# Assistance to Scenarisation of VR-Oriented Pedagogical Activities: Models and Tools

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Oussema Mahdi, Lahcen Oubahssi, Claudine Piau-Toffolon and Sébastien Iksal
Le Mans Université, LIUM, EA 4023, Laboratoire d'Informatique de l'Université du Mans,
Avenue Messiaen, 72085 LE MANS CEDEX 9, France.
{ oussema.mahdi, lahcen.oubahssi, claudine.piau-toffolon, sebastien.iksal }@univ-lemans.fr

***Abstract*—Although VRLEs (virtual reality learning environments) place the learner of a pedagogical situation in a virtual reality environment, they are dependent on a particular field or context and do not allow teachers to define or adapt their models of scenario. To help teachers in designing and generating VRLE adapted to their needs, we aim at defining a process for the design and production of VRLE and a scenario's model. We develop an editor allowing the specification of scenarios and pedagogical activities based on VR-oriented pedagogical objects.**

**Keywords-component; VRLE, TEL, pedagogical activity, learning scenario.**

## I. Introduction

Virtual Reality (VR) has become a specific disciplinary field, providing the user with an exceptional immersive experience. VR has a great interest in e-learning by allowing the creation of original and dynamic pedagogical situations, detached from the constraints that may exist in real training like risk, cost or uncertainty. Learning environments that use virtual reality techniques are known as VRLE (Virtual Reality Environments for Human Learning). Mikropoulos, and Natsis [1] defined a VLE as "*a virtual environment that is based on a certain pedagogical model, incorporates or implies one or more didactic objectives, provides users with experiences they would otherwise not be able to experience in the physical world and redounds specific learning outcomes*". We note that design and integration of learning situations into a VLRE is both complex and costly. Difficulties can be technical, induced by intrinsic interdisciplinary of VR, as well as cognitive, which are inherited from the TELs (Technology Enhanced Learning) [2] [3]. The literature developed on this subject is mainly related to descriptions of VRLEs. These VRLEs depend on a particular field or context, and they do not allow teachers to define or adapt easily their models of scenario to new pedagogical situations they would like to imagine. This article presents a research work to propose solutions for helping teachers to design, reuse and deploy their pedagogical scenarios in VRLE. Our objective is to offer technical and methodological solutions that are reusable i.e. that can be applied to several environments, whatever the field or the type of task to be completed. The research questions of this study are relative to the activity of design and operationalization of the pedagogical scenarios by the teachers - designers in the targeted VRLE. The main question is the following: how to help the teachers to express and formalize their learning situations, which are not dependent on a virtual reality-based environment? Once the pedagogical needs formalized, how to operationalize/to spread them in VRLE by respecting the pedagogical intentions of teachers and by limiting the semantic losses? As teachers' design practices are iterative and participatory, reflection taking place before, during and after the implementation of a pedagogical situation [4], we propose an iterative and participatory teacher-centered design approach. This article is structured in four parts: after the first section, we present a review of the literature on some critical aspects of VRLE. Then, we present our approach based on a VRLE design process. Before concluding, we present a first version of a prototype of editor, which embeds our model of scenario to allow teachers to design and adapt their pedagogical situations.

## II. VRLE : A LITERATURE REVUE

We have examined some of the VRLEs in more details and studied their design and production models and the embedded scenario's models in these environments. The process of designing and producing a VRLE must consider the pedagogical requirements of teachers in order to answer to their needs. The usual approach is to start with technical considerations before addressing pedagogical issues. For example, Trinh & al. [5] provide models for the knowledge explanation for virtual agents populating virtual environments. This knowledge focuses on the structure and dynamics of the environment as well as procedures that teams can perform in this environment. Some improvements of this model proposed by Chen and Teh [6] allow developing and evaluating in a formative way the simulations on a non-immersive virtual system [7]. Ritz [8] provides guidelines for best practices in integrating immersive virtual reality, especially Cave Automatic Virtual Environment (CAVE), into teaching. These guidelines will address a practical need by informing and supporting educators in adapting instructional design to emerging technology. We note that the proposed models are not easy to achieve for non-computer trainers; also, they don't help them in their VRLEs design process.

