Technological Advances and Teaching Innovation Applied to Health Science Education

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ABSTRACT
In recent years, computer application development has experienced exponential growth, not only in number but also regarding the fields that have benefitted from its use. In health science training and medicine in particular, the progressive incorporation of technological developments has transformed the teaching and learning process, resulting in true "educational technology", which this track focuses on given its repercussion and current dissemination. One of the most representative examples within educational technology has been the development of new content visualization systems, more complete and realistic than traditional learning material on paper. These applications are true learning environments aimed toward maximizing the student's work outside the classroom and the interaction with the contents given, an important support or complement to traditional teaching. The technological application development with teaching purposes in Heath Science is paying increasing attention to mobile phones, smartphones and tablets due to their portability, economic accessibility and Internet access, maximizing the dissemination and availability of developed applications. These changes in health science teaching pose a challenge for teachers and institutions when designing, developing, implementing and evaluating these technological applications, as well as an effort on behalf of students to adapt. Thus, it is fitting to provide a space to gather and reflect upon these practices in an event like the International Conference on Technology Ecosystems for Enhancing Multiculturalism.
Nowadays, a growing number of studies have directed their attention to the effectiveness evaluation of these applications with increasingly sophisticated designs. The results are encouraging and signal a promising future for the development of computer applications in health science. The purpose of this track is twofold: to offer a general vision on the contribution of medical informatics and related fields in health science; and to provide an excellent opportunity to promote and exchange innovative teaching experiences, especially those based on the application of new technologies.

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1. INTRODUCTION
With this track entitled "Technological Advances and Teaching Innovation Applied to Health Science Education", we intend to provide a general vision regarding teaching innovation technologies used in Health Science education, through the experience of different research groups that employ these technologies in teaching.

The irruption of technologies in everyday life is one of the most global realities today. Computer technology applied to heath science teaching has gone through many changes throughout the years, parallel to our society's technological evolution. We find ourselves in a world where information technology has become essential in many of our activities. One of the most evolved and benefitted fields from the use of modern information technologies is health science, medicine in particular, continuing its exponential growth. The 21st century puts traditional learning systems in crisis due to the social and technological changes in universities. Technology as a tool becomes a substantial support to the teaching system offering the possibility to get an education through a knowledge society in a world where we can all participate through the Internet. It is evident that technological development is transforming our teaching systems in health sciences, providing useful tools in university and incorporating resources in medical education that generate medical simulation environments or complementary and additional education in classroom teaching.

Today's medical education systems, within the European higher education framework system, use clinical simulations under technological procedures providing an interactive representation close to reality, allowing the observation of a phenomenon or clinical trial, as if in a real environment.

The use of computer technology environments in medical training, always as an additional teaching resource, facilitates and optimizes the learning and clinical abilities of students and residents in different medical specialties.

Beyond a doubt, the use of technological methods in training and knowledge visualization, and the exploration of its teaching possibilities, is our responsibility as teachers, being a constant challenge we have to face, both for professionals linked to teaching in health sciences, as well as for the ones in charge of developing technological applications to optimize the learning process.

The application of knowledge derived from technological advances in science has changed the way in which information is transmitted. Within health science in particular, it has represented a series of constant technological developments that have resulted in the transformation of medical training patterns. But applying technology in training is not only based on the instrumental domain of some computer equipment, but in the capacity to design teaching resources in health sciences, with the objective of reaching goals that we would have set for ourselves where applied. Therefore, as shown in the Council for Educational Technology, "Educational Technology is the application of knowing systems and techniques to improve human learning", we will probably witness an even greater development of innovative technology and its use in medical education within our country in the coming years.

It is evident that technological developments are transforming our teaching in health sciences, providing very useful instruments in university teaching and incorporating, in medical education, resources that generate innovative technological systems for complementary training to traditional education. It is necessary to look for new educational models with a technological basis that endow health science professionals with the necessary tools to develop their work. The objective of this track under the title "Technological advances and teaching innovation applied to health science education" is to improve health science education, to encourage the information exchange and dissemination regarding different training aspects in medical science. The application of computer technologies in education must help expand action, decision and intercommunication margins amongst teachers and students, allowing access to new means of exploration, representation and information treatment.

The use of Information and Communication Technologies has become one of the basic pillars in university education within health science. This statement is confirmed through the data presented by the Ministry of Education, Culture and Science which states that out of the 73 Spanish universities, 68 of them have and use a virtual campus, a teaching organizational space provided by the university through Internet. These platforms are generally used to publish material from different subjects and as communication systems through this e-learning environment.

It is proven and therefore seems evident that the use of technological methods in university education improves the attainment of teaching goals. Certainly, the Information and Communication Technologies are instruments that permit the design of an innovative teaching methodology, which is a complex process where not only teachers participate, but the institution as well; that is why both teachers and universities have to adapt the teaching and learning processes with the aim of accentuating the active implication of our students in their learning process. In order to do this, they must introduce the technological tools that today's society imposes and that new students are used to. The use of technologies in teaching has become one of the basic pillars in university education within health science.

