teacher was showing these to the students.

The difference between these examples and the category "capturing and streaming an external real life event" (for example) is that here the material filmed is created especially for educational purposes whereas in the other category the video materials witness events that would have happened anyway. What they both have in common to each other is that they are used in the same way as traditional video has been used for many years in education. More innovatively, these videos can be integrated in a large web site with other sources of information such as texts, animation, discussions so creating a virtual workshop.

Students and teachers can create their own media. What the video contains is very important, as it defines the level of difficulty of taking (and editing) the video sequences. Indeed, for some type of videos there is even a need for careful preparation and for a second person helping along. Antonopoulos S. G. et al. (2005)[89], categorised video content in four major categories (**A** to **D**), which will be explained shortly. Only the first three of these (A, B, and C) belong to what we deal with in the present section.

A) Scientific experiments performed ***with the aid of a computer*** using sensors or actuators (respectively to sense the data or to act accordingly). These **MBL** (i.e. Microprocessor Based Laboratory) experiments 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

B) Scientific videos: containing, for example, physics experiments, or giving instructions on constructing a device requiring a certain level of technological skill. This category has also 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.

Both the aforementioned general 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.

[89] Antonopoulos S. G., Garyfallidou D. M., Ioannidis G. S, Sianoudis J. A., Sotiropoulos D. J., Tsiokanos A. C., Innovative ways of combining teaching ICT with teaching science: video taking and editing by students and teachers, In *HSci2005 – 2nd International Conference Hands-on Science: Science in a changing Education*, (2005), ISBN 960-88712-1-2, pp. 63-69.

- 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 (speaking for Greece there are plenty of such places e.g. Acropolis, Olympia, Delphi) a certain town and its history, the inspiring biography of a great scientist, engineer, artist, poet, or author.

This should be considered of containing a medium-level educational value. The quality of the video is an important factor to the success, in this case. This category requires a very different approach that presents its own didactical challenges. It resembles categories A and B described above but it is less challenging as do not perform an experiment. We have a moving camera, and we record places with it while at the same time we say stories concerning what we present. TV edutainment can teach us a lot about the production of such streams.

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: This case has already been discussed in section 5.8: Capturing an educational event and producing a streaming medium

b) A real time event such as a song competition, a sport event, students presenting something etc. This case has already been discussed in section 5.9: Capturing an external real-life event and producing a streaming medium

c) A school event such an excursion of a ceremony etc. This case has already been discussed in section 5.8: Capturing an educational event and producing a streaming medium

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.

All such activities require the cooperation of teachers of different “specialisations” 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”).

5.13 Adding in the “virtual library” of freeware videos: teachers and students sharing their own resources

(This represents category ***II.vi*** in our classification of section 5.3)

After one has produced his stream, he would obviously use it himself for educational purposes. Just one-step after that would be to make it available for other teachers or students to use: in other words to make it available as freeware. In order to increase the number of potential users, he could even consider either transliterating it or to just add subtitles containing a (careful) translation. He may even find partners willing to help him in this difficult task.

By giving away his own product (all in the best interest of education), the creator is inviting similar donations to be directed to him. By joining this freeware or the shareware "movement" he joins a group, all the members of which will benefit from each others' work.

5.14 Creating your own media: technical issues

Digital video cameras and digital cameras (offering the possibility of limited video capturing) are nowadays inexpensive and common enough (even mobile phones have such capabilities nowadays). Modern computers can be used for video editing and video editing programs became cheap and easy to use[90]. Therefore, even amateurs, such teachers and students, can create their own media.

Most modern video cameras can produce reasonable imaging using special features such as night shot capabilities; poor lighting will adversely affect the final (compressed) medium. Contrast, colour saturation and outlines as well as low video noise and good lighting will produce a better quality final product. The camera should offer a high resolution. We can categorise the cameras available today as follows[91]:

	Video noise	**Image Quality**
Digital Betacam	minimal	optimum
Betacam SP, Betacam SX, IMX, DVCPro	minimal	very good
DV, DVCam, mini DV	very little	good
DVD	very little	good
SVHS, Hi-8	visible	average
VHS	clear	below average

The above classification is important as a broad starting point in classifying cameras. The first observation is that not all of these are digital formats (but they are still used, and the analogue professional formats are preferable to some newer amateur digital ones). It should also be noted that most of these commercial formats compress the image (some more so than others) in real time before recording it, simply because the recording medium is not fast enough to achieve an uncompressed image. This image has to be uncompressed before editing takes place; this whole procedure is responsible for some image quality degradation and, if possible, one should try to avoid the formats with large loosy compression schemes.

Important though it is, the previous classification is only based on the recording format used and misses-out on the two most important parameters defining camera image quality. These are: (a) the quality of the lens system and (b) the quality of the recording electronics responsible for converting the light captured by it into electronic signals. Modern computer-

[90] Antonopoulos S. G., Garyfallidou D. M., Ioannidis G. S, Sianoudis J. A., Sotiropoulos D. J., Tsiokanos A. C., Innovative ways of combining teaching ICT with teaching science: video taking and editing by students and teachers, In *HSci2005 – 2nd International Conference Hands-on Science: Science in a changing Education*, (2005), ISBN 960-88712-1-2, pp. 63-69.

[91] Kunkel T., *Streaming media: Technologies Standards Applications*, Wiley, ISBN 0-470-84724-7, p. 34

aided design and robotised numerically controlled lathes notwithstanding, a good quality lens is never cheap to produce. Therefore, the cheaper end of video-cameras cannot possibly have such a lens: it may be zooming a lot and all the so-called "specifications" publicised by marketing may appear impressive, but the final image quality will be inferior (at least in parts). In addition, the type of CCD (Charged Coupled Device) which produces the digital image in most modern cameras has great variations between them. In high quality cameras three separate CCDs are used (one for each of the primary colours), resulting in much finer image, as well as a more versatile camera. Most cameras offer reasonable quality, but for consistently good quality images, the cameras belonging to the more expensive range are irreplaceable.

The transmission of the video signals from the camera to the PC (either real-time or after it has been recorded through one of the formats in the table, above) could be done through different interfaces. Although these are of secondary importance in relation to the two major factors described above, there are also significant differences in the video-quality these interfaces are capable of transmitting. Some knowledge of such differences is considered useful, especially when modern digital links are concerned. For amateurs such as teachers and students, a minimum connection speed to the PC should be considered the one provided from a firewire link (a.k.a. IEEE 1394 and now 1394b). When the hard disk of the computer is used to store the video taken, a link at such a speed will allow a much higher resolution video to be stored in the PC than the one possible using an ordinary USB and now USB2 connection[92]. Firewire interfaces need less computer resources than the USB range needs, and everyday practice has proved that they are more suitable for video transfers, even when older versions of the 1394 standard are used. Recording the video at the highest possible resolution is the safest route to take, as the resolution can always be dropped (if it so desired) at the final stages (i.e. editing and compression) of video production, but the only way to add further details, would have been to re-shoot the whole video.

When recording, the camera should be kept very steady. Any movement will cause "noise" to the medium. A heavy and steady "professional tripod" is recommended for this purpose. A "pan and tilt" head on the tripod is essential to achieve smooth camera movements. Especially in case of real time broadcasts, unnecessary camera movements not only result is an unstable image, they also waste all available bandwidth. (This is the result of the intricacies of video-compression, and is explained in some detail in second chapter). Speaking about a live event, panning during video-shooting is necessary, though zooming-in and zooming-out of the main subject of interest will also increase the content (i.e. the information) of the video. Simply pausing for a few seconds at the end of a panning shot, will create a better quality medium.

The sooner we can decide on the way the medium will be streamed, how it will be embedded in the streaming server (or the learning platform), and how will this new medium be (educationally) integrated with other elements, the better it is. By taking such decisions early, one can direct the capturing to suit his ream needs more effectively. Another important concern in streaming service operation is, also, the (quite involved) copyrights issue, which should not be forgotten. Would one share his resources with others? If so, one could also adjust the capturing process to become more suitable for such requirements.

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92 Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: "Interactive Computer Aided Learning"*, Kassel University Press (2004) ISBN 3-89958-089-376

The shooting stage follows[93]. After all the raw video and audio material have been collected, it can be transferred to a workstation or a PC where they will be edited. Video editing programs are easy to handle, and allow the creation of special effects that can transform the video to a magnificent educational tool.

Streaming audio or video files can also be created from existing digital files, or by digitalising of the previously existing analogue audio and video recordings[94]. The next step is to compress the streaming medium to a size suitable for transmission over the network or a LAN. During compression, redundant or unnecessary data are thrown away. This makes the file size much smaller, but it also somehow degrades the image and sound. The smaller files produced require less hard disk space, less memory to run, and less bandwidth to play over networks such as the Internet.

Nowadays, many tools for compression are available and they are easy to use and require no in-depth knowledge of the complexities of compression technology[95]. Before the compression, the producer should also take into consideration the type of internet connection, the target audience the medium is more likely to have. This will affect the type of streaming technology or application he will use. During the compression, the media are directly transferred to one or more streaming format of choice (like MPEG-4, RealMedia, Windows Media, QuickTime, or Nullsoft NSV etc.).

After compression, the media should be stored, managed, and delivered to its target audience[96]. The user will need a streaming client at his desktop to decompress and execute (i.e. play) the medium. Many important software manufacturers provide free "media players". Almost all modern desktop computers fulfil the minimum hardware requirements for playing streaming media.

The quality of the media experience at the user side also depends on the network connection[97]. Although an old fashioned 56 Kbps modem could be considered as offering the minimum requirement for streaming (in principle), as real transfer-rates can vary depending on the time of day and level of traffic on the Internet, such a modem connection is not really of much practical use. An ISDN line is more stable, and such a connection should be considered as just adequate. A broadband (i.e. high-speed) xDSL Internet connection (of 1024 bps and above) is considered optimal.

We should mention here that it is much easier to transfer audio, and with good quality too. Therefore, in certain cases e.g. music events, dramatic performances, or lectures a higher proportion of the available bandwidth could be allocated to audio without much loss in the perceivable image quality.

Finally, firewalls might block or (adversely) affect the quality of streaming media[98]. Therefore, special care should be paid when such software is set up on the computer.

5.15 Teacher and students constructing their own resources: problems expected to be encountered

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. Various e-stream partners tried making their own

[93] Angelopoulos B.G, Garyfallidou D.M, Ioannidis G.S, Streaming media in education, In: Auer M. and Auer U. (Eds.) *Proc International Conference ICL 2004: "Interactive Computer Aided Learning"*, Kassel University Press (2004) ISBN 3-89958-089-3

[94] Ibid.

[95] Ibid.

[96] Ibid.

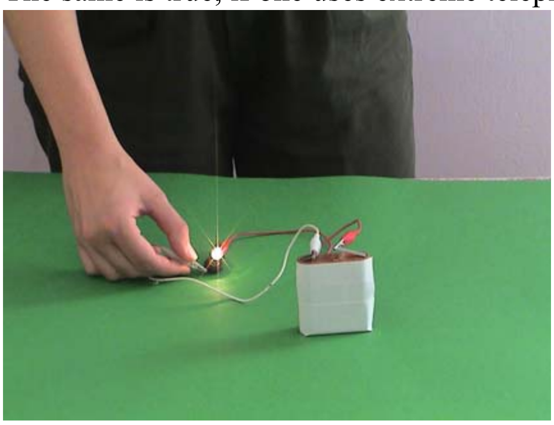
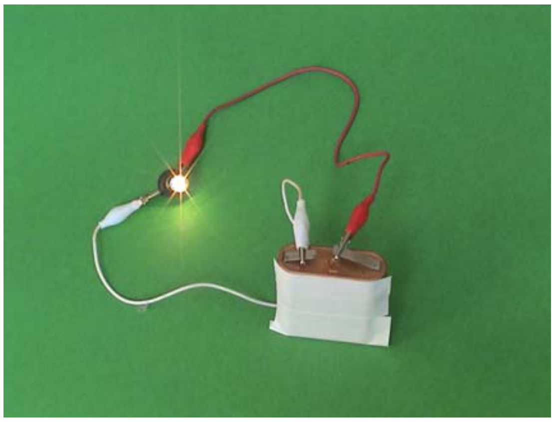
[97] Ibid.

[98] Ibid.

videos. Some members of the collaboration experienced certain difficulties (see also chapter 6 for some of the reasons given). Some partners used ICT teachers to supervise the procedure while some others gave special ICT – Video editing classes to the participating teachers. As ordinary teachers are much less experienced, they are advised to pay special attention to the following aspects.

1. The size of the object or the scene to be video-recorded will affect substantially the level of difficulty to be encountered – the smaller the size the greater the difficulty.
If the object of the video is to film an archaeological site, a school trip, a building, or a town, video taking tends to be much simpler. In case one wants to make a clip to be used for science teaching though, the objects we want to show are normally a lot smaller, often much less than half a meter in length. One needs to fill the frame (to show the detail) for most of the time during the film. To do that, one has either to move closer to the subject or, in case the camera has zoom lens, zoom into the subject. In both occasions the depth of field suffers, and especially so if the lighting is poor. (See point 2, below).

2. The lighting available. This is connected with the first factor, above.
For outdoor activities, sun light is normally enough. On the other hand for videoing science experiments where the objects we want to show are normally very small (e.g. bulbs batteries, experimental tubes etc), additional lighting should used. This presents its own set of problems like the positioning of the light sources, the avoidance of shadows, and the partial differential illumination of the subject to show its depth and texture. An experience photographer knows the difficult that becomes very much greater as the size of the object decreases. Video filming also presents camera stability problems. These do not only result in fuzzy or blurred pictures, it also increases the size of the video file (due to technical reasons having to do with the encoding (see chapter 1), which in turn quite possibly introduces continuity problems when this video is streamed. When filming small objects the requirements for stable camera increase and due to the proximity of the objects shake-problems become much more apparent. The same is true, if one uses extreme telephoto shots.

Observe the two pictures above. In the picture on the left side we can hardly see the poles of the battery, while unnecessary info (e.g. the trousers of the performer) are included, something potentially distracting. Notice that to avoid unnecessary distraction the cover of the battery (bearing the name of the manufacturer) has already been blanked-off. In the right hand side picture, the poles are clearly visible. Both pictures were taken under the same lighting conditions (day light). If the whole performer was visible in the frame, we would hardly have been able to see the small light bulb.

3. The time scale of the scene (i.e. if what we want to show has very short duration or not). It is obviously a lot more difficult to show a collision (e.g. a hammer hitting a

nail) than to depict an almost stationary object. For very slow changes (e.g. growth of a plant), time photography is needed.

4. The speed of the object to be video – recorded. A science or technical video film might want to show an effect which happens quite fast. In such case, the video image might not be recording fast enough; alternatively if the compression is not performed using a sufficiently powerful algorithm (see chapter 2), the important object of the film will be fuzzily recorded or will physically not show at all. When one needs to show a rapidly moving object, one is in a similar predicament. If he uses a still camera shot, (i.e. the camera does not move) then the object seem to be moving so fast that we face the same problems as above (fast event). If alternatively, he chooses to follow the object by panning the camera, he will be facing image stability problem, as this requires experience to achieve.

5. The previous experience already acquired by the people taking the video: it is quite obvious that inexperience students when unsupervised will face lots of difficulties in comparison to experience technicians or teachers. The same applies for inexperienced or un-trained teachers.

6. The ultimate factor is the final quality of video one is aiming at. For a better quality video, the standards should be kept really high. For something to show to friends and colleagues, almost anything will be good enough.

In general, there are easy subjects and difficult subjects to video-film. For the difficult ones (which, unfortunately, are the most powerful didactically) the problems are compounding, and they are therefore best to be left to the experts.

Students seem to do quite well when video filming ordinary scenes. As these are often of emotional value to the students themselves or they are taking in order to be shown of students of other schools in far away places, these videos do fulfil their role. This role is to be understood as increasing the interest of the students in the school activity and creating a social sense of belonging, when they are addressing other schoolchildren far away. For tasks that are more difficult, special equipment and especially experienced cinematographers are called for. Nevertheless, we could ask students to create a scientific video, if the aim is the better and in depth understanding of the students and not the quality of the video.

Students and teachers when creating their own media should pay special attention to the following issues:

1. In case we film a scientific experiment, the materials and scientific equipment to be used should be collected and tested beforehand. This step is considered crucial. Multiple sets of the materials/equipment that will be used are absolutely essential (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. A second camera is recommended for redundancy reasons, especially if the aim of the video is an outdoor activity that could not be repeated e.g. a special ceremony, a fashion show, a sport event etc. Multiple sets of tapes or other storage devices and lights (if required) are also recommended.
3. For scientific experiments special care should be paid to small details such as the background, 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, and in addition to that, there may be "parallax" problems associated with close distances. Connecting the camera to a nearby PC is the best option to avoid this, especially if we are dealing with smaller objects such as in scientific experiments. If we do not do so, things irrelevant to the experiment might appear in the video and distract the child's attention. A video editing program can be used to crop such "noise", but this increases the time and the effort devoted to the editing phase. This direct-to-PC solution could be avoided for outdoor shooting due to various reasons: mostly because the size of the subject is normally much larger, the distance greater, and the background is not that distracting. Practical mobility and safety considerations (i.e. having to move around carrying an operating laptop connected to the camera) are additional reasons.
5. The camera should be kept very steady, as already mentioned in the section 4.9 "creating your own media technical issues". A heavy and steady professional tripod" is recommended for this purpose.
6. The camera is best to be operated via remote control, in order to avoid any small movements and vibrations during the time of video capture (even if we handle the camera with care). This also allows the same person to be both the performer and the "shooter".
7. If the performer and the "shooter" are different persons and the video shooting is an indoor activity, such as a scientific experiment, that is going to take place in a small confined space, a second screen will be needed to allow a full view of the frame captured to the performer.
8. As already mentioned, when shooting scientific experiments, professional lighting equipment is required. It might be proven that setting up the lighting (e.g. avoiding shadows etc.) is a time consuming activity.
9. The camera if possible (e.g. indoor activities) should be set to the mode that allows saving the video to the tape and simultaneously sending it to the PC. That achieves the simultaneous production of a PC file as well as a tape file (for redundancy).
10. The camera should have a high resolution and the connection to the PC should at least be going through a firewire interface. The resolution can be dropped at the final step (editing and compression) but the only way to add details, is to re-enact the experiment.
11. Setting up the lights, PCs, Tripods, Cameras, find the right shooting position etc. is a time consuming exercise, and even more so if the teachers and students are inexperienced.
12. Speaking of scientific videos, it is best not to attempt the videotaping as one continuous take (i.e. one continuous shot). The probability to get the narration recorded correctly while shooting is very low. This probability might increase 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, prefer multiple takes (shots). Video editing is needed afterwards, of course, for fixing the details.
13. For the video editing a modern computer is recommended. (The larger the available RAM and larger the free disk space available, the better. A second computer disk dedicated to the video is also recommended.)
14. When talking of non-scientific videos, the videotaping can be achieved on one take (i.e. one shot); anyway, a real life event such as a fashion show, a sport event,

or even a lecture etc could not be repeated for us. A second camera and external microphones may be very useful in this case.

15. If the subject videoed is composed of several steps, it is recommended to shoot it step-by-step, and gradually store each scene in a different file. This will help in the editing stage as we deal with smaller pieces; concatenation is easily performed in the end.
16. Moreover, when recording a scene that is performed especially for the purpose of video-taking, more time should be planed for. For scientific and technical videos both the video taking and video editing process can be very time consuming.

Decisions such as which video editing program will be used, which video resolutions will be eventually used when streaming etc are best to be considered as early as possible.

For videoing a real life event that is going to be uploaded in a streaming server, special licences might be required. If we aim to videoing a dramatic performance, a fashion show, a conference, a sport event, a music performance etc. we should contact the organisers well in advance and ask for such permission. This procedure might prove complicated if different "authorities" are involved (e.g. local authorities, media broadcasters that have the exclusive rights for the event, sponsors etc). When obtaining such a permit one might also discuss the possibility for placing extra microphones (if they are needed) closer to the performers.

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

5.16 Teachers and students constructing their own media: What students gain

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.

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. They learn to collaborate with other members of their group, help each other, and develop their social competence in working as a team. They also develop their communication skills, and they are bound to enhance their mutual and social skills (group interactivity). They should improve their own judgment as to what is important and what is not, while learning to elaborate arguments to justify their opinion. They learn by themselves and by taking into account the opinion of their friends and co-workers on their project. These are important characteristics of adult people to have. They also practice self-learning techniques. They learn to evaluate their own work and to make the best of the assets they have available.

Apart from that, constructing and sharing their own media offers a very strong motive to the students[99]. 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.

[99] Antonopoulos S. G., Garyfallidou D. M., Ioannidis G. S, Sianoudis J. A., Sotiropoulos D. J., Tsiokanos A. C., Innovative ways of combining teaching ICT with teaching science: video taking and editing by students and teachers, In *HSci2005 – 2nd International Conference Hands-on Science: Science in a changing Education*, (2005), ISBN 960-88712-1-2, pp. 63-69.

Another advantage of this approach is the following[100]: 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.

5.17 Designing, producing, compressing and distributing professional-grade streaming media

Before we even start planning to create a new educational video, it is very important to have a clear idea in our minds what is our educational goal. To do that, it is a good idea to collaborate with an active teacher, (if we are not active teachers ourselves).

The design of any modern educational streaming media[101] should be along the following steps:

1. The educational target should be specified. The curriculum that is going to be the subject of the medium should be defined clearly and specifically. The cost of the streaming medium, the time spent fir it to be developed, and the time that it will remain in use should be specified in this step.

Some additional questions should be answered during that step such as:

a) Is another similar medium already in use? If yes, is the new one really needed?
b) Will the medium that is planed be useful for teachers and students?
c) Is it suitable for which age group?
d) Will it be in use for a long time in the educational organisations it is meant for?
e) Is there a plan for the medium to be expanded in the future, e.g. to cover more languages?
f) Is it better to create a bigger medium to cover a bigger and more general topic or it is preferable to create smaller media for more specific topics? Or perhaps both? How many topics should be covered in one medium?
g) Will the medium be designed in order to be used from users with different backgrounds in computers?

2. At the second step, we must gather every piece of information connected to the subject. We must also decide if we will make a medium to cover only a certain chapter, or a wider area.

3. The third step demands the co-operation of the medium experts, the expert on the subject (e.g. scientist), the education specialist of the subject, and some ordinary school-teachers. The expert specialist will define what should be included in the medium. The education specialist will define the way the subject should be presented to the student. The teacher will tell if he is in need of the medium, if it is user friendly and easy to use, and if he can use it creatively.

Bad co-operation or lack of some of the experts will lead to:

[100] Antonopoulos S. G., Garyfallidou D. M., Ioannidis G. S, Sianoudis J. A., Sotiropoulos D. J., Tsiokanos A. C., Innovative ways of combining teaching ICT with teaching science: video taking and editing by students and teachers, In *HSci2005 – 2nd International Conference Hands-on Science: Science in a changing Education*, (2005), ISBN 960-88712-1-2, pp. 63-69.

[101] Ioannidis G. S. and Garyfallidou D. M., Education using information and communication technology (ICT), and ICT education: categories methods and trends. In: Auer M. and Auer U. (Eds.) *Proc. ICL2001 workshop: "Interactive Computer aided Learning, Experiences and visions"*, Kassel University Press, (2001), ISBN 3-933146-67-4

a) To a medium without real educational value.

b) To a medium which, from the point of view of content (e.g. science education), contains important mistakes in the way it presents the subject.

c) To a medium where various events are successively presented, but there is no possibility for the user to interact and experiment. The computer is used as if it were a video-cassette player.

If the medium together with the accompanying links is meant for home training, special care should be paid so that it would be interactive, as well as scientifically complete. This is because there is no guidance and no teacher to complete the knowledge. The medium should also be easy to handle, and attractive to the user.

4. Then the teaching scenario should be prepared and the equipment should be collected and tested. It is also important to decide how the medium will be streamed, how it will be embedded in the web site or in the learning platform and how will this new medium be integrated with other elements. Another important matter in the operation of streaming services is, also, the copyright issue, which should not be forgotten

5. The shooting stage follows. After the raw video and audio material has been collected, it can be transferred to a workstation or a PC where they will be edited. Video editing programs are easy to handle, and allow the creation of special effects that can transform the video to a magnificent educational tool.

6. <u>The full team of experts should evaluate the prototype as well as final product be that a single streaming video or a learning environment</u>. They should try to simulate an ordinary class condition and evaluate all aspects of the program. If this step is omitted it is probable that the software will be hampered by serious mistakes and would therefore be of no use to anyone.

7. Encoding follows. For more details about encoding see chapter 5.14 “Creating your own media: technical issues

8. In this step, <u>the educational evaluation takes place</u>. Specific school classes are chosen, which means an adhering to certain standard statistical procedures. One-half of the students are taught with the aid of the medium and the other half by the use of traditional methods. At the end of the trial, the results of the different teaching methods are compared, resulting in the evaluation of the medium as a didactic tool.

9. Taking into account the evaluation of the previous step, <u>the experts improve upon the medium</u>.

It is an excellent idea for the medium to be accompanied by a detailed report about the content, the prerequisite knowledge, but also with worksheets.

Streaming audio or video files can also be created from existing digital files, or by digitalising of the previously existing analogue audio and video recordings.

After compression, the media should be stored, managed, and delivered to its target audience. The user will need a streaming client at his desktop to decompress and perform the medium. Many important software manufacturers provide free “media players”. Almost all modern desktop computers fulfil the minimum hardware requirements for playing streaming media.

MPEG-4 is a widespread international standard for video compression, and it is asymmetric (i.e. much more computation is involved for compression than for decompression). Special algorithms within MPEG are used to identify redundancy in audio and video and remove it. When recording an image of a talking head, most likely the background around the person remains the same. That MPEG algorithm is designed to recognize this and (for every picture frame) to save only the parts of the video that change. In this way, file sizes could be reduced by as much as two orders of magnitude (depending on the parameters of the compression and the quality of the algorithm performing the compression).

5.18 Standards and multimedia formats today

Lack of standardisation had the result of many encoding video-formats[102]. These are the result of the rapid progress in the field, but due to their mutual incompatibility, they only lead the lay user to confusion, and impede the adoption of video playing (and streaming). Recent media-players (i.e. software) can reproduce a number of such formats which is the common way to face the problem, but software industry has not yet reached such a level of maturity that we can claim that one media player can play all (or nearly all) video formats. The result is that users are forced to download (and maintain) all major media players onto their hard disk. The type of the video encoding can be deduced by the name-extension. Some popular names are:

.mp4	MPEG) Level 4, MPEG-4 (for Motion Pictures Expert Group), is an international standard backed by ISO
.rm, .ram	RealNetworks is a company who was historically the first to produce and distribute media players, and owns these standards
.asf	The so-called “Advanced Streaming Format” is a format owned by MicroSoft. Various other video, audio, and slide shows formats are supported by the MediaPlayer, distributed by this software company
.mov	So-called “QuickTime Movie” is a standard owned by Apple but an appropriate version works under windows operating system

Other video formats include the likes of .avi (i.e. audio video interleaved), which is a bitmap format, and .dv which is just binary. These are mostly used as video-recording formats, before the video editing, and the video compression that normally follows. Vector-based animation files have their own range of different formats. This field is a still in rapid development.

[102] Poynton C., A technical introduction to digital video, Wiley,(1996), ISBN: 047112253X

6 Examples of implementing streaming media in education

Contributed by members of the e-stream (Minerva) consortium

Education Highway - Centre of Innovation for School and New Technology Ltd.
ATiT - Audiovisual Technologies, Informatics and Telecommunications
CSP s.c.a r.l. Innovazione nelle ICT
Mayo Education Centre
Science and Education Centre, Patras, Greece
Swedish TelePedagogic Knowledge Centre
The Science Laboratory, School of Education, University of Patras, Greece

In this chapter, several aspects of good educational practices in the use of streaming technologies are explained and briefly discussed. Some examples of good educational practice are also presented here. These are not the only possible ones, but are presented in order to provide educators with some examples that can be of use when planning such an activity. It is not even in any way implied that the examples presented here are necessarily the best ones, but they are examples that have been tried out (one by one), and it was observed that they work with satisfactory results.

6.1 ATiT teaching teaching-scenario

Application 5: Creating and sharing own media

This teaching teaching-scenario was evaluated with teachers and teacher trainers in Flanders and implemented in Sint Lutgardis School, Antwerpen a Secondary school in (Flanders):

Topic: Student project work around environmental issues

- St Lutgardis Antwerp (secondary school, 2nd grade)

All resources used by the teachers to support the element of media creation during their lessons are freely available and can be easily adapted and used in your school!

6.1.1 Description of application used within present teaching scenario

The use of streaming media in the classroom is no longer the reserve of computer experts. This is due to the availability of free media players, large resource banks and plenty of best-case examples of good pedagogical use; it has found its way into many classrooms.

One possible way of using video in the classroom could be the making of such videos by teachers and learners themselves. The present state and cost of the technology has put the power to create video programmes back in the hands of teachers and learners themselves. As a class activity, this is not only a very pleasant but also a very pedagogically sound exercise, whereby teachers and students work together, often in teams, to produce and publish videos with content that is relevant to them. Both teacher and students can be creators of new online teaching and learning media material that can in turn be shared with others. From a learning theory approach, this is an appropriate way to work with media content. Students learn by doing, produce their own materials, and share it often in a self-designed learning environment with other students, while constructing their own understanding, not only of the subject content but also becoming more media literate in the process.

This type of application focuses on *Constructing and Sharing Own Resources*, appeals to the enthusiasm of teachers and learners, but it requires careful preparation. In the support documents linked to this implementation the following steps have been identified:

- Step 1: Look for inspiring examples from colleagues or from other schools, examples and ideas whereby both in a subject-related as well as in a cross-curricular context, teachers and/or students are creating their own streaming videos.
- Step 2: Formulate your own ideas and your objectives clearly: consider all the important aspects in the preparation of the contents.
- Step 3: Verify whether you have the right infrastructure and resources. Use a checklist to find out beforehand whether your school has the right hardware, software, recording materials and support at its disposal.
- Step 4: Check all remaining organisational aspects about availability of expertise and support.
- Step 5: Perform the activity with your class: create and publish your own materials. Create your own lesson plan to coordinate the planning, creation, publication and evaluation of the videos by the students.
-

6.1.2 Underlying pedagogical principles

Creating and using media materials in the classroom appeals to three closely related learning theories: constructivist learning, collaborative learning and experiential learning.

