An Approach to Assess Knowledge and Skills in Risk Management Through Project-Based Learning

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ABSTRACT

The increasing demand for Software Engineering professionals, particularly Project Managers, and popularization of the Web as a catalyst of human relations have made this platform interesting for training this type of professional. The authors have observed the widespread use of games as an attractive instrument in the process of teaching and learning. However, the project of a web-based instructional game that fulfills all pedagogical and technical requirements for training a project manager is not a trivial task. A gap exists between the theoretical concepts that are normally learned in traditional courses and practical aspects required by the real tasks. As such, this paper proposes the use of a persistent browser-based game intended for Risk Management as a component support in the qualifying process of new professionals of Project Management. The game provides to the player some experience in a real context of Project Management, in which new challenges are frequently posed to the enterprises.

Keywords: Intelligent Agents, Persistent Browser-Based Games, Project Management, Project-Based Learning, Risk Management, Serious Games, Software Engineering

INTRODUCTION

The importance and the real needs for the adoption of methods and principles of the Project Management (Project Management Institute, 2004) in organizations are currently widely discussed and accepted. In such organizations, the main role of the Project Manager is conducting a project to its successful conclusion. However, that is not what usually happens in software projects (Brewer, 2005; Gonzalez et al., 2011).

In an attempt to explain the high number of projects that fail due to reasons related to bad management, some studies have discussed a
possible relationship between the lack of certain abilities by managers and the traditional teaching methods. This is one of the consequences of acquiring knowledge without experience in some real project or complementary educational approaches, such as games and simulations.

In order to suggest a solution for this deficiency, in this paper we propose a tool to provide a new way of learning that is not only attractive, but efficient and collaborative as well. This tool meets the needs of users with distinct routines and schedules. This paper proposes the eRiskGame tool, which is a Persistent Browser-Based Game for educational purposes. The game is about the tasks that a Project Manager must perform in an organization. Its focus will be on Risk Management, more specifically in the Planning, Control and Monitoring (budget, time schedule and software quality).

This serious game uses Project-Based Learning – PBL (Ayas & Zeniuk, 2001; Mitchell et al., 2008) to bring the player a way to acquire knowledge on project management, particularly in the risk control involved in this process. To that end, intelligent software agents were employed in monitoring and controlling the environment, which is in constant change and affects the professionals, the organization and its customers.

This paper is divided into eight sections. In the next section, an overview of risk management is presented, followed by a description of the use of PBL in software engineering. The concept of persistent browser-based games and application of intelligent agents in computer games are then presented. Related work is also discussed, as well as the agent-based approach proposed and the role of each agent. The last section presents our final remarks.

**RISK MANAGEMENT**

Risk management is increasingly seen as one of the main jobs of project managers. It involves anticipating risks that might affect the project schedule or the software quality of the software being developed and taking measures to avoid or mitigate the impacts arising from those risks (Hall, 1998; Ould, 1999) apud Sommerville, 2006. So we can understand risk as an unwanted event that has negative consequences (Pfleeger & Atlee, 2009).

In a software project, various risks may exist and they are best understood if we divide them in three categories (Sommerville, 2006): Project Risks, which affect the project schedule or resources; Product Risks, which affect the quality or performance of the software being developed; Business Risks, which affect the software developing or procured by organization. Therefore we can identify particular risk implications in the projects and plan how to deal with these risks if they will or may occur.

Project managers are subject to uncertainties related to the difficulty of defining requirements, time and resources estimating or even to organizational or customer needs changes. To avoid that these risks jeopardize the project, the manager must anticipate them, understand their impact and take the appropriate action. This process consists of four steps (Sommerville, 2006): 1) Risk Identification, in which possible project, product and business risks are identified; 2) Risk Analysis, in which the likelihood and consequences of these risks are assessed; 3) Risk Planning, in which plans to address the risk by avoiding it or minimizing its effects on the project are drawn up; and 4) Risk Monitoring, in which the risk is constantly assessed and plans for risk mitigation are revised as more information about the risk becomes available.