Technological procedures in teaching entail an important adequacy and teaching content analysis to transmit and be acquired by students, as well as their careful presentation so that the message and knowledge reach the student more effectively. Due to this, the design of technological applications is very important so that is becomes attractive to the user, and the time spent in the learning process helps optimize it and facilitate its knowledge.

But the development of education technology tools in health science cannot be focused on Internet use only. The use of active methodologies in health science education is necessary as opposed to traditional teaching methodologies, to ensure an effective learning process for students, becoming ideal tools to keep working both in and out of the classroom.

In this context, the progressive miniaturization of computer components has allowed computers to have an increasingly smaller volume, which facilitates its portability. In recent years, portable devices have strongly irrupted in the market, like smartphones and tablets with the power to make complex math calculations, manage databases or connect to the Internet, to name only a few of its functions. The growing availability of these electronic devices offers the opportunity to develop new applications and pedagogical strategies, which optimize the teaching and learning process in the different health science complex disciplines.

The characteristics of these mobile devices encourage the implication of students in learning through the direct interaction with teaching contents, making them an excellent platform in university education. The use of portable devices is associated with a change in information and communication search habits amongst users. Little by little, new applications are developed, more adapted to curricular situations and teaching plans. Nowadays, it seems difficult to conceive a society where mobile devices are not important tools in our day by day, both professionally and leisurely.

One of the main advantages in the use of these technologies, from a functional standpoint, is the possibility to learn anytime and anywhere, taking into consideration the fast interaction with the computer application, the cost is not too high, more Internet accessibility, more portability, the possibility of a more collaborative (forming groups, sharing answers, providing information, etc.) as well as exploratory learning (learning on the field, exploring, experimenting and applying while learning a specific topic).

From a teaching point of view, the use of technological resources can encourage independent or group learning experiences, a mayor stimulus and additional support to classes; making learning less formal through complementary tools that enrich and improve the teaching system. Heath Science Education has become a more globalized process, so we should open ourselves to the outside looking for new horizons and aspects in education. It is necessary to look for new educational models with a technological basis, that provide health science professionals the necessary tools to develop their subsequent work with the professional capacity that is nowadays required in complex organizations.

The purpose of the research presented in this track has been to introduce, to teachers and researchers, current technological application tools and their possibilities in education; providing complementary training elements that help improve the teaching and learning process in health sciences. Technology applied to health science education has undergone many changes throughout the years, parallel to society's technological evolution.

The application of computer technologies in education, broadens the action and intercommunication possibilities between teachers and students, allowing access to new means of exploration and representation, together with new ways to access knowledge through diverse types of tools: powerful body structure visualization, multimedia imagery, computer simulations, stereoscopic visualization, virtual and augmented reality techniques, computer platforms for resource and document storage and mobile devices.

Using technologies regardless of space and time in digitalized information transmission is nowadays one of the greatest technological, scientific and cultural revolutions in our society. The rapid transformations in society as a result of technological advances are also having a great impact in university teaching methods.

The comprehension capacity of body structures is closely related with the ability to visualize them. Traditionally, the different diagnostic imaging modalities have shared a common limitation, the two- dimensional features of their representations. The visualization and interpretation of human body images from imaging techniques, has an added difficulty due to its complexity and individual morphological differences (biological variation). Learning human anatomy, one of the most relevant heath science degree disciplines, requires the understanding of morphological features and spatial relationships in proximal areas amongst the different body structures. Thus, volumetric visualization of these structures optimizes the presentation of complex information within morphological images obtained from diagnostic imaging techniques. Not only does the synthetic visualization capacity improve, but also the degree of interactivity and realism, overcoming the inherent restrictions of 2D traditional representations.

Considering this important aspect of spatial vision, many technological procedures have emerged that allow 3D body image reconstruction from sections obtained through diagnostic imaging modalities. The 3D reconstruction process or volumetric generation is the acquisition of one or more series of tomographic images, the posterior segmentation or identification and labeling of anatomical body structures, the extraction of contours/surfaces in adjacent transverse sections and the rendering of the 3D model.

The use of visual resources in three-dimensional format is an attractive and innovative method in teaching and student learning, as well as a reusable and useful tool to encourage and motivate student learning in any discipline within health science.

3D models have enhanced and renewed traditional pedagogical system resources, offering a more complete vision of anatomical body structure characteristics. These resources uphold the emphasis on using visual aids as key elements, beyond simple textbook illustrations. The generation of three-dimensional images developed with the help of 3D reconstruction commercial software, is part of a new pedagogical visual strategy, which allows teaching content activation and review to improve the understanding of body structures.

The visualization of 3D anatomical models creates a more realistic and precise visual perspective of different body structures than conventional medical imaging from diverse 2D diagnostic modalities. Volumetric visualization provides more complete information when defining the macroscopic morphological features and spatial relationships of body structures like bones or muscles.