On the other hand, many studies have addressed the issue of modeling pedagogical situations in virtual environments. Marion & al. [2] propose a learning scenario model POSEIDON able to integrate VRLE in the learning process. The authors use a meta-model that provides an abstract representation of virtual environments both generic and machine-readable. The approach is based on meta-modeling to provide generic modeling, regardless of the nature or domain of VRLEs, by using MASCARET [9]. MASCARET is a virtual environment meta-model that provides an abstract representation of the structure and the domain of environments that allow the description of pedagogical activities. It was also used to ensure the generic side of the POSVET [10] pedagogical scenario model, which allows reusing pedagogical scenarios on different platforms. This work aims at adapting the educational scenario to the learners' needs but doesn't offer solutions for assisting the teachers in their design process. Le Corre & al [11] identified the weaknesses of the Intelligent Tutorial System (ITS) PEGASE for virtual reality learning environments [12] and identified its lack of connection with the pedagogical scenario, its lack of modularity and its lack of individualization. To fill these weaknesses, they proposed an ITS called CHRYSAOR based on POSEIDON. This new proposal allows defining an educational scenario based on the environment knowledge representing the domain model, totally expressed in MASCARET, contrary to POSEIDON.

Based on that study, we identified that the model of scenario must be planned since the design of the environment where all possible situations must have been considered. In this research work, we aim at proposing solutions to: 1) Help and support teachers to produce VRLE adapted to their needs; 2) Help teachers to design, reuse and deploy their virtual reality oriented pedagogical scenarios.

## III. OUR APPROACH

In order to help teachers in producing or generating a VRLE, we propose a methodological solution based on a design process that includes several steps from the definition of the learning situation to its operationalization. This iterative and user-centered process was defined from existing ones in TEL and adapted to the specificity of VRLE. In a first step, teachers express their pedagogical needs. Then they are led to formalize them according to their learning situations. The second step of the process consists in identifying and adapting the 3D environment in which the formalized scenario and the necessary VR tools will be instantiated. This is a service that allows the reuse and adaptation of existing 3D environments to make them compatible with the situations desired by the teacher. The third step in the process is to operationalize scenarios on one or more 3D environments. The fourth step is dedicated to simulate and test the generated VRLE. Preceded by a learning step, the process uses a phase of adaptation of situations modeled according to the results obtained. It should be noted that the literature review allowed us to highlight two observations: on the one hand, the need for a model of scenario specific to VR-oriented scenarios, on the other hand, a tool able to provide the necessary elements for modeling such pedagogical situations. As part of this research work, we propose two contributions for the design phase of the process (a model and a prototype of an editor of virtual reality oriented pedagogical scenarios).

## IV. CONTRIBUTIONS

In the field of VRLE, the pedagogical situation is considered as a composition of activities realized by a set of actors. Each activity can be divided into a sequence of actions to ensure the learner's interaction using different resources to allow immersion and promote learning. The actions can be divided into some basic behaviors named Virtual Behavioral Primitives (VBP). VBPs can be grouped into four categories: 1) Observe the virtual world; 2) Navigate in the virtual world; 3) Manipulate in the virtual world; 4) Communicate with others or with the application.

During learning activities, we are interested in the notion of virtual reality oriented pedagogical object. For our approach, a VR-oriented pedagogical object is presented in the form of a raw object with educational and technical properties. A raw object, also called 3D object or graphic object, is a knowledge acquisition entity. Properties are used to store values associated with these objects. Some technical properties are common to all objects (such as those that govern the position, shape or color of objects), while others are specific to the object or the learning domain. In this work, we aim at defining a platform based on the concept of virtual pedagogical objects. This environment includes rules that describe the dynamic behavior of raw objects and their educational properties. The objective of this platform of VR-oriented pedagogical objects is to ensure their reuse in various situations regardless of the learning context.

