Virtual Man, computer graphics and 3D printers: technologies in telemedicine at University of São Paulo

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Abstract

The development of suitable educational programs cannot be seen exclusively under theoretical bases. Good programs must always lead the practical experiences and the application of the theoretical elements to solving problems. Here we present a model to build Interactive Media Labs with CGI and audio-visual resources, e-books development, compendium of info graphics, interactive games, and virtual collaborative environment for students.

Keywords: *Distance Learning; Telemedicine; Educational Learning Objects.*

Resumen

Hombre Virtual, gráficos por ordenador e impresoras 3D: tecnologías en Telemedicina en la Universidad de São Paulo.

La construcción de buenos programas educativos no puede verse sólo desde la perspectiva de la información teórica. Los buenos programas siempre deben llevar las experiencias prácticas y la aplicación de los fundamentos teóricos para la resolución de problemas. Presentamos aquí un modelo para la creación de Laboratorios de Medios Interactivos con recursos de computación gráfica y audiovisuales, desarrollo de libros electrónicos, infografías, juegos interactivos y entorno de colaboración para los estudiantes basados en Internet.

Palabras clave: *Educación a Distancia, Telemedicina; Objetos Educativos de Aprendizaje.*

Resumo

Homem Virtual, computação gráfica e impressoras 3D: tecnologias em telemedicina na Universidade de São Paulo

A construção de bons programas educacionais não pode ser vista exclusivamente sob o aspecto da informação teórica. Os bons programas devem sempre procurar levar as experiências práticas e a aplicação dos fundamentos teóricos para solução de problemas. Apresentamos aqui um modelo para criação de Laboratórios de Mídias Interativas com recursos de computação gráfica e audiovisuais, desenvolvimento de e-books, infográficos, jogos interativos e ambiente colaborativo de estudantes baseado em internet.

Palavras-chave: *Educação a Distância; Telemedicina; Objetos Educacionais de Aprendizagem.*

INTRODUCTION

Education is a complex process and the use of computational resources, interactive technologies and mobile communication can strengthen students' learning. Increasingly, the computer takes part of our daily life and so it is natural that education also appropriates the use of this technology and applies its potential as an important tool in the learning process.

There are currently a number of interactive technologies for educational support, either for the face-to-face education, either for distance education (Interactive Tele-education). Among them, we can mention the computer graphics in 3D, virtual reality, simulation environments, telecare, educational games, among others.

The increase of the educational quality in health is partly related to a coherent training with social needs, so that the educator can convey his personal and professional experiences. For this to be feasible, it is necessary to optimize the teachers' time. The use of Learning Digital Educational Objects, as the sequences of the Virtual Human Project (Figure 1), from Telemedicine Subject of the Faculty of Medicine, USP (University of São Paulo), can save up to 60% of the teacher's time in the transmission of complex knowledge, such as the ones related to pathophysiology, procedures etc. This time saving allows the teacher a more intense interaction with his students, developing reasoning and practical contextualization, among other aspects. The Virtual Human is an example of digital resource that can enhance the educational process in face-to-face environment or in distance learning[1].

The construction of good educational programs cannot be seen only from the aspect of theoretical information. Good programs should always try to take the practical experiences and the application of theoretical foundations for troubl shooting. Thus, the integration of various practical educational infrastructures becomes important for the structuring of a " Multiprofessional Knowledge Production Factory ".

As well as the improvement of the technological and telecommunication resources, particularly mobile ones, the accessibility to information through digital media is increasing significantly and rapidly, replacing the printed literature. It can be due to more quickly and easily update, or due to the lowest cost for distribution, for wider coverage, for incorporating dynamic and audiovisual resources, among other reasons. You can now observe the gradual consolidation of virtual libraries, Open Educational Resources (UNESCO Forum - 2002)[2] , digital libraries etc. This new reality also shows the urgent need to create a new laboratory to elaborate new types of intellectual productions in health, such as eBooks, audiobooks, videobooks, infographics, and case simulators.