Risks can have different impacts and occurrence probabilities, therefore different strategies must be followed to manage them. A preventive strategy requires that measures to reduce the likelihood of a certain risk to affect the project are taken. However, many risks cannot be avoided. A minimization strategy implies taking measures previously to soften the impact of risk if it occurs. A contingency plan must also exist to deal with the problem if it cannot be avoided.
PROJECT-BASED LEARNING

Project-Based Learning (PBL) was proposed by Ayas and Zeniuk (2001) as a means to conduct the education where the personal and collective skills are devised through the development of learning capabilities which allow short term reasoning. This learning theory allows to individuals and teams the creation and the sharing of knowledge. This theory presupposes a project centered on tasks in which prevail the pressures of short term. The participants must be in balance between action and reflection in order to build the learning capacity competence (Hsu & Liu, 2005).

The PBL can be understood as an educational technique in which situations of an actual context are modeled on a fictitious project in which the students must commit-to-finish it, and thus build knowledge regarding that experience.

A project is defined as a temporary effort driven by a group of people to create a product, service or single result. By temporary we mean that all the projects have beginning and end defined. The end is reached when the goals are achieved, otherwise the project has failed. A project is characterized by having an objective and clearly defined requirements (scope), by complying with the approved budget (cost) and must be finalized within specified term (time) (Schwalbe, 2010).

In the PBL, the learning comes through a process in which the students build a product, working as a team. The product may be something tangible (such as a model / prototype, a system or a robot), a computer product (such as a software, a presentation or a multimedia product), or a written product (such as a report, an assessment or a summary of experimental results). The product must answer a question, solve a problem or attend the needs and requirements lay down by the course instructor or identified by the students (Frank, 2008).

PBL is a hands-on approach that is focused on issues that lead students to meet the fundamental concepts and principles of a subject. It helps their abilities of creative thinking, showing that there are many ways to solve a problem. In addition, the education based on projects differs from the traditional education by its emphasis on the artifacts construction by the students themselves to represent what is being learned.

The central idea of the PBL is that the problems of the real world can capture the interest of students and cause serious reflections on how students may acquire and apply new knowledge in a problem solving context (Frank, 2008; Yadav & Xiahou, 2010). The teacher plays the role of the facilitator, working with the students for raising relevant questions. The teacher also helps in structuring significant tasks, improving both the knowledge development and the social skills. In addition, the teacher evaluates carefully what the students have learned from the experience. The supporters say that the PBL helps students to acquire thinking skills besides of the collaboration required in the workplace.

Project-Based Learning Applied to Software Engineering

The traditional approach in the Software Engineering teaching is based on a reading model. However, this model brings a big problem for students, mainly due to the little involvement with the theme. Students play a passive role in the educational process, differently of the role of Software Engineer which must be alert to what occurs in the projects which he or she coordinates and make decisions that will be the foundation for their successful conclusion.

Integrating the PBL in the learning of Software Engineering makes it possible to provide the student with a practical experience that cannot be obtained in activities performed in the traditional approach (Yadav & Xiahou, 2010). In the traditional approach, the problems are normally adapted and simplified in such a way that they do not appear to be relevant or are linked to solutions already pre-manufactured, which prevent reasoning and gathering of the students’ ideas to deal with problems of this nature. In addition, some issues, like process models, appear to be so theoretical that do not show the students how this will be used in practice.
Then, the PBL, when applied to serious games for the teaching of Software Engineering, is feasible and useful to the students in relation to the practice required by this discipline. This combination may also improve the learner’s analytical capacity, which concerns the ability to analyze data, not always interrelated, and from this analysis produce valuable information or knowledge.

**PERSISTENT BROWSER-BASED GAMES**

According to research carried out by the International Telecommunications Union (ITU) (ITU Telecommunication Development Sector, 2010), from 2003 to 2009, the number of people who have Internet access doubled and represents 25% of the world population, and in developed countries this number rises to 64%. Following this perspective of growth, from 2009 to 2010 the number of users that have Internet access at home have passed from 1.4 to 1.6 billion.

In view of the growth of “connected” public, it is increasingly interesting to invest in the Web platform. Along with that growth, it is possible to notice social changes experienced in the past 25 years that have arisen what is known today as Digital Natives (Prensky, 2001). They are people with easy and permanent contact with technology, representing today 50 percent of the active population and may reach 80 percent in 10 years.