- Constructivism: in complex project based learning situations such as this, students have to combine skills learning with gaining of insight into specific subject matter. Knowledge is constructed by the learner based on mental and practical creative activity. Learners are forced to be active participants seeking not only meaning but also technical and creative solutions. The constructivist theory claims that reality is constructed by the learner based upon mental activity. Humans are perceivers and interpreters who construct their own reality through engaging in those mental activities. Furthermore, the learner is building an internal representation of knowledge, a personal interpretation of experience. This activity involves a combination of both processes: data and information are converted into knowledge in the learning and in addition to that, the learner will appropriate the content and reconstruct it in a new representation that is meaningful to his co-learners. The action based learning process is constantly open to change, its structure and linkages forming the foundation to which other knowledge structures are appended. Learning in this way has become an active process in which meaning is developed based on experience.
- Collaborative learning is used not just as a classroom technique. It suggests, particularly in this type of project work where learners (as well as support people and teachers) work together in groups, a way of dealing with people, which respects and highlights individual group members' abilities and contributions. The result is shared authority and acceptance of responsibility among group members for the group's actions. The underlying premise of collaborative learning is based upon consensus building through cooperation by group members, in contrast to competition in which individuals try to do better than other group members. As an additional effect, a wider community that is reached via the intranet of the school or via the web, can use the same materials, and a collaborative community is born in which the tutor acts as a guide and the students interact with each other and with the available learning objects.
- Experiential learning encompasses learning focused on how to master skills, which can only be acquired by doing. Movie making with all its apparent complications can effectively be learnt better in a process of actively engaging students in the practical experience itself,

aiming at a real tangible outcome. During the process students discover and experiment with knowledge themselves instead of hearing or reading about the experiences of others. By encouraging the students to reflect also on their experiences, they can develop new skills, new attitudes, and new theories or ways of thinking.

6.1.3 Project based teamwork

To give all learners the possibility to have an active role in the project, we suggest forming small groups. We recommend an ideal group size of four learners. This number allows a healthy group dynamic. Distribution of the different skills and competences more or less equally over the different groups is also recommended to avoid concentration of a single skill in one or the other groups. The different skills that are usually required in this type of teamwork include a certain amount of management ability, creative skills, writing skills, technical skills and ICT skills.

The same skills should ideally apply for the tutor or teacher team that is providing guidance to the project, but to a more advanced degree. Indeed, the teacher and tutor need to be able to help the learners to create a concept for a video, write a synopsis and ideally a teaching scenario or script, to manage the recording (assisting in making the arrangements), help with the capturing of the video into digital formats, edit the video and add a soundtrack and credits to it, and then finally publish it on a media server (in a local network or on the internet).

6.1.4 Description of teaching scenario (implementing and performing the activities)

It is not realistic to expect that such project work can be completed within a single day. This type of project-based work ideally combines different lesson subjects and can therefore be spread out over time. In the implementation at the Antwerp school, the project involved English language, ICT and Science lessons as well as free student work time. The teachers involved were the English language, Science and ICT teachers, and an additional voluntary ICT support teacher. The overall duration of the project implementation took about 2 months during which in total 16 face-to-face hours were spent on the project, of which 8 took place during normal class hours, the rest of the time was extracurricular and took place in the schools Open Learning Centre.

The lead teacher of the project received supporting documentation from ATiT in September 2004. This teacher then initiated the idea to implement this project with her colleagues and a class of students from the 5th Year. Because the project was focused on pollution, and intended to share resources with schools in Central and Eastern Europe, it involved the science teacher for subject matter expertise, and the English teacher for journalistic and linguistic matters.

The class of 11 learners was divided in 3 groups; each group from then on worked quite independently and could plan its own progress. The teaching team provided at regular points in the schedule an appropriate introduction in the knowledge or skill that would be required at certain stages (for example: at the time of the recording, a brief introduction in camera technique was provided, enough to start the exploration process for the learners). The learners created their own teaching scenario, organised with the help of the teaching team the recordings, received the necessary support to view, capture, and edit the movies and in the final publishing of the movies. The students did not lack ambition in their first acquaintance with media: they interviewed for example a European Parliament Member, they made on location recordings, they created an alternative language version to also make the movies accessible to their peers in schools in Central and Eastern Europe.

6.1.5 Conclusions

Despite the relative complexity of the task, it was very positively viewed by the teachers and pupils alike. Not only did they find the subject area interesting, but also the entire process of conceiving, producing, and publishing media material was considered very worthwhile and plans are in hand to increase and expand efforts in this type of collaborative work in the future.

6.2 CSP teaching scenario

Application 5: Constructing and sharing own resources

The present teaching scenario has been implemented with 2 different schools in Italy:

- IIS Olivetti (secondary technical school)
- Istituto Regina Margherita (secondary teachers' training school)

6.2.1 Description of application used within present teaching scenario

- **IIS Olivetti**

The school used Adobe Premiere (old version) software, a nonlinear video editing application for real-time video and audio editing, and tried to obtain the best possible product. During shooting, as students were not trained enough, teachers had to repeat the same scene in order to adjust timing. There has been also an audio problem: because of a non-suitable room, students had to record at night, when there was silence.

The following technology has been used in the teaching scenario experimentation:

1. Audio-visual equipment:
   - Digital Video Camera Sony
   - Microphones Sennheiser
   - DVD and Cassette
   - Lights
2. Students' computers: ordinary up to date computer system.
3. Streaming server and software: Ordinary streaming server

   Software of Video Server is Video Weber v.2.4 Zen Technologies Co., Ltd
4. Editing software: Adobe Premiere
5. Network connection: ordinary modern connections
6. Streaming clients (on the users side)
   - Plug-in for Internet Explorer 5.x and Netscape 6.x or more
   - Windows Media Player

- **Istituto Regina Margherita**

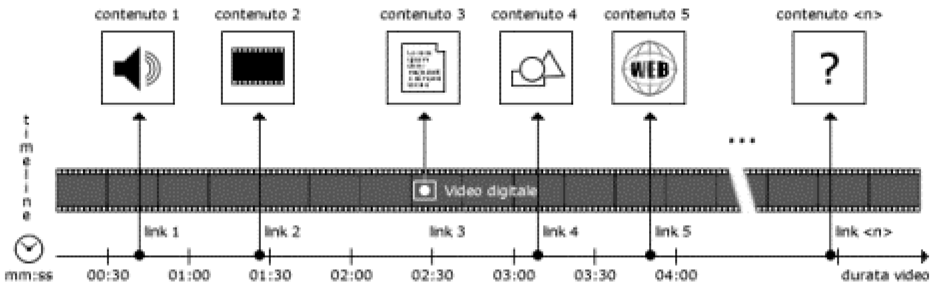
HyperFilm software allows enriching and distributing digital video with synchronized links to many different contents (web pages, text, sound, other videos...). The connections, in the two forms of time-based links and frame-based hot-spots, are synchronized to the main video, appearing at the right moment to extend the main's video narration, and allowing the user to freely decide how and when to view the additional contents.

The main advantage here is that with a minimal effort a video clip can be transformed to a complex educational multimedia file. The main advantage here is that with a minimal effort a video clip can be transformed to a complex educational multimedia file. This finally fully interactive environment, represents a new way of creating digital learning environments and it will become a model for the future information channels.

1) The first screen of a hyperfilm document: at the left side the video, at the right side the general information.

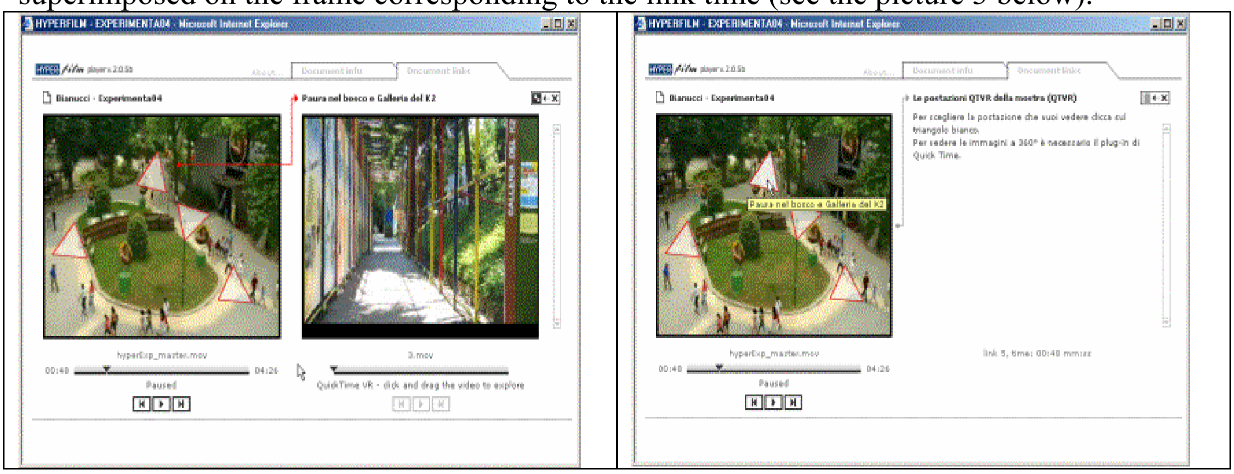
The player is multiplatform (for all Operating Systems for PC Intel/compatible, and for Apple Macintosh up from the MacOS 8 version) and requires only Macromedia Shockwave and Apple QuickTime as system resource. It is possible to publish a hyperfilm document on a web page (the digital video will be streamed), or to implement auto-running multimedia documents to be distributed on CD-ROM.

Hyperfilm concept: The Hyperfilm's main idea (its whole point of existence) is based on a very easy concept: starting from the temporal line of a video, the author can choose specific times that will be the anchors for the hypermedia link, as the following scheme shows.



On the left side the video is controlled by a standard VCR-like control panel; during playing the table on the right-side (links table) is populated. When the right time comes, the link appears and this event is highlighted by an animated label springing from the video and moving to the table. When the label reaches the table, it becomes an interactive element.

There are two different types of links, both synchronized in some way: one is a simple "*Synchronized link*" that becomes an item of a table on the right side of the video. The other is similar, but its content is activated by clicking on some geometrical shapes (i.e. hot spots) superimposed on the frame corresponding to the link time (see the picture 3 below).



In this case the hot spots are the “anchors” for the hypermedia links and the link type is called "Interactive frame". In both cases, for the end user, a click is enough to open it, and see the related content. It’s always the user that decides whether to see the content of a link or not. If the link is open, the relation between the link and its video time (and the associated frame) is immediately re-established. Of course, when the exploration of an enriched content is over, the user can choose Whether he/she will return to the video and continue from where he/she has stopped it in order to see the link, or from another point.

Authoring tool: Hyperfilm Authoring Tool is the software used to create, edit and publish hyperfilm files. Its features are directed exclusively to defining and managing the synchronized links related to the video timeline. The video itself, and the linked contents, cannot be in any case modified from inside the Hyperfilm environment. The workflow is very simple:

1) Start with selecting a digital video in Apple QuickTime format (both online or offline modes supported);

2) Fill in the general information about the new hyperfilm document (title, author name, video copyright...);

3) Play the video;

4) Stop the video when a point that a link should be placed and use the "New link" button;

5) Select the link type, "Synchronized link" or "Interactive frame";

6) Define all the link properties (link title, link description, linked content, spatial and visual hot spot properties...), using the dedicated tool;

7) Confirm the link creation.

When all links are created, the hyperfilm document is ready.

8) Use the Publish command and the hyperfilm is ready for distribution on a CD-ROM or on the Web.

The Hyperfilm software was positively received by the teachers and pupils, Because it gives them the opportunity to create educational hyperfilms in accordance to their need. The whole procedure was time consuming, as the subject chosen for this first trial was too complex. In addition, the students needed time to familiarise themselves with the technique. Though it is felt that next trial will be more successful,

6.2.2 Underlying pedagogical principles

The available teaching scenario is based on **constructivism theory**. Constructivism means that pupils construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. That means that the pupils are active creators of their own knowledge. In order to create knowledge they have to ask questions, explore, and assess what they know. The teacher’s role is to help students to construct knowledge rather than to reproduce a series of facts.

According to constructivism, the student moves from a passive recipient of information to an active participant in the learning process. The pupils should always be guided by the teacher, and construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook.

Students become motivated by applying their already existing knowledge and real-world experience, learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings.

6.2.3 Pedagogical organisation of teaching scenario

IIS Olivetti

In IIS Olivetti, they are gradually implementing the method of introducing video into lessons plan. This activity is spreading at the same time with the use of ICT: a PC in every classroom, linked to the LAN and TV projector in order to spread materials.

These materials are produced and used inside the school in order to fulfil specific purposes such as:

- emphasize in the construction of knowledge,
- avoid excessive simplifications on the representation of the natural complexity of the real world
- assign authentic tasks, that lead to a better contextualisation than abstract concepts
- offer learning environments taken from the real world, based on events.
- offer multiple representations of the real world
- induce reflection
- allow construction of knowledge depending on context and content
- allow cooperative construction of knowledge, through social negotiation

This kind of approach is particularly useful for those subjects which need specific documents to accompany traditional lessons i.e., in technical field, it can be useful to show photos of equipment, films of processes, system and structure diagrams.

The use of available on line lessons is a response to different needs and times. At the beginning, the lesson the students are seen the film together with the teacher and discussed the specific topic this was the global phase of lesson. In a second phase, the students could see the lesson autonomously, inside or outside school, in order to reinforce learning or personal study.

Students are involved not only in the use of multimedia materials, but also in the creation of new materials, in order to form a dynamic learning environment, which was open to all those, who were interested in giving their contribution

Istituto Regina Margherita

1. Discussion about storyboard of the video: the student discussed about the order of the different part of the video and at the end decided that it would be better to organize the materials according these topics: a) Presentation of the persons who were interviewed; b) the motivations to leave; c) the expectations before leaving; d) the problems when they arrived in Italy; e) the hopes for the future. They decided also to prepare also a short video to introduce the thoughts about the research to link to the hyperfilm.
2. A group of students, guided by an expert, edited the mean video
3. Shooting of the new short video: a group simulated a discussion about the results of the research; after, with an expert's help; edited the video.
4. Preparation of the materials to link in the hyperfilm: each group prepared materials about History of migration, about laws for the emigrants in Italy, about emigration and work in Turin, about pedagogic of inter-culture.
5. Learning Hyperfilm: the class, guided by the teachers, learnt to use the software.
6. The storyboard of the hyperfilm: during the discussion the students decided the title and decided where to link the different materials; further they decided to link the new video with the conclusions about the research at the end of the hyperfilm
7. Editing of the hyperfilm: each group prepared an hyperfilm with the different materials and, at the end, the class decided which it was better

6.2.4 Description of teaching scenario (implementing and performing the activities)

IIS Olivetti

In order to fulfil the above-mentioned purposes, teachers and students started producing short filmed lessons to be introduced into the classroom, as a support to the traditional lesson.

A special format was given and it includes:

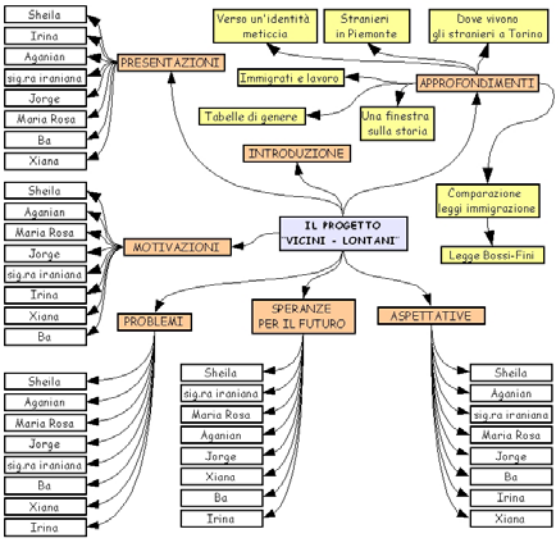
- index of topic: the user is always able to understand which part of the lesson is visualized
- box with slides referring to topic: two thirds of screen represent topic, these slides contain summary, photos and formula, which are gradually built as the speaker talks about the topic
- small picture of the speaker photos: on top left corner of screen you can see and listen to speaker talking about topic

The lesson can be seen to the end or it can be interrupted at any time in order to give additional explanation, let students ask for details and have a break in order to better learn formula

Learning goals and objectives of the TDP (Technology Design Project) have been:

- subject-related skills
- ICT skills
- Group discussion

Istituto Regina Margherita



The hyperfilm “NearFar. The thousand faces of migration. Interviews in Turin made by students of V BS (a.s’02-’04) of I.M.S Regina Margherita”

As the map shows, this hyperfilm documents the research about the subject “ Migration and differences of genus”; the main video shows the most meaningful parts of the different interviews according the step established: presentation, motivation, expectation, problems and hopes for the future.

The different links can be divided into:

- Text (Word) files: they have been used to insert parts of interview not filmed, to insert translations and some theoretical subject (history of migration in Italy, laws of migration, pedagogy of interculture). Some of them have been linked with a hyper-text structure.
- Audio files: they present the different parts of an interview taped but not filmed for privacy reasons.
- Web pages: with an historical subject
- Film (in MPEG format): it shows the simulation of a discussion among three students who think about the results of the research and its mythological aspects.

6.3 CSP2

Application 2: Streaming an external life event

The present teaching scenario has been implemented with 2 different schools in Italy:

- ITIS Vallauri (secondary technical school)
- ITIS Sobrero (secondary technical school)

6.3.1 Description of application used within present teaching scenario

- **ITIS Vallauri (secondary technical school)**

The following technology has been used in the teaching scenario experimentation:

1. Audio-visual equipment:
    - Digital Video Camera
    - Microphones
    - Tripod
    - DVD or Cassette
    - Lights
2. Students' computers: ordinary up to date computer system.
3. Editing software
    - Post-production: Adobe Premiere, iMovie, Final Cut Pro, MS Windows Movie Maker, MS Producer, RealSystem Producer
    - Capture cards bundle editing software
4. Capturing and encoding software
    - Windows Media Encoder, RealSystem, Flash Communication, QuickTime
5. Web design and FTP software
    - Frontpage 2000 or XP, Macromedia Dreamweaver MX
6. Network connection: ordinary modern connections
7. Streaming clients (on the users side)
    - Microsoft Windows Media Player, Apple Quicktime, Flash,

- **ITIS Sobrero (secondary technical school)**

The following technology has been used in the teaching scenario experimentation:

1. Audio-visual equipment:
    - Digital Video Camera
    - Microphones
    - Tripod
    - DVD or Cassette
    - Lights
2. Students' computers: ordinary up to date computer system.
3. Editing software
    - Post-production: Adobe Premiere, iMovie, Final Cut Pro, MS Windows Movie Maker, MS Producer, RealSystem Producer
    - Capture cards bundle editing software
4. Capturing and encoding software
    - Windows Media Encoder, RealSystem, Flash Communication, QuickTime
5. Web design and FTP software
    - Frontpage 2000 or XP, Macromedia Dreamweaver MX
6. Network connection: ordinary modern connections
7. Streaming clients (on the users side)
    - Microsoft Windows Media Player, Apple Quicktime, Flash,
    -

6.3.2 Underlying pedagogical principles

This teaching scenario is based on **constructivism theory** see section 6.2.2

6.3.3 Pedagogical organisation of teaching scenario

- **ITIS Vallauri (secondary technical school)**

The work starts from a series of main points:

- Computer science tools are part of our students' daily school activity and are used to search, tidy up, introduce, compute, plan, etc.
- Forums have the aim to allow a virtual or real discussion about the students 'job present and future Families, and any audience in the territory, can attend the same discussion about solutions of important social and economical issues.
- There are at least two important common factors for any curricula: the need for a continuous training, by improving while working, and the strict link between professional and computer science know how. In the video conference, students have discussed cultural and managerial bonds concerning proprietary informatics systems, in comparison with the different managerial autonomy of the open source systems. The participation and speech of Professor Angelo Meo, from Automatics and Data transmission Department – Politecnico di Torino, have aimed to clarify both the cultural and economic consequences implied by property managerial systems and the necessity, for Italy and Europe, of escape from American dependency in this important framework of future society development.
- In the last class of school, we want our students interact with operators both discovering troubles and presenting a research.
- The teacher must be a director: he/she must introduce the project, spot the groups in the class, and give them work and timing, prepare charts, control, and discuss the results. He/she must monitor the project's progress, as well as prepare testing to allow streaming video link.

This pre-activity allows the teachers to be prepared at the meeting with experts, lecturers, and professionals. It is clear that this activity offers a synthesis of all subject skills found in quite a few curricula (Italian, History, English, Computer Science etc.).

ITIS Sobrero (secondary technical school)

The hypertext produced includes four videos, Power Point presentations, language exercises with keys, articles, readings; the final result has been evaluated by a team of teachers dealing with quality in schools. The modules include final testing.

The "video instrument" allows to see again and to think over the different phases faced, especially during the first one, when the description of an unknown complex image to the addresses deals with variations and curtailments in the two handing over.

The construction of the other two films stimulates in students the reflection and the choice regarding the conceptual nodes and to the handing over to be maintained.

The participation and the interest demonstrated by the students have sustained the activity.

Learning goals and objectives of the experimentation have been:

1. Increase in student motivation
2. ICT Skills
3. Integrated language skills:
   - reading
   - writing
   - listening
   - speaking

6.3.4 Description of teaching scenario (implementing and performing the activities)

ITIS Vallauri (secondary technical school)

The main subject of the four video conferences concerns the students' job future and the problem of technological development in general on the North West territory inside European and local market.

The meetings are about Computer Science, Electric Engineering, Technological Culture and Engineering trends.

The school is willing to experiment videoconference to make its last year students meet experts, University Lecturers, professionals giving them the possibility to attend the subject discussion in a forum and ask question directly

The streaming video conference has been followed by families and audience in all the territory. Mail links allow contacting speakers directly.

Every ending class has been divided into four groups each one of them gathering information on University curricula concerning their skills, on jobs and professional associations, on local markets.

Each group told its class and points out at least 3 questions/curiosities/doubts they couldn't find any answer about. Every group was made up by 3 to 5 students each.

The 4th small group in each class has prepared a file to gather and tidy information about the professional future on which all the class is working. Their job is the exhibition of the whole class research.

The 5th grade students had the necessary know how of net resources:

1. ICT skills (internet and video streaming tools)
2. information research skill
3. at least two EU languages knowledge
4. synthesis skill
5. problem solving skill
6. peer relations skill
7. group-work organizing skill
8. timing skill
9. stranger adult relation skill

ITIS Sobrero (secondary technical school)

The experimentation consists in two didactical units representing the beginning of the "micro-language programme".

The structure is composed by the following steps:

- Preliminary reading
- Listening and writing comprehension of the text
- Acquisition of new vocabulary
- Grammatical review
- Graphical representation of a problem
- Listening
- Check

Reflections and evaluation of the learning path for the didactic unit processing:

- 1st activity: description of some images - the aim of this activity is to define objects and addresses of the description
- 2nd activity: reading of amusing texts (embarrassing situations) - situations are reconstructed in a grid, a sequence of events are identified in a narrative text. Later on the text is revised (summarized)
- 3rd activity: realization of a flow chart concerning the purchase of a computer - from the graphical representation to the description of the process.

The following activities are carried out in 2nd module:

- preliminary activity
- reading
- matching
- summarizing
- listening
- grammar exercises

- vocabulary work
- writing

6.4 Eduhi 1

Application 3: Streaming explanatory documentaries, tutorials, experiments

The present teaching scenario has been implemented with 3 different schools in Austria:

Topic: Music – Get to know the guitar – history, constitution and sound examples

- HS 1 Freistadt (secondary school, 4th grade)
- HS St. Anna Steyr (secondary school, 2nd grade)
- HLW Rohrbach (upper secondary school, 2nd grade)

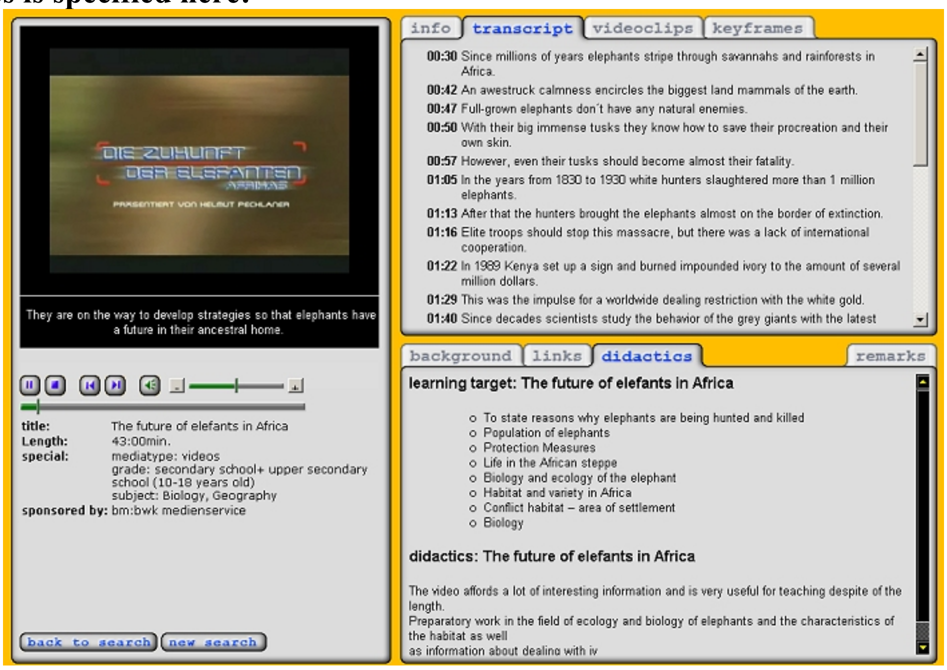
All outcomes, findings and changes during implementation in these 3 schools have been implemented and integrated in present teaching scenario so that you can easily adopt it and try it out with your school!

6.4.1 Description of application used within present teaching scenario

For this teaching scenario and through the employment of the modern streaming media on demand service it is intended to encourage students to find information and material for themselves to be in full activity. If you would like to organise the same teaching scenario with the media on demand service please go to http://estream.schule.at - Media on Demand and login with the guest-account. We have developed several working demonstrators (different multilingual videos) and the video "the guitar" used within this teaching scenario, which you can use for your own teaching lessons!

In developing and using the virtual demonstrator of the media on demand service, we set a high value on interactivity by students through providing many different learning resources in order to activate all senses. Beside the video source, we provided internet resources, text resources, the speakers text of the video, background information, video clips and key-frames.

The Media on Demand application with all specific features and didactical possibilities is specified here:



Screenshot of media on demand application.

This Screenshot shows the player window on user's side. Before this, there is also a login-page and the possibility to search for a specific video.

The media on demand application offers following special features:

Info: short description of the content of the video

Transcript: speakers text of the whole video through speech-to-text recognition (which has been edited because speech-to-text recognition does not provide text without mistakes) connected with a time-code so that we can provide subtitles.

Videoclips: thematic sequences of the video (if it makes sense to produce some) in order to provide only parts of the video (for example video-clip "history of elephants", 3:15-4:25). The clips are not gone through a real cutter or editor, but they are marked through bookmarks.

Keyframes: Special navigation through the video: automatically set segments on user-defined characters, such as words, pan shots or symbols. It automatically creates in- and out-points based upon those parameters.

Background: this is background information for the teacher, suitable to the topic of the video.

Links: additional links and web resources (divided into links, pictures teaching material, articles and software), suitable to the topic of the video.

Didactics: didactical hints and information for using the video in classroom (reference to curriculum, tips for teaching,..).

Remarks: online tickler for writing notes during watching the video.

6.4.2 Underlying pedagogical principles

This teaching scenario is based on **constructivism theory** see section 6.2.2

6.4.3 Pedagogical organisation of teaching scenario

Learning stations

Within this teaching scenario, we suggest to organise different learning stations. This differentiated type of teaching and learning encourages self-directed learning, capacity to act, social skills, methodical competence and self-responsibility of the pupils, which are the required key qualifications of the operational education. The media on demand application will be the central point of all stations. Starting from the media on demand service different learning materials and methods will be included and linked to this application. The media on demand service is predestined for constructivist learning.

"Learning with stations" enables individualised teaching within the whole classroom teaching and enhances motivation through self-directed learning and self-determination.

Learning station rules (which have been used in class)

1. Each group works together on one learning station.
2. Each group starts with their group number (f. e. group 3 starts with station 3)
3. Working time for each stations is 10-15 minutes (this depends on the number of your pupils and the number of learning stations)
4. At the end of working time an instrument (gong) sounds. Each working group changes to the next stations with the higher number (group 10 changes to station 1,..). Working tasks that have not been solved yet remain to be done.
5. Each group has to work on each station.
6. Results and solutions should be enlisted at the appropriate working sheets. These remain collected at the last learning station.
7. Don´t forget the group number on each working sheet.

If required the break will be worked through and the lesson (double lesson) ends earlier.

6.4.4 Description of teaching scenario (implementing and performing the activities)

Within available teaching scenario, it is intended to place emphasis on the media on demand application in close connection with traditional media and supporting materials.

The pupils worked with PCs in a computer lab. The students did not get any additional information about the media on demand application because we wanted to test the usability and if it is self-explanatory or not. The organization of the lesson took place in learning stations that were divided according to different topics:

- Learning station 1 – The family of the guitar
- Learning station 2 – history and usage of the guitar
- Learning station 3 – parts of the guitar
- Learning station 4 – attitude and first experiments with the guitar

For each learning station, we provided a station sheet for the students that included different types of questions and tasks according to the given topic.

For each station sheet, we provided also an answer-sheet with all the solutions and correct answers (filled-in station sheet) for self-controlling.

Each station sheet included different types of questions (crosswords, text-questions, multiple choice questions, open type questions etc.)

The questions had to be answered with the help of the media on demand application. One question concentrated e.g. on the speakers text, another question could be answered through reading the background information etc.

This special organization enabled us to concentrate fully on the media on demand application and all additional material, which went with it. Each team had a team pass where they had to fill in which stations and questions they solved. This is very motivating for students and helpful to keep in mind what has been reached already and what is still missing. In order to guarantee a smooth implementation it is recommended to use the learning station rules (mentioned above) and stick strictly on it.

