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The history of technology in education. A comparative study and forecast

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Abstract

The progress on the harmonization of university systems required during the process of building the European Higher Education Area, launched in 1999 with the Bologna Declaration, has bestowed such a magnitude and unprecedented agility to the transformation process undertaken by European universities. However, the change has been more profound and drastic with regards to the use of new technologies both inside and outside the classroom.

This article focuses on the study and analysis of the technology's history within the university education and its impact on teachers, students and teaching methods.

All the elements that have been significant and innovative throughout the history inside the teaching process have been analyzed, from the use of blackboard and chalk during lectures, the use of slide projectors and transparent slides, to the use of electronic whiteboards and Internet nowadays. The study is complemented with two types of surveys that have been performed among teachers and students during the school years 1999 - 2011 in the School of Civil Engineering at the Polytechnic University of Madrid.

The pros and cons of each of the techniques and methodologies used in the learning process over the last decades are described, unfolding how they have affected the teacher, who has evolved from writing on a whiteboard to project onto a screen, the student, who has evolved from taking handwritten notes to download information or search the Internet, and the educational process, that has evolved from the lecture to a collaborative learning and project-based learning.

It is unknown how the process of learning will evolve in the future, but we do know the consequences that some of the multimedia technologies are having on teachers, students and the learning process. It is our goal as teachers to keep ourselves up to date, in order to offer the student adequate technical content, while providing proper motivation through the use of new technologies. The study provides a forecast in the evolution of multimedia within the classroom and the renewal of the education process, which in our view, will set the basis for future learning process within the context of this new interactive era.

Keywords: Education process, Technology, history, interactive age, TIC.

1. Introduction

The current method of teaching has succumbed to some tremendous changes in the past 100 years, which makes us reconsider the model of teaching and the typology of the classroom, among others, as well as how to reproduce and display the information to the student.

Thus, we have gone from traditional chalk boards, accompanied by a master class through the audiovisual media and network resources that nowadays populate our classrooms.

The student, meanwhile, has passed through handwritten notes to full memos hanging on the website and having available for consulting many resources just a click away.

But have we gone too fast? Are these developments a success or a curse?

2. Development

To develop our study, we made a list of available resources in chronological order, outlining the most important criteria for and against them (Figure 1) [1]. Then we study its effect on the teacher, the student and the learning process.

AS A TEACHER
There's no doubt that traditional resources, chalkboard and master class, did not allow, especially in technical careers to show students the reality of professional life. The "hardness" of the master class forced the teacher to master the subject exhibited. The class almost entirely depended on the teacher, who could get very close to the audience or full bore.

Moreover, the graphical design subjects, or those that require the presentation of a drawing or a design of a machine, for example, required a great skill set by the teacher.

Visual methods, with the slides and transparencies, provided support, and have endured for many years. However, the teacher was using the board to develop the concepts. At the beginning, given the reduced number of devices available, the teacher had to carry it from class to class.

Flip charts have been very useful in small classes or seminars, since the teacher had to be close to the holder and had little space to write, so this technique could be not used in classes with a large number of attendees.

Whiteboards and markers were replacing, in many cases, chalk blackboards.

Television and video were used mainly to play movies, documentaries or videos taken on the matter. Since they were not frequently used, often dedicated classroom equipped with the media was used, or, in other cases, it was necessary to move all the necessary equipment to the classroom, with the consequent loss of time....

The revolution came with the video projector. This resource has brought, along with the PowerPoint file, a reign that can scarcely be forgotten in the classroom. The teacher can now bring all the material, previously selected and prepared, and give a class almost entirely with this media. We say almost, because even now, most teachers use the blackboard or the white board to solve exercises and problems. However, with the proliferation of pc tablets, sometimes the entire class is taught on the screen, including the exercises. [2]

Smart or interactive whiteboards allow, together with the use of clickers or pointers, that the student participates in an active manner in the classroom: Being able to also test the student's knowledge on the subject.

