Immersive Virtual Environment and Artificial Intelligence: A proposal of Context Aware Virtual Environment

Fabrício Herpich*, Gleizer Bierhalz Voss†, Felipe Becker Nunes†, Rafaela Ribeiro Jardim* and Roseclea Duarte Medina*

* PPGI - Computer Science Post Graduate Program
Federal University of Santa Maria (UFSM)
Networks Group and Applied Computing (GRECA)
Santa Maria, RS, Brazil

† PPGIE - Computer Education Post Graduate Program
Federal University of Rio Grande do Sul (UFRGS)
Porto Alegre, RS, Brazil

(fabricio.herpich, gleizer.voss, nunesfb, rafa.rjardim, roseclea.medina)@gmail.com

***Abstract*—Virtual worlds has emerged as an environment of great interaction and immersion, where students have at their disposal different types of tools which are necessary for carrying out its activities. The objective of this paper is to present a proposal for developing an immersive environment for teaching Computer Networks that fits to the context and cognitive profile of the student. For this, the OpenSim [1] virtual world and the environment Moodle [2] are connected by the technology Sloodle [3]. In the immersive environment, agents with rules of Artificial Intelligence (AI), which offer support to learners according to these cognitive characteristics and their level of expertise.**

Keywords–Virtual World; Artificial Intelligence; Cognitive Profile; Expertise; Computer Networks.

I. INTRODUCTION

With the increasing use of Information and Communication Technologies (ICT) in the educational scenario, several needs were emerging and making necessary a reflection on the new paradigms of computing in education. In this context, many studies have been conducted in immersive virtual environments to be able to provide the student interaction with learning objects and the ability to be immersed in the environment [4][5][6].

Through the virtual worlds, for example, Second Life [7], OpenSimulator [1] and OpenWonderland [8] it is possible to create immersive virtual environments. However, the creation of immersive environments focused on education requires many factors to be considered, such as educational objectives and teaching strategies based on well-defined learning theories, friendly design and objects that are able to encourage the interaction and collaboration among users.

This paper aims to present an immersive virtual environment in development, which not only includes features of an educational environment, but too characteristics of context awareness, because it provides personalized assistance to students according to their cognitive profile and their level of expertise. For that, Intelligent Pedagogical Agents (IPA), has been implemented through rules of AI, since, according to Soliman and Guetl [9], in an Immersive Virtual Learning environments, it is expected that the learner will have great flexibility, faced with numerous learning opportunities and therefore it requires intelligent support and guidance.

Immersive experiences tend to further the engagement between students with the objectives established in the environment; thus, it is also possible to claim that the IPA could contribute significantly in helping the students, because according to Soliman and Guetl [9], IPA can act as a teacher, learning facilitator, or even a student peer in collaborative settings. The IPA will guide the learner in the virtual environment, explain topics, ask questions, give feedback, help the learner collaborate with others, provide personalized learning support, and act upon the learner in different times and in virtual places.

This paper is organized as it follows: theoretical references are presented in Section II, which exposes some concepts about immersive virtual environments and artificial intelligence; in Section III, a metodology is presented. Section IV presents the proposal and related work. Conclusion and future work are discussed in Section V.

II. THEORETICAL FOUNDATION

This Section aims to identify the main concepts related to the use of AI in Immersive Environments for supporting the processes of teaching and learning.

A. Virtual Worlds

Also known as immersive virtual environments or metaverse, virtual worlds are tools that simulate the real world environment in three dimension (3D), providing the user with a controlled environment experience with many possibilities. According to Bainbridge [10], they are defined as persistent online computer-generated environments where people can interact in a comparable way to the real world, either for work or for leisure.

Virtual worlds allow performing many activities, including training and tasks of educational character. According to Valente et al. [11], 3D virtual worlds enable the inclusion and practice of activities for experiential learning, simulation, modeling of complex scenarios, among others, with opportunities for collaboration and co-creation that cannot easily

 ISBN: 978-1-61208-353-7

be experienced on other platforms. Medina [12] reinforces this by stating that the learning gained through the personal experiences of the participants and their interactions with other participants, becomes more productive, dynamic and consolidated.