Aiming to reach that market portion in constant growth, the billionaire electronic games industry has started to invest in multimedia titles totally in Web, focusing on the potential that this platform offers, such as: i) persistence, which is the state maintenance of the game in the server aiming posterior access; ii) platform independence, an increasingly necessary requirement, given the diversification of operating systems and devices for Web access; In addition to the iii) collaboration experienced in Web 2.0 and the explosion of social networks.

The browser-based games may include all the genres of games, which could be single-player or multiplayer, and the latter gained more emphasis due to its additional focus on the social interaction, often on a massive scale. Social networks make use of these games to bring more people, for example the Zynga’s Farmville, popular farm browser-based game running on Facebook.

In this context, we can define a Persistent Browser-Based Game (PBBG) as an electronic game that can be played and accessed by a Web browser and presents a shared persistent virtual environment, where the events continue to occur even in the absence of user. The users may recover their session later and continue in the game.

In a heterogeneous audience, with specific requirements of time and resources, the characteristics offered by PBBGs may be the key-point in the success of a learning tool. Since they provide people with separate provisions to interact, compete or exchange experience using the same tool. People who need to move could benefit from the portability of the PBBGs, once the information about the users’ profiles are stored in the server, and no special software is required, so that they may be accessed from any terminal through a browser and continue from the point where the user stopped.

PBBGs can also run on mobile devices, most of these with limited capacity. This is possible because most part of browser games do not count on complex graphs or sounds, which normally are compensated with one ludic aspect, thus maintaining their attractiveness.

**USE OF INTELLIGENT AGENTS IN COMPUTER GAMES**

To improve the effectiveness, or even the autonomy of computational tools, some techniques of Artificial Intelligence (AI) have been employed in various areas. Intelligent Agents have gained space and become very popular in computer games due to some of their abilities, such as: behavior guided by goals, reactivity, reasoning, adaptability, learning, communication and cooperation.
According to Russell and Norvig (1995), an intelligent agent is any entity which may receive information from the environment where it lives by means of sensors, and act in that environment by means of actuators, in a rationally manner. In other words, they act in a correct way, tending to maximize an expected performance measure.

There are several types of agents, but each one is elaborated in accordance with the environment in which they shall be inserted and the functionalities which they should provide. They may be software or hardware and are normally classified in four basic types (Russell & Norvig, 1995):

- The simple reactive agents select their actions based on the current perception, ignoring the perception history;
- The model-based reactive agents maintain the internal state to control the aspects of the world which are not evident in the current perception;
- The goal-based agents need a description of the current state besides some kind of information about the goals that describe desirable situations. Thus, these agents are able to achieve the goals;
- The utility-based agents use a performance measure which allows a comparison among different states of the world, in order to select which one will be more useful to them. Some environment states can satisfy the agent, however, a state may be chosen over another.

An autonomous agent sets in which agents cooperate among themselves aiming to solve a problem that is beyond the capacity of a single agent is considered a Multiagent System (MAS) (Pontes et al., 2010).

As the games become more realistic, in terms of physics and graphics, the characters and the environment have evolved and became more intelligent. Normally agents are used in computer games to provide a behavior not very obvious and different in each situation, making the players change their strategies and improve their performance in order to overcome the challenges presented.

Agents are present in all game styles, more often in RPGs (Role Playing Games) where enemies can be monsters or characters similar to the player, controlled by agents. The enemies should be autonomous and need to interact with dynamic and complex environments, which require reactive behavior, planning and common sense. They need to navigate by the virtual world, requiring (a) “pathfinding,” (b) space, and (c) temporal reasoning. Advanced agents may have mechanisms to adapt to the strategies of their opponents, and can also learn.

The modeling of partners or allies in computer games constitutes a research problem even more difficult than the enemies modeling. The ally will be side by side with the player during most of the game or during the entire game while the player will probably see his enemy once in the entire game. The challenge is get an ally agent with human behavior. The player may, for example, to want to talk to your allies, which will have to remember the conversations. So, an autonomous agent should be able to cope with many difficult situations without any intervention from the programmer (Buckland, 2005).

Intelligent Agents may be used in games with many purposes, not only in the representation of opponents or partners, but also in the representation of the environment itself, since the virtual environments try to represent real environments the most accurately possible way. These environments are subject to the most diverse circumstances, like climate changing or disasters, among other things that can influence the game progress.