Moreover, 3D models visualized in simulation contexts increase the possibilities of their global morphological assessment and reduce aggressions in surgical interventions. This advantage is especially important in planning virtual surgical approaches where precise delimitation in the intervention of body structures is required. In recent years, it has been possible to combine volumetric visualization with virtual reality systems that allow the surgeon to browse through 3D reconstructed body structures or even touch them, including resistance and texture simulation of various tissue surfaces or haptic feedback technology, vital when detecting tumors.

The development of acquisition and morphological image processing systems will help increase their applications in medical education.

Learning through these visualization techniques from teaching contents is directly linked with the student's implication level. The visual and interactive learning aids are incentives for students, improving long-term retention. Increasing student participation and attention will result in a better understanding of the morphological features and spatial relationships of anatomical structures.

Given these considerations, it is clear that teachers must reflect upon the way they educate, introducing new strategies and analyzing their teaching in order to improve it.

The papers selected in this track represent a sample of the state of the art applications of information and communication technologies in health education.

Most of the papers focuses on the development of digital environments aimed to enhanced the learning and teaching of medical contents and procedures, as briefly described next:

The paper entitled *Assessment-oriented Java development vs. Clickers' use in formal assessment of basic principles of dental radiology: the opinion of dentistry students* focuses in a new digital environment for the assessment to dentistry students.

The paper entitled *Medical training for echo-guided infiltration of Botulinum toxin by an echograph simulator* introduce an echograph simulator that allows us to virtually explore muscular groups both of the upper and lower limb, as well as point out the best spots where the correct and precise infiltration of the toxin in the spastic muscle can be done, identifying the structures seen in the echograph. It also includes magnetic resonance images of the common regions for echo-guided infiltration, where the different anatomic structures that comprise them are highlighted.

The paper entitled *Digital Viewer for Learning Regional Anaesthesia* focuses on the development of a novel and powerful virtual environment for the simulation of ultrasound exploration of the neck nerves and both the upper and lower limbs for regional anesthesia teaching and learning. It also includes a three-dimensional digital viewer for the identification of key structures involved in peripheral nerve block in neck, upper and lower limbs and a complete list of neuromuscular systems of the arms and legs, involving nerves and muscles, which are also displayed in the application.

The papers named *Using an E-learning Platform in Hospital Training* and *Health Education at La Ribera Univesitary Hospital* describe, respectively, the application of an e-learning platform in the context of the hospital La Ribera for organizing online medical training courses and the potential of this learning platform offering at the La Ribera Health Department where currently there are more than 100 activities and 5000 users.

From a more technical point of view, the paper entitled *Building 3D Models for Reconstructing a Virtual Cataract Surgery Haptic Simulation* focuses on the issues we found while creating the graphical elements of the surgery when developing a cataract surgery simulation using haptic devices. It also describes the design of eye models and some tools during the surgical procedure.

Also, we would like to point out two interesting papers in the field of medical learning and teaching. The first one entitled *Visualization and Interactive Systems Applied to Health Science Education*. This paper is presented in a different approach, summarizing the developments within the last decade of a research group called VisualMed System (Medical Visualization Systems) at the University of Salamanca (Spain) in this line of work. Their work basically focuses on three-dimensional representations of anatomical contents, the development and the application of computer-based teaching material based on powerful image processing technology, characterized by multiple interactivity features and rich visual learning material. Their goal is to promote an autonomous learning process to support traditional teaching methods. For a more extensive review of their work see references [1-24]. The second one, the paper called *Advances in teaching and learning of clinical and basic surgical skills in Medical School* which designed a virtual scenario based on Moodle for the acquisition of clinical skills. Interestingly, it includes an empirical assessment of the impact of this tool with very favor results.

Finally, two of the key features share by most of the works are, first, the emphasis on three-dimensional visualization as a more realistic and comprehensive representation of specific contents, specially anatomical ones; and second, the development of virtual environments. However, these two end-user products would not be possible without advance image processing software.

The paper entitled *Advanced Image Processing for the Study of the Neurovascular System* presents one of the most powerful tools for advanced image processing, Osirix, which just happen to be open source. In particular, this paper presents a detailed explanation of how it process medical images such as magnetic resonance imaging allowing a complete study of the cerebrovascular system for teaching and clinical purposes.

Two more papers deals specifically with technology, which enables multiple applications in the field of health care education.

The first one is entitled *3D PDF Technology Combined with JavaScript Functions Enables the Creation and Visualization of Interactive 3D Presentations* presents an innovative tool for visualization and creation of interactive 3D PDF presentations containing three-dimensional models which, in the case of anatomical structures, provide an interactive PDF document managed by a set of JavaScript-based functions, enhancing its visual exploration and customizing a collection of slides containing model views and textual descriptions suitable of teaching purposes.

The second paper entitled *Virtual Congresses for Pharmaceutical Learning* provides a virtual setting for the simulation of real scenario such as scientific congresses. Specifically, it allows to carry out face to face activities without the need for students and teachers to meet physically using the immersion capacity of the Second Life® (SL) platform and its possibilities for simulating real scenarios and situations. It facilitates student-teacher relations and relations among the students themselves, and it decreases the costs of the activities, since infrastructure and physical movement from one place to another are not involved.

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