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Abstract: This paper proposes a formal model of serious game understandable and usable by teachers in higher education. Serious games are often mentioned in higher education, but their use is restricted other than for teachers always looking for renewal. Indeed, there is a lack of tools to facilitate their creation and use, especially for teachers. This article presents serious games of the type case study designed empirically. To overcome this empirical aspect, we derive a formal model of serious play and methodology closely associating teachers in the creative process. We want to improve no only the design stage but also the use of serious games produced by teachers with their students. This model, called DISCO, will be the basis of a current work including an experimental approach taking into account the context of the job of teachers.

1 RESEARCH PROBLEM

In recent years teachers are faced with many changes in their job due to various factors: the new generation of connected students, onset of MOOC or use of serious games. In particular, serious games are now widely present in the world of business. Many achievements have shown their interest in the transfer of skills and knowledge by developing the attractiveness and promoting the motivation to learners. Nonetheless that interest is tempered by the lack of tools and methodologies for the design and production (Mariais et al., 2011). Meanwhile, the world of higher education is impacted, but with less enthusiasm. Additional factors may explain this phenomenon such as:

a. A need of large initial investments for the acquisition of expert skills and a reduced public limiting the return on investment (Marfisi et al., 2013),
b. specific dedicated developments, non easily reusable without strong adaptation (related to the choice of the teacher) (Marne, 2012),
c. complex authoring tools that require computer skills (Djaouti, 2011) (Marfisi, 2013).

These last two points merit attention: in fact, teachers in higher education, even those that are convinced of the potential of digital education, have difficulties adapt Serious Games to their pedagogy. Furthermore they have more difficulties in appropriating the authoring tools to build their own resources. The design of educational resources by themselves, or even just their participation in the design, would however probably guarantee a better use, as teachers want to remain masters of the resources they use.

The problem is to define models, methods and tools for the creation of serious games that strongly implicate teachers, which is a guarantee of better use.

2 OUTLINES OF OBJECTIVES

Our research has the following objectives:

a. To analyse serious games, specially serious games of the case study type.
b. To derive a formal model and to give the associated method to design serious games of the case study type.
c. To define and to specify artefacts reifying this model and to find links between each of them.
d. To produce instantiation of the model with the target audience (teachers) and to test these serious games on the field with students.

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e. To recover and to analyse traces in order to improve it.

3 STATE OF THE ART

The « serious games » term (or learning game for our case) has several definitions depending on the context and authors such as (Abt, 1970) or (Chen and Michael, 2005). (Alvarez and Djaouti, 2011) provide a definition clarifying the ambiguity of the concept: a serious game is a computer application for which the original intention is to combine with consistency, serious aspects, in this case learning, with playful elements taken from the video game. This definition involves the coupling of a pedagogical scenario and a playful scenario.

As we have already noted, teachers conceive serious games as complex resources to design and to implement in their teaching. In general, their creation is seen as a difficult exercise, including accustomed designers. Thus, although relatively new, research has been undertaken to facilitate the task of the creators of serious games.

The methodology MISA (Paquette et al., 1999) is an iconic design method for ILE (Interactive Learning Environment). It aims at specifying and starting the design and implementation of an ILE based on different expert actors. MISA offers a sequential approach unsuited to the creation of serious games, and where different experts work in cooperation rather than collaboration.

(Djaouti, 2011) offers a model for generic design of serious games, the DICE model. An initial definition phase is followed by an iterative development cycle comprising three stages: Imagine, Create and Evaluate. This approach, inspired by the work around the creation of purely entertaining video games, brings an agile dimension.

Proposed by (Yusoff, 2010), the Serious Game Conceptual Framework is a serious game design framework that introduces the idea of pre-combine fun elements and learning outcomes, themselves drawn from the targeted skills. It gives the different types of involved actors but does not detail their role in the process.

(Marne et al., 2012) presents a non-sequential design framework, the six facets of serious games design (Figure 1). These facets are design elements involving two broad categories of expertise (educational and playful), which must be taken into account when developing a serious game. This model, besides to help design and streamline the work, allow analysis of existing serious games.

