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Abstract. Despite improvements in educational tools, teaching some elements in the field of production engineering is difficult. In this context, teaching PLM systems remains difficult from a motivation point of view. The purpose of this paper is to propose a highly innovative approach around serious gaming. In the PEGASE project, we have realized an environment for coupling a gaming platform and a content platform in order to enact learning scenarios. This article presents this integration environment which is based on the characterization of business activities within the PLM. Then, we describe the design of scenarios in this platform particularly dedicated to learning PLM systems. We then present the validation of our approach based on different experiments performed with students and with industrial partners.

Keywords: Game Base Learning, Serious Game, PLM

1 Introduction

Teaching production engineering is difficult, and particularly for PLM systems. There are many reasons for this. The first reason is that students learn CAD systems without management constraints. When they find out PLM systems, constraints are more visible than the benefits. The second and probably more important, reason is that it is very expensive (in terms of financial cost and human resources) for an educational establishment : Installation, configuration, collaborative projects management...

In this paper, we propose a new approach for learning PLM system: learning a unit with Serious Game. This unit has been produced as part of a research project (PEGASE) that was initially intended to improve the change management. Noting the fact that resistance to change were the same for enterprises

and students, we developed a learning scenario using the playful aspects of the video games. In the first part, we present the concept of this Serious Game, then we present the experiment results that was achieved with students.

2   New learning for PLM systems

2.1   About the Games Learning Bases

Since a few years, Learning Management Systems (LMS) offer functionalities that are recognized as being valuable from different points of view [1]. For instance, students can learn at their own speed. These environments also allow the teacher to evaluate specific activities in a uniform way [2]. LMS allow to structure and to develop distance training. However they have not enough impact on the motivation and the attractiveness. Some students tend to consider LMS as unexciting [3]. So, Game-Based Learning Management System is based on that the way of acquiring knowledge during a learning session is similar to following an adventure in a Role-Playing Game (RPG) [4]. The combination of the two styles is called MMORPG (Massively Multiplayer Online RPG) and offers a good potential for learning reformulated as MMOLE (Massively Multiplayer Online Learning Environment) [5]. Nevertheless, although the students appreciate this approach and that Games-based Learning can significantly enhance learning, there is an obvious need for realistic information about students: skills, actions or behaviors especially for the teacher [6].

The difficulties that teachers face in teaching PLM System to students incited us to find additional motivation thanks to Game-Based Learning (GBL). Although the project below was not initially intended for this, we have conducted experiments to test this.

2.2   PEGASE : a Serious Game for PLM

PEGASE project [7] [8] is a Serious Game based on Learning Adventure ("LA") [9]. LA is a Game-Based Learning Management System representing a 3D environment where the learning session takes place (see Fig. 1). The environment is generic in the sense that it is not dedicated to a particular teaching domain. With the help from a pedagogical engineer, the teacher adapts the environment before the session by setting pre-requisites between sub-activities and by providing different resources (documents, videos, quizzes) linked to the course. Experiments have already been set up for learning Operating Systems as well as Project Management or Object Oriented Concepts in Computer Science. LA is thus a platform allowing one to describe, generate and enact different learning environments. The following items define the main characteristics of LA:

- A 2D or 3D multiplayer world, split into activity areas;
- Artefacts populating this world: objects, individual or collaborative tools, non-player characters (NPC), players represented by their avatars;

– Possibility to characterize the players / learners through a learner/user model and also through group models;
– Enacting facilities
– Avatar personalisation
– Tracing facilities of players' actions
– Tools for designing scenarios
– Scenario or quest editor, evaluation tools
– Possibility to modify dynamically the environment.