It is recommended to have small groups (teams) with 2 students for one PC. The materials used in class (learning stations, tasks, answers and team pass) are available in German language (also the websites and additional information within the media on demand application are in German,..). On the other hand, by going through the present teaching scenario you can easily adopt it for your special classroom situation by developing your own stations with your own questions and answers.

6.5 Eduhi 2

Application 1: Streaming an educational event

The present teaching scenario has been implemented for an Austrian company (Energie AG) with 3 outposts in the Czech Republic. Topic: German as foreign language

- AVE Prague
- VAK JC Budweis
- VAK Beroun

The language course (which comprehended level A1 – according to the European language portfolio) was divided in 2 parts:

Beginners and Advanced

6.5.1 Description of application used within present teaching scenario

For this teaching scenario, we used the virtual classroom software eduACADEMY that has been developed by ourselves. If you would like to have a look at an archived educational event please open following link: http://www.eduhi.at/go/educast.php?castID=42

User: demo1

Password: deutschkurse

In developing and using the virtual demonstrator of the virtual classroom software, we set a high value on interactivity by students and learners through providing many different learning resources in order to activate all senses. Beside the video source we provided a download section, the possibility to ask questions, a space for own remarks, a polls section and additional information.

The virtual classroom software with all specific features and didactical possibilities is specified here:

Screenshot of eduACADEMY

The screenshot shows the player window on users' side. Before this, there is a login-page and the possibility to search for a specific lecture.

What makes it special is the way of streaming the lecture: Besides the video-screen of the trainer, you can also see the PC-screen. That means you can easily follow what the trainer is doing on his PC – it is 1:1 transmission, synchronized with the video.

There are many interactive features in order to move from passive consumption of the lecture to active use with interactive participation.

The interactive features are activated in accordance with the trainer; who is the one that decides which features make sense for his special teaching lesson.

The virtual classroom software offers following special features:

Info: short description of the content of the lecture

Download: possibility to offer documents (Word, PPT, XLS, PDF, …) for the learners in order to download and use them.

Remarks: online tickler for writing notes during watching the video

Questions: there is a possibility to ask questions to the lecturer or trainer. The questions are anonymous. The lesson can be very interactive through this possibility

Archive: After the E-Learning course, the lecture is saved and stored in an archive so that users can repeat the lesson again at home or whenever they have time.

The software requires no special requirements of the user PC, you just need an actual browser (Internet Explorer 6 and higher), the Windows Media Player 9, a good graphic card (min. 32 MB) and a broadband internet connection (DSL - 768/128).

6.5.2 Underlying pedagogical principles

Constructivism and blended learning concept

This teaching scenario is based on **constructivism theory** see section 6.2.2

In addition to the constructivist learning approach, we took advantage of the pedagogical concept “**blended learning**”. Blended Learning means that users combine online and face-to-face approaches during learning. Blended learning is a new term in education, but the concept has been there for decades. Blended learning is defined as a method of learning at a distance that uses technology (online courses,..) combined with traditional education and training (face-to-face courses).

Blended learning

6.5.3 Pedagogical organisation of teaching scenario

The content of the face-to-face and online courses is strengthened via independent (but advised) learning parts. The learners are free to decide within a given framework how long, when and what particular learning content they want to repeat, and would like to train in.

The whole learning content can be accessed and repeated at any time.

Another important aspect is to coach the course participants, also between the face-to-face courses. Thereby it is possible to obtain a continuous active communication between the participants and the trainer, tutors and tandem-learners, and this again increases the motivation and identification for participating. This type of communication can take place via e-mail.

Additionally we use a new concept called “**tandem-learning**”. The term “tandem-learning” means that each participant (Czech) is assigned to a tandem-learner (Austrian). Both participants should communicate via mail or phone in the own mother tongue within given tasks of the trainer. (f. e.: find out if your tandem-partner likes to cook and what)

This is very motivating for learners and enables them to get in contact with a partner from the country of which they learn the language.

This was the distribution of time and how we organized the whole educational event:

Face-to-face courses: 3 learning units in total – each 2 hours.

E-Learning: 2 learning units per week

Tandem – Teaching: minimum once per week per e-mail

Independent learning phases: 2 learning units per week with CD-ROM and archived lessons

Total expenditure of time: 4 learning units per week, in total 8 weeks

6.5.4 Description of teaching scenario (implementing and performing the activities)

The learners worked with PCs in a computer lab in the office and in addition, they worked at home. We developed and provided an own website (community) with:

- a calendar with all dates of the courses
- links for participating in an online course
- links for accessing the archived courses
- contact details of tandem-learners, learners, technicians
- extra working space for independent learning with online dictionaries, vocabulary lists - texts suitable to the company Energy AG,..
- online vocabulary book for each participant
- extra space for asking questions to the trainers (anonymous, 24 hour service)
- information about the concept and the course
- online questionnaires in order to evaluate the teaching scenario and enhance it.
-

When there was a live **online-course** the participants logged in at 16.00 and could actively take part in the course, they asked questions to the trainer, they sent in tasks and homework during the course.

An online course lasted 2 hours with a short break between. At the next day, this course was already archived and available for streaming from the website.

When there is a **face-to-face course,** the participants sat in their office/working place in an extra training lab. The trainers were on the spot and the main focus was set on communication and active use of the German language.

When there was **independent learning phase** each participant used a CD-ROM (Perfect German). The whole course concept was based on this CD-ROM. It also included a working book and an audio-CD. Most important is that new learning content is only provided and presented by the trainer – either in an online-course or face-to-face course. During the independent learning phases the learner just repeats already learned content and stabilise it. It will not be very successful and difficult for learners to teach themselves new learning content.

6.6 Mayo Education Centre

Students with their Teachers constructing their own Streaming Material.

The present teaching scenario has now been implemented with 3 different schools in Ireland under the direction of the Mayo Education Centre.

Topic: Select an area of the National Science Curriculum and plan, design, film, edit & prepare an area or a specified experiment from this curriculum for use as a Streaming Media activity within the school or for use by other schools in the region.

- Sacred Heart Secondary School, Westport (Transition Year – Year 4)
- Knockrooskey National School, Westport (Primary School, 6th Class 11-12 years old)
- St. Patrick's BNS, Castlebar (Various senior Classes 10 -12 year olds)

The outcomes, findings and changes during implementation of this teaching scenario has been fully implemented in the Sacred Heart Secondary School, and is in the process of being completed in the two remaining schools. Even at this stage, the process has proven to be hugely interesting and valuable to the schools involved and though much technical support is necessary for the schools it is hugely worthwhile, constructive, and educational for the students involved in the implementation. Our experience so far would indicate that this teaching scenario should be encouraged in other schools where possible.

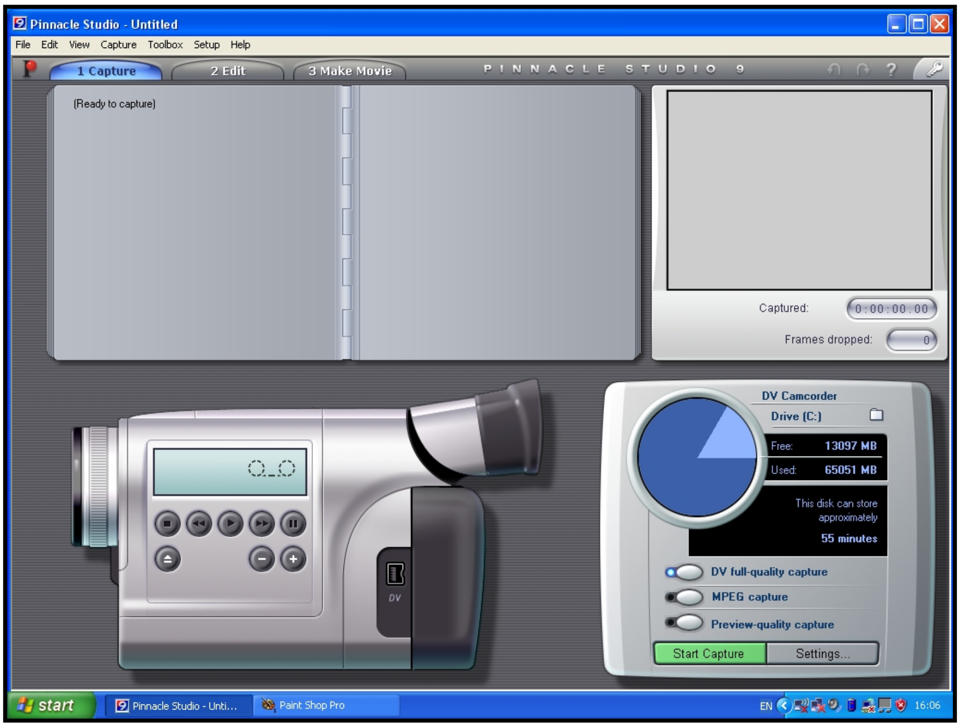
6.6.1 Description of application used within present teaching scenario

For this teaching scenario, we have decided to use Video Editing Software called Pinnacle Version 9 with the students and teachers involved in the project. This is an internationally available Video Editing package for use with PCs. The software is hardware hungry and demands that the PCs being used are of a relatively high specification (P4 Processor 2.4 MHz or higher, 1GB of RAM, an 80bGB hard drive and with a DVD writer available).

The schools involved were supplied with the software required. The schools had suitable computer hardware made available to them where needed and had video cameras, tripods, sound equipment loaned to them for the required period of filmwork.

The Pinnacle Studio 9 application allows the user to import digital video, edit, and re-export as DVD, streaming media or back onto film for later editing

The Screenshot shows the video import window of Pinnacle Studio 9.

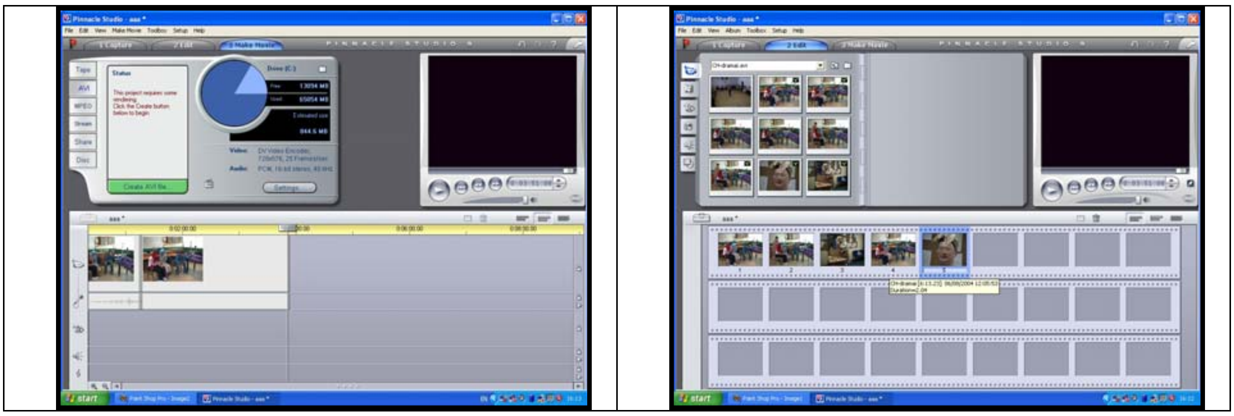


The Pinnacle Studio 9 application offers following special features:

Import raw digital video: This could be from a camera or from existing 'avi' media captured previously and saved as full quality avi or mpeg.

Editing: Teachers and students can edit all video clips imported. They can also add captions, overlays, sound tracks, credits, and transitions. This is done in a simple interface that students can very easily manage. This part of the exercise can be very intense and is very educational for the students and teachers alike.

Exporting: Once the final editing is completed the film can be exported through the software to MPEG or AVI or Streaming media, making the final product immediately usable as streaming media on web servers capable of sustaining the service.



The screen shots above show the editing & exporting stages of the process in Pinnacle

6.6.2 Underlying pedagogical principles

Constructivism

What is meant by constructivism? The term refers to the idea that learners construct knowledge for themselves---each learner individually (and socially) constructs meaning---as he or she learns. Constructing meaning is learning; there is no other kind. The dramatic consequences of this view are twofold;

1. We have to focus on the learner in thinking about learning (not on the subject/lesson to be taught):
2. There is no knowledge independent of the meaning attributed to experience (constructed) by the learner, or community of learners.

Although it appears radical on an everyday level, it is a position which has been frequently adopted ever since people began to ponder epistemology. If we accept constructivist theory (which means we are willing to follow in the path of Dewey, Piaget and Vigotsky among others), then we have to give up Platonic and all subsequent realistic views of epistemology. We have to recognize that there is no such thing as knowledge "out there" independent of the knower, but only knowledge we construct for ourselves as we learn. Learning is not understanding the "true" nature of things, nor is it (as Plato suggested) remembering dimly perceived perfect ideas, but rather a personal and social construction of meaning out of the bewildering array of sensations which have no order or structure besides the explanations (and I stress the plural) which we fabricate for them.

If we believe that knowledge consists of learning about the real world out there, then we endeavour first and foremost to understand that world, organize it in the most rational way possible, and, as teachers, present it to the learner. This view may still engage us in providing the learner with activities, with hands-on learning, with opportunities to experiment and manipulate the objects of the world, but the intention is always to make clear to the learner the structure of the world independent of the learner. We help the learner understand the world. But we don't ask him to construct his or her own world.

The great triumph of Western intellectual history from the Enlightenment until the beginning of the 2Oth century rested on its ability to organize the knowledge of the world in a rational way independent of the learner, determined by some structure of the subject. Disciplines were developed, taxonomic schemes established, and all these categories were viewed as components of a vast mechanical machine in which the parts could be explained in terms of their relationship to each other, and each part contributed to making the whole function smoothly. Nowhere in this description does the learner appear. The task of the teacher was to make clear to the learner the working of this machine and any accommodation to the learner was only to account for different appropriate entry points for different learners.

However, as it has been indicated above, constructivist theory requires that we turn our attention by 180 degrees we must turn our back on any idea of an all-encompassing machine that describes nature and instead look towards all those wonderful, individual living beings ---the learners--- each of whom creates his or her own model to explain nature. If we accept the constructivist position, we are inevitably required to follow a pedagogy, which argues that we must provide learners with the opportunity to: a) interact with sensory data, and b) construct their own world.

This second point is a little harder to be swallowed, and most of us constantly shift between faith that our learners will indeed construct meaning which we will find acceptable (whatever we mean by that), and our need to construct meaning for them. That would have meant, for us to structure situations that are not free for learners to carry out their own mental actions, but "learning" situations that channel them into our ideas about the meaning of experience.

6.6.3 Principles of learning

What are some guiding principles of constructivist thinking that we must keep in mind when we consider our role as educators? It will be outlined a few ideas, all predicated on the belief that learning consists of individuals' constructed meanings and then indicate how they influence museum education.

1. Learning is an active process in which the learner uses sensory input and constructs meaning out of it. The more traditional formulation of this idea involves the terminology of the active learner (Dewey's term) stressing that the learner needs to do

something; that learning is not the passive acceptance of knowledge which exists "out there" but that learning involves the learners engaging with the world.

2. People learn to learn as they learn: learning consists both of constructing meaning and of constructing systems of meaning. For example, if we learn the chronology of dates of a series of historical events, we are simultaneously learning the meaning of a chronology. Each meaning we construct makes us better able to give meaning to other sensations that can fit a similar pattern.

3. The crucial action of constructing meaning is mental: it happens in the mind. Physical actions, hands-on experience may be necessary for learning, especially for children, but it is not sufficient; we need to provide activities which engage the mind as well as the hands (Dewey called this reflective activity).

4. Learning involves language: the language we use influences learning. On the empirical level: Researchers have noted that people talk to themselves as they learn. On a more general level: There is a collection of arguments, presented most forcefully by Vigotsky, that language and learning are inextricably intertwined. This point was clearly emphasized in Elaine Gurain's reference to the need to honour native language in developing North American exhibits. The desire to have material and programs in their own language was an important request by many members of various Native American communities.

5. Learning is a social activity: our learning is intimately associated with our connection with other human beings, our teachers, our peers, our family as well as casual acquaintances, including the people before us or next to us at the exhibit. We are more likely to be successful in our efforts to educate if we recognize this principle rather than try to avoid it. Much of traditional education, as Dewey pointed out, is directed towards isolating the learner from all social interaction, and towards seeing education as a one-on-one relationship between the learner and the objective material to be learned. In contrast, progressive education (to continue to use Dewey's formulation) recognizes the social aspect of learning and uses conversation, interaction with others, and the application of knowledge as an integral aspect of learning.

6. Learning is contextual: we do not learn isolated facts and theories in some abstract ethereal land of the mind separate from the rest of our lives: we learn in relationship to what else we know, what we believe, our prejudices, and our fears. On reflection, it becomes clear that this point is actually a corollary of the idea that learning is active and social. We cannot divorce our learning from our lives.

7. One needs knowledge to learn: it is not possible to assimilate new knowledge without having some structure developed from previous knowledge to build on. The more we know, the more we can learn. Therefore, any effort to teach must be connected to the state of the learner; it must provide a path into the subject for the learner based on that learner's previous knowledge.

8. It takes time to learn: learning is not instantaneous. For significant learning we need to revisit ideas, ponder them try them out, play with them and use them. This cannot happen in the 5-10 minutes usually spent in a gallery (and certainly not in the few seconds usually spent contemplating a single museum object.) If you reflect on anything you have learned, you soon realize that it is the product of repeated exposure and thought. Even, or especially, moments of profound insight, can be traced back to longer periods of preparation.

9. Motivation is a key component in learning. Not only is it the case that motivation helps learning, it is essential for learning. This idea of motivation as described here is broadly conceived to include an understanding of ways in which the knowledge can be used. Unless we know "the reasons why", we may not be very involved in using the knowledge that may be instilled in us.

This teaching scenario is based on **constructivism theory** see section 6.2.2

6.6.4 Pedagogical organisation of teaching scenario

Essentially this part of the teaching scenario will be divided into 5 Phases:

Phase 1. Teacher Training
This will entail teachers who are participating in the teaching scenario attending a number of training evenings on the Streaming Video. This training will contain a number of elements:

Element A. Basic training in the use of digital video cameras, tripods, and sound equipment. This will given teachers a basic working knowledge of film and the equipment needed for production of short films of their own.

Element B. Basic training in the theory of film making, scripting, storyboarding, shot lists, shot types, settings, lighting & sound. This will give teachers an understanding of the need for preparatory work before engaging in any of the actual film work. Students will then develop a script, prepare a storyboard and a shot list before embarking on the raw filming.

Element C. Basic training in the use of the editing system Pinnacle Studio 9 so that the raw film can be 'finished' to as high a standard as possible. Teachers will gain an understanding of clip timing, transitions, sound tracking and various other elements of the editing process.

Element D. Basic instruction in the theory of video streaming so that teachers and students will understand the terminology & practical use of various video compressions so that they will be able to export the edited films to a suitable media format for streaming.

Element E. Conversion of the edited film into suitable format for streaming or other potential uses within education.

This element of the teaching scenario has already been implemented with all the schools involved in the project. One of the training evenings was conducted by ATiT in the Mayo Education Centre in January 2005. Two other training days were conducted by MEC to further enhance the skills of the teachers involved and additional teacher training was given at the schools where teachers were guided through some training exercises by the ICT Advisor Art Ó Súilleabháin

Phase 2. Implementation in the schools
This is where the teachers who have been trained in the use of this equipment and software now use these skills to encourage their students to become involved in constructing or reconstructing their own knowledge.

Again this process involves a number of required elements:

Element A. Introduction & discussion of the proposal to the students

Element B. Training of the students in all of the elements in Phase 1 of the proposal.

Element C. Selection of a topic for filming. In this case we have suggested that all the topics be science related. This can be in the area of chemistry, physics, biology or environmental science. (Already we have seen a number of these areas being addressed by the students – all drawing from the experience of their school or from their natural environment).

Element D. Development of a script, storyboard & shot list

Element E. Actual filming of the storyboard as designed

Element F. Editing of the raw video content using Pinnacle Studio 9

Element G. Rendering of the final edited version of the film into a format that is suitable for streaming and the hosting of that video streamable material on a suitable server so that other educationalists can use this material.

To date schools have completed 3 films using this teaching scenario. Now available in the E-Stream Community. (Go to eStream Website - Media on Demand - Open Media on Demand Webclient - Login with guest/guest) to see:

- **Distillation of seawater**
- **A fishy tale**
- **Our Leisler bats**

There are another 3 films now in production by the schools in the MEC Region

6.7 Swedish TelePedagogic Knowledge Centre: Communication, interaction and dialogues using streaming media

Application 6: **The present teaching scenario is being implemented by various schools in Sweden and elsewhere (see reference documentation)**

This application is in contrast to the other teaching scenarios an application in an emerging state, with its potentiality only in its initial stages of realisation, adoption, and exploitation. There are, however, persistent pressures for its adoption/usage in school-learning contexts emerging; these demands are expressed by teachers and students, as well as pedagogical specialists and professionals in the ICT sector, and they keep increasing.

This application assumes that there is already a relatively high level of ICT maturity, that there is a familiarity with mobile wireless devises (MWD), multi-user virtual environments (MUVE), interactive computing features such as ipods, chats, blogs, ip-phones, and other online interactive and info-consumerism tools as part of users' everyday life. This is also increasingly becoming the reality for those students 'Growing up Digital' (see Tapscott[103], et al). Based on a 'mediated immersion' there are also new learning styles emerging, that need to be better accommodated for in-future school practices. The present scenario cluster will cater for only a part of those.

This summary will only partially exemplify such streaming media-based learning scenarios

Description of applications used in the scenario:

For this scenario we assume that there is a set of prevailing learning styles among the students, which are recognised, adopted to, and embraced by the teaching staff that are to be engaged in, enabling and facilitating learning among the students characterised with learning style characteristics for 'digital learning' such as;

- Fluency in multiple media, valuing each for the types of communication, activities, experiences, and expressions it empowers
- Learning based on collectively seeking, sieving, and synthesizing experiences rather than individually locating and absorbing information from a single best source
- Active learning based on real/simulated experiences, with frequent opportunities for reflection
- Expression through nonlinear, associational webs of representations rather than linear "stories" (i.e. authoring a simulation and a Web page to express understanding, rather than on a paper)
- Co-design of learning experiences personalized to individual needs and preferences

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[103] Tapscott, D., "Growing up digital: The rise of the new net-generation", McGraw-Hill Education, (1997), ISBN: 0-07063-3614

On the technology side of the teaching scenario application, it is assumed that there is an interactive learning service environment available, which is capable of providing the teachers with the facilities for setting up learning scenarios, to provide the students with the capabilities, rights and communicative tools needed for the particular learning scenario that the learning tasks are to be catering for.

This would include, among other, tools and facilities that can perform the following functions;

- End-user video cameras inter-connectable with student computers
- Software for production of video-sequences, interconnected with presentation material
- Software/services for conversion of videos to steaming media and uploading it on media servers
- Software/services for collaborative learning scenario/assignment planning/monitoring
- Software/services for production of blogs/feeds/notes/announcements that can be syndicated
- Software for collaborative compilation of electronic info resources, incl. streaming media

Such composition of solution packages can be catered for in a school setting, either by a set of separate software packages or through a more integrated virtual learning service environment like the services provided via VCP (www.VCP.biz) through its range of 'engines', and with service environments that are capable of catering for usage of a range of devices and communication modalities among its users.

6.7.1 Underlying pedagogical principles

The application is extensively based on 'connectivism'. George Siemens[104] in his landmark article 'Connectivism: a learning theory for the Digital Age explained connectivism in the following way:

"Behaviourism, cognitivism, and constructivism" are the three broad learning theories most often used in the creation of instructional environments. These theories, however, were developed at a time when learning through technology was not viable or even thinkable. Over the last twenty years, technology has reorganised how we live, how we communicate, and how we learn. Learning needs and theories that describe learning principles and processes should now reflect the underlying socio-economic environment. Vaill[105] emphasizes that "learning must be a way of being – an ongoing set of attitudes and actions employed by individuals and groups to try to keep abreast of the surprising, novel, messy, obtrusive, recurring events…"

"All of these [conventional] learning theories hold the notion that knowledge is an objective (or a state) that is attainable (if not already innate) through either reasoning or experiences. Behaviourism, cognitivism, and constructivism (built on the epistemological traditions) attempt to address how it is that a person learns."

"A central tenet of most learning theories is that learning occurs inside a person. Even social constructivist views, which hold that learning is a socially enacted process, promotes the principality of the individual (and her/his physical presence – i.e. brain-based) in learning. These theories do not address learning that occurs outside of people (i.e. learning that is stored and manipulated by technology). They also fail to describe how learning happens within organizations.

Learning theories are concerned with the actual process of learning, not with the value of what is being learned. In a networked world, the very manner of information that we acquire

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[104] Siemens, G. Connectivism: A learning theory for the digital age, (1996), www.connectivism.ca

[105] Vaill, P. B., Learning as a Way of Being, San Francisco, CA, Jossey-Blass (Willey) (1996), ISBN: 0-7879-0246-2, p. 42.

is worth exploring. The need to evaluate the worthiness of learning something is a meta-skill that is applied before learning itself begins. When knowledge is subject to paucity, the process of assessing worthiness is assumed to be intrinsic to learning. When knowledge is abundant, the rapid evaluation of knowledge is important. Additional concerns arise from the rapid increase in information. In today's environment, action is often needed without personal learning – that is, we need to act by drawing information outside of our primary knowledge. The ability to synthesize and recognize connections and patterns is a valuable skill."

"Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories. Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning (defined as actionable knowledge) can reside outside of ourselves (within an organization or a database), is focused on connecting specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing. "Connectivism is driven by the understanding that decisions are based on rapidly altering foundations. New information is continually being acquired. The ability to draw distinctions between important and unimportant information is vital. The ability to recognize when new information alters the landscape based on decisions made yesterday is also critical.

Principles of connectivism:

Learning and knowledge rests in diversity of opinions.

Learning is a process of connecting specialized nodes or information sources.

Learning may reside in non-human appliances.

Capacity to know more is more critical than what is currently known

Nurturing and maintaining connections is needed to facilitate continual learning.

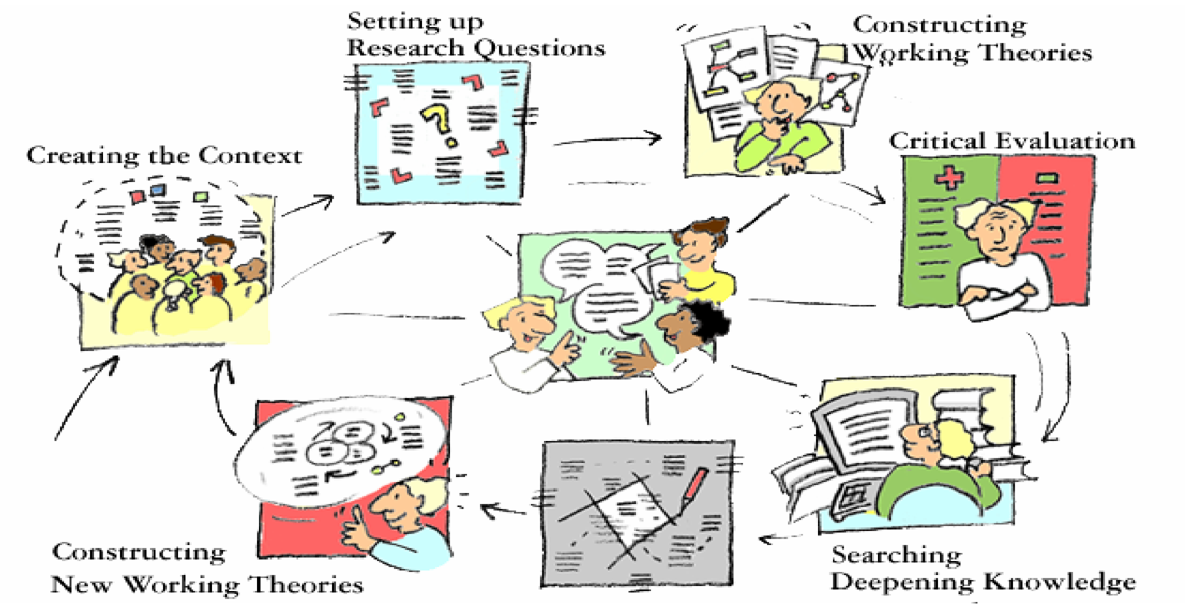
Ability to see connections between fields, ideas, and concepts is a core skill.

Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

Decision-making is in itself a learning process. Choosing what to learn, and the meaning of incoming information, is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

6.7.2 Pedagogical organisation of the scenario

The learning scenario is here provided to the learners as a set of two-layered scaffolds; a learning architecture level scaffold (as the one below) and one or more tool-level scaffolds. The completeness of these scaffolds at the point of handling over of the assignment from the teacher to the learners (individuals or groups) can vary depending on the particular assignments. Alternatively, the initiation of the scenario-driven learning can be provided in form of an assignment specification with pre-defined tasks and responsibility/involvement configurations. A practical application of this scenario can also take on different explorative implementation formats, such as the adoption of so called 'progressive inquiry approach', which has been illustrated below;



(for details[106], see http://www.ll.unimaas.nl/euro-cscl/Papers/133.doc)

The collaborative learning, assignment implementation, solution development and/or inquiry process are making use of the online tools/services to both manage the assignment handling, e.g by the available scaffolds and assignment management tools, as well as by facilitating the connectiviness among the involved actors, the interactions between them and the internal and external resources available to them (e.g. through Internet). The progress and the findings, reflections and proposals are shared through tools like blogs, SMS messages, chats, online meetings, recorded with videos and audio, shared and distributed via syndicated repositories, and with its documentary processes focusing both on the learning processes itself in parallel to focus on outcomes, effects and impact that those have made on the actors and their operating context.

Examples of blog-provided comments:

Illustrations on how the indicated tools could be used for application in scenarios that are utilising virtual community services like those in MVC/VCP will be introduced on the eStream site shortly.

An illustration of how self-produced video materials can be introduced in conventional blogs has been taken from the Streaming Video Diary (http://blogger.p2mn.com/), and its 10/10/04 comment on Streaming Video Blog, where the following streamed media explanation on how to use Camtasia was provided;
http://www.p2mn.com/wwwboard/videosupport5.html . More information on the type of school-related applications and conceptual bases for those, are available e.g. from these sources:

Dede, C. "Planning for neo-millennial learning styles"
IDG, "Can we learn digitally?"
Lewis, D.S. "Videoblogs and Podcasts"
Oblinger, D.B. "Educating the net generation"
Ricardson, W. "Blogging and RSS - .. Powerful New Web Tools for Educators"
Siemens, G. "Connectivism: A learning theory for the digital age"
Tapscott, D. "Growing up digital: The rise of the new net-generation"
Thomas, R. "Supporting online students with personal interactions".