**RELATED WORK**

Some games in the project management area have been proposed, such as TIM: The Incredible Manager (Dantas et al., 2004), a single-player simulation game with focus on Planning and Control (budget, time schedule and quality) developed on the Java platform. In this serious
game there are tasks that the player must assign to each developer and determine the limit time for completing the task, the number of inspections, among others, to finally submit this specification to a possible acceptance.

In Agarwal and Umphress (2010) a simulation model that uses the games paradigm is presented. In that work, agents are used to represent the developers and each agent has a different behavior pattern, assembled from observed statistics about PSP (Personal Software Process). The user assembles the team and the users themselves specify the data of developer’s performance and productivity.

The game developing takes place by following a XP process. Due to this, its context focuses strongly in stories described on cards. The SimSE (Navarro & van der Hoek, 2004) also focus on the software project management, including the phases of analysis, design, construction and tests. It was also developed on the Java platform. Another example is the SESAM (Drappa & Ludewig, 2000), which approaches the software development process focused on quality assurance.

eRiskGame

This session describes the proposed persistent browser-based game. This game may be used in software engineering formal courses (e.g., graduation courses, specialization courses, short term courses, etc.) to train or even assess the abilities of the students in how to deal with situations and common decisions made by project managers. It will also be a good way for aspirants to job positions to exercise their abilities, at the same time that they exchange information and experiences with other players.

This section is divided into six subsections. The next subsection presents the game storyline. The multiagent system that supports the game behavior is described and the communication tools available to players presented. The following subsection describes the module where teachers evaluate the attitudes taken by players, and a scenario of use of the game is presented. The last subsection describes both the used technologies and the game architecture.

Game Storyline

The eRiskGame was created to simulate an experience in managing software projects, where the player can get ready to control the expenses, to comply with the targets and deadlines laid down, in addition to accompany the team work productivity. In view of that, as a real company, the work will be subject to changes in the administration of the organization, requiring changes by customers and other risks which may prevent the success of their projects.

The game storyline consists of a Software House that goes through changes and is seeking new project managers. At the start, the player is involved in this context, which it is presented in the tutorial form, as shown in Figure 1.

The ludic aspect tries to captivate the players, to unwittingly submit concepts and leaving they free to reach them when the players consider it necessary to transpose any challenge imposed by the game. Besides the tutorial, an additional material about Risk Management, with integrated questionnaires is made available to the trainee. The questionnaire results may increase the final player’s score.

Once inserted in the game context, the player can start new projects, which have budgets, deadlines and targets, varying in acceptable intervals. That provides a certain dynamics to the game, avoiding that the players get unmotivated with predictable results. Each project is divided into phases which in turn are divided into weeks and days.

Players can monitor the result of their actions by means of numbers and graphics (Figure 2), which gives them better prospects of success in their decision making.

In the eRiskGame, the planning of the teams and, consequently, budget is highly important. For this, the user may contract (Figure 3) the most varied professionals and fire them at the time the user may deem advisable. To this end, the game brings a professional list, with detailed profiles, to analyze their charac-
teristics and determine which of them better fits the needs of the project at the time. Each professional has characteristics such as Teamwork, Leadership, Concentration, Technical Vision, Abstract Vision, Motivation, Hourly Cost, Productivity in Code, among others. These characteristics will influence the performance in the team project. It is up to the players dealing with different profiles so that they can maximize the results.

Due to the fact that the game is multiplayer, hiring or firing professionals requires that the player remains attentive to other factors besides the professional characteristics. The list which includes the available professionals for recruitment, called market, is the same for all players in the game. Thus the players should be cautious with the deadlines, because a professional that they intend to hire just for a specific phase may not be available anymore in that period. This same concern should also be watched over when firing, since in the game, the newly recruited professionals have a smaller productivity curve. That may hinder an exchange of these professionals in the final stages of a project phase.

Figure 1. Game tutorial
The amount of available professionals on the market is controlled by the game in order to supply only the needs of ongoing projects. There is no excess of professionals, but it could have a shortage in certain moments.