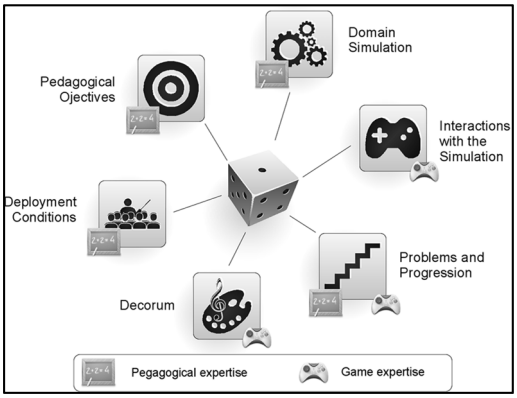

Figure 1: The 6 facets of serious game.

If we focus on serious game design support tools issued from Research in ILE, many only deals with the scenario of the game. ScenLRPG (Mariais, 2012) is an authoring tool, for role-playing learning games, that divide the scenario into educational activities taking into account the intentions of the designers.

Legadee (Marfisi, 2013), an authoring tool for the design of learning games, offers a partition of the scenario in components with a cooperative approach. It was tested with an audience of designers (educational engineers, game designers, etc.). It remains difficult to use with teachers because of the necessity of learning Legadee interface.

MoPPLiq (Marne and Labat, 2014) is a generic model able to describe the playful and educational aspects of the scenario of a serious game in stages and makes the scenario understandable and capable of being manipulated by teachers. This model comes with a tool called APPLiq enabling manipulation of the scenario to fit it into the educational background of teachers. MoPPLiq covers only part of the design but provides a tool for scenario design that we will use.

These methods and tools provide a framework for designing serious games but say nothing about the computer models used to translate these serious games design into artefacts. But experience shows that without predefined templates, teachers have difficulties to imagine objects to implement in the design phase. The central objective of this work is to define a proper formal model containing artefacts to develop. This model will guide teachers more closely in designing serious games, especially those of the « case study » type.

4 METHODOLOGY

The chosen methodological posture is based on the Design Based Research (DBR) (Wang and

Hannafin, 2005). This posture is based on the inclusion of teachers in the work environment, the interaction between researchers and teachers to advance proposals for research and confirm them on the field. The DBR favors iterative approaches and the use of qualitative and quantitative methods. This context of collaboration and the mix of methods is a posture suited to our research. In addition, this former is situated in the field and in contact with the teachers, and must follow an iterative cycle. At the implementation level, the experimental approach will be based on a user-centered approach adapted to a research context (Mandran et al., 2013). The methods used will be both qualitative to understand the needs of teachers and quantitative to analyse and evaluate the use of the serious game.

The experimental process will be conducted in three stages:

a. The acquired observations and experience of on the field will help to create a first proposal for a formal model of serious games of the case study type.
b. This proposal will be presented and tested with teachers during an interview campaign and focus group. The proposal could be improved. Improvements include firstly the model presented, but also the associated design methodology.
c. Traces of teachers (and/or students) during the use of serious games will be collected; it will validate the proposed model.

For the first stage, we began this work in September 2015 with an exploratory phase during the collaborative design of serious games of the case study type. This phase of co-design allowed to generate, with designers, a document describing the methodology (via interviews with them). An analysis step followed to reach a proposed model of serious games in this article. A first phase of interviews with teachers allowed to refine the model in December 2015.

The starting point of our work will be the observation and analysis of the experience of the creation of serious games with teachers, for a variety of themes in university and higher education.