[106] Rahikainen, M., Lallimo, J. & Hakkarainen, K Progressive inquiry in CSILE environment: teacher guidance and students' engagement" http://www.ll.unimaas.nl/euro-cscl/Papers/133.doc

6.8 *The Science Laboratory:* Implementation of streaming media in school 1

(Implementation that took place during normal school hours, teaching a subject contained in the school curriculum)

The aim of this teaching scenario was to use streaming media during normal teaching hours interleaved within the normal course of teaching in class. In particular present the streaming medium at a time when the teacher needs to give an example that by its very nature has the element of movement into it, such as an object or a mechanism that moves. Alternatively, the subject could include an experiment that is being (or was) performed, or animals or objects that are moving, or plants growing (time photography), or even seasonal changes in the weather. The teacher can alternatively use streaming media to present to his students something that is located quite far away form the school, such as a monument, a town, a country etc.

We should state here that the implementation of this teaching procedure represented the first research trial and, therefore, it was essential to measure what students learned when following the novel teaching procedure. For that reason, the knowledge remaining to the students when this teaching procedure was finished (experimental group) was compared to the one achieved using traditional teaching (control group). To achieve this, all the internationally accepted practices when doing research in science education were enacted. Careful questionnaire design (related to the content taught), with clearly stated and specific questions was very important in order to avoid systematic errors. In addition, a content-independent questionnaire was given to the students, to measure their computer knowledge and their attitude towards ICT.

Special care was paid to select the different types of classes took part in the test. It was made certain that they were representative (as they should have been), containing students of more or less the same level of knowledge, same background etc., in order to avoid bias.

The teacher (or the researcher together with the teacher) decided the concept that he/she believed that was better to be taught with the use of streaming media.

I) The teacher chose amongst the available videos on the e-stream server (or any other streaming server), those media having a subject that suited his requirements and at the same time fitted with the way he planed to present the subject.

II) The pre-tests were given to the students before any teaching took place. Even though the questionnaires contained mostly multiple-choice questions, this procedure lasted one teaching hour. Students were not familiar with this process (something expected, because most students are used to memorise instead of understanding); therefore, they needed extra time to understand the nature of the task in addition to reading the questions and giving the answers. It was explained to the students that this questionnaire was not another form of test, and that they were not to be graded from their answers. It was stressed to them that their class was chosen to participate in a research project, the results of which would (perhaps) affect the way teaching and learning takes place, and that, therefore, it was of vital importance for the research that the students should answer the questions carefully, without “cheating”, and to the best of their knowledge.

III) The data from the pre tests were analysed.

IV) Some teaching took place just in order to ensure that all the students had the prerequisite knowledge, so that they could follow the lesson offered to them afterwards. For the control group (traditional teaching, used for the educational evaluation - comparison) this teaching was incorporated in the normal teaching.

V) This introductory teaching was given to all experimental classes and it lasted a couple of teaching hours. Obviously, this is not a step necessary in non-experimental situation, as in this case the teacher will choose the right time to use the streaming video.

VI) The teacher prepared the worksheets beforehand. (During normal educational streaming server operation in the future, any existing content-related worksheets could me made available on the server and they would be very welcome by all. On the other hand, all these should be available in different languages and this might be difficult to arrange).

VII) Instructions were given to the students concerning the innovative teaching approach.

VIII) For the innovative teaching class (e.g. the "trial" class), students were divided into small groups of 2-4 people. It should be noted here that the optimum number of students working in front of a computer is two. When in larger groups, problems regarding communication were observed (e.g. too much noise because the distance from each other is greater), and co-operation (e.g. who will operate the mouse), as well as space problems (everyone should have a clear view on the screen, table-space to spread the worksheets). The distribution of the students into the groups was done before entering the computer lab. It was proven better practice to allow students to choose their mates, although this often results in uneven groups: the "stronger" students may stick together leaving the rest to make their best. The aim was to let students learn by following their own pace. Therefore, uneven grouping was not considered a problem. On the contrary, special care was given to prepare and provide the "strong" students with additional worksheets to occupy them as well as to satisfy their natural curiosity.

IX) A problem faced was noise. This was because the class was large and the video had an audio soundtrack with some type of narration. The class was composed of 15-20 students, which means 7-10 groups of students, each one in front of a different computer listening to a different part of the video. Under these circumstances, it was very hard to concentrate. Headphones could provide the answer here, although the video was in a foreign language and students could simply lower the volume level, as they just needed an aural cue on who is talking. Without headphones the students appear to compete against each other, which groups' loudspeakers will be the loudest and "silence" the rest.

X) The actual teaching took place. Students watched the film/films and then tried to complete their worksheet. (The following variation was not tried, but it can happen as well: The video can depict an experiment being performed and its explanation. In this case, the students might be asked to go to the Science lab and perform the experiment in reality after watching the video). The time needed here depends on the subject taught the length of videos that the students should watch, and the level of understanding the students should reach in the end of the teaching. For scientific videos, which were used in this research, this phase took two teaching hours. It is estimated that for non-scientific ones one school hour might just be fine.

XI) As this was a first experimental trial, a few weeks later, the post-tests were given to the students, to measure the remaining knowledge. This took another school hour.

XII) Data analysis on the post–tests commenced afterwards. The evaluation of the teaching approach had several steps. The first level is based on questions testing the knowledge that all students (both for the students exposed to the streaming media and the ones learning using the traditional way of teaching) should have acquired by the end of the lesson. Special care was paid here for the questions to be objective and fair. E.g., questions referring to topics covered by the streaming media but not covered by the students' schoolbook were avoided.

XIII) Some of the students (the "stronger" ones) that followed the innovative way of teaching were offered additional worksheets. An additional questionnaire was provided for those students in order to measure their understanding. Of course, for this questionnaire, there will be no equivalent for the group of students that followed the traditional teaching.

XIV) Comparison between the pre and the post-test results was the natural step afterwards. In addition, comparisons between the experimental group and the control group took place.

XV) Based on the comparison of these results, the educational evaluation of the teaching approach took place. Serious assessment of the level of success of the teaching approach would ensure corrections and alterations to optimise the results next time round.

This scenario was implemented in two classes of primary school by Antreas Grigoropoulos who is research collaborator and member of the Science Laboratory. The present trial conducted can be considered as a preliminary trial, used to iron out the glitches (e.g. most students reported that the subtitles were disappearing so quickly that they could hardly read them) before the next frame that followed). Such preliminary trials also reveal the amount of time needed for the implementation of this scenario. Due to technical reasons, such as delays in obtaining the video that were caused mostly by copyright issues, it was not possible to start implementing this approach until much later than expected. The procedure described in this section will be completed during the next academic year using more schools, as all the preliminaries (e.g. contact with the teachers, test distribution etc.) have already been made.

6.9 *The Science Laboratory*: Implementation of streaming media in school 2

(Implementation that will take place after normal school hours, either at school or at home)

The aim of this teaching scenario is to use streaming media during a daylong school (i.e. morning and afternoon teaching) or for self-study at home (if the students have a broadband connection to the internet).

In case this is a research trial, all measurements should be taken, following the same way, as those described in the previous section 6.8 (paragraph 2).

The steps that will be followed are the following

I) The teacher chooses amongst the available videos on the e-stream server (or any other streaming server), those videos that suit best a certain topic already taught to the students.

II) The pre-tests should be given to the students before any teaching takes place. For details, see point II in section 6.8.

III) The data from the pre tests should be analysed.

IV) Teacher should prepare the worksheets beforehand (see point VI in section 6.8.)

V) Instructions should be given to the students concerning the innovative teaching approach.

VI) The students should be allowed to work individually. They watch the video as many times as they like and answer the questions on their worksheet(s). The time needed here depends on the subject taught, the length of videos that the students watch and the level of understanding the students should reach by the end. In this teaching implementation, the time needed for this phase is not really matter much, because as it is already mentioned the students will all watch the videos on a self-study basis.

A variation on this teaching scenario is to divide students into small groups 2-4 people. (See the benefits in section 5.16 and the difficulties in section 6.8 point VIII of the present book)

VII) A few weeks later, the post-test should be given to the students, to measure the remaining knowledge. This will take another school hour.

VIII) Data analysis on the post–tests follows. The evaluation of the teaching approach will have several steps. The first level will be based on questions testing the knowledge that all students (both the ones used the streaming media and the ones learning following the traditional way of teaching) should have acquired. Special care should be paid here so as the questions to be objective e.g. questions referring to topics covered by the streaming media but not on the students book should be avoided. The next step is:

IX) Comparison between the pre-test and the post-test results collected within the experimental team. (See section 6.8 point XII.) A possible measurement could be the following: the streaming server has a mechanism to trace which students saw which videos, as this will reveal any correlation between the length of media that the student watched and the acquired knowledge.

X) Based on the comparison of these results, the educational evaluation of the teaching approach takes place. Serious assessment of the level of success of the teaching approach would ensure corrections and alterations to optimise the results next time round.

Due to technical reasons, such as delays in obtaining the video that were caused mostly by the copyright issues, we were unable to start implementing this approach until much later than expected. The procedure will be completed during the next academic year, using more schools, as the contacts with the teachers and the students and the distribution of the pre-tests have already been made

6.10 *Science and Education Centre*: Implementation of streaming media in school 3

(Implementation that can take place using many PCs streaming in parallel, and teaching a subject not necessarily contained in the school curriculum)

The aim of this teaching scenario was to use streaming media during a daylong school or in locations that students can visit as a class for a day (as, for example, "houses of knowledge" or "science museums")

As this was also a first research trial, measurements will be taken, in the same way, as those described in section 6.8.

The steps followed were the following.

I) The teacher (or the teacher together with the researcher in the house of knowledge) chose amongst the available videos on the e-stream server (or any other streaming server), those videos that suit best a certain topic. Those videos should present a subject that suits his requirements.

II) The pre-tests were given to the students before any teaching (or the visit to the "house of knowledge") took place. For details, see II in section 6.8.

III) The data from the pre tests were analysed.

IV) Instructions were given to the students concerning the innovative teaching approach.

V) Students were divided into small groups of 2-4 people. We repeat here that the optimum number of students working in front of a computer is 2 (see the benefits in section 5.16 and the difficulties in section 6.8 point VIII)

VI) A certain task was assigned to each group of students. They could watch as many from the videos as they liked in order to prepare a small presentation of what they saw, for their classmates. The tasks, assigned to the students were in accordance of the capabilities of the members of each group. Strong students prepared something more difficult, while the weaker ones something easier. In this case, all students accomplished the task they had. This satisfied them and encouraged them to try a bit harder next time. Therefore, this acted as a very strong motive for self-improvement. The time needed here depended on the tasks and the length of the videos that the students should watch. Scientific videos are always more time consuming.

VII) Students presented their work to their classmates. The other groups asked questions for topics that presented. (As it is only natural the teacher and the researcher interfered if needed be, to clarify things and make sure that the scientifically correct ideas were explained to the students)

VIII) A few weeks later the post-test were given to the students to measure the remaining knowledge. This took another school hour

IX) Data analysis on the post – tests took place.

X) Based on the comparison of the results the educational evaluation of the teaching approach took place.

7 The research

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The Science Laboratory, School of Education, University of Patras, Greece

During the first stages of the e-stream implementation, it was decided to try and compare how student's learning is affected by the use of streaming media. All partners were supposed to use the same medium or similar ones in order to teach a certain subject and then the results should be compared amongst all partners. However, it was not possible to obtain enough media to stream for such a teaching approach, mainly due to copyright issues. It was therefore decided that each partner could freely decide the method he will use to test the streaming media in school. Practices diverged, as most partners decided to try to produce their own media teaching different things.

Under these circumstances, common content specific questionnaires were out of the question.
It was obvious that the common questions simply had to be general-type and non content-specific. Non – common (i.e. application and partner specific) questionnaires were still possible and an attempt was made to have a couple of local content-specific questions for each partner, although those questions only had a local value and couldn't be compared with the content-specific questions of another partner (i.e. only local pre-tests and local post-tests results could be compared). In the end (mainly due to scheduling reasons e.g. delays in deciding content and specific teaching procedure early enough), no content-specific questionnaire was developed for any of the partners, with the exception of the Greek schools which decided to pursue the outsourced-video teaching scenario. Therefore, a generalised questionnaire was developed, which was content independent (and procedure independent), and this was used by most partners. The general idea was to "compare procedures" amongst partners. As mentioned already, additional content specific questionnaires were developed for the Greek schools but these educational trials are still continuing and these additional results could not be included in the present publication.

7.1 Testing and measuring procedure used in education research

A commonly practiced testing routine, as followed in science education research, would include procedures containing the following steps.

1. Find what the students already know about the subject they are going to be taught, or experience during their learning practice by giving a pre-test to them. The pre-test should be given before the teaching procedure starts: Without such pre-test, we have no knowledge of what the students already knew (or what their opinions were on the subject taught) before we started teaching them. This helps along 2 lines: (a) it gives a hint from where to start and (b) it provides the raw data for evaluating the educational trial (teaching approach, teaching scenario, or curriculum). That means that (in the end) the knowledge the students had before the educational trial should be compared with the knowledge remained to them after the trial. When finished, this procedure will reveal how successful the trial was; it will also point to any possible pitfalls the chosen procedure might have.

2. The educational trial (lesson or series of lessons or the learning project) takes place. Strictly speaking, this teaching procedure should happen twice. The first attempt (on some

students outside the final sample) is used as a trial and it is meant to test the teaching procedure and reveal any problems that may exist, while the second attempt is the real teaching and it is the one on which the research measurements will be taken. The researcher should be present while the innovative teaching procedure takes place; he attends the procedures taking notes - research observations (e.g., how many students actively participated, how often the teacher interrupted to give instructions, if the students interact with each other, what difficulties they faced etc.)

3. A few weeks (normally a month) after the teaching intervention (i.e. the lesson, or the lessons or the learning project), the post-test procedure is performed, to measure the remaining knowledge on the students. The final questionnaire is given to the students and the differences in student's performance between the pre and the post-test signify what students gain from this particular teaching procedure.

We should also mention here that there were substantial differences between student's ages. Therefore, it was decided that primary school students should be treated separately.

7.2 The statistical analysis

We believe that the present analysis is valid, within the limits of the experimental errors of the present study. These errors were painstakingly calculated separately for each and every point in our diagrams, and are plotted in every histogram and noted in all tables presented. All relevant statistics were calculated using specially constructed software, interfaced with a popular computational and plotting package. The statistical variance was computed and the Bessel-corrected standard deviation was calculated for all data points presented.

No experimental measurement can avoid systematic errors. Special care was taken so that large systematic errors were avoided and any known biases eliminated. Evaluation of any systematic error remaining in the data, led to a figure of 2.5% for all student samples. This figure is considered fair (if on the low side perhaps, in some cases) and is generally comparable with all statistical errors computed. This means that we believe our total error to be neither statistics-dominated nor systematics-dominated, and this holds true for every diagram presented. The total error was then computed by adding in quadrature the systematic with the statistical errors, these two being independent, by definition.

The data are presented in histograms, depicting the percentage of students holding a particular idea. 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.

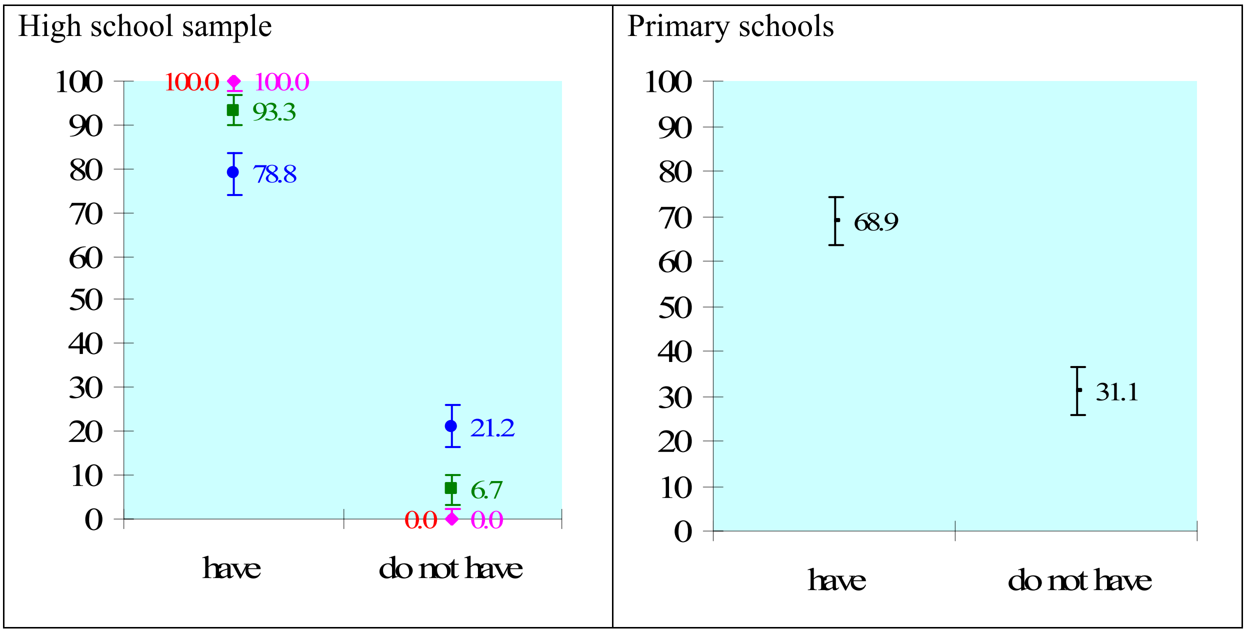
All histograms represent percentages. In the pre-test histograms, the points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refers to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students, (numerical values are also given on the right side of each point on the histograms). It so happens that in some diagrams two points might overlap. In this case, the corresponding numbers are given on either side of the "almost common" point. In some questions of the questions presented, the students could choose more than one answer. For this reason, it is possible the sum of the percentages (for these questions) to add-up to something above 100.

The aim of the general purpose questions were given to define the students' knowledge on ICT as well as their hands-on experience.

7.3 The Research: Pre test statistics

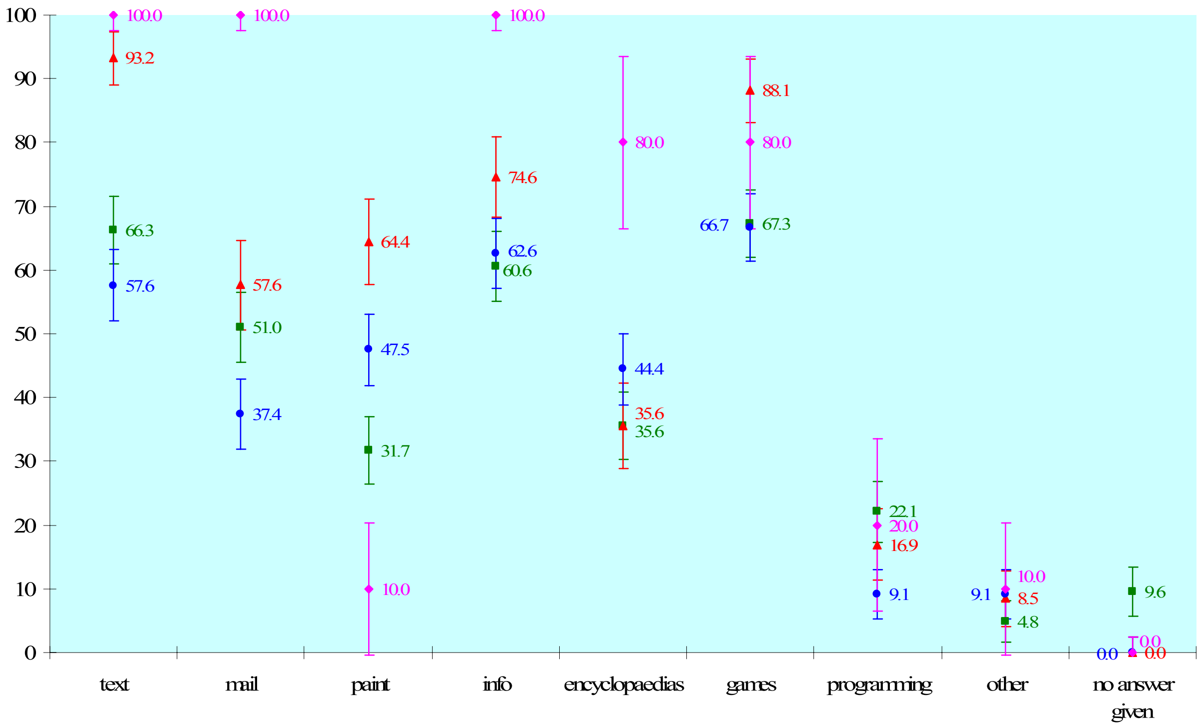
We should mention here that the trials conducted in Greece tested a fundamentally different aspect of use of streaming media in education, namely the one involving pre-recorded videos. In this trial, the following number of pupils participated:
59 students from Austria (lower secondary school, 12 to 15 years old)
10 students from Belgium (upper secondary school, 15 to 17 years old)
99 students from Greece (lower secondary and upper secondary school)
106 primary school students also from Greece, (10-11 years old; these are in addition to the ones above)
103 students from Italy (upper secondary school, 16 to 20 years old)

7.3.1 Do you have a computer at home?



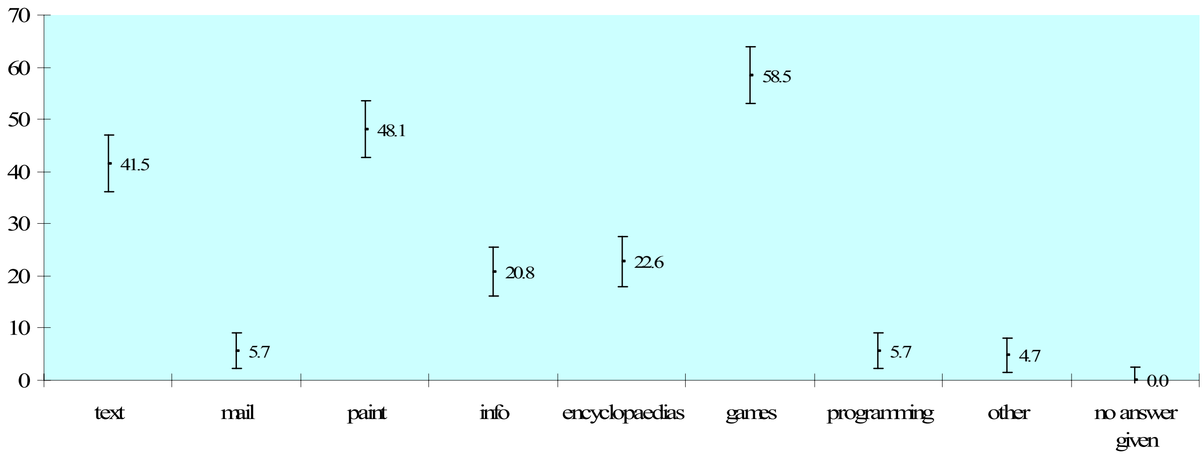
Points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students.
It seems that a smaller percentage of Greek students have a computer at home, something not very surprising given that the country has been slow to adopt ICT. The mean income of the families of Greek students (on a national level) is also lower than that of the other countries, this offering an explanation to the trend observed.

7.3.2 What do you use the home computer for?



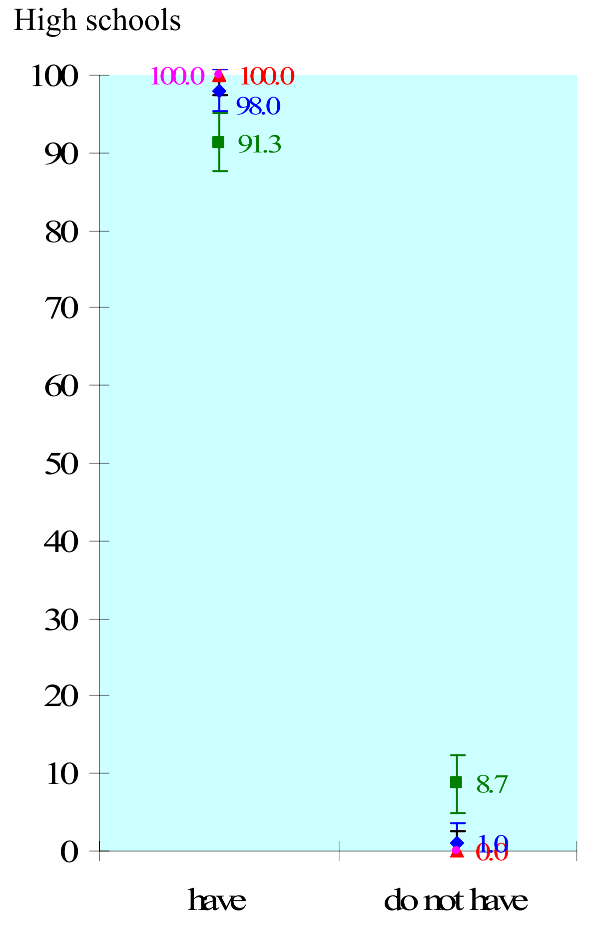
Points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

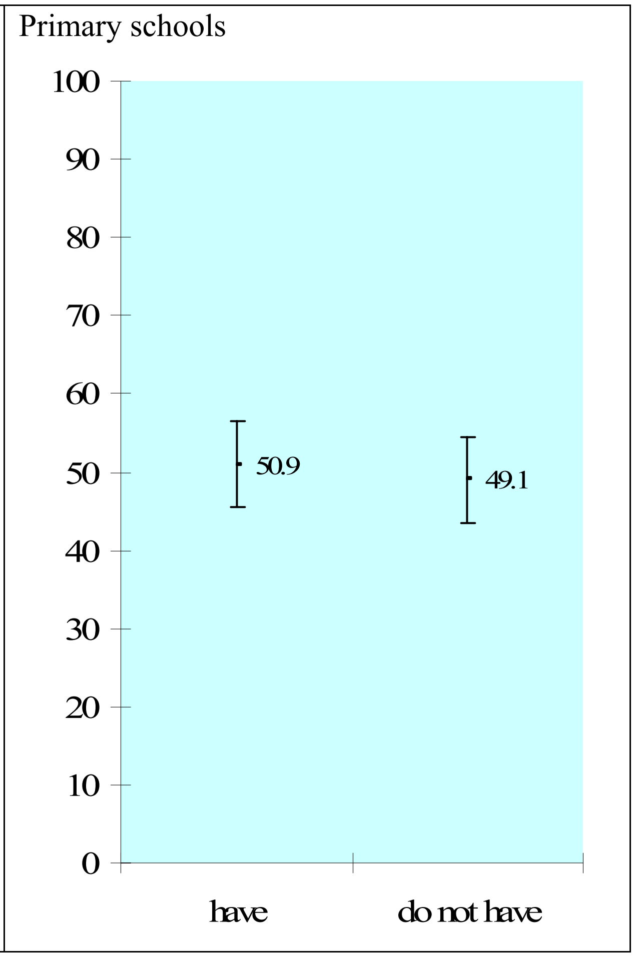
The result that was not expected here is the 80% of the Belgian students that use their home computer to consult encyclopaedias or to gather information. There is also a substantial split between countries concerning the number of students that use home computer for text editing. Perhaps in Austria and Belgium teachers have already started accepting printouts of the students' homework instead of hand-written text. There are, perhaps, some cultural differences observed too: not all countries like to paint on a computer, to a similar degree!



On the primary school sample, we observe that most primary school students use the computer to play games. The other two most common answers were painting and text editing and were to be expected. This is probably because children are young, or perhaps because this is what most parents can "teach" their children to do.

7.3.3 Do you have a computer at school?

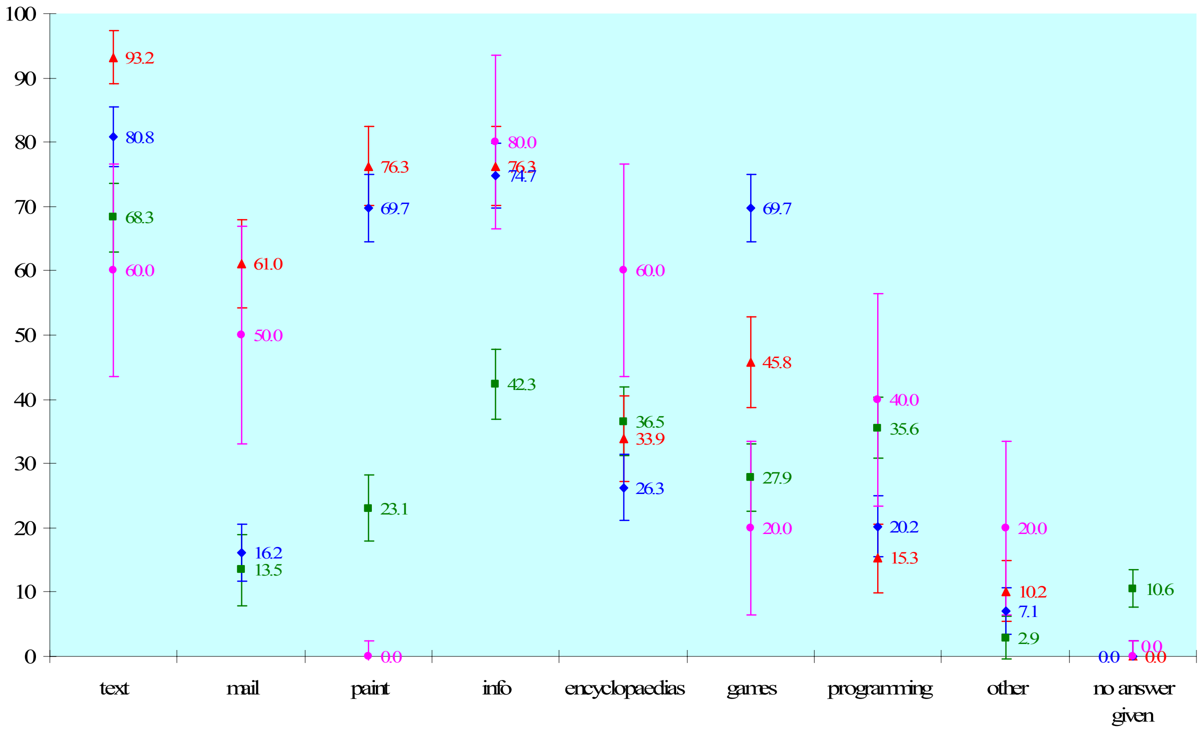




Points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

The results show something more or less expected, since European Union decided a few years ago that all high schools should have an organised networked computer laboratory, and that primary schools should have some ICT equipment as well.