To confer greater dynamics to the game, the professionals’ attributes (Vigor, Motivation, etc.) are not static. Over the days, professionals get tired, lose the motivation or even get distracted, affecting their productivity. To deal
with this, the players can make new acquisitions, through which they can invest and revitalize the staff.

Acquisitions are material assets (printer, coffee maker, among others), courses, conferences (motivational or techniques) or case tools that improve the team productivity in some way. These acquisitions include the overtime, which may be paid to increase the team activity. Other acquisitions have preventive effect, for example, the acquisition of a backup system to avoid possible future problems with loss of data.

A new project, once started, brings fairly detailed planning done to the whole project and also for each stage: budget, time in weeks, artifacts and codes to be produced, among other details. Thereafter, the player’s mission is to meet these targets and deadlines in the best possible way. However, it is given the option to negotiate the deadlines or budget. This fact entails a decrease in the project’s final score.

Each concluded project, successful or not, gives the player a certain score, calculated in accordance with the fulfillment in a timely manner of each phase, the financial balance, the production targets and the reached quality. These scores generate some rankings in which the players can measure their performance compared to other players.

The eRiskGame has its own time. The days elapse without the player’s intervention and they progress differently from real time to prevent that the projects prolong for months or even years. This way, the players can prepare their strategies and let the game develop according to their planning, and may recur in their available schedule to verify the game’s progress and to take other actions, if necessary.

This feature allows that several days take place without the need of the player to logon to the game. However, the player’s absence for a prolonged time may bring the project to irreversible situations, since any inconvenience caused by agents may occur and if no action is taken in a timely manner, the progress of the project may be compromised.

**Multiagent System**

The focus of this serious game is on Risk Management. One of the greatest difficulties of a project manager is to predict the problems that may arise and design plans to minimize their effects. A real project management environment is very complex to be represented, mainly due to the risks of the project that are involved in it. These risks affect the time schedule or resources. While product risks affect the software quality or performance, business risks affect the organization that develops or purchase the software. To help representing this complex environment, intelligent agents were used to provide the game with some of these risks in different stages and different conditions for each project. Some risks and consequences modeled in the game were:

- Professional is ill, having to be away from work by a certain period, but maintaining his costs in the project;
- Valuable professional quits the team;
- Problems in the application server resulting in partial or complete loss of the program code due to lack of backup system;
- Financial problems in the company forcing a reduction in the project budget;
- New similar software product launched on the market leading to a reduction within the deadline for completion;
- Inspection made in the software detecting several errors;
- Client requires new functionality not expected previously;
- Conflicts between professionals become routine and are starting to affect the productivity;
- Bad rumors and relationships problems among workers, affecting concentration, motivation and performance of the staff.

Due to the diversity of problems, many agents had to be implemented, being each one of them in charge of monitoring several
Tables 1, 2, and 3 bring a modeling of some of the main implemented agents using MAS-CommonKADS methodology (Iglesias & Garijo, 2008).

Agents are sociable and when one acts, providing some adverse situation; the others are informed, increasing or decreasing the risk of occurrence of other mishap. For instance, when a professional quits, the agent in charge for “rumors” may influence the other ones concentration.

Besides analyzing the professionals’ attributes and the project progress, the agents that have been developed count with a peculiarity: their actions shall be subject to a probabilistic factor. All agents have a numeric attribute that represents the mishap (risk) occurrence probability. Then, when a state of the environment is detected, the action related to it will not always happen. A random number is chosen and compared with this attribute to determine whether the agent will or will not act. This way, the game provides a very common and necessary element in management environments: luck.

Some different AI techniques were used to provide intelligence to the agents, being the Fuzzy Logic the most used. For example, fuzzy logic is used in the agent responsible for examining the professional’s health conditions

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### Table 1. The disease-causing agent

<table>
<thead>
<tr>
<th>Agent</th>
<th>Disease-Causing.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agent Type</strong></td>
<td>Simple Reactive Agent.</td>
</tr>
<tr>
<td><strong>Short Description</strong></td>
<td>This agent represents the risk related to the leave of the professionals for medical reasons.</td>
</tr>
<tr>
<td><strong>Goal</strong></td>
<td>Make away sick professionals.</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
<td>Vigor and motivations of the professionals.</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td>Health state of the professionals.</td>
</tr>
<tr>
<td><strong>Preconditions</strong></td>
<td>Professional to be linked to a project and not be away.</td>
</tr>
<tr>
<td><strong>Post Conditions</strong></td>
<td>Professional away from the project.</td>
</tr>
<tr>
<td><strong>Goal Description</strong></td>
<td>The agent analyzes the health state of the professionals and makes them away for medical leave for a specific period, in accordance with their present physical condition.</td>
</tr>
</tbody>
</table>

