New instruments for advanced distance learning universities
The virtual lab on Lighting Technique

Alessandra Pieroni, Università degli Studi Guglielmo Marconi, Rome, Italy

ABSTRACT. The use of innovative high technology-based instruments to deliver higher education in e-learning Universities is a challenge that must be addressed to satisfy the growing request for distance education in high technologies. It has long been proved that technology-based instruments provide effective, efficient and timely access to learning materials, and many studies prove that students obtain significant learning advantages by use of innovative dynamic distance learning instruments, such as interactive virtual laboratories, in place of conventional static lecture materials delivered by conventional e-learning Universities. In other words, a non-negligible difference exists between conventional universities that provide static courses in a distance learning way and advanced e-learning Universities that bridge the main gap of distance learning by supplying the students with dynamic and high technology-based instruments. This approach gives the students of conventional e-learning Universities an augmented ability to enrich their learning experience, acquiring deep knowledge of the topics they are investigating. This paper intends to prove the valuable contribution that advanced distance learning Universities may give to their students, by illustrating an instance of a dynamic virtual laboratory developed for a specific course at the Guglielmo Marconi University.

KEYWORDS: Distance University, Lighting techniques, Technology education, Virtual laboratory

Introduction

The innovative use of technologies creates more effective techniques to distribute learning in non-traditional ways. However, distance
Learning universities are facing a number of challenges to provide appropriate, high quality and sustainable support to teachers and students. Distance learning universities that offer technical degrees must provide (more than universities that offer humanistic degrees) laboratory exercises and multimedia instruments to provide a complete and high-quality suite of courses (Veljko et al., 2010). This challenge drastically increases the complexity of the development of a potential e-learning system. Indeed, new approaches and new specific knowledge are needed to develop such systems.

Figure 1 shows a comparison between a conventional and an advanced distance learning approach. On the left side, a conventional approach is illustrated in which the student, after starting a study session, can only access static contents before examination. On right side of the figure, instead, a set of high technology-based non-conventional instruments (NCIs) is provided to the students to improve their learning experience.

In this NCI example, Virtual Labs (VLabs) and Virtual Classrooms (VClass) can be identified as effective ways for the students to iteratively interact in view of the final examination. This kind of approach has been proven to substantially improve the learning experience of a distance learning student (Antonios et al., 2001). According to this so-called “learning by experience” approach, the students play an active role and are not only passive receivers of the information provided.

Figure 1. A comparison between conventional and advanced universities instruments for distance learning universities.
The next section illustrates the main objectives of advanced distance learning universities and the problems to face in the implementation of VLabs. The third section illustrates the VLab for a course in Lighting Techniques, developed at Guglielmo Marconi University, and the final section gives concluding remarks.

Virtual labs in advanced distance learning universities

Advanced distance learning universities make use of high technology instruments to enhance the students’ learning experience while improving the quality and reputation of the university itself by exposing non-conventional services for e-learning. Such universities should proactively use high technology-based virtual instruments in order to improve students’ skills, allowing them to achieve knowledge experience in a multisensory interactive way. This approach involves intangible factors related to the students’ cognitive experience, such as perception, imagination, intuition, emotion and memory (Briganti, Francescone, 2015). The several advantages achieved using virtual laboratories in such Universities are obtained as a consequence of some fundamental requirements:

- The knowledge approach should be creative, and the objectives should stimulate student interest and imagination
- The teaching contexts should be dynamic and suitable to the previous experiences of the student
- Student achievements should be obtained by using an approach able to identify students’ needs and problems. The university should adopt a proactive approach by monitoring student progress and by avoiding barriers and difficulties for the students. (AACSB 2009-2007).

Nevertheless, this approach has to face issues of various natures, such as:

1. The use of a dedicated team for the design and development of innovative and multimedia high technology-based instruments
2. The usability and portability of VLab content on different platforms (hardware and software).

The next sections discuss in more detail such issues.

VLabs dedicated team

A technical virtual laboratory should provide a suite consisting of four services (or sections): a Theoretical section, a Virtual reality section, a practical section and a quiz section (Tudevday et al., 2014), as shown in Figure 2.

The Theoretical section includes all necessary reading materials. Materials can be supported by voice recording and by a list of additional resources of related materials. Reading materials have to be formulated clearly and concisely.