The "Virtual Human Project" is a method Dynamics and Addressed Communication (CDD). It consists of the graphic representation of a large amount of specialized information, in a pleasant, interactive, dynamic and objective way.

The need for new strategies to disseminate knowledge on health favored the emergence of Virtual Human. The complexity of the human body makes it difficult to explain its structures and functioning only in words. The illustrations and photos help, but do not have movement and three-dimensionality, fundamental requirements for a full understanding.

The 3D computer graphics emerged as an ally of medicine in the construction of accurate and dynamic images that portray molecules, cells, organs, muscles, bones, tissues and all the other components of the body. And it goes beyond. The digital design, added to the scientific knowledge allows detailed visualization of physiological processes as well as the causes and effects of diseases, drug action, surgical procedures and training in skill and simulation laboratories. It is a powerful iconographic resource that helps learning, since it facilitates and expedites the understanding regarding complex issues.

Conceived by the Telemedicine subject of the Faculty of Medicine of USP (FMUSP), the Virtual Human Project began in October 2002 and allows the production of programs for health promotion and disease prevention, illustrating the physiology of the human body or the pathophysiology of the diseases. With more than 10 years of experience and uninterrupted work, the FMUSP has a group of digital designers specialized in computational modelling "organic" in 3D and currently has an important library about human body and health already developed[3].

Our goal is to develop a model for creating Interactive Media Labs with features of graphics and audio-visual computing, e-books development, infographics, interactive games and collaborative environment of the students based on Internet.

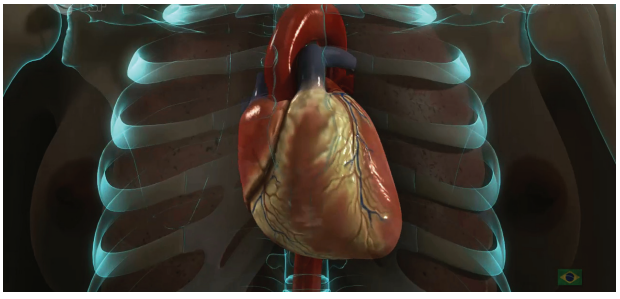

Figure 1: Virtual Human Project

METHOD

Through Inovalab Project (Innovation in Education), the Faculty of Medicine (FM), of USP, through the Telemedicine Subject of the Department of Pathology, developed a new method to improve the learning of human anatomy producing anatomical structures with realistic details, through the use of 3D printers (Figures 2,3). These structures are based on the collection of the Virtual Human Project, also the Telemedicine Subject that consists of digital and three-dimensional dynamic images of the human body and its processes.

Through 3D computer graphics, the sequences of the Virtual Human Project reproduce structures such as bones, muscles, organs, cells and even molecules. Added to 3D printing and the Virtual Human Project, are features such as augmented reality, digital visualizer table and anatomical pieces in full size, carved in styrofoam. The initiative is part of the anatomy with clinical, surgical and physiological area. Thus, according to its application, the printed models can be categorized as Clinical-Anatomical, Surgical-Anatomical or Morphofunctional.

The 3D models are part of the lines of investigation in development at FMUSP: one about clinical and anatomical or morphofunctional models that help the understanding of anatomy, physiology and clinical procedures, another about communication methods for disease prevention. With adjustments in language by a Design Team of Educational Communication, all of these materials are used to disseminate knowledge to the population (e-Care), once they allow the visualization and the manipulation of the structures, facilitating the "experiential" learning of concepts many times abstract when only explained in books or spoken. Through Connected Interactive Laboratories, this structure allows the use of Interactive Educational Technologies to enhance the in-service training and create a network for sharing educational infrastructures of the various institutions (Education 3.0) - Knowledge Factory in Health[4].

This initiative stems from the concept of learning proposed by Inovalab, which considers the axis technology of the development of a more efficient teaching and with greater range. The result is the embryo of what we call hybrid education, that is, more interactive, flexible, contextualized and adaptable to the focus of students' interests and social needs.