We can quote as examples of metaverse Second Life, OpenSim and OpenWonderland. This project will work with OpenSim because it is open source, it has extensive documentation, and also, according to Voss et al. [13], it allows the creation of the virtual world, in which all desired objects are placed, such as the creation of classroom, chairs, interactive scripts, among others. Also, this tool is used by the research group in which the authors of this paper belong to.

B. Artificial Intelligence

Artificial Intelligence is an area of computing that for years has been devoted to propose methods, techniques and tools that may be able to represent human knowledge in artificial systems. Besides, according to Liu et al. [14], artificial intelligence is the science of research, design and application of intelligent machines or intelligent system to simulate intelligent human capabilities and extension of human intelligence.

Filho [15] suggested that these methods and techniques should allow the computer to simulate the behavior aspects of intelligence, such as playing chess, proving logical theorems, understanding specific parts of a natural language, for example, Portuguese, among others.

However, other authors such as Liu et al. [14], Pollock [16], and Singh and Gupta [17], state that the AI should also be able to be aware of and demonstrate cognitive skills (problem solving, reasoning, and be autonomous to the point of being self-taught) and not just replicate knowledge.

C. Intelligent Agents and IPAs

Intelligent agents in the educational context are widely used as tools to support students with the goal of supporting the student interaction with the environment they are situated, providing personalized learning. In this context, Tyugu [18] understands that intelligent agents are software components that possess some features of intelligent behavior that makes them special: proactiveness, understanding of an agent communication language (ACL), reactivity (ability to make some decisions and to act).

Some authors such as Guetl and Soliman [9] and Garrido et al. [19] define intelligent agents used in education as IPAs, which, according to Guetl and Soliman [9], IPAs combine different characteristics including artificial intelligence capabilities to enrich the learning environment. Already Garrido et al. [19], states that they are software agents, which have educational purposes. They are able to communicate, cooperate, discuss, and guide other students or agents.

Moreover, Soliman and Guetl [20], elect five Pedagogical Agents Functional Requirements, which are: Learner interface requirements, Autonomy, Cognitive abilities, Agent Social Abilities, Environment and Context Awareness. For the development of this research, were approached three of these concepts: Autonomy, Cognitive Abilities, Environment and Context Awareness. The autonomy of the IPA is critical because that is how you will give origin to the processes of learning in virtual worlds, through interactions, explanations of classes, 3D objects or scenes. Another interesting point related to this research is the question of Context Awareness, because, according to Soliman and Guetl [20], inside a virtual world, this is related to the ability of the agent being able to discovering, constructing or suggesting learning resources, scenarios or scenes that are suitable to learner abilities and goals.

D. Context Aware

Context aware computing is characterized by performing the collection of various information involving the user, i.e., computational context of the user, physical and time. Thus, information is collected about the environment, in which its location and computational device used. According to Dey [21], context is any information that can be used to characterize the situation of entities that are considered relevant to the interaction between an user and an application.

Systems that use context information to provide personalized services to users, such as the adaptation of content and tools according to the user preference, may be considered a sensitive environment to the context. For Baldauf et al. [22], these are able to adapt their operations to the current context without explicitly requiring the user intervention, thus seeking to maximize their usability and effectiveness, taking into account the environmental context. Possible applications are the tour guides, restaurants, smart homes, among others.

According to Knappmeyer et al. [23], context area can be considered as an interdisciplinary field of research involving artificial intelligence, mobility, human-machine interaction, among others, in which, many researches have been conducted to overcome existing challenges.

In this aspect, information about the context of the cognitive profile of the user and their level of expertise will be used, which will be incorporated into the API from the implementation of rules on Artificial Intelligence, as described in Section IV.