### Table 2. The rumors agent

<table>
<thead>
<tr>
<th>Agent</th>
<th>Rumors.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agent Type</strong></td>
<td>Model-Based Agent.</td>
</tr>
<tr>
<td><strong>Short Description</strong></td>
<td>This agent creates rumors or discussions among professionals.</td>
</tr>
<tr>
<td><strong>Goal</strong></td>
<td>Generate conflicts, discussions or rumors which may degrade performance of the team.</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
<td>Number of professionals, number of errors and elapsed time of the projects, leadership and teamwork of the professionals.</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td>Level of “good relationships” of the team.</td>
</tr>
<tr>
<td><strong>Preconditions</strong></td>
<td>There are more than one professional in the project.</td>
</tr>
<tr>
<td><strong>Post Conditions</strong></td>
<td>Probability of occurrence of other risks intensified.</td>
</tr>
<tr>
<td><strong>Goal Description</strong></td>
<td>The agent analyzes some characteristics of project progress and sociability of the professionals to determine situations of conflict and create rumors that affect the professionals and the project’s progress.</td>
</tr>
</tbody>
</table>
and keeping them off temporarily by medical leave. That is a simple reactive agent that monitors the motivation and the vigor (Figure 4a) of all professionals who are designated to a project and identifies a health condition, as shown in Figure 4b, to determine how long this professional should be kept away.

As the degradation of the attributes of the professionals is continuous, if there was not a factor of probability associated to the agents, as soon as a professional’s health was measured below 90, this one would already be kept off for 3 days, preventing the physical state get worse until a most critical situation. In this case, the associated probability is a very low number, which avoids the occurrence of deviations and allows that the number of days off be different in most cases.

The agent responsible for creating rumors or discussions between the professionals is a model-based agent. It notes the quantity of professionals in each project, the time elapsed

Table 3. The data loss causing agent

<table>
<thead>
<tr>
<th>Agent Type</th>
<th>Data Loss Causing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Description</td>
<td>This agent causes partial or total data loss.</td>
</tr>
<tr>
<td>Goal</td>
<td>Impose data loss at critical moments to the project.</td>
</tr>
<tr>
<td>Inputs</td>
<td>Staff productivity, project time, deadline of the steps and the presence of backup system.</td>
</tr>
<tr>
<td>Outputs</td>
<td>Fragility level of the project.</td>
</tr>
<tr>
<td>Preconditions</td>
<td>There is no backup system in the project.</td>
</tr>
<tr>
<td>Post Conditions</td>
<td>Partial or total data loss.</td>
</tr>
<tr>
<td>Goal Description</td>
<td>The agent analyzes if the project is at a critical stage, close to a deadline and if there is a backup system, to impose data loss, according to the project fragility.</td>
</tr>
</tbody>
</table>

Figure 4. Fuzzification and defuzzification graphs

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and the quantity of errors in the project, the leadership and teamwork of each professional for, from time to time, inform the players if any of them is clashing with the team or if the staff is concerned with any factor linked to possible changes in the company organization or even rumors involving the project discontinuity.

After to detect certain states, this agent must inform the player about what has been occurred and store data on a report. Subsequently, if the environment perceptions related to these data have degraded and no corrective action has been registered, the agent will create some situation in the project that will result in lack of concentration or high concern in the professionals, thereby increasing the risk of poor performance of several other agents.

The players are informed about the occurrence of any of these contingencies by means of messages in their inbox in addition to other reports related to the performance focus (Figure 5). The available message inbox is essential to maintain the player updated about the changes occurred in the project and it is one of the main communication tools included in the game.

**Communication Tools**

The eRiskGame was designed on the Web platform, aiming at potentialization of the relations between students (players) and teachers (evaluators) through the use of forum, chat and electronic messages. These communication means can be exploited by teachers in application and orientation of the activities developed in the game, besides sharing knowledge and acquired experience.