5 SERIOUS GAMES AND CASE STUDIES

However, to create a formal model that is suitable for a whole class of serious games, it is legitimate to find a type of serious game compatible with the largest number of themes addressed in higher education. In fact, several studies have shown the interest of the Case Method to create serious games by teachers in higher education, particularly following the collaborative project Generic-SG (Marfisi et al., 2013). Indeed, the case studies are a device based on a constructivist pedagogy and can be applied to many fields of knowledge (law, management, medicine, biology, physics, mathematics, sustainable development, etc.). They can be the basis of educational scenarios of serious games. The case method established at Harvard for many years (Dooley, 1977) refers in many areas. In medicine, learning diagnostic techniques via the Script Concordance (SC) tests (Charlin et al., 2000) use real situations: the students have to choose assumptions validated during design by a panel of doctors in an uncoordinated manner, each expert gives his solution to the situation in light of his experience. The TOPAZE model was designed for the editorial chain SCENARI (Quelennec et al., 2010) (Gebers and Crozat, 2010) to facilitate the digitization of case studies. Nonetheless, this model is one of the tools used to produce the serious games explained in the following paragraph.

Initiated in 2010, the Scientific and Practical Case Studies for Higher Education and Research (in french Les ECSPER) are case studies that combine knowledge and expertise in a fictional setting based on real events all in a playful environment. The first case « Le Robot tueur » (killer robot) released in 2012 (Robot) (Figure 2), was made to demonstrate the feasibility of the design and implementation of a serious game in scientific topics by teachers.

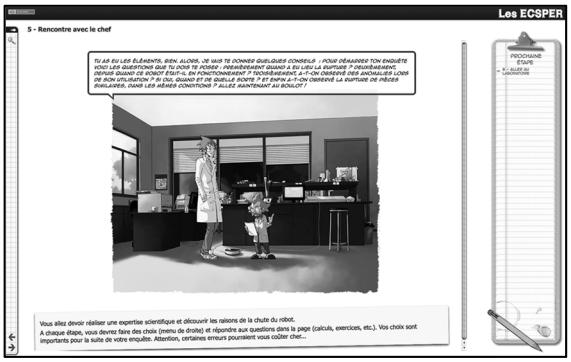

Figure 2: Interface of the game "Le Robot Tueur".

Based on real situations, we introduced some elements of a video game as challenge, graphics and an ambiance borrowed from the comic, and humorous situations. The playful approach here offers a way to involve learners in a realistic world

(Sanchez et al., 2011). Furthermore, the « Robot Tueur » is a game with intrinsic motivation (Fabricatore, 2000) as opposed to serious games where the game aspect is an added layer without related learning content (extrinsic metaphor).

Three cases were constructed empirically (two in physics, one in project management) since 2010. Their use in various institutions of higher education and with different teachers (Fronton et al., 2015) received the recognition of educational community and ICT engineers (FFUP2013). Furthermore, due to the need expressed by many teachers, there has emerged the requirement of a formal model that facilitates the design and creation of serious games of the case study type and methodology adapted to the model.

6 FIRST OUTCOME

The first case was built around the role of scientists commissioned by a judge to carry out an expertise on a piece of evidence. A first action was to define initial objectives, what is recommended for ILE by (Paquette et al., 1999): What should the student performed? What will he learn? Which knowledge or skill does he confirm? And how? What will he do at the end of this serious game? What are we assessing? The choice fell on two aspects: the validation of knowledge viewed in courses and the acquisition of solving methods corresponding to this expertise.

A first model of the domain, D, was proposed simply based on the experience of teachers. This initial model, very brief, took the form of a simple text file and contains the necessary initial knowledge of the learner. The collect of expertise is a difficult task for teachers (for different reasons: cognitive, psychological, organizational) and a delicate point in process of developing a serious game, that requires the establishment of an effective and rigorous approach (Marne, 2014). We have worked in parallel on the simulation domain and the potential interactions between the students and the serious game: teachers must present the articulation between knowledge, so that these interactions allow the acquisition of knowledge.

At the same time, we defined with the teachers the learning objectives, O, the conditions of use of the serious game, C, and worked on a first scenario, S. This last was initially built using post-it, then it was digitalized using a mind map tool to facilitate its evolution (Figure 3). Simultaneously an author of comics, accustomed to video game scenarios, worked with teachers on the playful scenario of the serious game.