III. METHODOLOGY

The development of this study arose from the need of a tool that can contribute and assist students in their learning process in the discipline of Computer Networks. This research proposes a different approach to the theory-practice relationship in the discipline of Computer Networks approach through an immersive virtual environment. For this purpose, a set of steps that the environment should suit were developed, as it follows:

The first phase was characterized by a survey of the theoretical reference about the topic, where also the technologies that would be used in the development of this work were defined, as shown in Figure 1.

The technologies discussed were WampServer [25], Moodle [2], OpenSimulator [1], Sloodle [3] and Firestorm [26]:

- WampServer was selected because it is free, hosts the necessary applications for the operation of technologies and includes three elements: MySQL, PHP and Apache. It creates a local server that will host the MySQL database application of OpenSim and the learning environment Moodle.
- Virtual Learning Environment (VLE) Moodle was selected because it is open source and widely used

 ISBN: 978-1-61208-353-7

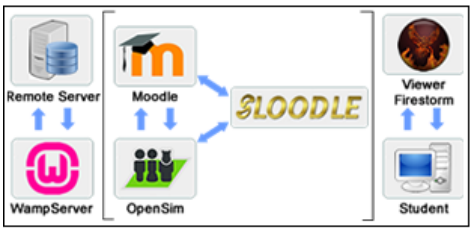

Figure 1. Technologies used. [24]

by the research institution of the authors, as well as OpenSimulator. Moodle materials and activities related to the discipline of Computer Networks were available and they were displayed to the students through Sloodle technology.

- Sloodle technology was chosen because it is open source and its performs integration between OpenSim and Moodle, thus enabling the display and interaction of materials available on the VLE for users of OpenSim. As for the Firestorm viewer, which is used in the projects of the research group of the authors, it has the function of making the connection to the virtual world, plus allowing importation of several objects, as already discussed by Nunes et al. [27], which highlighted the importance in choosing a viewer.

The second phase addressed the implementation of immersive virtual environment in OpenSim. In addition, a course was created in Moodle, inserting contents about Computer Networks.

As the research is still in progress, other phases will be discussed: lesson plan, learning objects in 3D, instructional design and theories of learning in immersive virtual environments, and finally, evaluating the environment with undergraduate students.

IV. PROPOSAL

This study presents a work in progress, which involves the development of an immersive virtual environment for teaching Computer Networks. In this environment, it will be used context information of students for the adaptation of materials, tools and activities to their cognitive profile. This same context information will also be used to define the level of expertise of the student. Such context information is very important for the process of teaching and learning of students, because through the adaptations of contents to the students and the support offered by the intelligent agent, it is possible to offer an appropriate, personalized and objective support to the learner.

In addition to the cognitive profile information and level of expertise, this environment also aims to gather information about the progress of the process of student learning through Sloodle Tracker, where it is possible to monitor the progress of students within the immersive environment. With this tool, it is possible to obtain location information of the student within the environment and monitor their activities. In this sense, it is intended to make the intelligent agent follow the student activities and offer him support in cases of difficulty.

Thus, the environment will advance to collect information about the cognitive profile and level of expertise (Figure 2). Later, it will collect information about the student learning process. From this information and with the formulated context, it will be possible to implement via AI, rules so that the IPA can offer adequate support to the needs of the student, thus providing a personalized education.

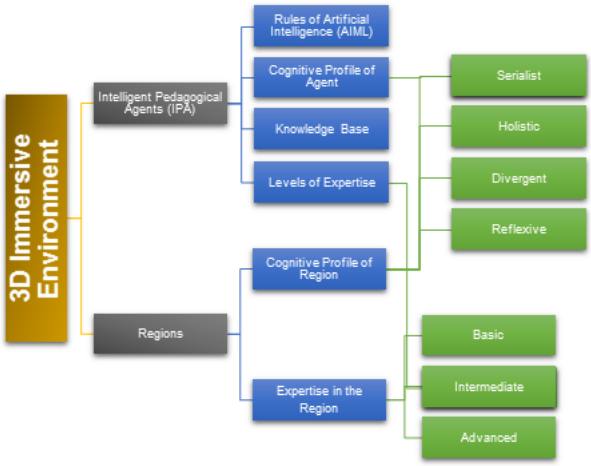

Figure 2. Structure of the proposal.

