THREE-DIMENSIONAL COLLABORATIVE VIRTUAL ENVIRONMENTS FOR SUPPORTING B-LEARNING

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Abstract

This paper advances the use of the Three-Dimensional (3D) Collaborative Virtual Environments in blended learning context as tool to help in the interaction between students, teachers and learning resources. These environments promote new concepts, new approaches and new strategies which have been changing the paradigm of teaching and learning. In addition to these benefits, the virtual words are now being used as environment/development platforms. The development of 3D virtual environments requires a systematic process, led by a series of well-defined phases and activities, which helps us to efficiently develop high-quality applications. The research presented here focus on a enhanced students' performance model based on the methodologies mentioned above and it consists in five main phases: planning, analysis, design, implementation and assessment. The whole process begins with the analysis of students and environment characteristics. The content analysis is performed to explore the structure of environment. The identification of learning events, learning units and instructional methods are included in the design. The assessment is a critical factor to ensure well-designed blended learning environment, therefore the evaluation design process is discussed in detail.

The study highlights also a set of design guidelines that help the educators developing appropriate learning styles and preferences according to students' learning needs. Additionally, it stimulates the acquisition of knowledge and provide high-level of interactivity, allowing the exchange of information, experience and the necessary validation of knowledge. The people learn on their own as well as interact in group.

Keywords: virtual Worlds, B-Learning, Collaborative learning, Collaborative virtual environment.

1 INTRODUCTION

Nowadays, teaching and learning activities are increasingly realized not only in the classroom context, but also carried in out online environment. This is possible through the use of new technologies that have emerged (and arise) in the labour market. Some of these new technologies have allowed the emergence of environments that include representations of some elements that we see in real world. These elements are virtual humans, which interact with each other, virtual physics objects (lands, oceans, and virtual objects), and the gravity. These environments have peculiars characteristics (synthetic, immersive, presence, interactive, realistic and three-dimensional space) which make them different from traditional applications. The process of communication, information's searching, sharing and learning activities, are easier because they can to take place at anytime and anywhere; Capability that could not be accomplished with conventional methods.

Advances of technologies replace traditional classroom meetings with online sessions and lead to a hybrid approach, which is defined as blended distant learning [3]. Blended distant learning supports both offline and online learning, offers a "bi-directional model of knowledge flow and employs synchronous and asynchronous communication and learning tools such as: email, forum, chat, audio-video conference, presentations, wikis, Whiteboards, Web Tours, e-voting, Applications Sharing, portals, etc " [1].

To introduce the virtual worlds in educational settings makes us reflect on their development process. Some of these environments show various problems in the design, putting in risk the satisfaction of basic requirements such as performance, flexibility and ease of use. Experience show that the process of development is not an easy task to accomplish. It is a complex task because of the number of activities to coordinate, require specialists in different fields of knowledge, making the co-ordination as the main challenge to maintain the unity and integration of the project.

The present study presents a techno-pedagogical model which allow development of courses in b-learning context and emphasize the importance of assessment to ensure well-designed. By techno-pedagogical model we understand "a proposal of definition of structure of environment, objectives,

learning evens, learning units and instructional methods; and a set of guidelines on how to take into account in the development of these courses.

Specifically, this paper has two objectives:

- To describe a techno-pedagogical model focused on enhanced students' performance.
- To define set of design guidelines to help the educators developing appropriate learning styles and preferences according to students' learning needs.

2 METHODOLOGY

The present research followed the research methodology called design science proposed by Vaishnavi [7] and it's shown in figure 1.

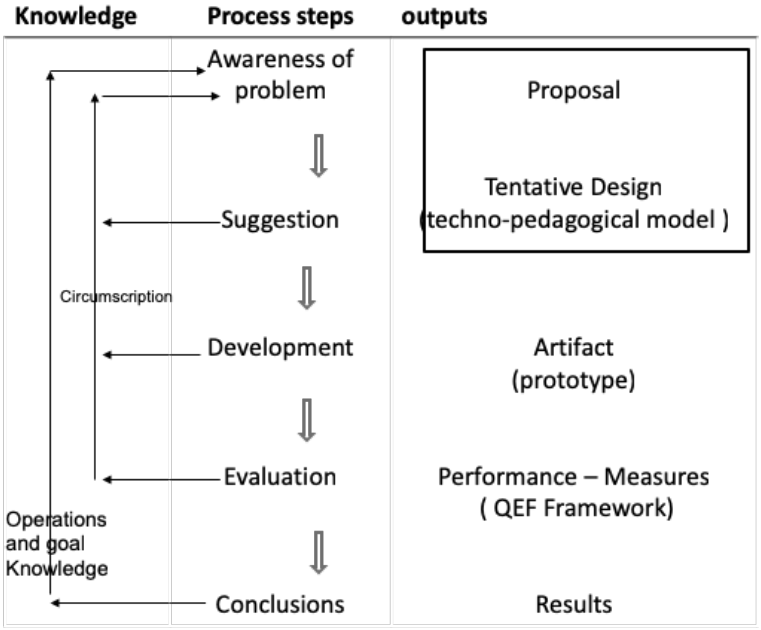

Fig.1 - General methodology of design research [7].

