Innovative Technologies to Support Education and Training: Researches by LabTEVE

Liliane S. Machado, Ronei M. Moraes

Laboratory of Technologies for Virtual Teaching and Statistics (LabTEVE)
LabTEVE/DE/CCEN – Universidade Federal da Paraíba - Brazil
http://www.de.ufpb.br/~labteve
liliane@di.ufpb.br, ronei@de.ufpb.br

Abstract: Training systems based on virtual reality, serious games, assessment methods, systems to support learning, assessment methodologies and technologies to extend interaction with educational content have been the focus of researches at LabTEVE. The interdisciplinarity can be observed in each project, highlighting the need for dialogue between areas for the production of solutions and technologies that can be used today as well as prospected for the future.

Keywords: *virtual reality; augmented reality; innovative research; educational technology.*

1. Introduction

The Laboratory of Technologies for Virtual Teaching and Statistics (LabTEVE) was created in 2000 to research and develop innovative methodologies and techniques to provide and support the learning by systems that allow information access any time and anywhere as well as training of individuals to deal with new technologies. Each project involves multidisciplinary teams that combine their expertise to provide consistent solutions to real problems. Thus, researchers from several academic centers of the Federal University of Paraíba take part in LabTEVE, specifically from the departments of Statistics, Computer Science, Psychology, Nursing, Medicine, Education, Engineering, Information Sciences and Chemistry. Nowadays, the group is composed by 27 researches and collaborators, including under graduation, master and PhD students. Additionally, there are partnerships with researchers and institutions from Brazil, Canada, France and Portugal.

The focus on education is the master line of the LabTEVE researches, that can be categorized in:

- Training Simulators based on Virtual Reality
- Methodologies for Real Time Skills Assessment
- Serious Games
- Virtual and Augmented Reality Applications

2. Main Projects

The innovative methodologies for education consider new ways to interact with the information, extending the reality possibilities. Since education processes are present in different stages of life, the researches of LabTEVE include since basic to professional (and permanent) education.

2.1 Training simulators and methodologies for real time assessment

Virtual Reality (VR) has been adopted in the proposal and development of simulators for medical training as a demand of medical education. In order to provide realistic manipulation of human body structures, haptic systems have been adapted and included in the simulators. The purpose is provide practice in virtual environments, free of risk, and fill the gap between theory and real practice for health students. The research also include the study and proposal of metrics that consider psychomotor skills. Those metrics are necessary to allow the use of interaction data, besides other virtual environment information, as input of assessment modules.

The simulators developed at LabTEVE include an intelligent assessment model. Intelligent models for real time assessment of users' skills are online (real time) systems able to monitor users' movements and environments variables, to provide a feedback about the procedure performed. This is a relevant area of research at the laboratory, with several methodologies proposed to provide feedback in real time, coupled to the VR simulator. These methodologies for real time assessment can consider one or more users acting in the simulator at the same time [7]. In the first case, they are named Single User's Assessment System (SUAS) [10] and in the second one Multiple Users' Assessment System (MUAS) [9]. This last one is able to assess each user in the system as well as, their interactions to complete a task (figure 1). Each assessment system is developed according to the specificities of the problem: the variables and the knowledge related to the task simulated.

The practice of incisions for surgical procedures is an example of simulator integrated to an assessment module. The incisions simulator brings a SUAS an assessment system based on the use of Support Vector Machine and rules of classical logic [11]. Other example is the simulator for training administration of drugs by needle (SIMTAMI), that included the proposal of metrics [5] and a SUAS to evaluate user's choice of tools and needle manipulation data, among other tasks, to produce an assessment report able to indicate right/wrong and acceptable/ unacceptable movements and choices. In both simulators, the tool manipulation data is provided by a haptic device.

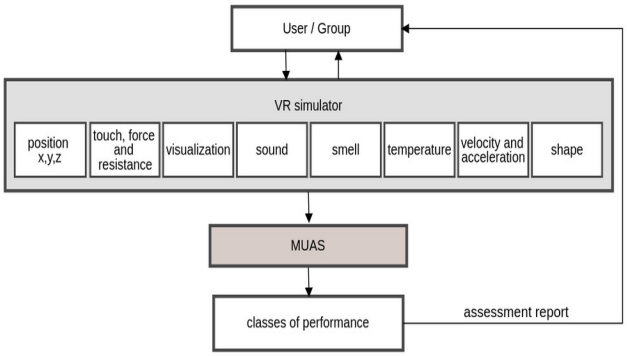

Figure 1. MUAS interaction with VR simulator.