Fig. 1. Screenshots of the Learning Adventure (*LA*) environnement

In the PEGASE project, the gaming environment is associated to a content platform (Audros). This content platform is a PLM system very used in SME/SMI. Moreover, a Trace-Based System (TBS) captures the behavioral traces and activity traces. These traces are essential to monitor the progress of the users in the scenario. Thus, after several steps (collection, selection, transformation, aggregation of different traces), we are able to provide specific indicators [10] giving meaningful information to the teacher (see Fig. 2). Moreover, some of these indicators may also be used to update the user model of each student and to present accurate information for the teacher. The interoperability issues have been resolved by relying on a service-oriented architecture [11] (see Fig. 2)
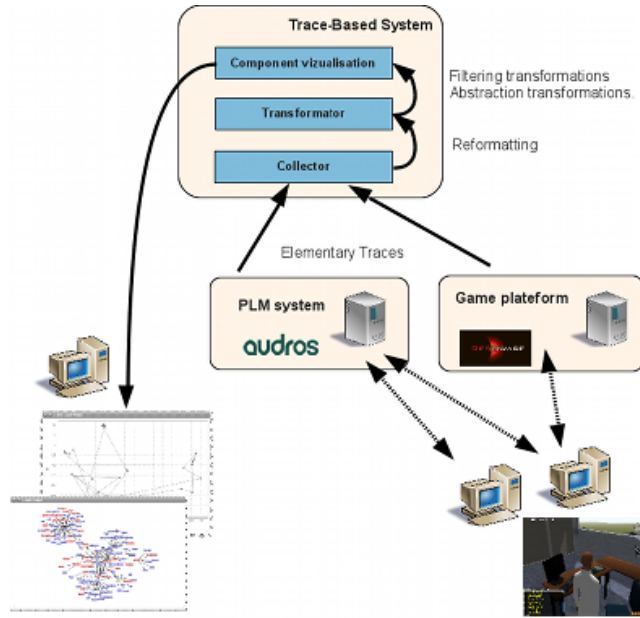
Fig. 2. PEGASE architecture

3 An example of a pedagogical scenario for PLM

In order to design a pedagogical scenario for PLM, we looked for an industrial
process that was sufficiently generic to be used by any student. This process
referred to a case study from the plastic industry. The transformation of an
industrial process into a pedagogical scenario was achieved thanks to research
work concerning gamification [12].

This architecture is generic in sense that it can design any pedagogical sce-
nario. We chose to conceive a first scenario for discovering the main functions
of PLM. In the design stage, this classification enables the trainer to build his
scenario from a descriptive guide. Initially, the proposed scenario was structured
around a simple industrial process (purchase order) described in Figure 3. With-
out a PLM system, this process is achieved through traditional activities where
the risk of error, as well as the tedious tasks involved, should be considered.

In a first part, this process is carried out in the PEGASE Serious Game with-
out any PLM system. The following items and figures describe the corresponding
actions:

- Discussion with colleagues and watching a training presentation (see Figure
  4);
- Collecting documents in order to complete and visualize the tasks in the
  process;
- Visualization of the order form, retrieval of information from the archives;
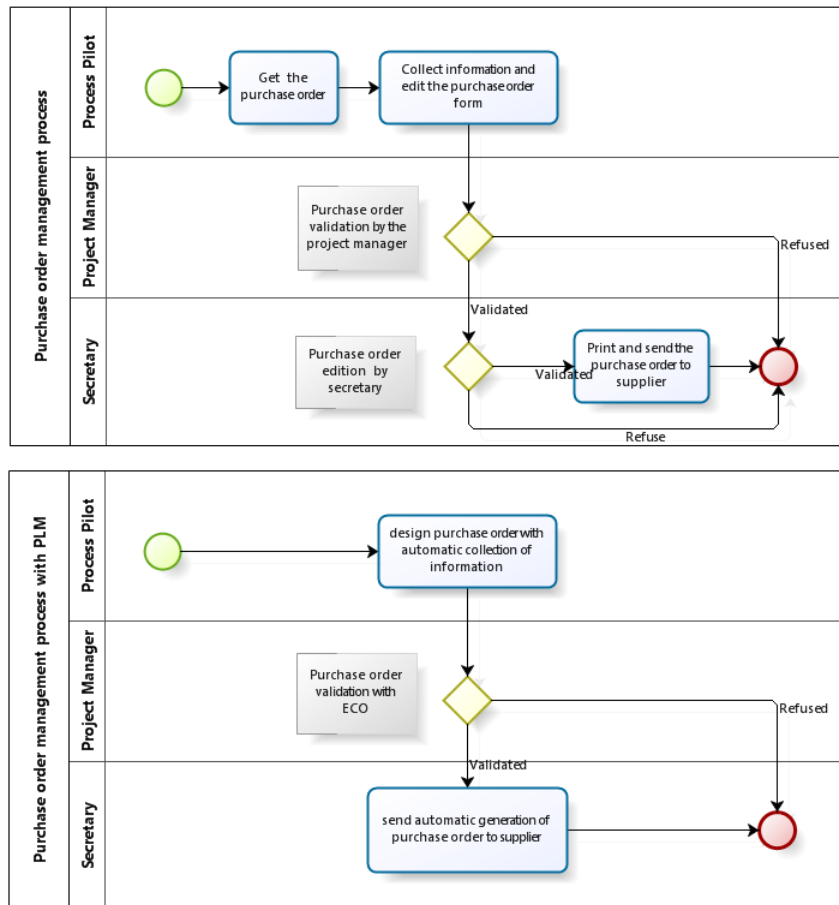
Fig. 3. Purchase order management process with and without PLM