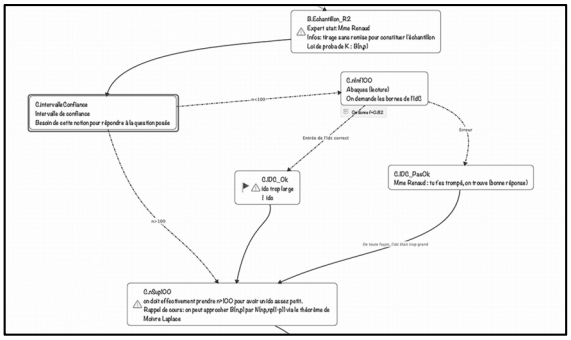

Figure 3: Sample of scenario graph of a case study.

At this stage a rapid prototyping was needed. Indeed, this conception « just in time » and without using validation tool can generate scenarios containing dead ends and difficult to detect loops. To detect these imperfections and improve the script, the prototype of the game was designed on paper and then implemented in PowerPoint. Multiple iterations on this prototype and dialogues between teachers and the author of comics allowed the finalization of the scenario, but also a reflection on the players progress in the serious game and validation of playful aspects. This iterative design with rapid prototyping can be found in the literature (Marne and Labat, 2014).

Once the different authors validated the scenario, each stage has been reviewed to incorporate the interactions selected into the panel of available interactions. We implemented it using the tool SCENARI and Topaze documentary model. This last was designed to digitalize multi-linear case studies (Quelennec et al., 2010) (Gebers and Crozat, 2010).

After this phase, the first tests with teachers started. Initial feedback (obtained trough informal discussions) reported on the media and the scenario quality. Nonetheless, the conditions of use have been modified to fit with the educational practices of each (especially regarding the evaluation of students). We then launched to students a survey in the form of a questionnaire. Unfortunately, responses, too weak and too imprecise at this time did not allow achieving meaningful and usable numbers.

With this first exploratory phase, we pointed out the research questions that will be the subject of our future research. We have induced this first iteration the following result:

A serious game type case study can be considered as a 5-tuple containing the objects D, O, I, S and C such as:

- D: Domain Model, a graph whose nodes are the knowledge or skills domain and arches reflecting the prerequisites links. This graph must include the necessary initial knowledge of the learner.
- O: Objectives, a sub-graph of the graph of domain model with possibly an indication of the expected level of performance.
- I: Interactions, a set of available interactions with the simulation of the domain model. For example, the completion of puzzle or drag and drop are possible types of interactions.
- S: Screenwriting, a scenario defined as a directed graph, each node is the complete realization of a problem, giving great flexibility in screenwriting. The links (as proposed MoPPLiq model) reflect the teacher's expertise. Each teacher can freely modify and adapt them to his own use.
- C: Usage Context, a sentence explaining the context and associated constraints.

This gives the DISCO model.

7 STAGE OF THE RESEARCH

In this article, we presented a formal model of serious game type case study where the teacher plays an important role at the design stage (in addition to its traditional role of prescriber). We should now refine the model DISCO, specify and describe each element of this 5-tuple and the links between them. We should also provide the tools to facilitate the work of teachers within the model for the creation of serious games of the case study type. Finally, we should validate this model by creating and experimenting serious games built using the DISCO model with authors and/or users. These serious games and prescribed to students by teachers generate data for analysis.

The analysis of these traces will also respond to our initial problem: with a strong implication of teachers in the creation of serious games, based on the use of a formal model based on the use of design methodology, should we see a better use of serious games? This framework will also give the opportunity to design a significant number of serious games, increasing the returns to serious game designers and researchers.

REFERENCES

Abt, C., Serious Game, *Viking Press*, 1970.

Alvarez, J., and Djaouti, D. 2011. An introduction to Serious game Definitions and concepts. *Serious Games & Simulation for Risks Management, 11*.

Charlin, B., Roy, L., Brailovsky, C., Goulet, F., and Van der Vleuten, C. 2000. The Script Concordance test: a tool to assess the reflective clinician. *Teaching and learning in medicine, 12(4)*, 189-195.