2.1 The Model

This methodology starts with Awareness of problem, which helps to identify the problems, in this case, inherent in the use of virtual worlds in education. Once the problem has been identified, it will be necessary to develop research to identify suggestions for solving the problem. This phase, called Suggestion, is linked to the previous one, because it aims is to propose a first design of a model for the development of b-learning applications.

The third phase is the Development where the design of the model is developed and implemented through a prototype. The techniques used in its implementation depend on the artifact to be developed. The implementation itself does not have to be new. Innovation lies mainly in the design of the model and not in the construction of the artefact [4].

The next phase is the Evaluation where, once built, the artifact is evaluated according to a set of quality criteria, defined for the study.

The implemented model is evaluated by empirical methods regarding its viability and quality. The evaluation includes the use of the QEF framework [5]. The methods used in this project were the experimentation and the demonstration through previously defined scenarios which showed that the solution is feasible and valid. From this phase, new clues to be explored in a new iteration of the methodology that leads to the refinement of the model [7].

The model proposed uses abstraction and techniques of software engineering to allow a concise description of complex information items and specification of complex navigation patterns and interface transformations.

It is based on several assumptions, namely:

- promote a structured development, giving the process the form of a set of ordered steps, identifying the activities and rules involved in them;
- provide an adequate semantics of how to work properly all the critical aspects in educational collaborative virtual environments development;
- to be a model easy to understand that help to understand the system design and stimulate new ideas, supported by a language that facilitates communication among the different elements of the development team.

Given the complexity of collaborative virtual environments, it is important to do several revisions in conception phase. The modification of some environment aspects leads us to different dynamic behaviors in order to have a life cycle model that allows modifications throughout its specifications. Also, it is necessary to look for the previous phases as well as for the improvement and exploitation of the solution space.

This model is composed by five-step and supporting an incremental or prototype process model. Each step focuses on a particular design concern and is supported by a set of diagrams that facilitate the understanding between the various elements involved in the development of the virtual environment. Figure 2 summarizes the steps, products, mechanisms and design of model.