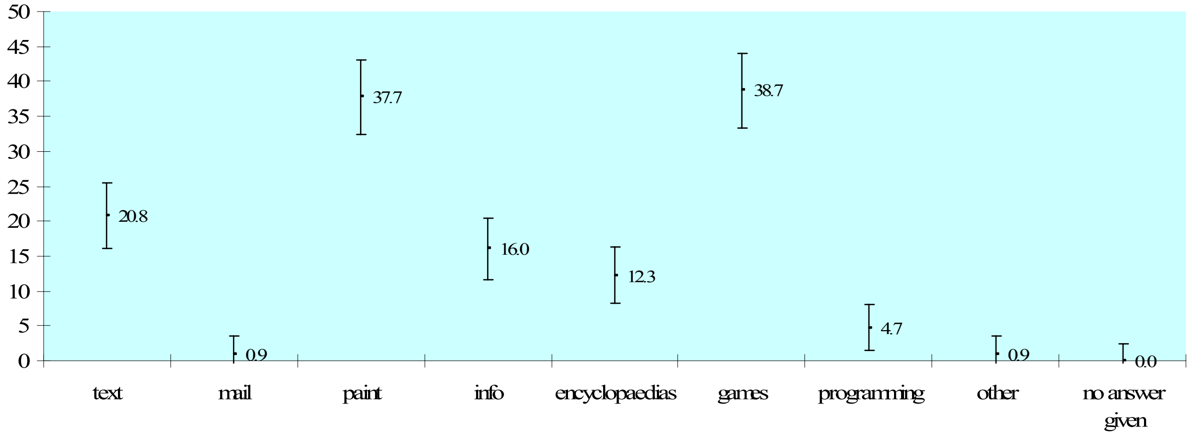
7.3.4 What do you use the school computer for?



Points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

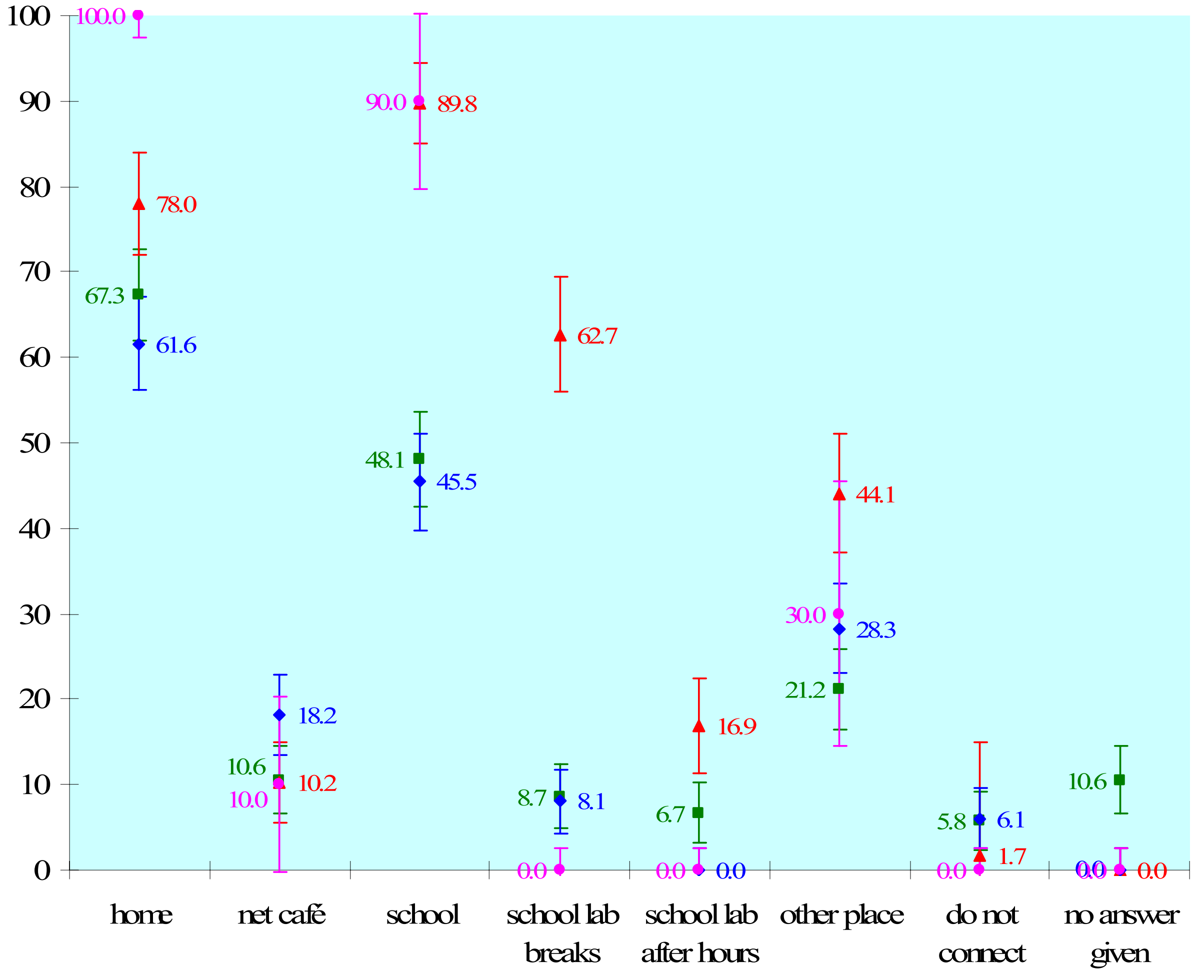
We can observe a small difference to the number of Austrian students that use the school computer for text editing. We also observe that a higher percentage of the Greek students play games at school lab. Although some of these students are younger, (Greek and Austrian students include also lower secondary schools in their sample), this might also indicate that it is about time to revise the ICT curriculum in Greece, and offer to the high school students something more substantial and interesting.

Primary school sample



Looking into the primary school sample, we observe a higher percentage preferring paint and games at school lab, something that was expected. Paint is the application program that is taught normally by default during the optional computer lessons in primary schools, and is followed by a text editing application.

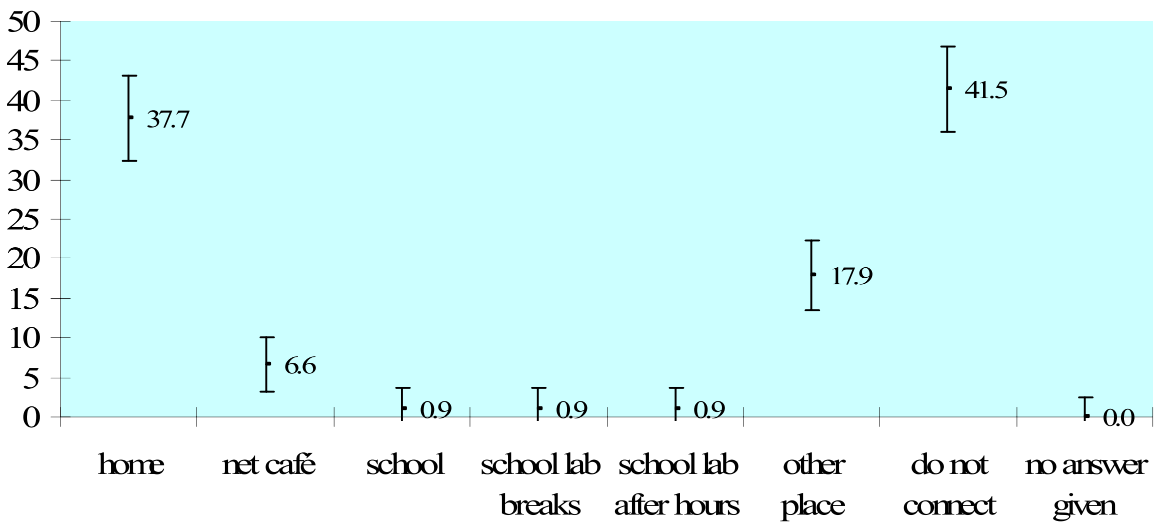
7.3.5 From where do you connect to the internet?



Points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

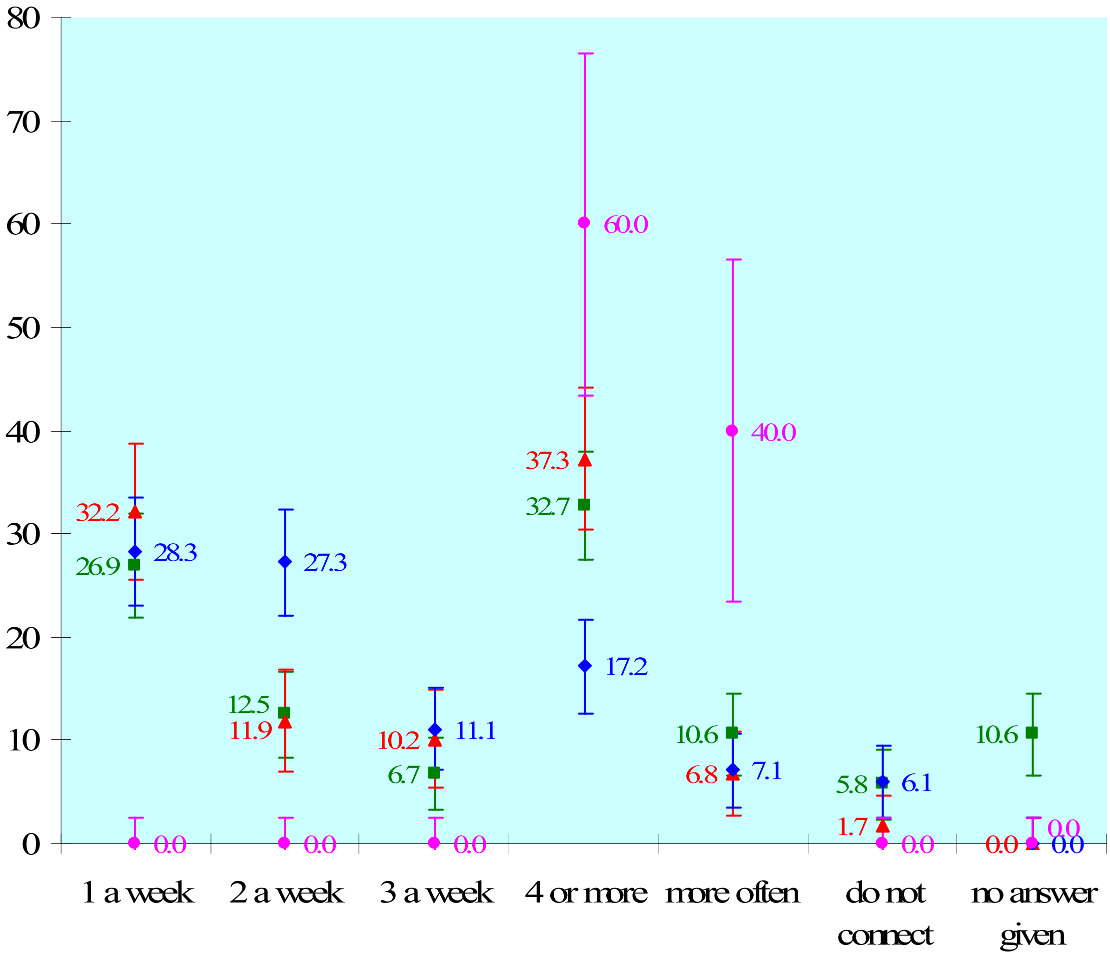
Most of the Austrian students connect to the internet from the school (be that during the lesson or during the breaks). They are way ahead from anybody else. No wonder for that, since all Austrian schools are now equipped with ADSL or satellite broadband internet access.

Primary school sample



Most of the primary school students do not connect to the net, as expected. The reason might be attributed to most parents having only limited knowledge about computers, although they are well aware of the dangers that such activity might bring (e.g. pornography, use of credit card etc). Therefore, they do not so readily allow their younger children to connect to the net unsupervised. The 17.9 % of the primary school children connected from other places is also expected. Primary school students often follow their parents to work after hours or during school holidays and it is common for the parent to let the child use the office computer (to keep it silent, but under their supervision).

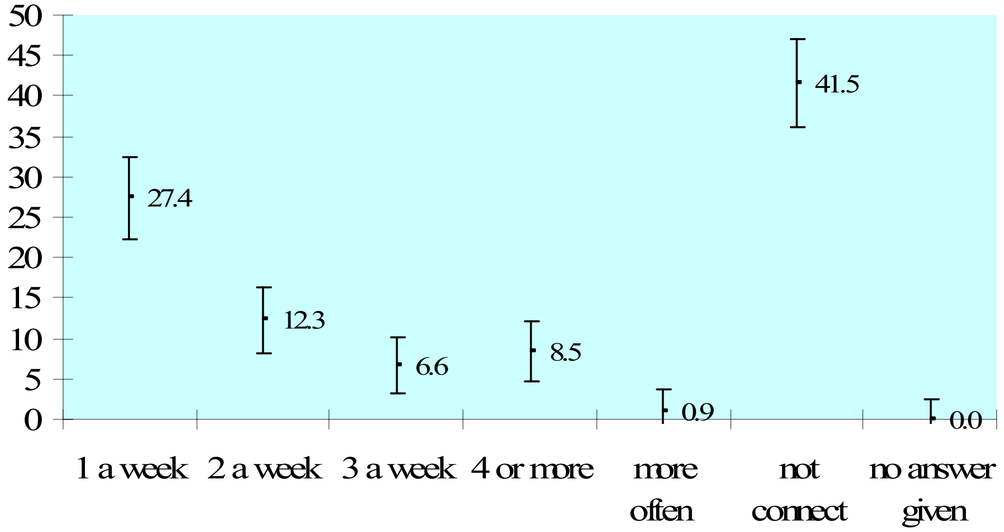
7.3.6 How often do you connect to the net?



Points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

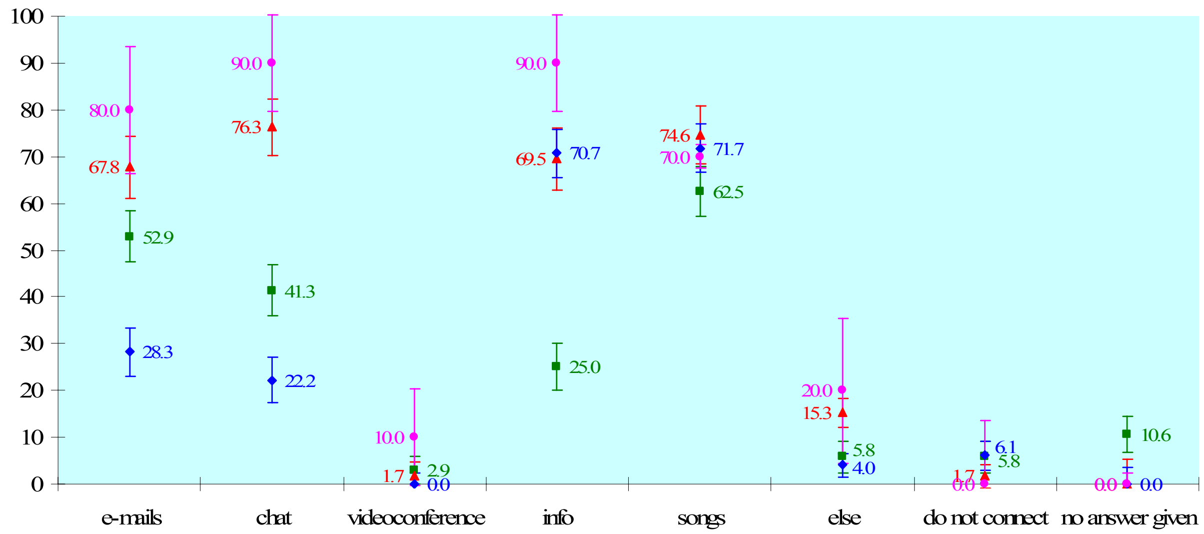
There are no substantial differences observed between the various samples from the countries represented.

Primary school sample



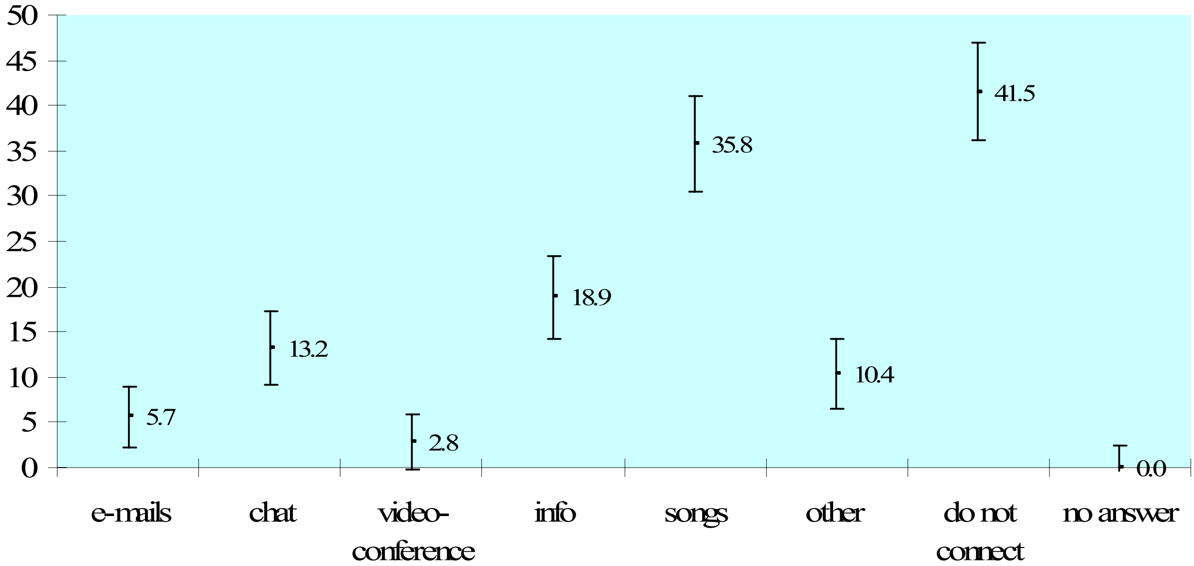
In the primary school sample, only a 40% of the students connect to the net once or twice a week for reasons that have already been explained.

7.3.7 What do you usually do when connected?



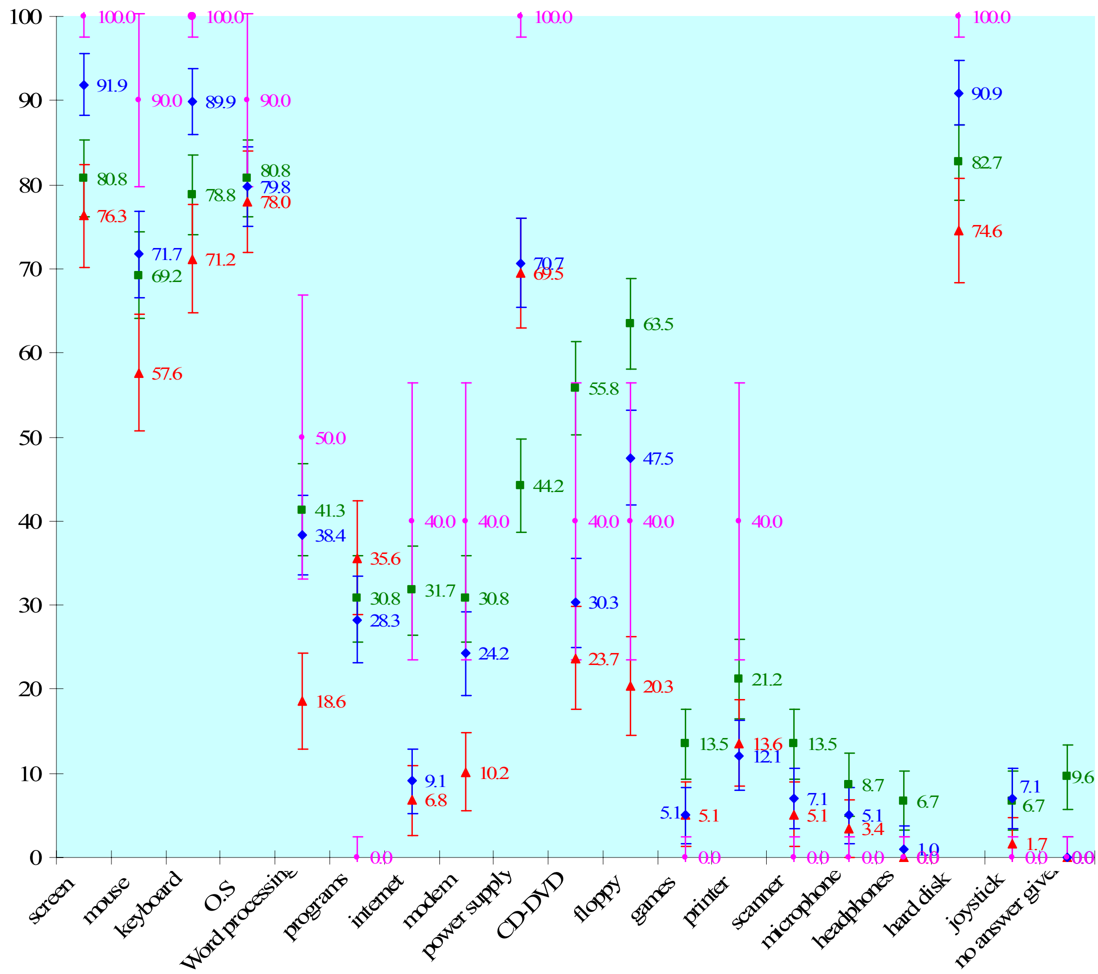
It appears that the majority of the students in all countries use the net for Mp3 downloading as well as for ring-tones. Only a small percentage of the Italians students seek information on the net. Greece is still far behind in communication through e-mail and chat, something well known and partly attributed to the higher cost for internet access in relation to the rest of Europe.

Primary school sample



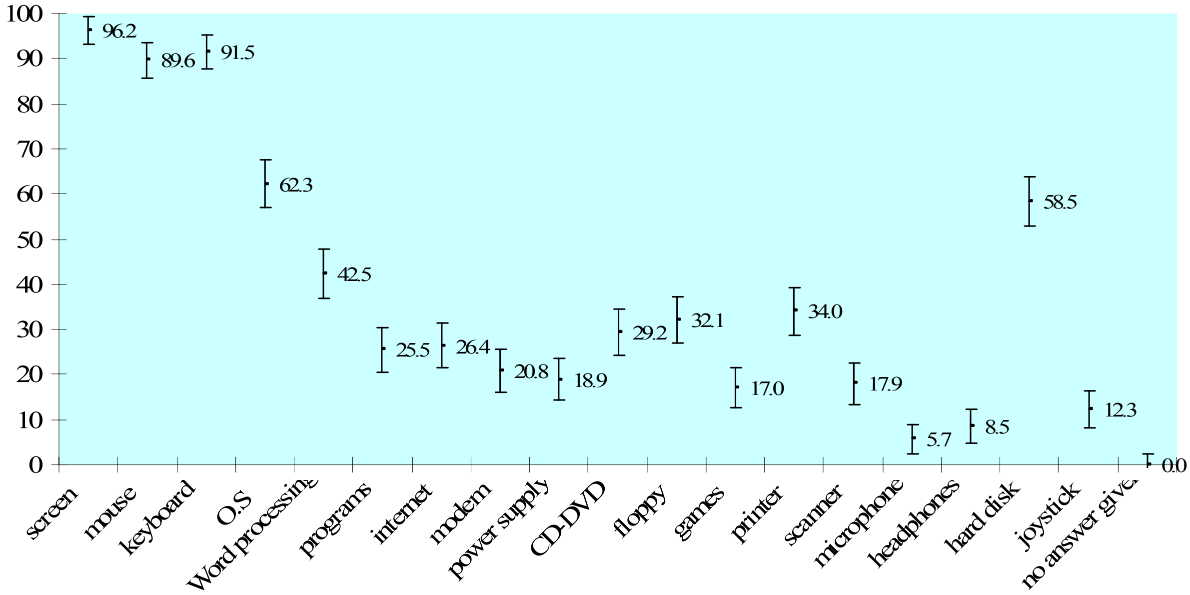
Again, most of the students seem to just search for songs and ring-tones.

7.3.8 Which of the following are <u>absolutely</u> necessary for the operation of a Personal Computer?



Interesting, albeit complicated, data are presented here. Although one should not try to read too much from the answers presented (just look at some of the error-bars), some interesting observations can be drawn hinting on what type of explanation students get at school as regards the scientific explanation on how computers work. This aspect of education is totally distinct from being shown how to operate a computer.

Primary school sample



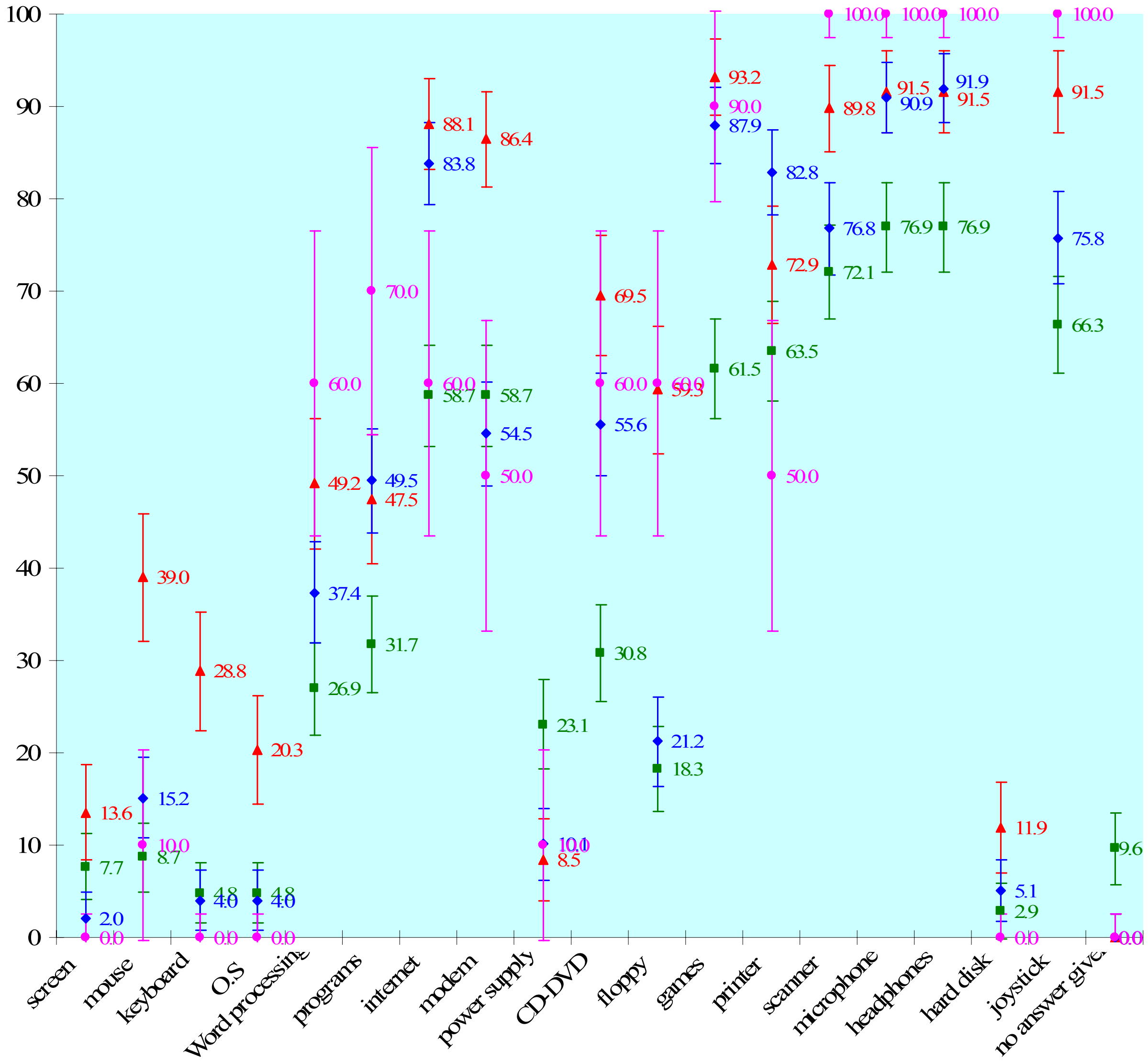
Despite their young age, at least they get the basics right!

7.3.9 Which of the following are not necessary for the operation of a Personal Computer

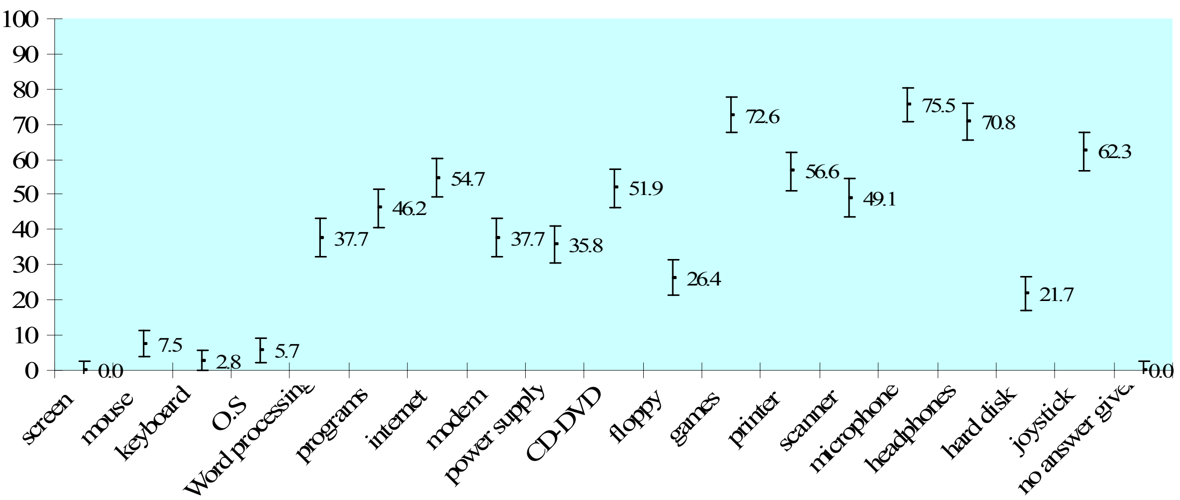
In the next histogram, points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, the ***blue circles*** refer to the ***Greek*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

This is a more "refined" question in relation to the previous one. Again, if one does not try to read too much into in, some interesting patterns emerge. It should also be kept in mind that the nature of what is commonly seen as a "normal" computer today is somehow different to the one we had a couple of decades back. It is unlikely for any of Europe's offsprings to have even seen any of the older relics operating without a hard disk, for example (it shows from their answers too). It should also be kept in mind that we do not quite try to test the scientific validity of such answers; the information presented concerns students' perception of what constitutes "essential equipment" for a computer, as they have seen it to be. This is not an examination question aimed at computer graduates, therefore!