Students are no longer passive receptors of information in the classroom and become active participants in their learning environment (Xakaza-Kumalo, 2010). Thus, a teaching tool cannot be limited to transmit knowledge, without any feedback. It must allow students to exchange information and discuss about its content, so they could formulate questions and acquire new knowledge.

E-mail in the eRiskGame allows sending messages to only one receiver at a time. If the players wish to send some information to a user group, they must create an interest group and send the message to it.

As a synchronous communication way, the eRiskGame has a chat system to facilitate the exchange of instantaneous information among players. To access the system, the user will see a list of the existing chat rooms and their respective themes and will have the option of creating a new one and restrict the access with password, if desired. As soon as the creator user leaves the chat room, all participants will also be removed and the chat room will be automatically closed.

A discussion forum was also developed to promote discussions and information exchanges among the participants. However, the forum’s success depends on the number and quality of contributions. Without focus or concern about certain standards, a productive and prosperous debate is impossible. Therefore, the topics and messages may be moderated by a teacher.
These tools make the game more attractive, communicative and efficient. In addition, the communication is a foundation of the learning proposed by PBL, where the debate and the knowledge exchange among the students favor the development of their own concepts and knowledge as well.

Evaluation Module

Education is a kind of characterized service with a high intangibility degree. Contrary to the assets’ quality, which can be measured objectively through indicators such as durability and defect number, the educational service quality has a more abstract and intangible nature (Zeithaml et al., 1996). It may be difficult an assessment of its efficacy or even the adequacy of its use.

In these cases some measures may be taken to verify if the student is making proper use of the subjects exposed and if the tool actually works according to its purpose. It is possible to assess the quality perceived by the users by questioning them if the tool reached their expectations and if they have acquired the worked content. It is also possible to evaluate the real knowledge acquired by attributing to the specialists (teachers) the role of analyzing the obtained results by means of tests and other evaluation methods.

Having some kind of evaluation is important, because it allows the identification of deficiencies and the verification if the students are making progress in a wrong way. This way, teachers can guide when and how to perform in order to achieve better results. The eRiskGame has a special module designed to help the teachers in the task of monitoring the progress of the students and interpret their knowledge, skills and actions, in view of the expected changes in behavior, proposed in the tool goals.

Among the evaluation tools available in that module, can be cited:

- Monitoring the players’ actions: all acquisitions, recruitment or any changes that the player makes in the project is recorded and shown in an interactive list of daily events (Figure 6a);
- Monitoring the project progress: the teacher has access to productivity statistics and projects’ advancement (Figure 6b);
- Rankings: the general ranking scores, project score and other classifications may also be accessed (Figure 6c);
- Communication: the communication tool available at the game can be accessed for guidelines, chats and debates. The moderation in the forum may only be made by users which have joined to this module.

The evaluation tools allow the teachers to analyze the projects’ progress and which actions have been taken at each moment, in addition to be able to compare the scores for a balance between the results of a certain player and the average of the others. The rankings provide a numerical comparison through the actions history. The teacher is able to determine in which points the players may have taken some actions which jeopardized their good progress and guide them how to face certain obstacles ahead.

The assessment is an essential didactic task for the teaching work. By presenting a great complexity of factors, it cannot be summarized in simple tests execution and grades attribution. The measurement taken only gives quantitative data which must be appreciated qualitatively. The model used in the game intends to provide means to support the teachers’ work as evaluators and explore their sensitivity to detect when and how to intervene in the learning process of their students.

Game Scenario

A game scenario could be described as follows. The player accesses the eRiskGame and provides his or her login and password. The game validates his or her information, verifies the type of user (player or evaluator/guiding) and redirects the player to the respective interface. The game, once identifying the user as a player, offers the option to start a new project or access...
a project in progress. The player then selects one of his or her existing projects.

The game interface is finally available and the player accesses the Deadlines Menu to check on which day/week is the project and the remaining time to finish the current phase. The player realizes that he or she is only two weeks away from the next deadline to complete the actual project phase and only 70 percent of the planned functionalities for this phase had been developed.