To this end, in addition to the IPA, the immersive environment as a whole offers five regions, which are: Serialist, Holistic, Reflective, Divergent and Computer Networks. From this perspective, when the student accesses the immersive virtual environment, he will be directed to the area of Computer Networks (Figure 3), in which the person has to answer a questionnaire, so one can set his cognitive profile. Then, the student will be teleported to the region that fits its cognitive profile; but, it is important to note that the student will not be prevented from viewing the other regions, providing freedom of choice to the user.

Figure 3. Immersive virtual environment.

Furthermore, immersive environment will also use information from the user's context to make adjustments to the immersive environment and IPA characteristics. This is essential to the process of personalized teaching and learning. Also, it is essential to identify the cognitive profile of the student and his level of expertise. In addition,in order to provide an adequate level of education based on the experience of the student, it is also possible to focus the teaching on the student's preferences and/or needs.

 ISBN: 978-1-61208-353-7

V. Conclusion and Future Work

With the integration of new educational technologies in the teaching context, new paradigms of teaching and learning that are transforming traditional education scenario emerged. Thus, the creation of new methods and instructional strategies that address the extent of teaching beyond the classroom environment and the use of technology in education become necessary.

Given this context, this paper has proposed a work in progress toward the teaching of Computer Networks. To provide resources and establish an immersive virtual environment to the students, integration of Moodle with OpenSim has been accomplished by Sloodle tool. These immersive environments allow educators to create new teaching alternatives, through simulations of equipment and performing experiments.

In this research, it was observed as a general result, the existing potential in immersive virtual environments focused on education. This case could corelate theoretical concepts with practice, not only because of the immersive environment, but also because of the personalized support offered by the IPA, the content presented in Computer Networks, and the tools available to the student.

Moreover, the fact that the immersive environment uses context information of the user to perform the adaptation of their characteristics is fundamental to the process of personalized teaching and learning, as well as to identify the cognitive profile of the student. It is also capable to identify their level of expertise and thus, in addition to it, provide an adequate education for the level of the student experience. It is also possible to do a more focused teaching based on their preferences and/or needs.

According to what has been presented, this study proposed to cover as future work the implementation of other features and functionality in the immersive virtual environment.

It will be validated with the use of the students that are taking Computer Networks at the undergraduate level. A comparison will be performed based on the knowledge level of the students before and after the use of the environment. This way we can show and prove the efficiency of the use of virtual worlds for education. The control group for this comparison will be the students who did not use the virtual lab. There is also the intention to tailor the user interface environment using instructional design concepts supported by theories of learning and their use in virtual worlds.

References

[1] "Open Simulator," 2014, URL: http://www.opensimulator.org [accessed: May/2014].

[2] "Moodle," 2014, URL: http://www.moodle.org.br [accessed: April/2014].

[3] "Sloodle," 2014, URL: http://www.sloodle.org [accessed: May/2014].

[4] M. Callaghan, K. McCusker, J. L. Losada, J. Harkin, and S. Wilson, "Integrating virtual worlds & virtual learning environments for online education," 2009 International IEEE Consumer Electronics Society's Games Innovations Conference, Aug. 2009, pp. 54–63.

[5] F. M. Schaf, S. Paladini, and C. E. Pereira, "3D AutoSysLab Prototype A Social , Immersive and Mixed Reality Approach for Collaborative Learning Environments," iJEP, vol. 2, no. 2, 2012, pp. 15–22.

[6] F. B. Nunes, S. Stieler, G. B. Voss, and R. D. Medina, "Virtual Worlds and Education: A Case of Study in the Teaching of Computer Networks Using the Sloodle," 2013 XV Symposium on Virtual and Augmented Reality, May 2013, pp. 248–251.

[7] "Second Life," 2014, URL: http://secondlife.com/ [accessed: July/2014].

[8] "Open Wonderland," 2014, URL: http://openwonderland.org/ [accessed: July/2014].