The simulator for Gynecological Exam named SITEG (Figure 2) uses a SUAS based on the fusion of several fuzzy assessment methods. In this system, each method assesses variables according to their respective statistical distribution of data and aggregates these results using granularity computing [15]. SIMCEC is a collaborative simulator for surgical education of health professionals that will integrate surgical teams. In it, users can perform the simulation in one of the 3 available profiles:surgeon, surgical technician and anesthetist. Together, they must execute a preoperative phase of a maxillary surgery. A MUAS based on classical logic monitor each user activities and interactions to compute successes and mistakes [13].

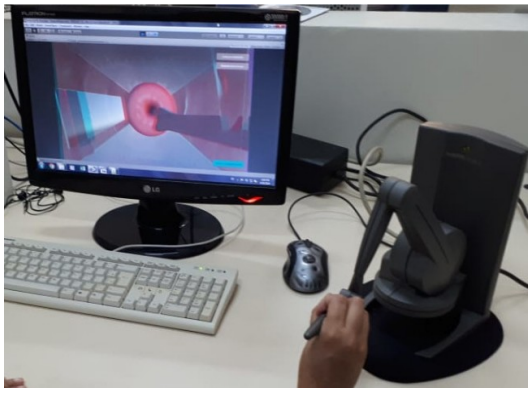

Figure 2. Haptic manipulation with SITEG.

There is another way of assessment for cases where training must be carried out continuously to improve the user's skills. The continuous assessment aims to assess the user in the repetition of tasks in a simulator in order to produce reports with notes, graphs and tables to illustrate the evolution of user's skills [8].

2.2 Serious games

The proposal of innovative Serious Games is also present in the LabTEVE researches. Some of those games include VR approaches to improve players' sense of presence and enjoyment. The design of serious games at LabTEVE have been focused on player engagement and include studies about presence, natural interaction and automatic balancing of difficulty level. The content is always the kernel of the game design process.

An example of those serious games is the FarMyo, a game to rehabilitation of patients pos stroke that uses an electromyography device to capture player movements [3] by natural interaction. Specific gestures in this rehabilitation game were recognized by neural networks. The game is in the final stages of testing for clinical evidence (Figure 3).

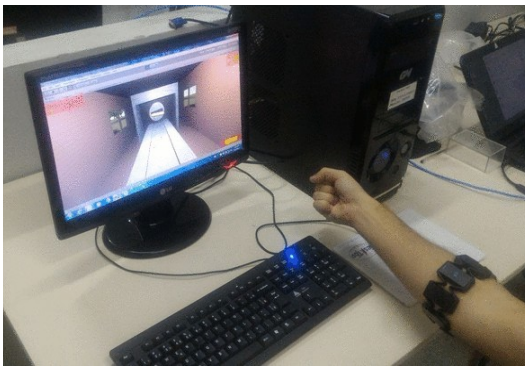

Figure 3. Playing FarMyo using an electromyographic device.

The Caixa de Pandora game was developed in 2015 as a tool for the qualification of health professionals about the violence against women [1]. The game was reformulated for mobile and general public in 2018[12]. Since 2019 has been conducted a redesign of the game for a VR approach with a 360º environment [4].

The intelligence models are also present in the serious games. Their goal is to monitor player actions to identify their comprehension of the game subject and 1) modify the game progress, 2) reinforce a content presented, or 3) extract measures. The third case can be seen in the Paki Mirabolândia, a game dedicated to identify player personality traits [14] (figure 4). Paki Mirabolândia is a serious game that integrates a decision making model based on the Item Response Theory to relate the choices and actions of players to their trace latent.

Figure 4: The Paki Mirabolândia game to identify user trait of personality.

2.3 Virtual and Augmented Reality Applications

Several other researches have been conducted in the LabTEVE and use virtual and augmented reality as a way to approximate content to people and improve learning processes.

In project Interactive Archaeology was developed an immersive and multiplatform environment of the archaeological site of Ingá Stone, one of the most important of Brazil. The environment have a set of historic and archaeological information found in the site and in the literature. By VR technology it was possible to visit the site in a three side display (figure 5) system [6]. The environment was rebuild using HTML5 to provide 3D view and navigation by web at: http://www.de.ufpb.br/~labteve/download/inga/.