### A. *VR-oriented pedagogical scenario model*

The pedagogical scenario model we proposed has been designed from the theoretical analysis of the different existing scenario models in the fields of TEL and VRLE, and the design of three examples of different pedagogical situations. One of our objectives is to develop a VR-oriented pedagogical scenario editor that embeds our model allowing teachers to easily design and adapt their situations and generate their own VRLE. According to Marion & al. [2], a VR-oriented pedagogical scenario, describes the organization of activities in a virtual environment, the pedagogical goals associated with them - in terms of knowledge or skills -, the prerequisites, the roles of different actors in the educational situation - whether they are teachers or learners - and the tools and resources (virtual objects) that are necessary to realize these virtual activities.

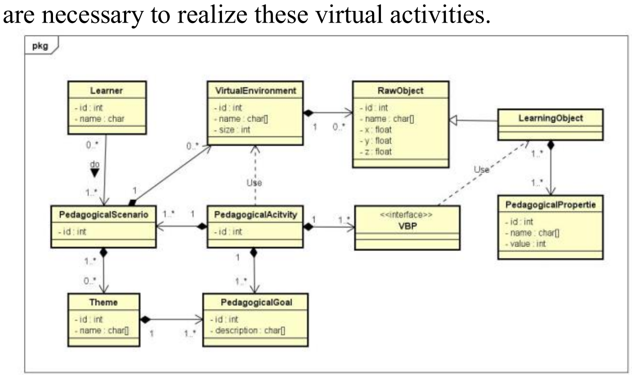


Figure 1. VR-oriented pedagogical scenario model

The entities composing our proposed VR-oriented pedagogical scenario model are illustrated in figure 1. Among the specificities of our proposal, we note the tools of interaction (VR tools), the types of interactions (Virtual

Behavioral Primitives: VBP) and the concept of a VR-oriented pedagogical object. Our proposal is an enhancement of existing models by a refined description of activities (using the VBP concept) where learners interact with a device in order to take into account the specificities induced by the execution of activities in a virtual environment. To keep its generic and flexible character, we illustrate our scenario model with three different pedagogical situations in different fields. This work is based on the co-design process presented in section 3 in which the different teachers participate in the design of the different models of pedagogical situations through an iterative, user-centered approach.

### B. *A prototype of scenarios' editor*

We have developed a prototype of a scenarios' editor that facilitates the creation of new pedagogical scenarios. The objective is to allow the creation and adaptation of the different components of a pedagogical scenario, in particular the learning environments, pedagogical activities and their organization.

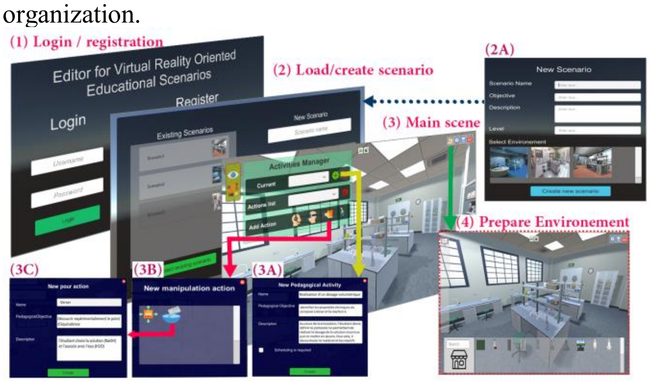


Figure 2. Defining the VR actions of a pedagogical activity

The figure 2 shows our editor's interfaces. We illustrate our proposal with a pedagogical situation concerns a pedagogical activity named "Realization of a volumetric dosage" in a course of chemistry. First, the teacher starts by creating a new scenario project (fig2.2). Then, he chooses a virtual environment adapted to his pedagogical activity (fig2.2A). We consider that the adaptation of virtual environments and virtual learning objects will be realized on the virtual pedagogical object's platform. In the following steps, objects are selected from the inventory and placed in the chosen environment (fig2.4). Because of each learning object has a list of properties then teacher will define the expected values. Then the step dedicated to the definition of the scenario begins. In this step the teacher describes the pedagogical activities (fig2.3A). For each activity, a description of the expected actions is done using the bar containing the list of possible actions (fig2.3B and fig2.3C). Actions represent all the operations done by the learner (for example: moving, pouring, deforming, cutting, etc.). Finally, the order of pedagogical actions and the order of the execution of pedagogical activities are controlled by the teacher in the virtual environment.