FOR	AGAINST
Chalkboard	
Allows deleting and overwriting.	Time to write it.
The teacher must know the subject rather well.	Requires good writing and order.
The student sees the teacher solving.	Required to draw well.
Closeness to the classroom.	Cannot show the reality (photos)
Dynamic.	Once deleted does not allow to return to previous boards.
Slide Projector	
Can show the physical reality (photos)	Requires prior preparation of the contents (slide revealed)
Can turn back to previous slides.	Requires glimmer light or no light.
	Can't paint over them. Requires a support board for explanations.
	Static.
Overhead projector	
Allows to paint on the transparency	Static.
Can turn back to previous transparency.	Requires prior preparation of the contents (transparency)
Opaque Projector	
Allows projecting any book without prior preparation.	Static.
Can turn back to previous transparency	Can't paint over them. Requires a support board for explanations.
Flip Chart	
Allows deleting and overwriting.	Time to write it.
The teacher must know the subject rather well.	Requires good writing and order.
The student sees the teacher solving.	Required to draw well.
Closeness to the classroom.	Cannot show the reality (photos)
Dynamic.	Limited space.
Can turn back to previous paper roll.	Requires few students.
White Board	
Allows deleting and overwriting.	Time to write it.
The teacher must know the subject rather well.	Requires good writing and order.
The student sees the teacher solving.	Required to draw well.
Closeness to the classroom.	Cannot show the reality (photos)
Dynamic.	Once deleted does not allow to return to previous boards.
Cleaner than chalkboard.	
Television and Video	
Dynamic.	The teacher fades into the background during projection.
Can show the physical reality (photos and videos)	Requires prior preparation of the contents (search or pre filming)
Closeness to the student.	Requires glimmer light or no light.
	Can't paint over them. Requires a support board for explanations.
Video Projector (VIDEO + DVD + PC)	
Dynamic.	Requires prior preparation of the contents (Video, DVD, PC)
Can show the physical reality (slides, photos and videos)	Can't paint over a slide, photo or video Requires a support board for explanations.
Allows switching quickly between video, DVD and PC.	
Can turn back to previous contents.	
Closeness to the student.	
Electric and Smart Whiteboard	
Dynamic.	Requires prior preparation of the contents (Video, DVD, PC)
Can show the physical reality (slides, photos and videos)	
Allows switching quickly between video, DVD and PC.	
Allows to paint over a slide, photo or video.	
Can turn back to previous contents.	
Network Resources	
Show instantly updated information (web)	Slow if network collapses.
Students feel more comfortable than with notes or books.	
Closeness to the student.	

Figure 1: Number of students enrolled at the UPM

From the standpoint of the teacher, all these supporting tools provide an excellent aid to teaching in the class. In technology subjects, the student can display the state-of-the-art and latest projects available online in the whole world. Since the search of information takes place online, the answer is usually instantaneous, but sometimes the search can fail due to various reasons (server crashes, network failures, slow download, etc.).

AS A STUDENT

The student will not necessarily experience these changes as deeply, as they are "short term" passengers in the University. Nevertheless he has changed from taking handwritten notes of all subjects and drawing by hand during blackboard and master classes, to hardly take any notes and have a large number of references, books and documents posted on the web to consult.

This has led to a change that allows him to pay more attention to the explanations, not so focus on taking notes, and thereby, participate more actively in class. [3]

In addition, technological developments show the student the professional world in a more clear and simple manner, by means of videos, links to web pages and presentations prepared by the teacher.

The dynamism of the classes that these new tools leverage, more visual and glamorous, makes it easier to capture students' attention, however, sometimes the excessive use of impacting transitions, effects, videos, etc., helps the student stay with the visual effect disregarding the relevant content which is really useful and practical.

OVER THE LEARNING PROCESS

Currently, we have been seeing that over the last few years, the learning process has changed. Thus, generally speaking, we have gone from passive learning to active learning. Without going into detail on each of the many cases, we will stay with three, which ultimately, summarize the evolution and changes over the past 100 years: master class, collaborative learning and project-based learning, the first a clear example of passive learning, and the latter two representing the active learning.