We can cite as an applied example of this model the human heart developed for unity application. A 35-megabit file that aggregates from the three-dimensional image to animated demonstrations of the physiological functioning of the organ. This file is also used as basis for printing the 3D physical structure, which can be done in photosensitive resin to ultraviolet or plastic filaments.

The Virtual Human Project files allow the viewing and printing of parts of the human body, organs (healthy or affected by diseases and injuries), as well as cuttings and extensions of all structures. Through a piece of these the student has contact with a structure extremely didactic that facilitates its understanding, besides having the opportunity to feel on his hands the anatomy, since the touch is a type of intelligence in this area.

RESULTS

The Interactive Media Laboratory in Health is an environment that brings together high-performance computing resources (computers, peripherals and softwares) for the production of interactive and audiovisual materials, games and computer graphics. Their activities are a reality within the graduation course in Medicine of the Faculty of Medicine, USP (FMUSP). Here we highlight three initiatives that illustrate the recent results of this project.

In May 2015, the first face-to-face class of the 21 Curricular Unit (Integrated Discussion of Cases I), about 90 students were able to learn in an innovative way, about respiratory failure, through a case of pneumonia.

With the support of the Telemedicine Subject of the Department of Pathology of the FMUSP, the learning model included the use, in face-to-face classes, of anatomical parts printed in 3D (produced from digital files of the Virtual Human Project and image exams of patients). Used during the inauguration class of the course, the overlapping structures of respiratory and cardiac systems allowed the first contact of students with the anatomy and helped in the understanding of the topic. According to the professor Maria Lucia Bueno Garcia, from the Department of Medical Clinic and the coordinator of UC 21, the fact of being in 3D and arising from a real image of tomography allowed to show accurately the anatomical details, enabling the introduction of physiological and pathophysiological reasoning of the relationship between the intrathoracic systems.

The Digital MedUSP also made available a library with videos of the Virtual Human Project. In the first module, students studied with the videos about anatomy/ physiology of the respiratory system (gas exchange and respiratory movements, relationship between intrathoracic systems) and pathophysiology (inflammation of airways, alveoli and

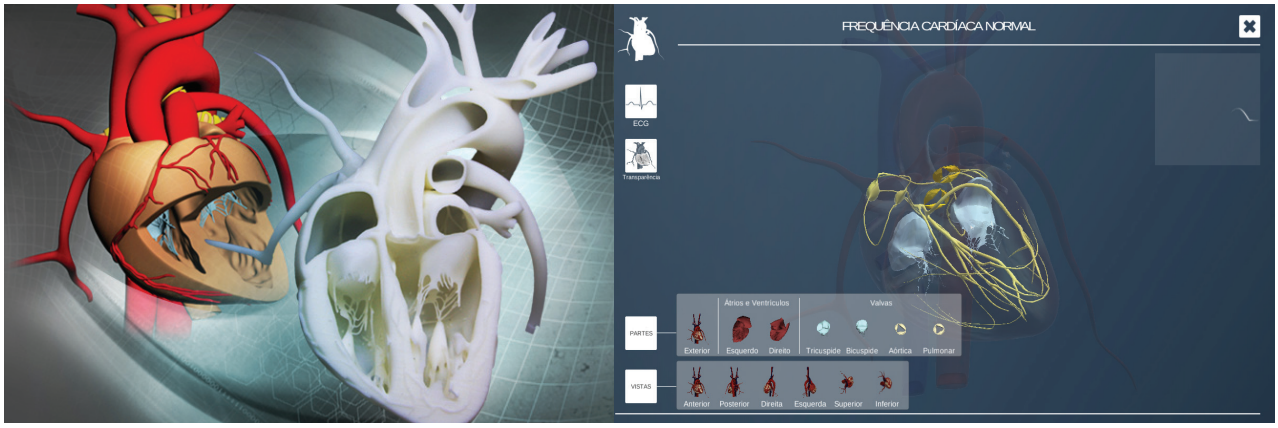

Figure 2: 3D printed heart and unity interactive file from the Virtual Human Project

alveolar-capillary membrane). On the platform, the students can, during the group study of the digital material, use a specially developed system to insert and vote on the questions they could not answer. The top-rated are worked with them during the face-to-face activities.