[9] M. Soliman and C. Guetl, "Intelligent pedagogical agents in immersive virtual learning environments: A review," MIPRO, 2010 Proceedings of the 33rd, 2010, pp. 827–832.

[10] W. S. Bainbridge, "Online Worlds: Convergence of the Real and the Virtual," Human-Computer Interaction Series. Springer-Verlag London Limited, 2010, p. 318.

[11] C. Valente and J. Mattar, "Second Life e web 2.0 na educao: o potencial revolucionrio das novas tecnologias," Novatec, 2007.

[12] R. D. Medina, "ASTERIX: Aprendizagem significativa e tecnologias aplicadas no ensino de redes de computadores: integrando e explorando possibilidades," Tese de Doutorado. Universidade Federal do Rio Grande do Sul, Porto Alegre, 2004, p. 174.

[13] G. B. Voss, F. B. Nunes, A. R. Muhlbeier, and R. D. Medina, "Context-Aware Virtual Laboratory for Teaching Computer Networks: A Proposal in the 3D OpenSim Environment," 2013 XV Symposium on Virtual and Augmented Reality, May 2013, pp. 252–255.

[14] Q. Liu, L. Diao, and G. Tu, "The Application of Artificial Intelligence in Mobile Learning," 2010 International Conference on System Science, Engineering Design and Manufacturing Informatization, Nov. 2010, pp. 80–83.

[15] C. F. Filho, "Histria da Computao. O caminho do pensamento e da tecnologia," Porto Alegre: EDIPUCRS, 2007, p. 205.

[16] J. L. Pollock, "How to Build a Person: A Prolegomenon," Cambridge: MIT Press, 1989.

[17] V. K. Singh and A. K. Gupta, "From artificial to collective intelligence: Perspectives and implications," 2009 5th International Symposium on Applied Computational Intelligence and Informatics, May 2009, pp. 545–550.

[18] E. Tyugu, "Artificial Intelligence in Cyber Defense," 3rd International Conference on Cyber Conflict, vol. 3, 2011, pp. 1–11.

[19] P. Garrido, F. J. Martinez, C. Guetl, and I. Plaza, "Enchancing Intelligent Pedagogical Agents in Virtual Worlds," in Proceedings of the 18th International Conference on Computers in Education, 2010, p. 8.

[20] M. Soliman and C. Guetl, "Evaluation of intelligent agent frameworks for human learning," 14th International Conference on Interactive Collaborative Learning (ICL2011) 11th International Conference Virtual University (vu'11), 2011, pp. 191–194.

[21] A. K. Dey, "Understanding and Using Context," Personal and Ubiquitous Computing, vol. 5, no. 1, 2001, pp. 4–7.

[22] M. Baldauf, S. Dustdar, and F. Rosenberg, "A survey on context-aware systems," Int. J. Ad Hoc Ubiquitous Comput., vol. 2, 2007, pp. 263–277.

[23] M. Knappmeyer, S. L. Kiani, E. S. Reetz, N. Baker, and R. Tonjes, "Survey of Context Provisioning Middleware," IEEE Communications Surveys and Tutorials, vol. 15, no. 3, 2013, pp. 1492–1519.

[24] F. Herpich, R. Ribeiro, F. B. Nunes, G. B. Voss, L. M. Fontoura, and R. D. Medina, "Virtual Lab: An Immersive Tool to Assist in the Teaching of Software Engineering," XVI Symposium on Virtual and Augmented Reality (SVR), 2014, pp. 118–126.

[25] "Wamp Server," 2014, URL: http://www.wampserver.com/en [accessed: April/2014].

[26] "Firestorm," 2014, URL: http://www.firestormviewer.org [accessed: May/2014].

[27] F. B. Nunes, G. B. Voss, F. Herpich, A. R. Muhlbeier, C. C. Possobom, and R. D. Medina, "Viewers para ambiente virtuais imersivos: uma análise comparativa teórico-prática," RENOTE - Novas Tecnologias na Educação, vol. 11, no. n. 1, July, 2013, pp. 1–10.

 ISBN: 978-1-61208-353-7