Overall, the picture is not disappointing. If one were pressed for a comparison between the samples from various countries, is would be fair to say that the Austrian students faired best. This is impressive, considering that they are a few years younger (on the average) to the rest. (See student ages at the beginning of section 7.3).



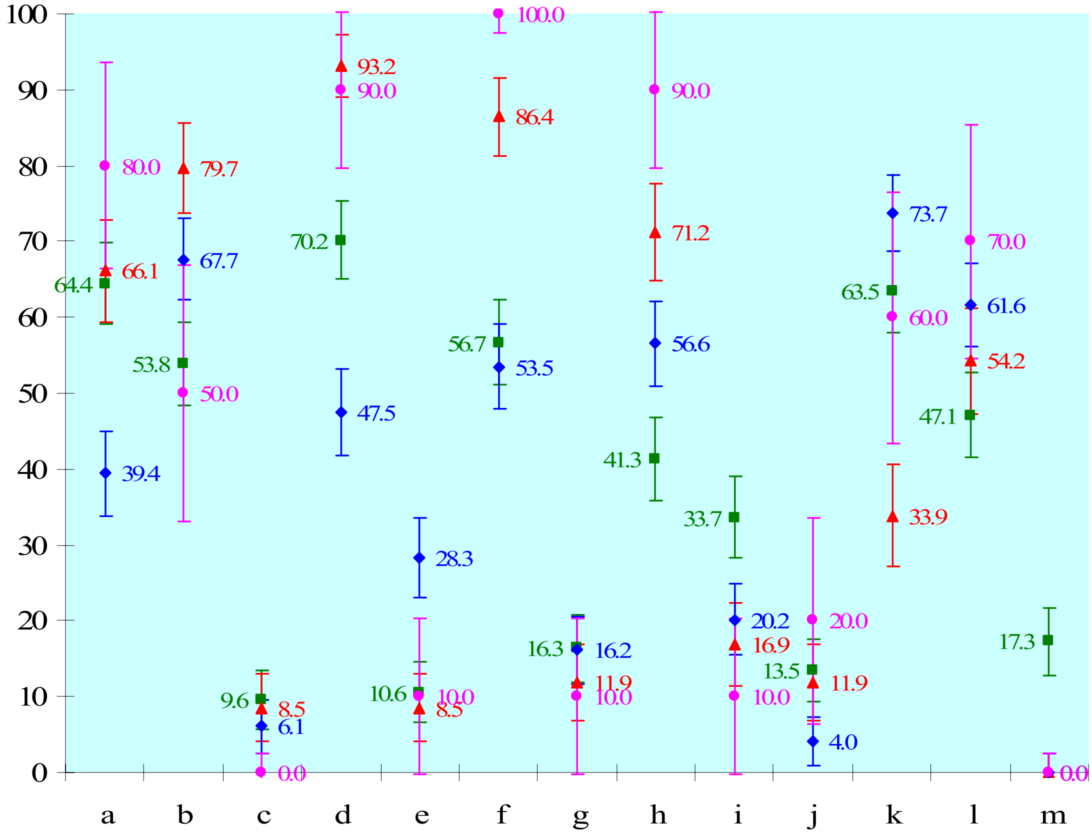
Primary school sample



The overall picture is not all that bad, coming from a primary school. Great potential is shown by these pupils.

7.3.10 Which of the following questions are correct?

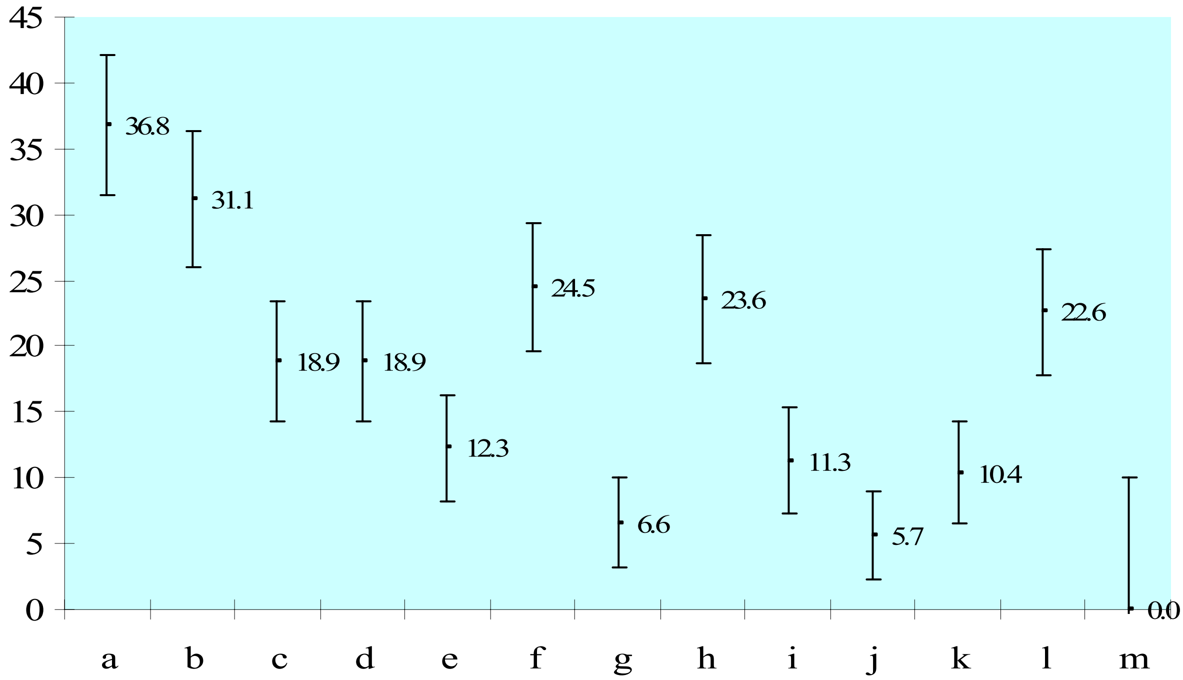
a. An operating system is a program that controls the computer.
b. A program is a set of instructions, explaining to the computer which task to perform.
c. A computer works without any instructions. We just open it and it operates
d. Hardware is the components that a computer is made of.
e. Hardware is the programs that control the operation of the computer.
f. Software is the programs that control the operation of the computer.
g. Software is the components that a computer is made of.
h. In order to access the Internet, a browser, and an internet provider are needed.
i. In order to access the Internet, a browser, a program for handling the e-mails and an internet provider are needed.
j. In order to access the Internet, a browser and a program for handling the e-mails are needed.
k. Visual Basic, Pascal, C, Logo, Perl and Java are programming languages.
l. Programming languages allows the user to create his own programs, fitting his/her requirements.
m. No answer given.



This set of questions is meant as a test of the education students receive as regards IT. Teaching is quite diverse in Europe and this is depicted in this figure. Overall, the above figure shows the depth of knowledge students have achieved, concerning basic IT concepts. The addressing of this knowledge is often done in an indirect way, but it still reaches for the basic concept. Inevitably, one tests for simple things like names and definitions but the picture is still here.

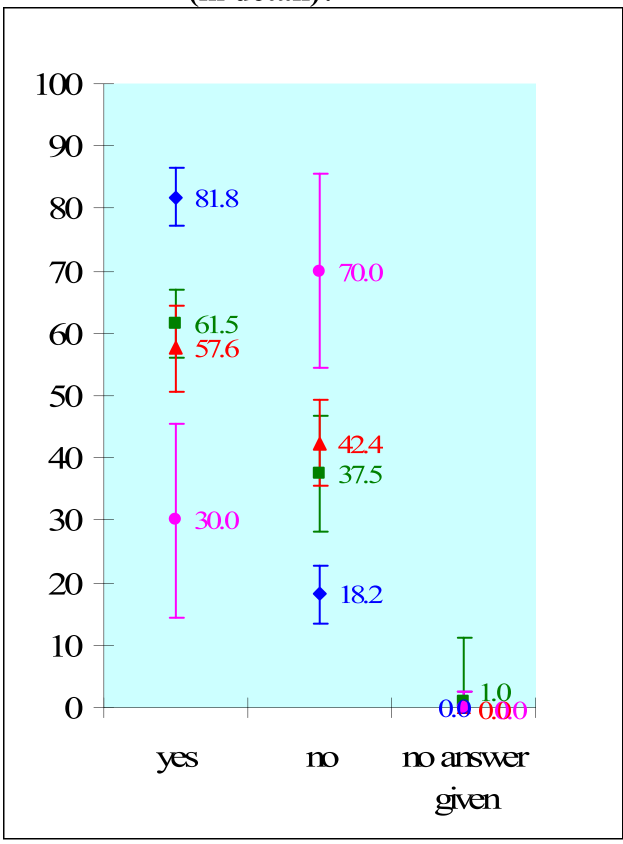
If this image teaches us (educators) something, it is that we have not yet reached a consensus on how a "good and proper" IT curriculum for schools should look like, and where should the emphasis be.

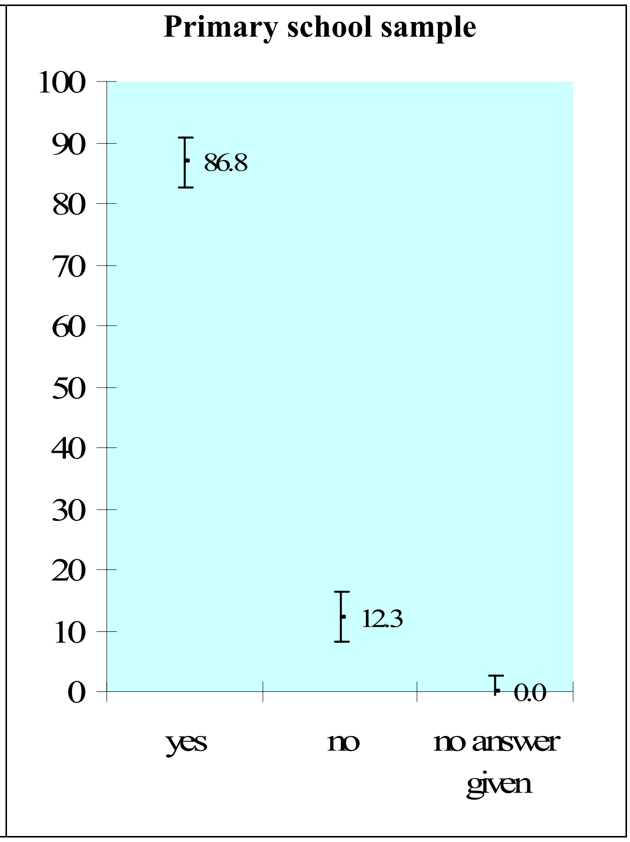
Primary school sample



This set of questions is probably too much for primary school students, given the circumstances. Some of them did quite well, though, and they all had a sporting effort to answer correctly.

7.3.11 Would you like to take lessons explaining (in detail) how computers work (in detail)?



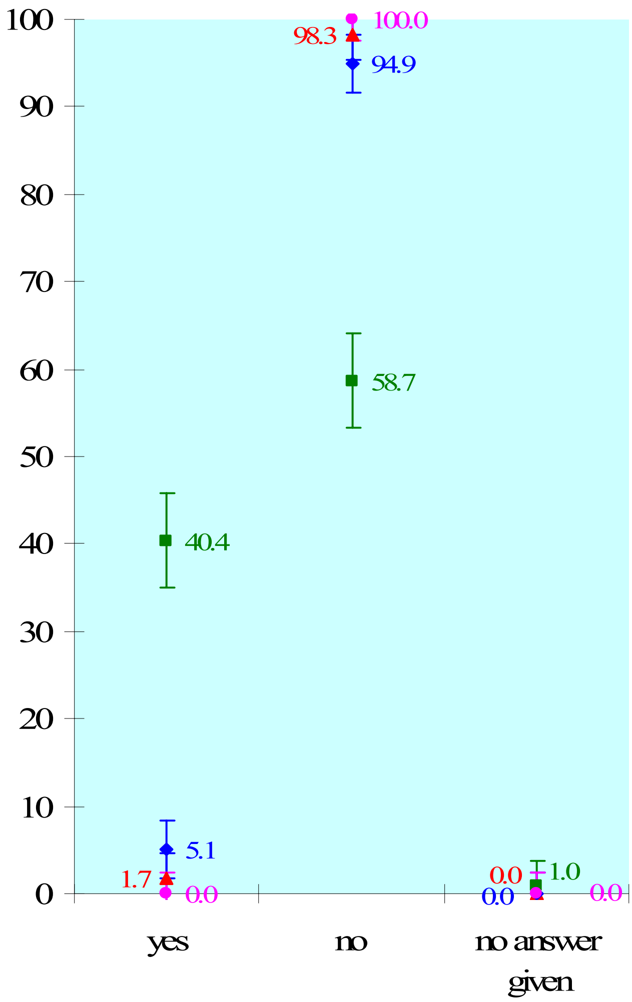


It seems that the Greek students are more willing than the rest to learn about computers in detail. Did curiosity kill the cat?

Younger children want to learn! What an inquisitive lot some of these younger ones are too!

It is perhaps right to ***compare*** this plot with the previous one. We see an overall trend, which is in line with what many research results indicate: young children are more willing to learn new things. As children grow older, they loose their interest in learning[107]. All of us in education should be very worried about this trend, because surely the schooling system and the curriculum have some role to play in this disappointing trend. We all get it wrong, somehow, and sometimes excessively so.

7.3.12 Have you ever taken part in a school project under which you produced streaming video? (I.e. produce your own video film and allow other people to see the video over the internet)



It seems that Italian schools are far in front of the rest of the participating countries concerning the use of streaming media in the class. They should keep up their good work!

Primary school sample
All primary school students answered no to this question, as expected.

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[107] Millar R. & Osborne J, Beyond 2000: Science education for the future (1988) ISBN 1-871984-78-5

7.4 The research: Post test results

It should be repeated here, perhaps, that the trials conducted in Greece tested a fundamentally different aspect of use of streaming media in education, namely the one involving pre-recorded videos. These educational trials are not completed yet due to several different reasons such as delays due to difficulties in obtaining the copyrights for using pre-recorded media, technical problems, translation problems, which simply served as an overall delay in the testing process. All the schools were contacted, pre-tests were distributed, some teaching materialised, and some post-test results collected: it was not attainable to finish the trails during the present academic year, and these will continue during the next one. For this reason, only 43 Greek students (from one single school) have completed the post-test till now and they are all from the primary school sample.

In this trial, the following number of pupils participated:

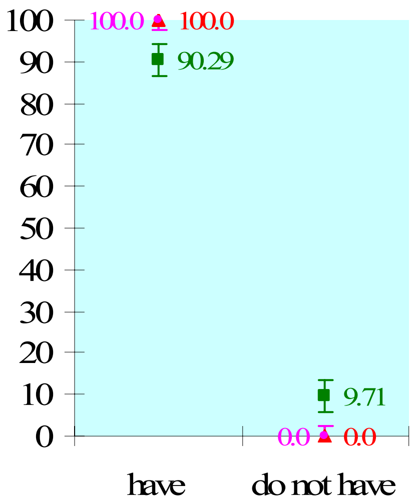
58 students from Austria (lower secondary school, 12 to 15 years old)
9 students from Belgium (upper secondary school, 15 to 17 years old)
43 students from Greece (primary school only 11 years old)
104 students from Italy (upper secondary school, 16 to 20 years old)

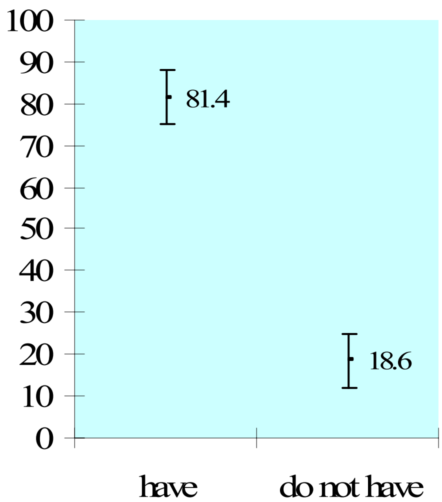
It is well known that students change their mind about things, over time. In addition, some of the students questioned do not pay much attention to the question, choosing at random. In order to take into account these phenomena, some of the pre-test questions were repeated during post-test. Some such correlations are presented in the form of a double diagram.

All histograms represent percentages. In these, the points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, and the ***green rectangulars*** refer to the ***Italian*** students, (numerical values are also given on the right side of each point on the histograms). It so happens that in some diagrams two points might overlap. In this case, the corresponding numbers are given on either side of the "almost common" point. In some questions of the ones presented, the students could choose more than one answer. For this reason, it is possible the sum of the percentages (for these questions) to add-up to something above 100.

7.4.1 Do you have a computer at school?

We got the same results as in the pre-test. That means that most of the high school students were aware of the importance of cooperating in a research and paid the attention they should.

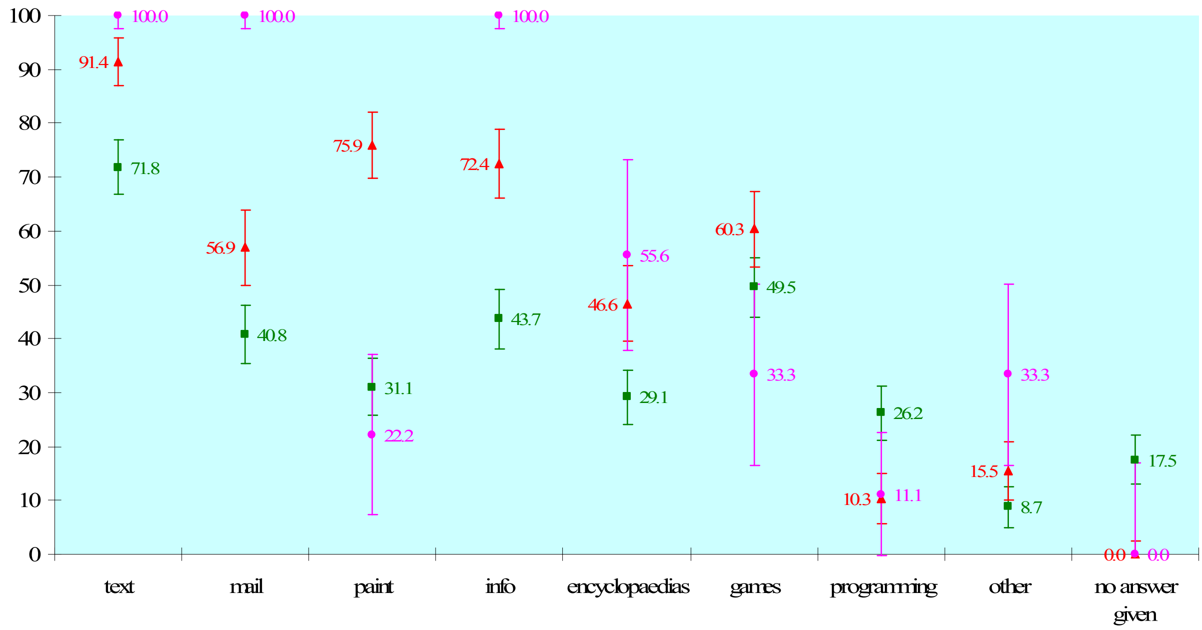




The points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, and the ***green rectangulars*** refer to the ***Italian*** students.
This figure contains no more information from the equivalent in the pre-test, except that it shows that students answered in a consistent way.

Only **43** of the primary school students took the post test. The substantial differences between the pre and post-test were expected, because the sample here is composed of students from a single school.

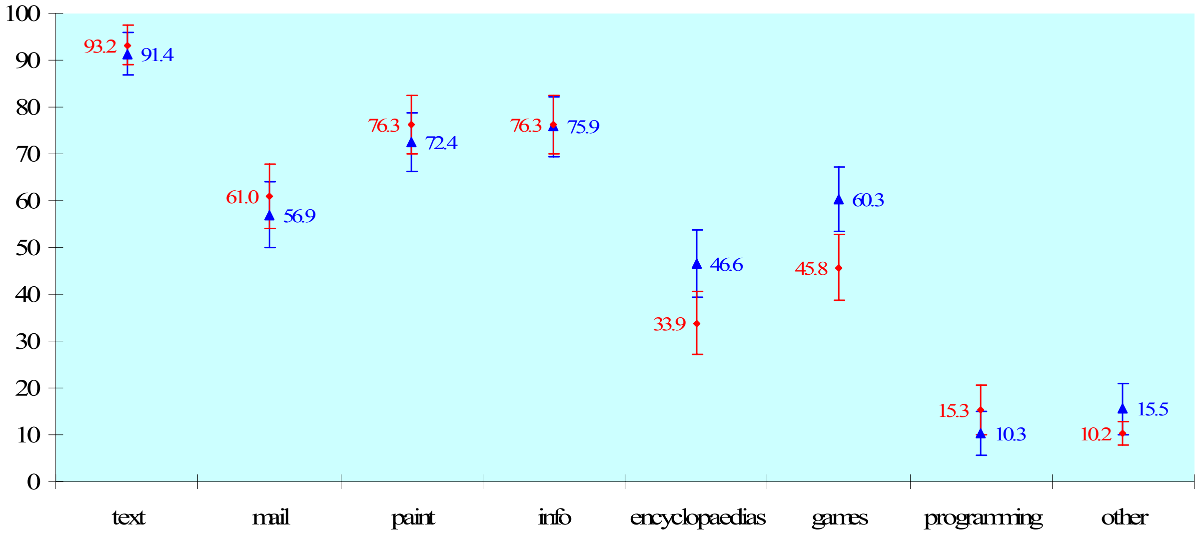
7.4.2 What do you use the school computer for?



The points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

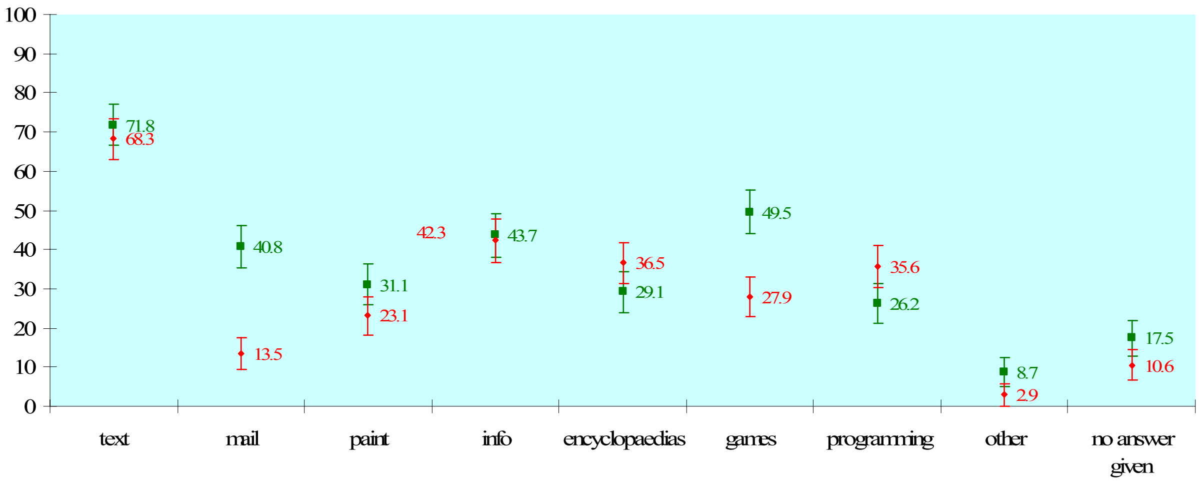
We can observe a small difference to the number of Austrian students that use the school computer for text editing. Although some of these students are younger, (as Austrian students are lower secondary school), they fare quite well. In addition, some small-unexpected shifts were observed. The present question was investigated comparatively.

The following three figures depict the input from each of the participating countries, comparing answers of the pre-test and the post-test from one single country each.



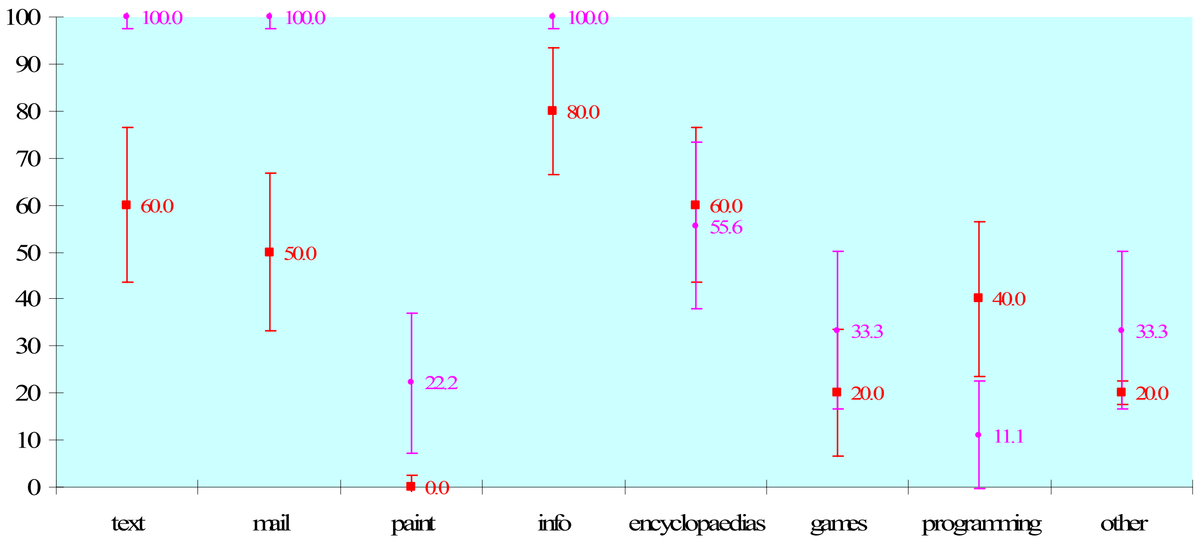
In this figure, we compare data taken from Austria only. Red-diamonds represent the pre-test answers while blue triangles represent the post-test answers.

We observe that the results in the pre-test and post-test are broadly similar. It is obvious that most high school students were aware of the importance of the test and cooperated willingly with it paying due attention to their answers.



In the above figure, we compare data taken from Italy only. Red-diamonds represent the pre-test answers while green rectangles represent the post-test answers.

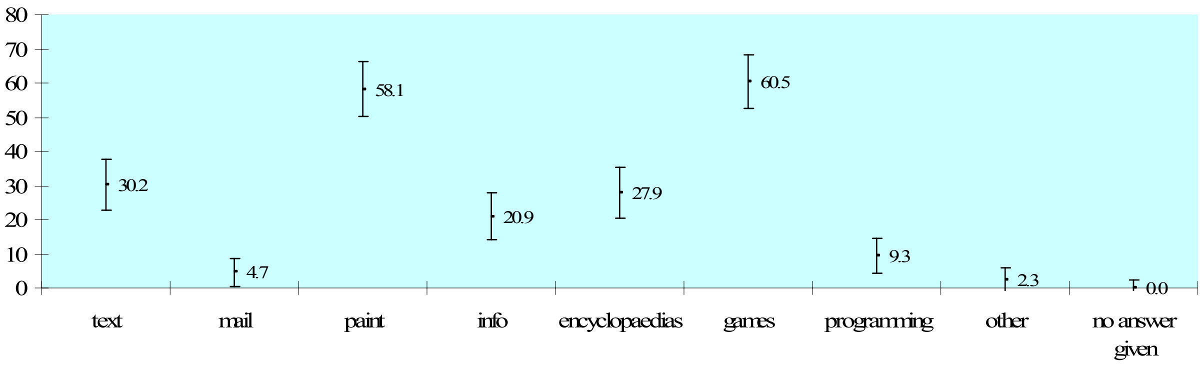
We observe that the results in the pre-test and post-test are compatible. It is obvious that most high school students were aware of the importance of the test and cooperated willingly with it paying due attention to their answers.



In the above figure, we compare data taken from Belgium. Red rectangles represent the pre-test answers while violet circles rectangles represent the post-test answers.