- Summary of time-consuming steps (see Figure 5);
- Explanation for creating a purchase order with Audros platform(see Figure 6);

Once the process is carried out without a PLM system, a collective and individual balance of mistakes made by the player is presented. A mini training session on possible solutions to resolve their mistakes with the Audros PLM system is then proposed. The process is therefore performed with a connection to the Audros platform.

Experiment of this scenario.
An experiment was carried out from September 2011 to December 2011 in the Technical Institute (Lyon - France) with 224 students. During the experiment,

Fig. 4. PEGASE screenshot: a player interacting with the game environment

Fig. 5. PEGASE screenshot: reminder for the player's tedious tasks

Fig. 6. PEGASE screenshot: a player interacting with Audros system

each group of twelve students with their teacher was present in the classroom equipped with 12 computers. Each student accessed the virtual environment through his/her workstation, and had a personal (adapted) view on the world. They were explicitly allowed to communicate through the chat tool provided with the system and were warned that they would be observed regarding the use of the system.

As explained before, the course was dedicated to the understanding of the PLM problematic. The learning content dealt with «PLM elementary concepts»: the session was split into two parts: experimenting without (long and tedious) and with a PLM system. The solution (final document) had to be approved by a PLM system expert who was online via the PLM business tool (Audros) and was receiving each document produced. The aim of the session was to assess the knowledge and know-how of the students about the objectives of a PLM system. A story guided the knowledge quest thanks to metaphors. Indeed, the challenge is encouraged through NPC who propose a coherent contest. Immersion is reinforced when the users' actions have a direct impact on the objects of the world. Finally, the teacher was also present in the game via an avatar: it was possible to chat with him, to ask for help for example.

Looking at the experiment results with regard to previous years when this module was done without SG, we observed two improvements. The first is a very slight increase in overall average. However, there is a significant reduction of the standard deviation. This is confirmed by a survey showing that there were fewer unmotivated students than usual.

4   Conclusion

In this article, we have illustrated an example of new learning technologies for PLM system. Using a serious game has shown very positive effects. This allows to more easily accept the PLM system constraints. Furthermore, students' motivational level for deepening such systems, is greatly increased.

Naturally, some drawbacks persist: we must recognize that it is very difficult for the teacher to be both present in the game, help the students and regulate the session even with these specific tools. We currently think that we can develop some specific indicators only dedicated to some classical fields of a domain. An interesting perspective could be to develop and propose directly within the indicators some basic regulation actions such as « play specific PLM video » , « propose new activity » or « enable/disable such facility/ies for this student» in order to improve and adapt the learning progression.

The LA environment is collaborative, multiplayer and fully observable thanks to traces left by the users during the game. These traces allow us to elaborate collaborative indicators. Moreover, thanks to the feedback collected from these experiments (questionnaires and debriefing sessions directly after the game), we are able to imagine new factual indicators of collaboration exploiting traces left by the users. Future experiments will be done around collaborative activities in the PLM systems. In this brand new scenario (context : futuristic enterprise,

multi-role player, handling quality non-conformance process), we want to test some advanced functionalities (ECR, ECO, co-design, ...) around the conception of some complex products.

Acknowledgement

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