More recently, the design and integration of augmented reality to didactic material was presented in the AminoViewer project (figure 6). In this project was proposed and developed a book and an application to explore aminoacids in undergraduation courses [2]. Further developments include the design of a game for collaborative activities in this subject.

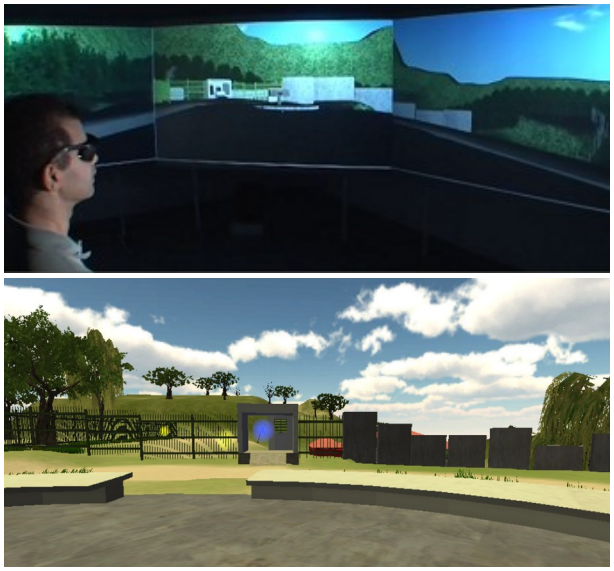

Figure 5. The virtual Ingá archeological site in a three side display and online at web.

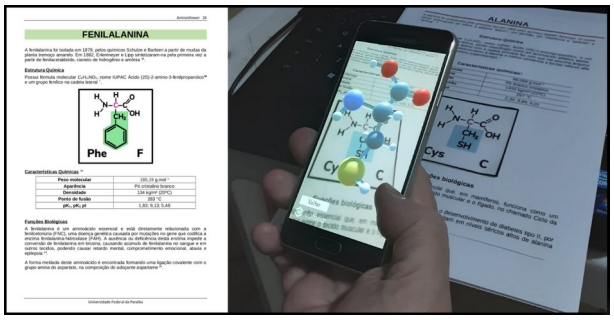

Figure 6. The AminoViewer didactic material.

3. Social, Technological and Scientific Impact

LabTEVE has contributed to the advancement of research related to educational technologies, with regional, national and international impact. In this context, it has also contributed to the technological production of solutions, made available to society, and to the training of human resources. Next, the main impacts are highlighted.

3.1 Scientific impact

The projects and research developed at LabTEVE have been published in regional, national and international scientific journals and conference proceedings. It is a constant goal of the group to disseminate this research in order to collaborate with the advancement of science. In the last 10 years, the group has produced 59 papers in journals and more than 100 in conferences.

3.2 Social impact

As a way of reaching society, the research group is present at major national scientific events. Particularly, since the year 2014, the group has participated annually in state technology fairs, exposing its results to society. It is also important to remember that several of the products developed by LabTEVE are available to society free of charge, reaching schools and educational institutions, collaborating with training processes.

3.3 Technological impact

The technological production of LabTEVE has an institutional impact, since the group has ensured the registration of this production with the National Institute of Industrial Property through the Technological Innovation Agency (INOVA) at the university, with incentives from this agency. From its creation, LabTEVE has already registered 29 computer programs and required patent for four inventions. Since 2016 the LabTEVE team receives annually from INOVA inventor awards for their software products.

3.4 Impact on Human Resources Training

The training of human resources at LabTEVE has taken place from undergraduate and graduation works. The doctorate and master degree works are carried out by the Postgraduate Program in Decision and Health Models and have an interdisciplinary character, while by the Postgraduate Program in Informatics there are master's orientations that, although they are in Computing, are integrated with multidisciplinary projects of the laboratory. In its 20 years of operation, LabTEVE has received more than 50 students, including undergraduates, master's and doctoral students.

4. Final Considerations

This paper presented the main research lines of LabTEVE and some projects developed in the last ten years. Previous works can be seen on the laboratory pages and in a previous publication about the group [16].

Since 2009, LabTEVE is member of the Brazilian Institutes of Science and Technology, through the

research network of Medicine Suported by Scientific Computing (INCT-MACC), which involves more than 20 Brazilian and international institutions.

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