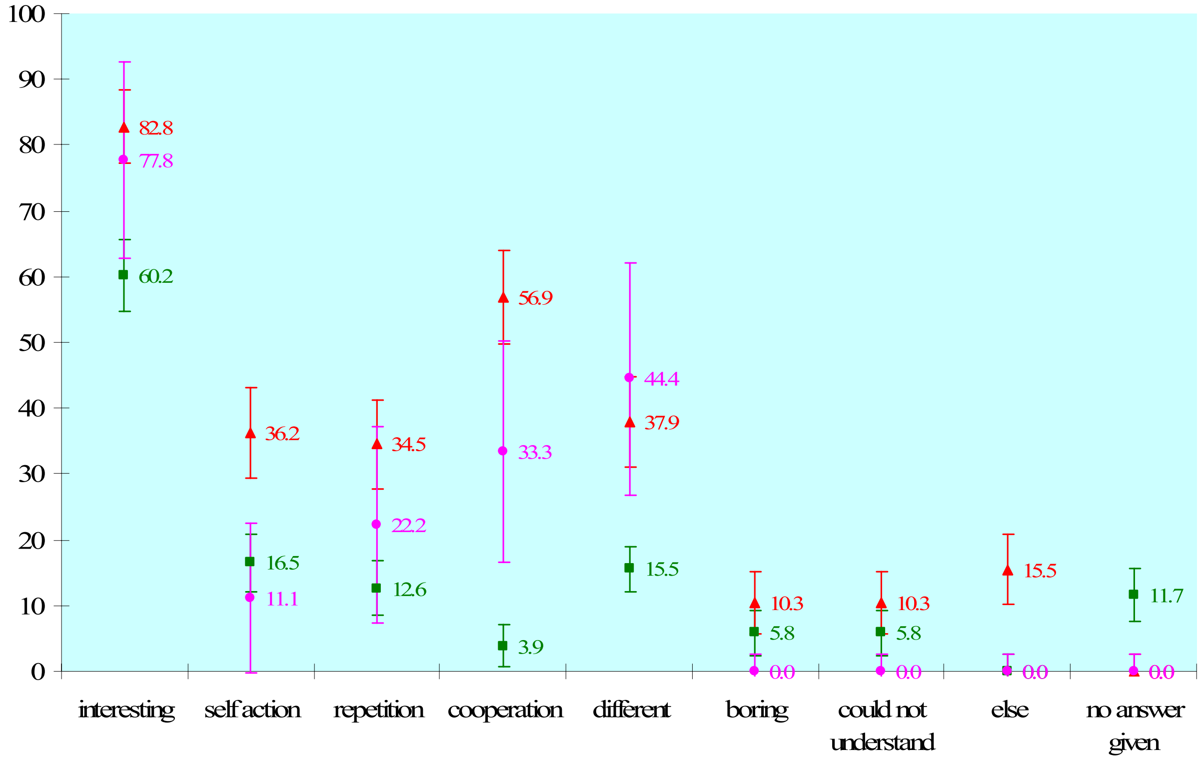
This is an indication that the systematics used in the experimental error calculation might perhaps be underestimated, in this case. Since the sample is just one-figure small (9 students), one can assume that the effect is not that significant, overall.

Primary school sample



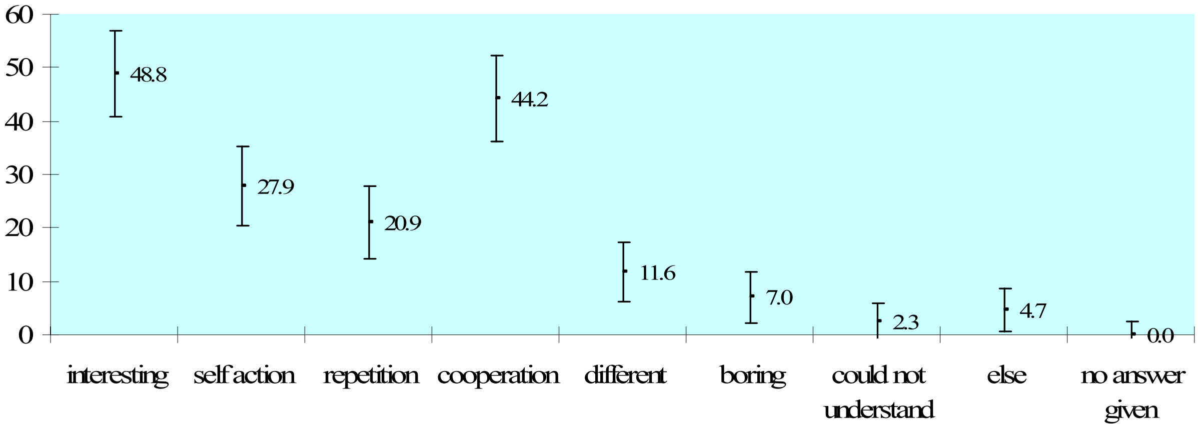
Again, the small differences between the pre and post test results derive from the fact that only a single primary school is represented here and the students in the present sample are more familiar with computers.

7.4.3 How did you find the learning approach?



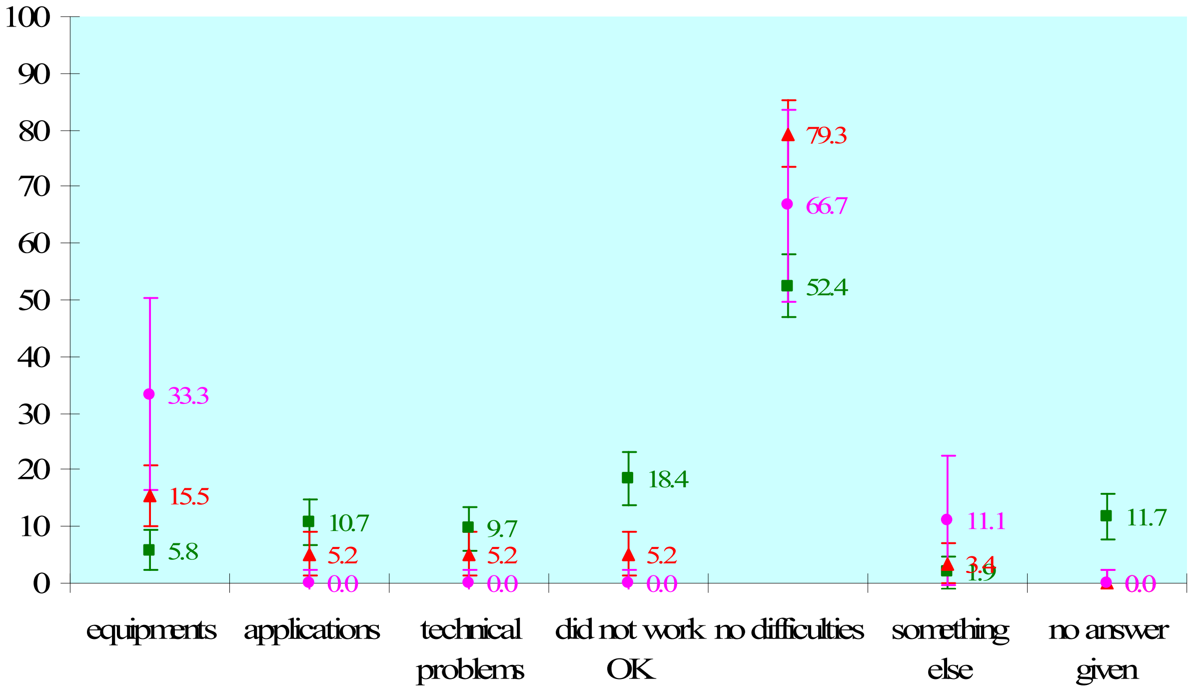
The points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

Please notice that the answers to this question were not mutually exclusive. A student, for example, could have found the experience satisfying and difficult to understand at the same time.
Most of the high school students found the approach (creating their own resources) interesting, satisfying, and improving cooperation. An overall smaller portion of the students had an ambivalent attitude towards this learning approach, and they would need some encouragement from their teacher. Negative comments (in general) were received by a smaller sample of students. Combining answers might give us more insight on how students feel like towards the teaching procedure followed. This might be done at a later stage, after the end of the present analysis. On the other hand, the looks of the data are very encouraging indeed.



The results of the primary school sample are also encouraging, but to a lesser degree, perhaps, than the secondary school. We should not forget here that not only these are younger children, but also the teaching scenario was different too. It involves using a pre-recorded video streamed from the internet. Almost as many students think that teaching approach was interesting, as the ones that consider the co-operation characteristic of the approach as equally important (itself a positive comment too). Considering their age and the circumstances they faced (subtitled translated video and some early technical problems too) these results are, in general, quite impressive.

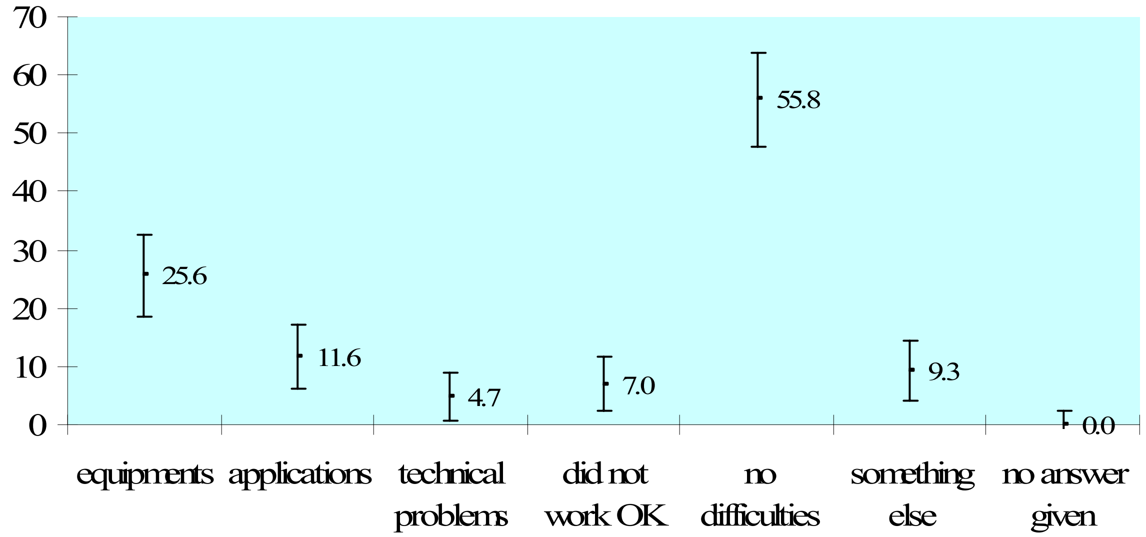
7.4.4 Did you have any problems/difficulties with the equipment or the programs you have just used?



The points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refers to ***Belgian*** students, and the ***green rectangulars*** refer to the ***Italian*** students.

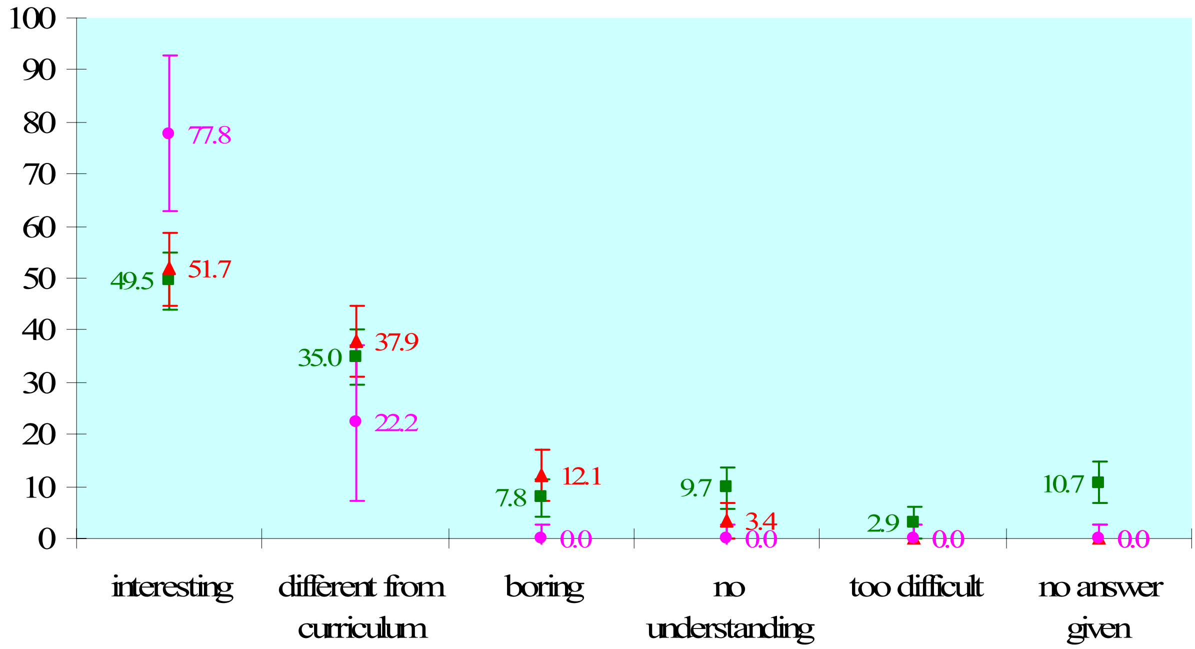
It is clear that most of the students found no difficulties during teaching, something quite impressive in itself.

Primary school sample



Most of the primary school students encounter no difficulties. The 25.58% of them answered that that found difficulties with the equipment, which obviously refers as much to the performance (internet speed, short time given to subtitles appearing in relation to narration, and all that) as with them operating the device. Younger children like these are still not that familiar with PC equipment.

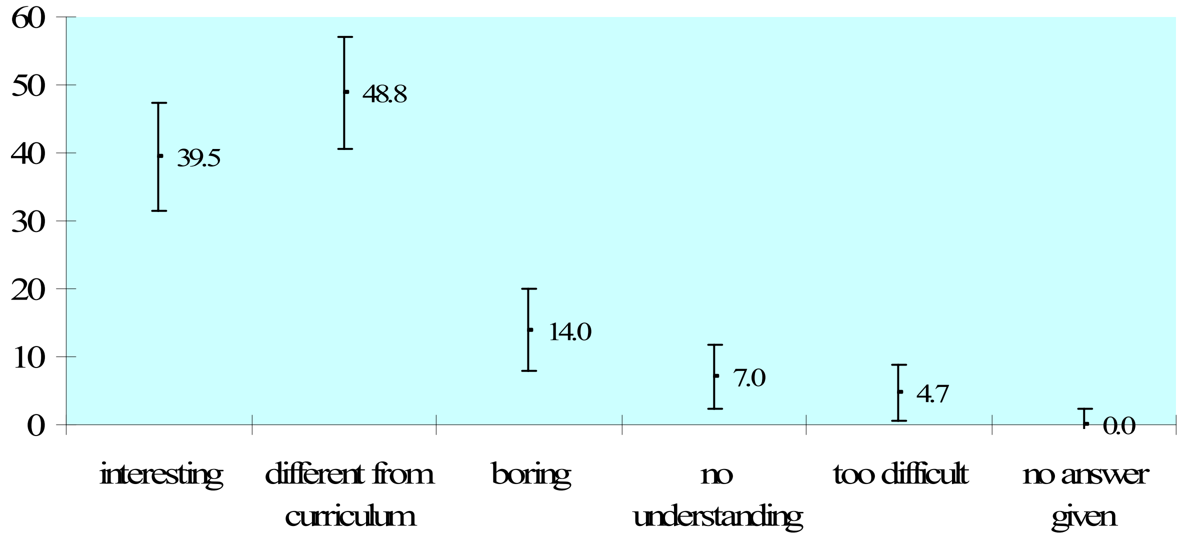
7.4.5 How did you find the content of what you were trying to learn? (You may select more than one answer, if you like)



The points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, and the ***green rectangulars*** refer to the ***Italian*** students

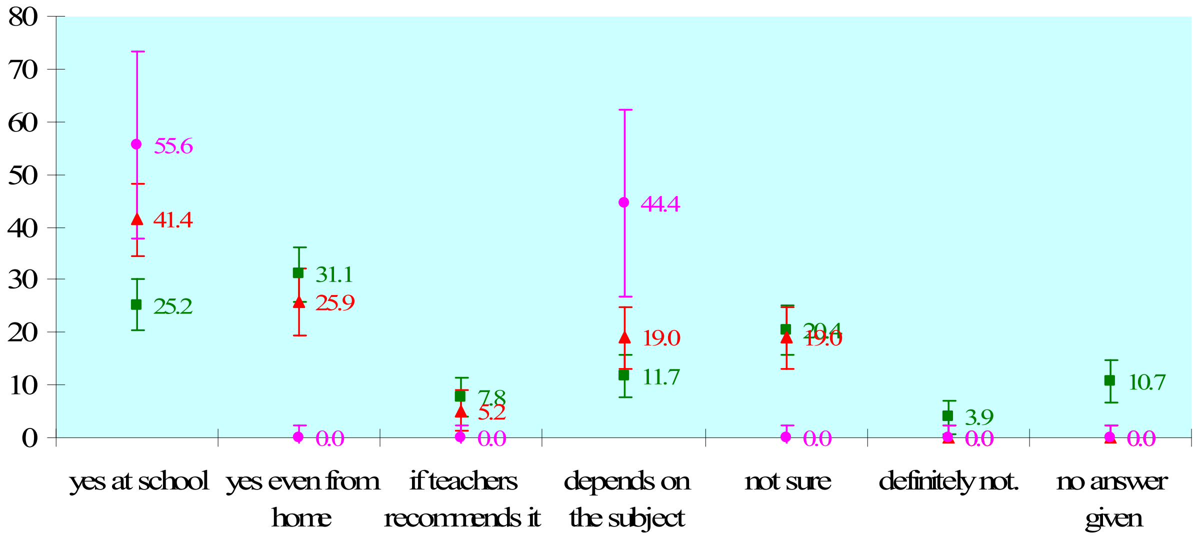
Most of the students found the content of the lesson (while constructing their own resources) interesting. A rather sizable percentage remains uncommitted (i.e. undecided) as to if they liked it or not. They prefer to give the more vague answer of the new experience being "different" from what they normally do at school. A very small percentage was broadly negative about the experience they have had.

Primary school sample



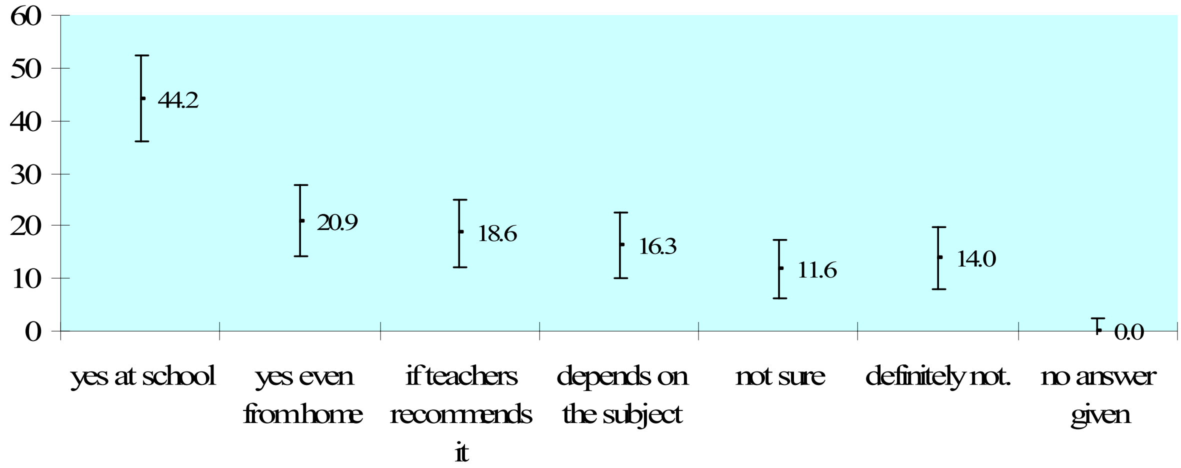
Broadly speaking the same observations as with the secondary schools, apply well to the primary school student sample.

7.4.6 Would you like to participate in another lesson taught the same way?

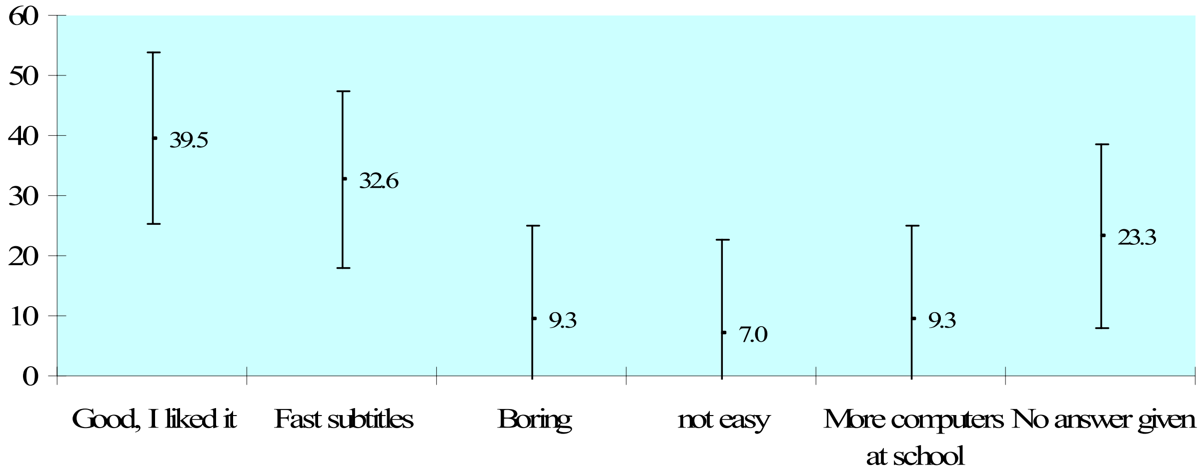


The points represented by ***red triangles*** refer to ***Austrian*** students, the ***violet circles*** refer to ***Belgian*** students, and the ***green rectangulars*** refer to the ***Italian*** students

Most students would have liked to participate to other similar activities. The second bin, in the figure above represents an even more positive opinion than the first bin. These two bins added together result in the finding that the majority of students (i.e. more than 50%) are positive about streaming. The third, fourth, and fifth bin answers come from students uncommitted in one way or another, those that would require encouragement to proceed along this line. Some think that it is not certain that it suits all subjects taught, while some state that they will adopt the teacher's opinion on it. An almost negligible percentage disliked the experience they had, and that is very encouraging indeed.



Most of the primary school students would also like to participate in another teaching activity. This too is mighty impressive.



Primary school students also reported some difficulties they found. Most of them found difficulties with the subtitles. They were too fast to follow. This refers to a technical problem that will be solved very soon, hopefully.

7.5 General research conclusions

The research successfully conducted by the partners of the e-stream team has demonstrated the state of the art of streaming media in Europe, today. It has highlighted all the important educational aspects of the technique, some of which have to do with ***collaboration***, ***interest build-up***, ***vitality***, and crucially ***learning***. It is fair to point out that all e-stream partners succeeded in their teaching, which was well received by the students. Most of the students would have liked more of the same (they were, thus, pleased with what they experienced).

Each partner was left free to choose the didactical approach by which streaming media will be used and tested in his area. It is significant that all groups succeeded in their effort of ***motivating***, ***capturing students' interest*** and ultimately, ***educating***.

Learning *using* the new media, also brings *learning about* the new media, as an extra-bonus to the schools. This is something that was investigated during the pre-test stage of e-stream testing. (Most of the students have gone through at least some ICT experience in school). The questionnaires taken reveal most of all, the ***eagerness of the students to learn***. This resulted in them trying to understand (and not just use) IT. This is not always done consciously, from the part of the student. Whether or not the schooling system succeeds in helping the student in that effort is a different question altogether. On first account, the results are mixed, on this one (and e-stream just tests and reports it, it does not aim to intervene here). It appears that some schooling systems succeed well on average, while some others do not. Again, some individual students succeed, despite the best efforts of their system so that they do not!

On second thought, what we have seen in terms of ICT teaching is not very surprising. ICT is a very new subject, it has relatively recently been introduced in schools, and just not enough time has elapsed for researchers and educators to form a consensus on what is to be included in that curriculum, let alone how one could teach that. Subjects like Mathematics or Science had centuries to sort that question out, while they never had to face the question of teaching a field of knowledge which, if it is taught superficially (i.e. just user-knowledge), it becomes truly worthless so rapidly. From the first findings it would seem that teaching in our schools is good and efficient but in quite a few cases it is superficial and, therefore, it will not stand to the test of time (in the sense that as technology changes, what we teach becomes useless). It would appear that only a more “in depth” teaching (as opposed to simply teaching the use of ICT), will give to the students something of lasting value, that will be of any use by the time students get a job. Could ***streaming*** cure that? Perhaps yes, if the subject it will try to teach is ICT. Nevertheless, yet again, this is not our main aim in our research. We just report the findings, as we deem them to be significant, in that they record the situation in many European countries at the same time.

Students received ***streaming*** very well, as it appears from the report of the researchers and the teachers. On the everyday negative side, the research performed has revealed some of the problems that we all suspected that they existed, but we were never able to quantify their importance. Some were explained in chapter 5 where the teaching scenarios were expanded.

So ***streaming*** is strong but not without worries. Amongst those, the ones with educational considerations (quite involved though they may be) we all feel quite confident that will all be answered, in the end. The technical contingent seems to have answers to all major questions; in any case, further (important) improvements are on the way, and promise to solve the remaining glitches wonderfully. This research has also allowed two other major obstacles for streaming adoption and proliferation. The first has to do with copyright management for the media streamed. It is a legal issue, which is both complex and international at the same time. It is not totally unrelated to the second obstacle, namely translation, transliteration, or subtitling of media. Both these issues have their financial aspect. The serious consequences of such issues can be found in the annals of technology: quite a few of otherwise excellent products failed to take off due to lack of availability of media content. Precisely because, in the case of streaming, enormous interests are at stake, one can trust that, eventually, these obstacles will be overcome.

8 Emerging developments and their expected impact on streaming media

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Caveat emptor: futurology is a precarious subject to embark upon. Furthermore, when trying to predict developments in ICT, the rate of change is so rapid and the direction of change so unpredictable, that even great thinkers have in the past failed to foresee important developments.

Yet, even a wrong prediction is a much better option than no prediction at all. By not taking into account potential change, you are bound to loose, and loose a lot. Education is in an even worse predicament. As educational software and specialist tools need time to be developed and further time to be tested, education is chronically slow to respond to changes, and could even sustain great loss of effort (as it happened many times in the past) if it “bets on the wrong horse”. By the time the educational software (either streamed or not) is ready and tested, it is already useless, as the technology has changed and it will not operate in the modern environment, or alternatively the need to use the tool does not exist any more. A systems analyst is indispensable, especially at the early stages of design of educational tools.

Keeping all that in mind, here is a list of future developments that are considered potentially to be capable of affecting streaming media in general and its use in education in particular. As many of the factors presented affect each other (mostly in a positive manner), some of the arguments would seem convoluted: They often really are!

8.1 Infrastructure: technical developments.

The deployment of ***network lines of ever-increasing capacity*** will continue resulting in increased overall capacity to transmit data. This development will make internet much more stable than at present, and more reliable for streaming.

Satellite technologies already play an important role today (mainly for trunk-line data-transmission over long distances), and it is possible that ***direct satellite links*** to and from the final consumer will have an increased role to play in the future, as various commercial companies will compete for a better service to the final consumer.

A very special infrastructure development lately is ***The Grid***. The Grid is the ***most generalised, globalised form of distributed computing*** one can imagine, and behind it is CERN, which is Europe’s supercomputing centre and Europe’s particle physics research centre. (Incidentally, CERN was where the web started too – it was literarily invented there!) The Grid is attracting a lot of interest lately, as it is potentially ***revolutionary.*** The Grid is currently governed by the Global Grid Forum, defining the ***Open Grid Standards Architecture.*** Through these standards one can rest assured that future Grids will not rely on cycle scavenging (e.g. seti@home style) from individual processors, but rather on load balancing between different independent large resources, such as clusters and local Grids. The Grid goes ***well beyond simple communication*** between computers and its ultimate aim is to turn the global network of computers into ***one vast computational resource***.

8.2 Bandwidth demand

The demand for bandwidth will increase for several reasons. It is already considered certain that telephony will quickly change from the circuit-switching model of today to the packet-switching model in the near future. This streaming technology together with possible increase in demand for video-telephony (another packet-switched real-time streaming application) will increase demand. A large increase can only come by the adoption of video streaming on a very large (commercial) scale, either as video on demand by future “TV stations” or by “near-video-on-demand” service. This can be achieved today either using xDSL lines or using direct digital satellite technology. The latter is today via simplex transmission (i.e. no interactivity), and using simple broadcasting as a model. Developments in satellite technology could change that to near-video-on-demand, and later even to real video on-demand streaming. In addition, if terrestrial systems prevail (see later on in this chapter), TV-news broadcasting will be transformed into a real-time streamed video transmitted on the net. Interactivity (of a certain level) can result mainly from developments in home TV-sets being transformed into what will effectively be media-computers (probably sold under a different name). Whether or not the final data transmission will be from a terrestrial system (i.e. the development of xDSL, WiFi, UMTS, Bluetooth, etc) or an extra-terrestrial one, will depend on many factors but mainly economic ones. It is considered likely that both will coexist, as different countries with different geographies, climate, and population concentration, have very different needs.

8.3 Cost

It is perhaps a fair assumption that the developments in infrastructure will continue to be more profound than the rise in demand, at least in medium-term future. This effectively means that because supply will exceed demand the cost to the final consumer will fall. This means that both in terns of actual final cost per MB of information and/or in terms of monthly cost of service, prices will fall, perhaps substantially. Maintenance (or growth) of revenue for TELCOs (i.e. telephone companies) will depend on the growth in demand (i.e. more MB if information being transferred). As actual final costs are reduced, it is expected that educational use of available bandwidth will increase.

8.4 The final kilometre (of connection to the user)

It is not so obvious that the (monetary) cost for maintaining copper telephone lines and/or cable are lower than the costs for maintaining any type of wireless (or cellular) connection. As quality of service and transmission speeds of mobile networks (GSM / GPRS / UMTS) are increasing, and becoming comparable to those offered by xDSL networks, mobile telecommunication companies have already started competing with ordinary telephone companies for what is effectively the same market. The possibility of mobile networks totally replacing traditional TELCOS really exists; ordinary telephones could really become extinct. After all, it is not certain that we need both methods of connection. As mobile telephone companies amortise installation costs, the cost of maintaining existing network is the only serious factor differentiating the two kinds of service. It is uncertain if it is cheaper (or even if it is worth to) maintain our existing telephone lines for the last kilometre to homes, offices, and schools.

Some (but by no means all) of the telephone companies have realised their predicament. They have already started the process of converting their operations from line switching to packet switching. The question is if it is already too late. Mobile telephone networks in Europe have already started incorporating packet switching, for some time now. Non-mobile companies will need to innovate just to survive. Faster and more reliable xDSL type connections should proliferate, and costs should fall substantially, just to maintain customers. In the longer term, it is perhaps inevitable that inner-city areas (or even whole cities) will be covered by WiFi type "hot-spots" offering internet connection and videophones and voice-phones. Under this scheme, common copper-wire connections will only be reserved for rural areas. Even under that scheme, it is imperative that non-mobile connections should have a distinct difference in network connection speed (i.e. one order of magnitude) in comparison to the mobiles, for their service to be perceived as distinctly different; otherwise, consumers will choose mobile only. Some of the problems outlined above seem to find their solution through plans for ***fourth generation*** (4G) networks (see below) which are thought to be "***pervasive***" by design.