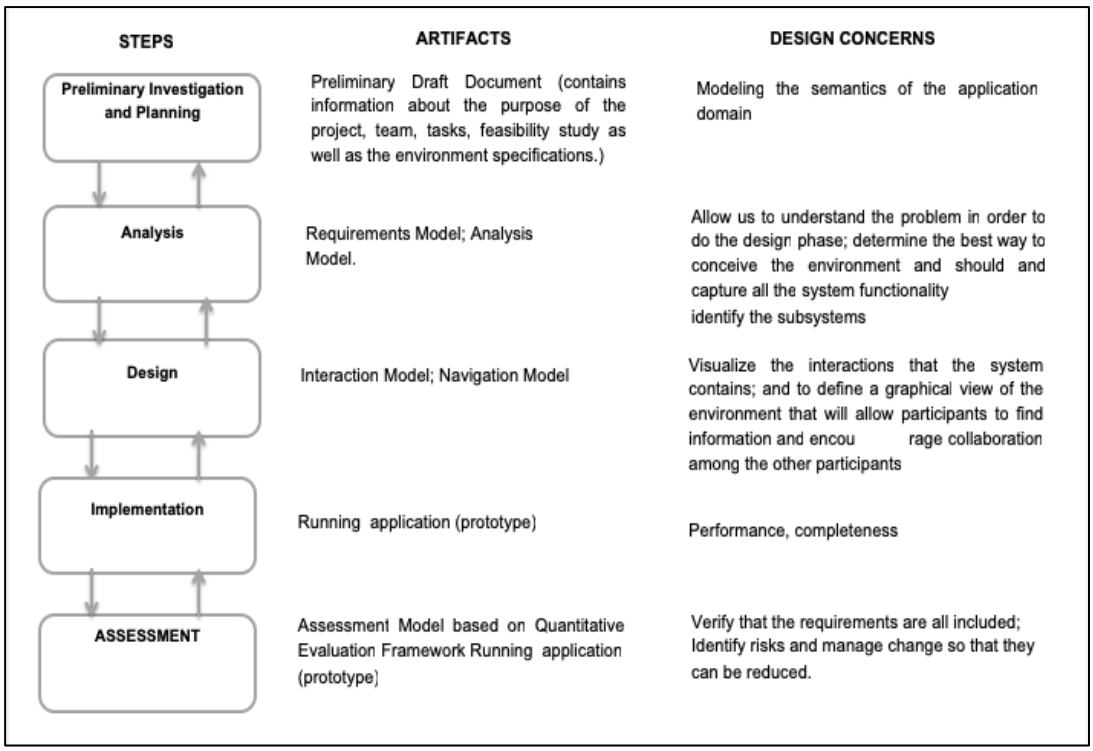

Fig.2 – Phases of Model

2.1.1 Preliminary Investigation and Planning

In this step we specify a sequence of actions, such as, to identify the objectives of environment, define the target population, specify the pedagogical model, define the instructional strategies, choose learning techniques, and describe the activities and the content of the design and finally, the definition of the structure' characteristics to support the interaction. Also, we must include a range of activities, which emphasize the system organization (including the team constitution and their responsibilities), the structuring of the tasks (WBS - Work Breakdown Structure), project schedule, risk analysis and costs. These two steps are related, because they constitute a single phase, called the Conception phase. Here, we issued a document called Preliminary Draft Document that describes the work done in Preliminary Investigation and Planning steps. Its purpose is to determine the best way to conceive the environment and should contain information about the purpose of the project, team, tasks, feasibility

study as well as the environment specifications. The specification of the environment is one of the most important parts of document, because the system's success depends on it.

2.1.2 Analysis

This step consists in modelling a real-world system in order to be understood. It is important to take account the system's features. It is based on examination of the requirements and analysis of the implications.

We propose two models: a model of requirements and a model of analysis. The model of requirements has as aims to capture all the system functionality. These objectives are developed using the modelling technique of UML - Use Case Diagram.; and the model of analysis consists in scenarios' specification-storyboards. Our aim is to simplify a construction of the system because the scenario becomes a central element of the environment where users will develop their "actions" which will lead to learning processes. The storyboards have as aim gives a global view of the virtual environments, where we have clear idea of the speech, plot and other instructional questions. Here, the design team and teachers share a continuous flow of assessments (corrections and/or suggestions) by sending and receiving versions of the storyboard.

2.1.3 Design

The Design step is composed by two distinct phases and consists in developing of an interaction model and navigation model. The interaction model is designed to visualize the interactions that the system contains, because for us "an interaction between a student (avatar) or students (avatars) and one environment (optionally including content resources, tools, instruments, systems computer services, real-world events and objects) helps in the answer to a task intended to learning something " - Learning Activity. The interaction model becomes crucial. We suggest development the several diagrams, namely:

- Table of Action which identify all participants of the system and their actions within the system;
- Collaboration Diagram based on the Menchaca methodology [6], which involves the creation of social groups. Social groups are working groups, composed by students, who will perform some tasks in the environment. After identifying the social groups and with the table action, we are able to do a short description of the functions, restrictions and services that each group;
- navigation model defines a graphical view of the environment that allows the users to find information and encourage collaboration among the other participants. It aims to provide a graphical model showing the relationships between the various subsystems of the virtual space, i.e. a map navigation of the system.

2.1.4 Implementation

All the specific environment features should be implemented (coded) according to the descriptions reported in the previous phases. It is not our intention to indicate the use of a specific programming language. The main goal is to assist in the development of a collaborative virtual environments, under a 3D virtual environments platform such as Second Life, Active Worlds, OpenSim, and others.

2.1.5 Assessment

To evaluate the environments, we suggest applying the evaluation model proposed by Escudeiro [5], which is based on the framework called QEF (Quantitative evaluation Framework). We chose this framework because it allows us to identify a set of requirements for the environments. We are currently identifying requirements related with b-learning and after this step we will evaluate the systems and publish the results.

3 RESULTS

The model was tested through of development a prototype, which we applied a iterative evaluation process throughout it development lifecycle. The results of iterative process helped to avoid usability problems and refine the diagrams. Also helped us define some basic design guidelines that must take into account in developing these environments. The Table 1 shows the basic design guidelines of virtual worlds.