The Virtual reality section should include two and three-dimensional animated objects of laboratory. The cost of virtual laboratories, obviously, increases if using additional three-dimensional contexts.
The Practical section should consist of exercises that play a main role in the laboratory. Creating a practical environment, which gives to students the feeling of real laboratories, is one of the biggest challenges for the development team. This section may include different types of exercises, like calculation of data, drawing graphics, measuring objects by virtual devices, etc.

The Quiz section is the part of the virtual laboratory where students have the opportunity to perform self-assessed evaluation by carrying out quizzes integrated into the laboratory. During the learning process the student can use a quiz to measure and check successful learning, repeating some topics if necessary.

To implement such a suite, the advanced distance learning university should make a dedicated team available for the design and implementation of the multimedia high technology-based instruments. According to this assumption, Guglielmo Marconi University has created a dedicated team of experts in the field of multimedia didactic content production, engaged in research on online advanced education solutions. In other words, the expert team involved in the planning, development and delivery of technology-mediated learning guarantees attention to the intangible and immaterial character of knowledge to stimulate the students’ interest in the educational projects and to lead them toward the achievement of their final study and professional objectives (Ricci, Francescone, Casalino, 2012).

VLab portability and usability

The unavoidable issue that the virtual labs development team has to face is providing content that may be portable and usable for fixed or mobile devices, such as notebooks, tablets or smartphones. Furthermore, the delivered content for distance education should be independent of the software platforms of the devices.

For these reasons, the dedicated team must be compliant with specific design and implementation criteria to face the growing request for portable services and contents, such as contents for advanced distance learning universities.

New programming techniques able to support the needs of service and content design for distance education systems must be adopted (e.g., HTML 5). According to this approach, it is necessary to partially scarify the use of interfaces and content that may result particularly heavy from a multimedia
point of view while simultaneously enhancing the usability and portability properties of the contents (Francescone, 2014).

According to this new design paradigm, the Guglielmo Marconi University dedicated team implements the layout of multimedia contents in order to be usable and portable for both mobile and fixed versions, by deeply studying and evaluating, for example, the graphical animation aspects. In particular, the production of transitions and interactive animation effects has to be performed by the programmer in close collaboration with the graphic designer who outlines the guidelines, e.g. the type of animation for that specific VLab. Particularly for the mobile version, the navigation must be simple and the contents proposed need to be reduced in size, by enabling, for example, the download of the main textual contents.

To be compliant with all the above-mentioned criteria, in the development of new V Labs the Marconi University team makes use of the most popular and up to date technical programming/development languages, such as HTML5, CSS3, jQuery, Bootstrap, jQuery Mobile (Francescone, 2014).

The virtual lab in Lighting Technique

An instance of a real virtual laboratory developed by the Guglielmo Marconi University team for the Lighting Techniques course will be illustrated in this section. The aim is to prove the above-mentioned valuable contribution that high technology-based instruments may give in order to improve the students’ learning experience.

The home page of the VLab is illustrated in Figure 3. The home page contains four main sections with information about the main contents of the Lighting Technique course, and two additional sections with a set of proposed practices on the above-mentioned contents. In particular, the four main content-sections are:

1. Historical background
2. Controllable properties of light
3. Lighting objectives
4. Design principles

And the two practice-sections are:
1. Application 1
2. Application 2

The following sections illustrate, by showing several screenshots, the main VLab interfaces.
The Historical background content-section deals with historical context regarding lighting techniques, as illustrated in Figure 4. Reading through these pages, the student can improve his competences and enhance the knowledge acquired during the conventional study process.

**Figure 4**: Screenshot of the Historical background content-section
The second content-section is the Controllable properties of light section, which is illustrated in Figure 5.

Figure 5. Screenshot of the Controllable Properties of Light content-section.

This section contains four subsections: Intensity, Distribution, Color and Movement. Each of these self-explanatory subsections is a rich source of useful information that intends to examine in depth the main topics of the Lighting Technique course.

The third main content-section, illustrated in Figure 6, is Lighting Objectives.

Figure 6. Screenshot of the Lighting Objectives content-section.

This section is also composed of four main subsections: Visibility, Revelation of the Shapes, Selectivity and Atmosphere. The student may easily explore the subsections to find all related information, as illustrated in Figure 7, which shows the details of one of the four subsections.
The last content-section, Design principles, is illustrated in Figure 8.

The last content-section consists of five subsections, namely: Positioning and targeting, Front light, Side light, Back light and Bottom light. By surfing this last content-section, the student may acquire basic knowledge on the main international symbols of the lighting devices approved by CIE (Commission Internationale de l’Eclairage) which is the International Commission on the Illumination. Furthermore, in this last content-section the student may learn about the several effects derived from the positioning of lighting devices.
Practice sections

Figure 9 illustrates the first of the two above-mentioned practice-sections.