The lecture, as we have seen, it was quite hard, and depended largely on the teacher. The student was taking down notes during the class and had to study outside the classroom, in a specific manner or in a group. This way of presenting subject was in general not collaborative and was cumbersome for the student.

Collaborative learning, supported by the availability of reference material to be consulted by students, conferred greater interaction between the teacher - student. It required much preparation by the teacher, but allowed students to connect more efficiently with the teacher and the rest of the class.

The current project-based learning, tries to place the student in a situation identical to the one which it would be in the workplace, and allows students to "discover" and makes their learning process to happen sometimes in a self-taught manner, both individually and in groups. In that matter, the video projector and the Network resources have had a very important impact on active learning.

3. Conclusions

It is obvious that technological advances have brought us some notable improvements in the teaching process, but we may have abused of them, or we have not known how to guide them, often favourably. Conclusions bellow pose a series of questions, which should each teacher, each student and each college resolve according to their capabilities, resources and objectives.

The teacher has undergone substantial changes and now has some means of support in the classroom that provides him safety and reliability. But sometimes, the use of such media has been in detriment of the communication between the teacher and the student; as some teachers are limited to "read" and rely too much on the projected material, forgetting one of the major functions of teaching: motivation. Moreover, the teacher is totally reliant and at the mercy of the electronic resources, so that in the event of failure, he can hardly teach class. On the other hand, providing students with absolutely all the information implies that the teacher can teach a lot faster, so subjects are widening, requiring the student to processing a large amount of information, which it does not always have a positive impact.

The student has seen no need to take notes in class, he may attend or either be dispersed, as it is confident that at home he will have the possibility to download some perfect notes from the web. But does he really look at all the material at his disposal? Ease of access is causing some teachers to hang lots of information for consultation. The student does not always print all information, which is beneficial for the environment, but can you study on a screen as well as on a paper? The main difficulties that these media poses to the student are the difficulty to highlight information, to write down notes in the text or remember a paragraph associated with a particular location.

Thus, the new programmes advocate for subjects with oral and written communication, but gradually we see how our students have stopped writing on paper. Many of them only use this means during the exams.

Homeworks of collecting and finding information, in other words, the state of the art, in many cases are obsolete, since the student can download the homework directly from either a national or a foreign university, shamelessly plagiarizing their contents. Even worse is when they do it from blogs or any other not contrasted resources. This, forces the teacher to change the teaching method and propose work on the basis of the logical reasoning more than on the information itself.

But since that information is "raw data" coming from the internet and often is wrong, it is very likely that in the near future appear in every degree subjects to prepare students on how to search, find and analyze information on the web. This critical analysis is, in our view, essential.

A key advantage that favours the learning process is that this information is often located within foreign sites, so that the student strives to translate or interpret these pages, learning, almost accidentally technical terms, and improving the student's foreign language knowledge.

Therefore, we have witnessed a transformation of teaching methods focused on the teacher (almost the only teacher to the student), a student-centered teaching, which gets it and is nourished by the teacher, peers, the web, other universities, radio, television, etc.. Working in groups was used to train students in horizontal skills as important as teamwork.

The shape of the classrooms is also undergoing changes. Classrooms are getting smaller, so, modern classrooms do not use the standard configuration "amphitheatre type" but they are flat. This reduction in size is done aiming to accommodate a smaller number of students and in order to enable them to perform the collaborative learning and the project-based learning that we have described above. As for the layout, classrooms nowadays have a configuration which is not teacher oriented, with several round tables arranged around the whole space and screens on all four walls.

Classes full of computers that become soon obsolete or that fail because of misuse, viruses, etc. will disappear. Each student will carry a laptop that can connect wirelessly with the university's network, the department's network, or classroom's network. These computers will be inexpensive and will be constructed and customized with regards to needs of memory, capacity, graphics, etc., depending on the specific requirements per degree.

When referring to the aforementioned concept of student-centered teaching, we could state that the Internet has broadened the perimeter of the classroom, being a receptacle without walls, completely open and global.