Also from the first semester of 2015, the Inovalab MedUSP Digital Educational Platform has made available organized themes in the video and educational learning object format. More than a thousand educational materials make up the list of contents for the students, which are available throughout the year. So far they have been made available in the platform contents about Telemedicine in Primary Care, Clinical Gastroenterology, Geriatrics, Clinical Cases in Diabetes, Psychiatry in Primary Care and the basic course on Electrocardiography (ECG) of InCor-HCFMUSP.

Finally, from July 2015, the Telemedicine Subject of the Department of Pathology of the FMUSP began to lend the 3D printed structures to students for purposes of anatomy review, physiology and propaedeutic. The Virtual Human Project collection has been used by the Telemedicine Subject of the FMUSP, for the production of more than 90 anatomical structures of support to the teaching of students through 3D printers.

Today, the project has more than 150 titles, representing, for computer graphics, three-dimensional and dynamic, organs, bones, tissues, systems, cells and molecules in the human body, besides clinical, surgical and emergency procedures. These digital files have been adapted to originate the physical structures, printed with the use of 3D printers. In addition to being able to learn the visualization and manipulation of the physical structures, the students can access the Virtual Human Project collection in the Digital Inovalab MedUSP platform.

CONCLUSION

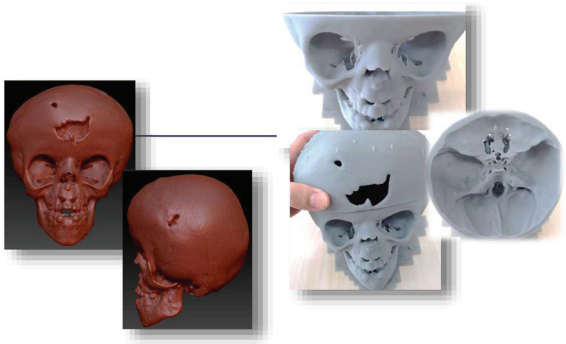

Figure 3: 3D printed object from magnetic resonance

The contextualized learning, more effective and lasting, makes the students have more interest in the topics and helps the overall perception of the graduation course. This can be measured by students' marks in the subjects and questionnaires given to professors who aim to detect their perception regarding the practical learning degree applied of the students. There are evidences that courses that integrate basic and clinical knowledge do not necessarily result in increase in marks in cognitive assessments of basic themes, but raise, significantly, students' marks in cognitive assessments of clinical topics[5].

The creation of an Interactive Media Laboratory enables the development of new types of educational content intended to be used by tablets, ultrabooks, PCs and smartphones, and can enhance the learning process. In addition, this laboratory can also be the environment for students to develop their own materials and share them in the collaborative environment of the graduation. This process can stimulate the learning and a greater integration among students from different semesters and among professors and students. This laboratory can also be the basis of teaching other skills that are not part of the formal curriculum of

the medical graduation, such as Communication in Health, Management in Entrepreneurship, Development of Socio-cultural Actions, among others.

As an Interactive Media Laboratory for the production of digital materials (ebooks, audio and videobooks, infographics, simulation games, etc.) and for the use of students in creating a collaborative space of the graduation based on website arose. The use by students has the potential to stimulate learning based on the development of educational contents, the learning through teaching (student more graduated teaching colleagues in the early years), the introduction to scientific research and publication. It can also provide the learning of additional knowledge that will be important for professional life such as digital inclusion, security and netiquette, communication (written, verbal, graphic and visual), administrative management of digital resources, the entrepreneurship, publishing materials in digital environments etc.

This is a project that modernizes education, disseminates the methods that encourage the integrated learning (OSCE), and creates infrastructure to compose the repository of educational contents. It is an evolution of the education in synchrony with the changing of technological and social realities.

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