Table 1. Design Guidelines of 3D Collaborative Virtual Environments

Guidelines	Purpose
Identify the scope, target audience, learning outcomes and the results required to the target audience	In the construction of 3D collaborative virtual environments, it is necessary to be aware to whom the Virtual World is addressed (target audience), the purpose of learning, the results required to the students, the contents;
Identify the idea, define a metaphor that allows creating a teaching situation	The metaphor is the bridge between the real and the virtual worlds. The world's structure and organization make it easy to build navigation and increase the interaction quality. If the virtual world model is not representative of the real, the user does not build a consistent mental model with the reality. Moreover, the representation of the real can capture attention and influence the student involvement, because the realism is one of the characteristics of virtual worlds.
Define scenarios with their objects (fixed and dynamic) and content	The scenarios should be created taking into account the different learning styles students and the different ways of acquiring knowledge. For objects, it is important to define their behavior, which can be interactive, autonomous, connected to other objects as well as without behavior. For objects without behavior (known as fixed), it is necessary to define their positions in the scenario. The contents should be defined and structured according to how we want the users should be involved in learning process. These can be static, allowing users to explore, observe, and do not interact, or generative, which allow users touch objects, start a task, select to customize or modify a specific content.
Define the learning space	Education virtual world should be examined in a pedagogical perspective of the learning activities, including the type and learning strategies that it is necessary to be adopted. We can include associative models (task-oriented approaches), constructivism (approaches based on existing knowledge by the student-Vygotsky) and situational (approaches socially constructed - Wenger). The tasks that enable students to achieve the objectives of learning should be idealized in order that the performance results are consistent with the knowledge acquired.
Different types of interaction and communication between individuals	3D collaborative virtual environments allow a greater interaction between individuals, namely among students, student(s)/teacher(s), contents and objects. Communication can be synchronous or asynchronous. A combination of different forms of interaction can lead to richest results [4].
Create a map that facilitates navigation through the environment	Navigation is the foundation for a useful application. The world should have information that helps the user to answer basic questions such as, where am I? where can I go from here?

4 CONCLUSIONS

The development of Three-Dimensional (3D) Collaborative Virtual Environments for supporting blended learning is a complex task because it includes different areas of knowledge such as human-machine interface, design, education. This implies that the development team is multidisciplinary. In this sense we decided to develop a model of high level that (1) allows facilitate the understanding of all team members and (2) that the model is very flexible framework which can be used for the whole lifecycle or just for a set of processes. The main features of the model were introduced underlining the importance of collaboration in education virtual environments. We believe that it is necessary to develop virtual environments with quality, to increase of the users' motivation to perform activities in the environment, giving them pleasure and keep them interested in the content of 3D collaborative virtual environment [5].

To achieve this objective and based on the knowledge of designers who have experience in the development of collaborative virtual environments, the present work presents a design model e defines a set of design guidelines. The guidelines give the emphasis to the need of good and meticulous planning, in order to make the best use of collaborative virtual environments in b-learning context. It is our intentions that the use of 3D virtual environment in context b-learning allow students to develop activities together, when questions arise and, can share their learning and thinking with their colleagues.

We intend that this work serves as basis for building of Collaborative 3D collaborative virtual environments for supporting b-learning, allowing students and teachers become more involved in teaching and learning process and create more dynamic learning experiences [2].

REFERENCES

[1] A. Giannakoulopoulos, I. Kostarikas, I. Varlamis, , “Blending Distance Learning Platforms and 3D Virtual Learning Environments”, Proceedings of 6th International Conference in Open & Distance Learning – November 2011, Loutrali,Greece

[2] Eastgate, R. “The structured development of virtual environments: Enhancing functionality and Interactivity”, Thesis submitted to the university of Nottingham, September 2001.

[3] Gros, B. “Knowledge Construction and Technology” Journal of Educational Multimedia and Hypermedia, vol. 11, no. 4, pp. 323-343, 2002.

[4] J. Neto, “Second Life e Web 2.0 na Educação: o potencial revolucionário das novas tecnologias”, São Paulo, Novatec, 2007. 280 p, 2007.

[5] P. Escudeiro, ”X-Tec Model and QEF Model: A case study”, in *T. Bastiaens & S. Carliner (Eds.),* Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Chesapeake, VA: AACE, 2007, pp. 258-265.

[6] R. Menchaca, R, Ballares,B., Quintero R. and Carreto, C. “Software Engineering, HCI Techniques and Java Technologies Joined to Develop Web-Based 3D Collaborative Virtual Environments”, *Proceeding CLIHC '05* Proceedings of the Latin American conference on Human-computer interaction, 2005.

[7] V. Vaishnavi, W. Kuechler, “Design science research methods and patterns: innovating information and communication technology”, *NY: Auerbach Publication*, Taylor & Francis Group, 2007.