Education should be prepared to make the move to mobile services as needs arise. In the meantime, education could make use of the reduction in costs that this competition will bring. Wireless streaming over the last kilometre (from the telephone exchange) is probable. If whole cities become WiFi hotspots, the use of portable computers, tablets, and portable (dedicated) media player devices in schools will be further facilitated. Educational research on the use of such devices in schools, to the extent that it is possible to be done at present, could provide helpful guidance for such potential changes in the school environment.

8.5 Terrestrial versus extra-terrestrial web connections

As a corollary to the above discussion, extra-terrestrial (i.e. satellite) links will most probably coexist with earth-bound connections, mainly serving remote areas (e.g. small islands, mountains etc) or sparsely populated areas, with (interactive) television, web, and telephone.

There are already pioneering educational trials serving schools in remote areas of Europe with high-speed internet[108], and monitoring the educational impact of such profound technological development.

8.6 Streaming or downloading in the future?

It is quite possible (even probable) that land-based WAN networks will provide in the future ***so high a bandwidth*** that transmission time will become insignificant, even if we use the download model instead of streaming. On the other hand, streaming offers additional advantages over downloading; therefore, even in this case it can be expected to remain at least as a valid alternative in the near future.

8.7 Legal issues concerning copyrights of content on an international scale

One can only hope that this important matter will be solved. There have been some recent attempts to solve the issue in the USA and EU, but they have not yet been tested in practice (i.e. in court). Several issues are involved, all clearly outside the scope of the present publication. Indeed, some of the issues involved seem to be only understood by specialist lawyers. As internet is universal but laws national (by definition), enormous issues are involved, while technology makes possible the previously unimaginable (e.g. "exchanging songs" on the net). Inertia in understanding the technical issues and altering existing laws is such that by the time the law is enacted, technology has changed, thereby rendering the law redundant. It is clear that the system is presently ill-equipped to deal with such issues (for various reasons). Yet the problem must be faced, and one can only hope for the best

[108] Education Highway - Centre of Innovation for School and New Technology, Lintz, Austria, private communication.

8.8 Development of large data bases of streamable media, or educational portals

It is imperative that such web portals and / or databases containing suitable materials should be developed and maintained properly. The material contained should be described in a manner that can be searchable by the potential user without first seeing it. Issues involved are legal copyright issues, language/ translation/ subtitling issues, transmission format and transmission speed issues, and many others more common to the operation of large streaming sites. The evolution and adoption of MPEG metadata standards describing video content might help along the way. A Google-like extended web search might (in this case) solve some of the problems in selecting amongst video clips available, but even this could hardly be considered to be a real-time task; accuracy in the content description cannot be guaranteed nor can the streaming speed be in any way pre-recorded and pre-selected for, as it depends on many factors. A lot of work is still needed to improve such selection and accessibility issues.

8.9 Interactive whiteboards

Interactive whiteboards are large display panels used in classrooms, and function as a combination of ordinary whiteboards, data-projector screens, electronic copy-boards, and computer projector screens on which the computer image can be controlled by touching or writing on the surface of the panel instead of using a mouse or keyboard. (Here we are not referring to “virtual electronic whiteboards” such as Microsoft NetMeeting, which are used for virtual conferencing).

Their primary function is as computer data-projector screens, but as they are interactive, they actually are a lot more than that. Technology allows writing and drawing on the surface, printing the image, saving on the computer, or even distributing it over the school LAN. The interaction with the computer driving the device means that programs can be controlled from the whiteboard using a special pen (instead of having to go to the computer), allowing the teacher to operate from a traditional position (i.e. standing up and facing the students). Furthermore, the teacher can write notes or draw on the screen over the image projected; the result can then be saved to disc.

Interactive whiteboards are ideal instruments to be used in blended learning and teaching. In that since, they are ideal companions to ***streaming media***, as their great advantage is their ability to blend well with ordinary teaching practices. One can surf the web while the whole class can watch procedure and see site contents, and all that under the direction of the teacher next to the board. Furthermore, the computer driving the whiteboard can be ***stream video***, while the teacher can (potentially) switch from streaming to writing on the whiteboard in a matter of seconds. Already prepared text and graphs can also be presented, and all that can be altered from the board and saved again, all in real-time.

Disadvantages of whiteboards include the expense to buy (considerably more so than conventional data-projectors) and to maintain (surfaces can get damaged). Locating interactive whiteboards in the class can also present problems. Their height is often too much for some people to reach the top (to write), whereas if mounted lower they are not easily visible. Front-projection boards present more problems with students interfering with image projected, and present similar alignment problems as conventional data-projectors. Finally, if one allows input from all sources and everyone present, keeping control of the input can present new problems (like gibberish or unrelated drawings on screen).

For interactive whiteboards to operate, specialised software needs to be installed in the (hopefully powerful) computer who operates the data-projector, projecting either from the front of from the back of the whiteboard on its screen. Not all such software has similar function or reliability (e.g., handwriting recognition, or saving to computer might not be available etc). Any input (i.e. pointing, drawing, or writing) on the whiteboard is sent directly to the computer. Some expensive systems use a plasma display instead of a back-projector.

There are currently three different technologies to detect pen position and movement, resulting in different types of board, each with its own advantages:

A. Touch sensitive surface: Resistive Membrane

These whiteboards have a soft, flexible rubbery surface. This is made of two pieces of resistive material separated by a small gap that creates a touch-sensitive membrane just as in some mobile telephones, PDAs, or tablets. Movement is tracked by detecting the pressure of the stylus on the surface and the co-ordinates are calculated. Any object (even finger) can be used to “write” on this board. These are less costly, but board surfaces can easily get damaged.

B. Hard surface and electro-magnetic movement detection

They look just like traditional hard-surfaced whiteboards and can be used like one. For interactive operation, special battery-driven pens are utilised, emitting electromagnetic signals detected either by sensors in the whiteboard frame, or (just like in a computer-tablet accessory) by a grid of closely embedded thin wires, criss-crossing the whole surface.

C. Hard surface and laser tracking of movement

These hard-surfaced boards have laser scanners mounted on the top corners to detect pen movement. The lasers emit in the infrared, so that light cannot be seen. For interactive operation, special felt-tip pens are used, incorporating one IR-reflective ring each, also showing the pen colour.

Quality of operation and cost of interactive whiteboards

A high screen resolution (e.g. 1000 lines per inch or more) results in beautiful and clear images and helps pattern recognition (i.e. handwriting recognition). A high tracking speed (e.g. more than 200 inches per second) on the other hand, ensures instantaneous execution of commands, and writing appearing instantly on the screen. Image resolution, maximum contrast, and luminosity are very important factors to consider, as they affect the usability of the device; it is important to me able to project images under any weather, even with bright sunlight outside. Size, resolution, and tracking speed will be the most significant factors affecting price, together with system functionality. Very small size whiteboards, sometime called interactive whiteboard tablets are to be avoided as their educational use is both limited and better served by other systems described below. If flexibility and interactivity are important during teaching, large interactive whiteboards are today irreplaceable, despite their cost.

Looking into the *future*, should we expect interactive whiteboards to proliferate (or even to survive)? It all depends on the speed with which prices (of large, high quality fully functional whiteboards) will come down. The educational market is by no means small, and it can arguably increase if the current re-training fashion accelerates. The variety of technologies available, and the even greater variety of companies competing for that same market, might ensure that this (expected) further drop in price will not materialise until another, totally different product achieves the same goal (interactivity) through different means and at a lower price. Success today is no guaranty for survival tomorrow, in IT !

8.10 E-beams and other alternatives offering interactivity of a sort

In case the class is large, interactivity is limited, simply due to numbers. In this case, total freedom in interactivity might as well be abandoned in favour of other (much cheaper) interactive systems. Such interactive systems include powerful data-projectors coupled with wireless keyboards and mice, or conversions of ordinary whiteboards, or the use of tablet PCs and wireless graphics tablets, and will be examined presently.

There are several alternatives worth considering, which are detailed below.

8.10.1 Whiteboard conversion kits: e-streams and the like

There are some conversion kits trying to convert ordinary whiteboards into electronic copy-boards. These are generically referred as ***e-beams*** (offered from the similarly named company, but other products (e.g. mimio) offer similar functionality. In these, the main unit is a transceiver device that clips on the ordinary whiteboard and communicates to the computer supporting the process. The device locates position and movement of the markers via either ***ultrasonic signals*** or ***radio waves***. A separate data-projector displays the computer-generated image onto the board. Interactivity is achieved, in this case, not through the board itself but through a wireless mouse, (i.e. one cannot point directly on a menu, but using a mouse one can direct the pointer to the relevant "button" projected on the screen, and click). This decrease in functionality, plus some reported failure to reliability pick all pen-movements ensures that prices remain lower, as well as some irritation during use (e.g. letters can be picked up incomplete). These devices are really kits, as manufacturers can only control part of the final system. One suspects that the proficiency in locating and interconnecting these devices plays an important role in their functioning efficiently.

8.10.2 Wireless keyboards and mice

If all one needs during teaching is interactivity from the "front of the class" (and not data capture from the board) then an ordinary data-projector and computer combination when equipped with a wireless keyboard and mouse, works remarkably well at only minimal extra cost. Currently available devices work on either of two principles, infrared or radio frequency (often Bluetooth devices), the second performing more reliably in general.

A special case of a mouse is a ***3-dimensional "gyro" mouse***. As the name implies, there is a tiny ***gyroscope*** inside the mouse, and the devise calculates its position from the base from the ***Coriolis force*** (its strength and duration) on the gyroscope axis. In practice it works like an ordinary mouse (and for the same purpose, i.e. pointing), but to operate it does not require either a mouse pad or any surface. You just move the mouse in space and click. This is very useful if a teacher needs a mouse while standing in front of the projected image. People attempted to make such mice a very long time now, but they seem to have succeeded to make them (cheaply) and work reliably, relatively recently. Furthermore, the latest such "gyro" mice work wirelessly at fairly large distances. In the future, following the tendency of technology to migrate from scientific and military applications to commercial items, totally solid-state 3-dimentional mice will be produced, having no moving parts (i.e. no gyroscope) resulting in improving reliability further.

8.10.3 Wireless graphics pads

Wireless graphics pads are small portable panels that can be written or drawn on with an electronic pen. Architects and artists often use them. Unfortunately, *the image drawn does not appear on the pad* but only on the screen; the user, therefore, has to develop the technique of correlating horizontal hand-movements with images he sees on a different plane (the vertical projection screen).

8.10.4 Tablet PCs

An interesting alternative to achieving interactivity is a ***tablet PC*** equipped with WiFi wireless LAN devices linking them to the desktop computer driving the data-projector. These mass-produced inexpensive devices are ***small laptop PCs without a keyboard***. Interaction is via the outward facing screen (like a tablet) using a **stylus,** and there is handwriting recognition software available to turn figures drawn on the touch-sensitive screen into letters. Incidentally (and unlike ordinary graphic pads also called "tablets") the user can see the figure he draws on the screen. The tablet can be shatter by the students in the class (to express their ideas to all). This is significantly cheaper than an interactive whiteboard, but it does not function (didactically) in a similar way. Students (and teachers) would not stand up to express themselves and it can hardly be considered as a group input device. However there is a future in their didactical use especially if their price falls to become omni-present in education (i.e. each student could have one in front of him). Before this happens, though, tablet PCs should improve considerably, especially in their function as pattern-recognition devices which is not very efficient now. It seems that for that to happen considerably higher computing power is needed, as well as pattern-recognition software that is more intelligent. Tablet PCs do not offer the specialised software that helps interactive whiteboards work seamlessly. Despite all that, these and PDAs-Mobile telephones should be considered the next big incremental step introducing ICT in the classroom on a mass scale.

8.11 Mobile computing, laptops notebooks etc.

Mobile computing (in general) represents a great opportunity for education, especially as recent devices offer built-in communication capabilities and prices seem to be falling (at last). They can become the standard method of delivery of schoolbooks to students, as well as other teaching material. Interactivity in the classroom is achieved by wireless LAN. Several didactical problems need to be investigated now, before this scheme is introduced in schools, even on a limited scale. We believe that, as soon as pattern recognition (i.e. voice recognition and handwriting recognition) is improved, their large-scale use in education would start becoming a reality. Accuracy and speed of pattern recognition will need improvement on a vast scale for that, though.

8.12 Tablet PCs

In section 8.11 (just above) the role of tablet PCs as units achieving interactivity with a projected image was examined. In addition, if such PCs overcome their present problems and if (in the future) become available to all students (i.e. one personal tablet PC per student) they potentially represent a novel and powerful educational tool. Not only do they offer access to internet, they represent a natural way for students to write their homework and to be able to email it to the teacher soon afterwards, so that the homework is corrected and sent back at (or even before) the next lesson. (Normal practice today involves 2 lessons before homework is given back to students creating didactical problems.) Handwriting recognition makes it ideal for use by primary school students. Indeed, it can be used as a tool for 7-10 year olds to learn to write. All that will perhaps become a reality if such devices improve their operation.

8.13 Portable media players

A portable media player or **PMP** is a device offering a colour screen (LCD or OLED) and are capable of storing and playing back more than one type of media format. They have a miniaturised hard disk or a flash memory just as musical MP3 players. They are quite versatile as they can play different video-formats (e.g. MPEG, DivX, and XviD), or audio ones (e.g. MP3, WAV, or Ogg-Vorbis), or even display digital images, (e.g. BMP, JPEG, GIF etc).

Presently available media players are of limited use in education. Their communications capabilities are limited, and the screen "form-factor" (i.e. height versus width) is not standard to all. They are also often large and heavy, cost a considerable amount and their batteries do last for long before recharging. It is a fair assumption that these devices present just a "tendency" in the present development of mobile devices, which includes carrying something smaller and cheaper with a media-play capacity. It is perhaps a fair guess that this "tendency" will be absorbed into the mobile telephones of the future, especially when commonly available network transfer-rates become higher (i.e. late and more mature 3G phones or even

4G devices). It should not be forgotten that most students have a mobile phone in Europe today, so one can imagine the possibilities.

8.14 Personal digital assistants PDAs, and Palm-top computers

Perhaps the greatest inhibiting factor for educational use of PDAs is their screen “form-factor” (i.e. height over width), which is not common for all of them. Otherwise, some of these devices already offer reasonable communication capabilities (wireless LAN, and wireless internet). A fair guess is that the mobile telephones of the future will all play the role of PDAs, as some of them already do, in fact.

8.15 Mobile phone technology

One could hazard a guess that mobile telephone devices of tomorrow (at least some of them) will also be able to function like PMPs, PDAs, and rudimentary video cameras. A wilder guess could be that they could also function like tablet PCs or even like small notebooks. The scene is already set for such an integration and the process has already started: Third generation mobile devices offer video recording (and transmitting) in addition to photography. There are already “smart phones” offering music reproduction and some PDA function. Other devices (e.g. Ericsson 900 family and its flip-open predecessors like the 380) have been offering touch-sensitive screens for six years now, as well as virtual on-screen keyboards. Handwriting recognition was attempted (albeit with limited real world impact), and all these are functions reminding mini tablet PCs. The “communicator” family by Nokia has been offering real QWERTY keyboards (of a size meant to be used with bare fingers) for another six years now, in this flip-open business phone line. Streaming has been possible on these devices (using HSCSD, a 2^{nd} generation service) since the end of 2002, while “office-like” capability is also standard. They now come not only with mass-storage capacity but also with WiFi and Bluetooth on top of ordinary IrDA and cable communications. These are mini-notebook functions, while document output is compatible to that of ordinary computers.

Mobile telephony is a very dynamic market, with more users than computer-users, and these people (at least in Europe) upgrade their devices every couple of years on average. Under these circumstances, progress has naturally been very rapid and it is very likely to remain so for some time. Improvements in software and hardware are driving the scene, as well as major changes in mobile networking technology (explained in the first 5-6 sections of the present chapter). Despite its disappointing early start, direct-satellite communication is still a valid (additional) option for 4G devices when operating from remote areas.

On the negative side, not all application software is compatible with all devices (and in addition the market is currently fragmented along two or three major operating systems) making it difficult to standardise applications; also screen size and “form factors” keep changing, making it difficult to standardise videos. Time will cure all that, though. In the meantime, now is the time for serious educational research using such devices as they exist today, in an educational context; if not, the educational community will be unprepared to adopt such devices in schools when the time is ripe.

Looking into the medium term future of mobile telephones/PDAs/PMPs as they will perhaps develop to become, ***screens may become flexible***, allowing the devices to be rolled-up into cylindrical shapes, parchment-style. This will solve the device size problem and will mark the beginning of these multi-talented devices merging with mobile computers.

Looking into the more distant future, colour images can (potentially) be projected directly onto the retina of the user, either by the device itself or by eyeglass-like wireless accessories, incorporating ***capture and reproduction*** of both ***sound and vision***. Bluetooth headphones-microphones available today represent the audio-only predecessors of those devices. Not only will this solve the problem of screen (and device) size, it has also the potential of offering a ***3D image*** in the future (i.e. projecting different image in each eye).

Those predicted technological advances would materialise anyway, at least in part. The real question is whether they will proliferate, to become as common as photography-equipped telephones today. A reserved guess is that they will, because they address some real needs of the masses: communication and entertainment (i.e. mobile TV) at will. Information distribution, personal management, and productivity enhancement will come free in the package, subsidised (financially) by the forces that be.

Education should prepare for this as soon as possible, as the potential is enormous. ***Virtual reality classrooms*** using real-time streamed images (even on-the-move), represent the potential outcome. Professional training on a need-to-know basis can also be achieved, on the spot, and precisely when the student demands it. As it is certain that he/she will immediately practice the newly acquired knowledge, the education/training will also have a long-lasting effect. The potential increase in productivity is nothing but phenomenal. Also, very specialised, extremely high-level virtual classes will become possible, as the pupils will not only be enlisted from all over the world (thereby increasing potential market), they would also be able to utilise their mentally-idle time (i.e. travel, sports, repetitive chores etc) thereby extending the numbers further. Synchronous as well as asynchronous delivery of educational material can be catered for, as well as real-time coaching, and very short time reply to questions. This will be a real “education on-demand” situation.

Educationally, the key to all this is ***streaming technology*** such as it exists today. If education is to reap the benefits, now is the time for more (careful and systematic) didactic experimentation, as this is naturally a long-drawn process. It also requires a period of time from the part of the experimenters and the educators, to reflect, digest, and discuss the educational outcomes of the experiments.

8.16 Wireless streaming on a local (i.e. close range) scale inside the classroom or inside the school

Wireless streaming inside the school will be achievable in a short period of time, as wireless technology speeds move into real broadband range. If the school (or the classroom) wireless communication server has ample bandwidth, a class with many (wireless equipped) tablet PCs or notebook PCs distributed around, can achieve wireless steaming as well as interactivity inside the class. It is almost certain that appropriate application software will be available as soon as this becomes feasibly useful, which will be soon enough.

8.17 Streamed vector-based animations

Streamed vector-based animations (e.g. Flash, Expression, the expected MS entry in the area etc.) can be transmitted almost instantly, even with old-fashioned narrow-band networking. It is called vector-based because only vector coordinates are transmitted resulting in much reduced network load. When a vector animation is displayed on the screen, the computer uses instructions to redraw each frame. Typical such instructions would be location points, colours, frame rate, time length and script commands. Vector animation files are much smaller than pixel-based animation. Photorealistic animation is not possible with vector-based graphics and all such animations are "cartoon" type graphics. Computer processing power used to be a problem once, affecting the animation speed, but all current computers have more than enough CPU power for that not to happen.

Vector-based still graphics has been in wide scale scientific and technical use for the best part of the last three decades now. Video animations (as a type of medium) have been available relatively recently. Education has yet failed to grasp the potential of such technology; alternatively, it has been slow to make use of it, as it requires the collaboration of people with real graphic-arts skills.

Animation represents to cinematography (or video) whatever the sketch represents to still photography. It contains smaller amount of data, by avoiding to showing trivial details (e.g. detailed texture of depicted objects). The viewer has less amount of data to process and can therefore concentrate to absorbing all real information contained in the image.

Educationally this is very powerful (albeit less realistic), as the attention of the student is directed precisely where it should (didactically) be drawn upon, by leaving out all superfluous data. Conveniently, this also means occupying less bandwidth to transmit. Many educational books have started using both a sketch and a picture, side-by side. The streaming equivalent of this would have been to present both, a vector-based animation and a video-clip, side-by side on the screen, something that is technically feasible in principle.

It is possible to create ***3D scenes*** that have ***dynamic, time dependant behaviour***, by animating 3D objects. Although an impressive amount of such animation is already available, this type of dynamic 3D animation is still very much in its infancy. Its use is quality simulation would be very substantial indeed, resulting in important educational gains in the future.

On the negative side, vector-based animations are generally considered dangerous to carry a virus in their file. For this reason, many seasoned internet users choose to prohibit such files (especially streamed ones) from being executed and displayed on their computer, by deploying appropriate protection software. This represents a serious problem and it simply has to be conclusively solved, before such animations can be used in education on a large scale.

8.18 Streamed three-dimensional video images (holographic video images): 3D-TV

Video holography (and its predecessor holographic cinematography) has been the “dark horse” of much serious (and very impressive) experimental scientific research for many decades now. Totally overlooked and unnoticed (invisible even) by all people, except the highly qualified in experimental science and technology, this research (in addition to its potential scientific, technological, and medical applications) represents the ultimate in private (or even public) entertainment, namely ***holographic 3D-stereoscopic TV***. The time such systems will become commercially available depends on many factors mainly connected with concepts like factory investment amortisation, capital return (especially from public TV industry), and planned obsolescence; anyway, none of these factors has anything to do with education.

If and when it will become available, such three dimensional holographic video (especially the streamed TV variety) will represent a tremendous opportunity for education. To prepare (educationally) for such an e-learning eventuality, one again needs to carefully experiment with streaming now. Anyway, for reasons hinted above, the time when such technology will start to be used, is not expected to come soon.

8.19 Virtual reality (VR)

Virtual reality represents one of the pinnacles of IT technology today, and it is used in entertainment, training, and education. Indeed, “total immersion” VR techniques (i.e. the user looses touch with outside reality) have been proven extremely effective for some complex and specialised professional training programs that involve training in situations that are extremely hazardous (e.g. professional pilot training, type certificates etc). In those training programs, VR techniques are so well respected that they are considered truly essential. In entertainment, reasonably realistic surround sound techniques, and special interfacing devices (e.g. feedback-inducing joysticks, steering wheels and the like) have been used with high commercial success. Some novel VR systems even use special three- dimensional interactive haptic devices (to derive a virtual sense of touch) {ref ICL 2005] and highly sophisticated sound effects on top of stereo imaging, with remarkable educational success. Professional VR installations even control acceleration on the body of the trainee by artificially tilting moving and accelerating his operating environment.

Streaming Virtual Reality has not yet materialised to the best of my knowledge (if one disregards the complex clustering arrangements of the super-workstations that drive static VR installations, that is). It is not just a matter of available bandwidth, which is scarce even for non-VR interfacing requirements. As the whole VR scene is really new, the market for most peripherals is small and the prices, consequently high. This is the opposite of a settled market, therefore. It is a fair assumption that by the time the type of peripherals would have somehow settled, available bandwidth would be plentiful. Education suits VR wonderfully and vice versa. They have a bright future together.

A special case of ***Virtual Reality classrooms*** has also been examined above under the “mobile phone technology” heading. These are partial-immersion applications, but they require no more than that. In fact, this suits the user who moves. Not only is he also allowed to function doing the trivia of life while he is in his virtual class, learning. New edutainment applications can be developed explaining the architectural style or historical details of the buildings (or paintings) he happens to be looking at (for example), if he is so interested. The user could also demand information about restaurants, public transport, pharmacies, or other services offered nearby and information will be streamed to him/her on his mobile. Human faces he sees/captures will be recognised (consulting a remote data bank) and names and personal details will be streamed and projected to him at will. The ultimate PDA described also shows him the way to places in cities unknown, and is not science-fiction but rather a research project of today. Education can count of it becoming available sometime not in the distant future.

8.20 Blogs, Vlogs, media blogs and all that, using RSS

A **weblog** (or **blog**, or **web log**) is a web-based publication consisting primarily of periodically updated articles. Although most early weblogs were updated manually, tools to automate the maintenance of such sites made are now available, and the use of some sort of browser-based software is now a typical aspect of "blogging". Many weblogs enable visitors to leave public comments, which can lead to a community of readers centred on the blog, and hence the educational value of such constructs.

There are many ***educational*** applications of blogs. See, for example the contribution by the *Swedish TelePedagogic Knowledge Centre* in section 6.7. Students can use blogs as records of their learning while teachers can use them as records of what they taught. For example, a teacher can blog a course, recording day-by-day what was taught, including links to internet resources (carefully pre-selected so as to avoid those with dubious or unscientific content), and specifying what homework students are required to carry out. This has many practical advantages: (1) a student can quickly catch-up if they miss a class; (2) the teacher can use the blog as a course plan; and (3) the blog serves as an accurate dynamic summary of the course for future reference. Students can also blog an educational excursion, recording on an or hour-by-hour basis all places visited, and what was learned, including photographs, and audio-video. As several students can contribute to the blog, this helps the competitive spirit amongst them in its purest sense, (see sections 3.6 to 3.8 of learning theories) while the blog itself becomes an educational project. Blogs can also work wonderfully in distant education. It is in the collaborative features of blogs where the true pedagogical advantage of them lies. A community-learning spirit is created, cultivating the view that learning is an adventure, and that far from being static it requires constant updating.

A ***vlog***, or ***videoblog***, is a kind of weblog that uses video as its primary presentation format. Vlog posts are usually accompanied by text, images, and additional metadata to provide a context or overview for the video. In this sense, a vlog can be seen as an ***integrated streaming medium*** accessed freely on the web. The latest headlines, with hyperlinks and summaries, are offered in weblogs in the RSS (or the newer Atom XML format and protocol), to be read with a “feed reader”. A ***feed reader*** or an ***aggregator*** is software that can check RSS-enabled webpages on behalf of a user, and display any updated articles that it finds; alternatively it can track updates on a regularly visited site. The availability of RSS feeds on web sites is increasing, even to many smaller sites. A blog feed could be written in HTML or JavaScript, but more commonly, it is an XML-based file, in which the blog hosting software places the executable part of the blog, so that it can be "syndicated" for further distribution on the web. ***Web syndication*** is a term referring to making web feeds available from a site, so other people can display an updating list of content from it (e.g. the latest forum postings, etc.). **RSS** is not one but a family of XML file formats for web syndication. The acronym stands for all of the following: Rich Site Summary, RDF Site Summary, and Really Simple Syndication, as each acronym refers to a newer format version! As explained, the usefulness of blogs in education is multiple and its use by schools should be encouraged. Having an (apparently) assured future, bloging and vloging are fun and a raging fashion.

8.21 Real time translation and real time subtitling

These are two technically complex problems. Real time translation involves not only pattern recognition but also the artificial-intelligence related subject of fast and accurate translation. Real time subtitling only involves pattern (i.e. speech) recognition and it is intended to help people with special needs (hard of hearing or deaf). These are not easy to achieve if they are to done faultlessly. It is also uncertain if the problems are best solved using the computing power of the client (e.g. the user’s) computer or at the server level. The final solution might be found in a combination of techniques, but in any case, more computing power (and more intelligent algorithms) are essential for any concrete progress in this area. In the meantime, everything is done manually or we all switch to English by default.

8.22 Extending the software categories that utilise streaming media educationally

This aspect of streaming media has been treated in detail in section 4.3: In the future, either the whole or only a part of the program may be delivered as a streaming medium. In the first model, (a) the whole program may reside in the streaming server, and it may be delivered to the user’s computer in educational blocks, each with a different function: the whole function of the device changes, this way. Alternatively, (b) the main core of the program may already reside in the hard disk of the user’s computer and the software may be programmed to call upon a specific internet address where one or more interesting media are offered. In this second model of software, the streamed medium could be a video but also an encyclopaedia (or a dictionary), or an educational simulation etc. Although the practicalities of educational programs have been covered in the aforementioned chapter 4 section, one should not fail to notice how both these software models could be used in virtual reality teaching, both the static and the mobile-phone variety, as described above in the present chapter.

9 Conclusions

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Our age is very much a visual age. We are offered a plethora of moving images all through out daily lives. Children going to school today cannot even imagine how life can be without television, interactive videogames, streamed videos on their computer and now even on their mobile telephones. Schools have to evolve to adapt to the expectations of the younger generation, or they would face the loss of interest. Once it might have been adequate to have an eloquent teacher to explain to his/her pupils how they should imagine a place, a situation, or an experiment. At a time when motion pictures routinely use "special effects" to depict the impossible as routinely possible, this lonely teacher may find it hard to repeat the trick of his predecessors. Even if streaming media were to be used just to regain this lost attention from the part of the students, it would have meant enough to justify their use in school.

Streaming media offers to education a lot more than that. The present study, with all the supporting research activities, shows precisely that. The future is here in front of us, now. The first trials conducted in school have been successful, despite the scarcity of previous research on the educational aspects of implementing streaming media in schools. This research has also allowed various problems to surface. Much effort has been placed in trying to analyse all those problems that came to our attention. For most of those, we feel confident that one or even more solutions will be found soon enough. These points involve all that we mainly investigated presently: educational questions and technological ones. Nevertheless, two further points surfaced during our investigations that are considered both serious and just beyond our reach (and, hence, doubly frustrating). Legal points concerning digital rights of media streamed, and the one concerning translation to different languages. These are by no means new problems for the entertainment and edutainment industry, but they are for education. Streaming technology simply complicates the problems involved, while elevating the need for solution to urgent. These points need to be addressed, somehow.

In the meantime, education can reap the benefits of what it is presently available. Hopefully, the contents of the present publication will provide some information as to how and why. The e-stream team is unanimous in believing that streaming media will proliferate anyway in the future and they education has a lot to offer and a lot to gain in the process.

As we talk about the future, what a bright future that is! Just a glimpse in chapter eight of this publication is enough to demonstrate that. It is full of media, productivity, information, education, and mobility.

As we said, we always wanted learning to be fun; especially blended learning using streaming media should be real fun, fun for all of us involved!

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