The player accesses the Progress Menu and checks how many functionalities his or her team has produced in the last weeks, therewith he or she estimates that at current rates the deadline will not be met. Then the player decides to look for professionals that are available in the market (Market Tab in Team Menu) to hire some professional(s) that could help to accomplish this goal. After reviewing all the available professionals, the player verifies that two of them have the features that he or she was looking for. Then he or she accesses the Budget Menu to examine whether the available capital allows the addition of these professionals to the team for the desired period without affecting the amount available for the project completion.

With these data the player makes some accounts and concludes that professionals’ hourly rates do not fit the available capital for the project. So he or she decides to pay some overtime to two of the most productive team professionals. He or she accesses the Acquisitions and Restrictions Menu, selects the Overtime Option and then a list containing the team professionals is displayed. The player selects the desired professionals and determines two additional hours for the next two weeks.

Having done that, the player verifies his or her mail box to try to get some news about the game and realizes that he or she received a game warning stating that some of his or her professionals have had some conflicts. In spite of that, the player decides to do nothing about it and ends his or her session.

Figure 6. Monitoring options
Figure 7. Architectural design

Used Technologies and Game Architecture

The eRiskGame was implemented using the following technologies: PHP 5 as the server side scripting language, MySQL 5 as the database management system and JavaScript jQuery library, aiming to provide higher interactivity and usability to the game.

The system was built on the architectural pattern MVC Model 2, which is widely used in Web development by promoting reuse, reliability, maintainability and mechanisms for group work (Brambilla & Origgi, 2008). The architectural design can be seen in Figure 7.

In the architectural model presented in Figure 7, there are three main elements: the Model, the View and the Controller. The Model represents the current state of the application and its business rules while maintaining a close relationship with the persistence layer (Database Management System - DBMS). The View collects artifacts visible to the user (e.g., HTML, CSS, XML, JavaScript, JSON) observing the current state of the model. Finally, the Controller analyzes the user requests including submission of data, cookies, sessions and so on, manipulating and updating the model as well as directing the flow of the application to the most appropriate View.

CONCLUSION

In this paper a Persistent Browser-Based Game has been presented, the eRiskGame. This game was proposed as a tool to support the training of new project managers. It was designed in line with the increasingly demanding users’ needs, with different routines and schedules, which motivated its development on the Web platform.

The methodology adopted has used the information technology potentialities allowing the creation of new teaching models. An efficient communication scheme was added to compose an environment where the teaching-learning process occurs in a more spontaneous way and involves the students more easily in the proposed context. In addition, the proposed tool offers a Risk Management practical vision different from the traditional education patterns.

Some earnings are easily noticed when using a game totally designed on the Web and without the need for special software to access it, such as: time flexibility, cost reducing, space flexibility and less interference in work routine. The high accessibility level promoted by this serious game also allows user to start a session in a given place and resume the game from any other place, using any access device. Thus, even people with very dynamic routines can benefit from the use of this tool.
Concerning the sharing and the quality of information exchange, one of the characteristics of the distance education systems, especially those which make use of asynchronous communication tools, such as forums, is that both the teachers and the students have the opportunity to ripen their ideas and consult sources beforehand, favoring the preparation for more productive discussions. Thus the exchanged knowledge is better prepared, facilitating the users’ understanding with different levels of familiarity with the theme for that matter.

All these benefits make this tool an innovative learning environment with characteristics very important to reach and gather distinct publics, allowing a greater collaboration between students and teachers. The proposed persistent browser-based game could even be a model for other educational games involving the most distinct topics.

Then, we can conclude that the eRiskGame fulfills the gap between the theoretical concepts that are normally learned in traditional courses and the practical aspects required by the real tasks of the Risk Management as a component support in qualifying process of new professionals of Project Management.

FUTURE WORK

As future works we intend to do a case study with professionals working on software companies by comparing the outcomes before and after the use of the eRiskGame. Another case study is being developed with graduate students in computer science, identifying the strengths and weaknesses of the tool aiming to improve it.

In the following we intend to improve the game so that it allows tailoring of the challenges of the game according to the profile of the players.

The next step will be the availability of the game in the clouds, storing all information of the game and of the players on remote servers, making it public to be used by all who wish to improve their qualities of Project Manager and share their knowledge.

REFERENCES


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