Djaouti, D. 2011. Serious Game Design: considérations théoriques et techniques sur la création de jeux vidéo à vocation utilitaire. Doctoral dissertation, Toulouse 3.

Dooley, A. R., and Skinner, W. 1977. Casing case methods, *Academy of Management Review*, p. 277-289.

Fabricatore, C. 2000. Learning and videogames: an unexploited Synergy. *AECT National Convention, Secaucus*, NJ.

FFUP2013. http://www.jeux-serieux.fr/2013/10/28/ffup-2013-les-ecsper-prime-meilleur-jeux-serieux/

Fronton, K., Vermeulen, M., and Quelennec, K., (2015). LES ECSPER : retour d'expérience d'une étude de cas de type serious game en gestion de projet, Colloque e-Formation des adultes et des jeunes adultes, Lille.

Gebers, E., and Crozat, S. 2010. Chaînes éditoriales Scenari et unité ICS, *Distances et savoirs 7.3*, p. 421-442.

Mandran, N., Dupuy-Chessa, S., Front, A., and Rieu D. 2013. Démarche centrée utilisateur pour une ingénierie de langages de modélisation de qualité. *Rev. RSTI Sér. ISI Vol 18 N°3 XVIII,* 3.

Marfisi-Schottman, I. 2013. *Méthodologie, modèles et outils pour la conception de Learning Games*. Doctoral dissertation, INSA de Lyon.

Marfisi-Schottman I., Labat J.M., Carron T. 2013. Building on the Case Teaching Method to Generate Learning Games Relevant to Numerous Educational Fields , Proceedings of the *International Conference on Advanced Learning Technologies, ICALT*, p.156-160.

Mariais, C. 2012. Modèles pour la conception de Learning Role-Playing Games en formation professionnelle. Doctoral dissertation, Grenoble.

Mariais, C., Michau, F., Pernin, J. P., and Mandran, N. 2011. "Learning Role-Playing Games": méthodologie et formalisme de description pour l'assistance à la conception-Premiers résultats d'expérimentation. In *Environnements Informatiques pour l'Apprentissage Humain, Conférence EIAH'2011*. Editions de l'UMONS, p. 95-107.

Marne, B. 2014. Modèles et outils pour la conception de jeux sérieux: une approche meta-design. Doctoral dissertation, Université Pierre et Marie Curie-Paris VI.

Marne, B., Wisdom, J., Huynh-Kim-Bang, B., and Labat, J. M. 2012. The six facets of serious game design: a methodology enhanced by our design pattern library. In *21st Century Learning for 21st Century Skills, Springer Berlin Heidelberg*, p. 208-221.

Marne, B., and Labat, J. M. 2014. Model and authoring tool to help teachers adapt serious games to their educational contexts. *International Journal of Learning Technology, 9(2)*, p. 161-180.

Michael, D., and Chen, S. 2005. Serious Games: Games that educate, train and inform, *Course Technology, 2005*.

Paquette, G., Aubin, C., and Crevier, F. 1999. MISA, A knowledge-based method for the engineering of learning systems. *Journal of Courseware Engineering, 2(63-78)*, 202.

Quelennec, K., Vermeulen, M., Narce, C., and Baillon, F. 2010. De l'industrialisation à l'innovation pédagogique avec une chaîne éditoriale. In TICE 2010.

Robot. https://campus.mines-paristech.fr/pluginfile.php/11280/mod_resource/content/1/index.html.

Sanchez E., Ney M., and Labat J. M. 2011. Jeux sérieux et pédagogie universitaire: de la conception à l'évaluation des apprentissages. *Revue Internationale des Technologies en Pédagogie Universitaire (RITPU)/International Journal of Technologies in Higher Education (IJTHE),11(2)*.

F. Wang F., and Hannafin, M. J. 2005. Design-based research and technology-enhanced learning environments. *Educ. Technol. Res. Dev. 53*, 4, p. 5–23.

Yusoff A. 2010. *A Conceptual Framework for Serious Games and its Validation*. Doctoral Dissertation, University Of Southampton.