## V. CONCLUSION

We presented in this paper our work under progress, which focuses on the problem of designing and producing pedagogical situations in VRLE. Our approach aims at proposing both technical and methodological solutions to assist teachers in describing, adapting or reusing their pedagogical scenarios. So, we developed a process for designing and producing a VRLE, we modelled the pedagogical activities and objects described in the pedagogical situation and proposed a scenario model and a first version of a prototype of an authoring tool. Our current work concerns the development of additional functionalities for our editor in order to facilitate the design task of teachers and allow them to reuse and adapt existing situations. Tests and experiments are to come in order to test the model and editor-prototype in various situations and show the generic character of our approach.

## REFERENCES


[1] T. A. Mikropoulos et A. Natsis, «Educational virtual environments: A ten-year review of empirical research (1999–2009),» Computers & Education, vol. 56, n° 13, pp. 769-780, 1 Avril 2011

[2] N. Marion, R. Querrec et P. Chevaillier, «Integrating Knowledge from Virtual Reality Environments to Learning Scenario Models-A Meta-modeling Approach», CSEDU 2009, pp 254-259.

[3] K. Carpentier et D. Lourdeaux, «Generation of Learning Situations According to the Learner's Profile Within a Virtual Environment,» Communications in Computer and Information Science, pp. 245 - 260, 2014.

[4] S. Bennett, S. Agostinho et L. Lockyer, «The process of designing for learning: understanding university teachers design work», Educational Technology Research and Development, vol. 65, n° 11, p. 125–145, 2017.

[5] T.-H. Trinh, R. Querrec, P. De Loor et P. Chevaillier, «Ensuring semantic spatial constraints in virtual environments using UML/OCL VRST '10, 2010,» pp. 219-226, 2010.

[6] C. J. Chen et C. S. Teh, «Enhancing an Instructional Design Model for Virtual Reality-Based Learning,» Australasian Journal of Educational Technology, 2013.

[7] C. J. Chen, S. C. Toh et W. M. Fauzy, «The Theoretical Framework for Designing Desktop Virtual Reality-Based Learning Environments», Journal of Interactive Learning Research, vol. 15, n°1, Norfolk, VA: Association for the Advancement of Computing in Education (AACE), pp. 147-167, 2004.

[8] L. T. Ritz, Teaching with CAVE virtual reality systems: Instructional design strategies that promote adequate cognitive load for learners, SMTC Plan B Papers. 5, 2015.

[9] C. Buche, R. Querrec, P. De Loor et P. Chevaillier, «Mascaret: Pedagogical multi-agents system for virtual environment for training,» Journal of Distance Education Technologies, vol. 4, n° 12, pp. 41-61, 2004.

[10] M. Fahim, A. Jakimi et L. El Bermi, «Pedagogical Scenarization for Virtual Environments for Training: Towards Genericity, Coherence and Adaptivity,» International Journal of Advanced Engineering Research and Science, vol. 3, n° 112, pp. 96-103, 2016.

[11] F. Le Corre, C. Hoareau, F. Ganier, C. Buche et R. Querrec, «A Pedagogical Scenario Language for Virtual Environment for Learning based on UML Meta-model. Application to Blood Analysis Instrument.,» chez Proceedings of the 6th International Conference on Computer Supported Education (CSEDU), Spain, 2014.

[12] C. Buche, C. Bossard, R. Querrec et P. Chevaillier, «PEGASE: A generic and adaptable intelligent system for virtual reality learning environments,» International Journal of Virtual Reality, vol. 9, n°12, pp. 73-85, 2010.