Some universities, renowned and others, have begun offering free online courses, known as Open Courseware. These courses consist of audiovisual information, notes, exercises and assessment tests. Are taught by teachers who teach the same topic, with the difference that they are pre-recorded and there are followed when students pleases. Costs per student decreases dramatically and only when online aid is provided have an associated cost. But if we look closely at these courses, it can be noted that the audiovisual material is in 90% of cases, a regular class of a teacher recorded with a video camera.

Blogs allow teachers to perform tasks in a collaborative manner and share knowledge with either students or other teachers. The podcast allow them to share audio files with students. Thereby, internet enables collaboration and knowledge exchange, evaluation of the student, student's time management and online tutoring regardless of time or location of the student. Thus, the student may choose at any time what the student wants to learn, when to learn it and where to learn it.

Sites such as Youtube or Teachertube allow audiovisual information exchange and sharing of various resources. However, are far from being great learning centres, since anyone can upload content and that content could be inaccurate. In addition, some of those sites allow advertising before the content can be visualized, producing a "distraction" effect to the student, who often, will be zapping between browsers while waiting for content to be displayed.

Digital augmented-reality books allow to retrieve clear text, images and videos from a paper containing just codes. This system is still under development and it is quite expensive, so we'll have to wait for it to be completed in full in order to see if it is feasible and economical to use it in several areas, being one of them the Universities. The excessive use of 3D within this system and the succession of effects, allows the student to learn by means of a virtual system which is very appealing, but on the other hand, the student faces different messages and inputs that can be a distraction to achieve the primary target.

Some systems require the use of glasses or special devices, which makes it difficult to use them within classes with large number of students. However, this system is very interesting for field trips, in which the student, is not obliged to pay attention to the teacher's explanations all the time, but can get information any time (and repeat it) at will. Visits to completed construction works (ports, bridges, dams, etc.) will be recorded so that any student could view them whenever and wherever the student wishes for.

What lays down for us in the future? We must first of all consider what will happen to the classroom. Shall we face a future with physical or virtual classrooms? In the first scenario, we support the idea of having classrooms without fixed computers or fixed projectors, since they tend to become obsolete in a short period of time, but classrooms with small portable devices, such as a modern self-contained pocket projector 3M ™ PocketProjector MP180 or similar [4]. With regards to information, teachers will not use computers, but they will perform a wireless connection to the projector using their mobile phone and run the presentation from the cloud. This will cause that classroom come move along with the teacher, and therefore, classes could take place in open areas, as long as there is at least a wall where to project. Additionally, students could attend to online conference performed by renowned professionals, who, without having to move, can demonstrate their knowledge to the students. We ignore at this moment if in the future, even this wall will not be required for the projection, since it could be possible that we might have portable projectors to create holographic screens or 3D displays in any direction and space.

In the second scenario, if virtual classrooms are the winners then we possibly will face a future of distance learning in which classrooms as such will disappear, and teachers will summon students to virtual classrooms, such as those provided Second Life, in order to conduct classes. This will allow the student to have a more flexible schedule than currently and to obtain more free time, as student will avoid having to commute to the college premises. Student will attend remotely to virtual labs and simulators. Currently e-learning methods and b-learning are being used mainly for postgraduate courses and masters for graduates who are working and have a limited amount of time.

The teacher as a transmitter of a vast amount of knowledge tends to disappear, or will disappear in the foreseeable future. The student will have to study and break down the subject on their own, supported by dynamic electronic self-study means (which will explain, evaluate and respond autonomously), leaving the teacher as a person research within the specific limits of knowledge and encourage students to cross these barriers and will promote innovation on the student as well as research. Therefore, the teacher will be encouraging creativity, will be an organizer of knowledge and will be managing the student's time.

We do not know for sure what the future will be, even every day we are at a crossroads of whether the means, techniques and reasoning we try to use to improve education will provide adequate training for our graduates. Today we can only strive to find what we think best, but ...only time will tell.

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