Figure 9. Screenshot of the Application 1 practice-section

This practice consists of choosing the right illumination diagram for the selected illumination scheme. In this specific example the requested illumination scheme is: front light from above. The student has to choose one of the proposed illumination diagrams and then confirm the choice to verify the correctness of the selected diagram. By selecting one of the proposed lighting diagrams, the application shows the effect of the selection on the subject. In this specific example, diagram “A” has been selected, as better illustrated in Figure 10.

Figure 10. Screenshot of the Application 1 practice-section: example1

Before performing the preferred choice, the student has the opportunity to visualize the effect of all possible lighting diagrams on the subject in the figure, by clicking on the following link: click to view
The effects of the applied lighting diagrams are shown in Figure 11.

![Figure 11](image1.png)

**Figure 11.** Screenshot of the Application 1 practice-section: example1 effects of lighting diagrams

However, the student is allowed a maximum of three attempts to perform the right choice. After three attempts, the application returns an error message and provides the right answer, as shown in Figure 12.

![Figure 12](image2.png)

**Figure 12.** Screenshot of the Application 1 practice-section: example1 wrong answer

Feedback on the correct lighting diagram is valuable for the student, which improves his knowledge not only in lighting theory but also in the practical activities. Figure 13 illustrates the second of the above-mentioned practice-sections.
In the second application, the student has to select the right lighting diagram among those proposed, in this specific example: Lighting diagram C, Lighting diagram G and Lighting diagram D. The aim is to obtain the lighting effect shown in the left-side image.

The effect of the selected lighting diagram, rather, is shown in the right-side image, as illustrated in Figure 14. Also in this second application, upon choosing the wrong lighting diagram the system returns an error message and provides the right answer, as shown in Figure 15.
In both applications, a large number of exercise combinations are proposed in order to evaluate the student’s achieved competence level and how knowledgeable the student is on the main course topics.

**Conclusion**

The use of innovative high technology-based instruments to deliver higher education in e-learning Universities has been defined as the main challenge that must be addressed to satisfy the growing request of high technology distance education. Indeed, it has long been proved that technology-based instruments provide effective, efficient and timely access to learning materials. This paper has proved that a non-negligible difference exists between universities that provide static courses in a distance learning way and higher education institutions that provide the students with dynamic and high technology-based instruments. To support this assumption, this paper has illustrated a real instance of a Virtual Lab, developed for a specific course at Guglielmo Marconi University, and has shown the valuable contribution that advanced distance learning universities may give to their students.
References

http://www.aacsb.edu/~/media/AACSB/Publications/white-papers/wp-quality-issues-in-distance-edu.ashx

Antonios Alexiou, Bouras Christos, Giannaka Eleftheria (2001), Virtual Laboratories in Education, Research Academic Computer Technology Institute, and Computer Engineering and Informatics Dept., University of Patras, Greece


Sintesi

L’applicazione delle nuove tecnologie informatiche per l’erogazione di corsi a livello universitario costituisce una sfida primaria per la formazione superiore, anche per soddisfare la crescente richiesta di flessibilità nello studio e nella formazione continua da parte degli studenti di Tecnologia. È ormai consolidato il fatto che la formazione tecnologica permetta un accesso efficace, efficiente e rapido ai materiali didattici e molti studi provano che gli studenti traggono grande vantaggio dall’applicazione di tali strumenti innovativi e dinamici allo studio, come i laboratori virtuali interattivi in sostituzione delle tradizionali lezioni in presenza e anche in confronto alle lezioni video statiche. In altre parole, esiste una considerevole differenza tra le università che applicano le tecnologie video e digitali ad un modello di erogazione dei contenuti di tipo statico, e quelle università avanzate che superano i limiti della formazione a distanza potenziando l’interattività con strumenti dinamici altamente tecnologici. Questo approccio permette agli studenti di allargare notevolmente le loro prospettive, migliorando l’esperienza didattica in vista di una maggiore e più profonda acquisizione di conoscenza nella disciplina studiata.

Il presente articolo intende dimostrare quale valido supporto le università tecnologicamente all’avanguardia possono offrire ai propri studenti, descrivendo il caso del laboratorio virtuale dinamico sviluppato nell’ambito di un corso della Università Guglielmo Marconi.