Multiplayer Role Games Applied to Problem Based Learning

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ABSTRACT
The educational community is willing to approach the learning applications to the engaging and immersive formats of multimedia and video games as a way of increasing the motivation of the so called "digital natives" [19]. During this decade the interest for videogames as a way of combining learning with fun has grown exponentially. But despite the best intentions of teachers and technologists, the efforts to integrate games into the curriculum have often fallen flat. Most students see learning through videogames as "chocolate covered broccoli" [1] while many teachers consider games as a waste of time. In this paper we propose an approach, the NUCLEO framework, that is getting good results in several testing implementations for the Spanish higher education context, turning a whole problem based learning scenario into a role game. The conceptual framework and the system presented here are aimed at getting effective learning in a motivating environment that seeks a student's change of attitude towards learning. It is intended to be used within the context of a LMS (Learning Management System), complementing its features with new interfaces and modes of content interaction.

Categories and Subject Descriptors
K.3.1 Computer Uses in Education.

General Terms
Experimentation. P1.10 [Educational/Serious Games].

Keywords
Game based learning, learning in virtual environments, problem based learning, computer supported collaborative learning.

1. INTRODUCTION
Let's take a look at two simple cinematic problems:

"One train leaves Madrid at 5 p.m. travelling at 100 Kph towards Paris. A second train leaves Paris at 6 p.m. travelling on the same track at 80 Kph towards Madrid. Both cities are 1280 km apart. When will the trains collide with each other?"

And:

"Our undercover agents within enemy ranks have reported unusual movements of the enemy's spaceship fleet which were located behind Mars, 102 million km away from the Earth. The ships are getting closer to the Earth at a chilling speed: According to our calculations, at around 5 millions km/h. In order to repel the attack as far away as possible from our planet, the Alliance's spaceship fleet, only partially armed, have left the Earth 5 hours later than the enemy's ships departure. Unfortunately our armament resources are not fully operative and our top speed is only 3 million km/h. In order to prepare the fleet for the attack in the optimum conditions, our armament specialists will need at least 9 hours to prepare them for the attack. Will we have the time to battle in full conditions before we collide with the enemy in the outside space?"

Both are focused on the same learning objectives, which of the two would you have rather solved in your physics class?

Our students are no longer the people that our educational system was designed to teach. According to several authors [8], [16], [19], their early exposure to technological devices in their everyday lives has made them prefer different forms of interacting with contents. They are used to: accessing information discontinuously jumping from one topic to another, mainly on non-printed, digital sources; giving preference to images, movement, and music over text; feeling comfortable with multi-tasking processes; being permanently connected with other peers; or being used to obtain immediate responses and feedback. These peculiarities in the way they process and interact with contents, have led the educational community to embrace passionately new approaches to learning, particularly game based learning.

Nevertheless, as recent research reveals [22], there is a fundamental mismatch between being able to obtain the educational objectives contained in a curriculum and keeping the game essence, that is, the fun. From the student's point of view, embedding educational content into games dilutes the fun, and from the teacher's point of view games makes the learning process often too long and focused on the wrong objectives.

On the other hand, game based learning approaches have often been developed backwards to Learning Management Systems (LMS), probably the most extended tools for managing the whole educational process in higher educational institutions (from teaching and learning to administration). We think this is a huge mistake: even though learning through games has very positive educational values, it obviously can't cover all the range of the educational needs. In addition, games or Multi-User Virtual Environments (MUVE) work poorly in performing several key aspects of an integrated educational process like: at storing and managing the learning contents, at performing specific learning management tasks or at maintaining historical student records.

In this paper we present an instructional framework that uses a pedagogical approach deeply grounded in the socio-constructive stream [25], in which students collaborate in small teams to reach the solution of real-world, open-ended, ill-structured problems as they would do in a classical problem based learning scenario [14]. The difference is that in our system, the real-world is a virtual fantastic one. The learning takes place in a futurist scenario in which, conducted by a metaphor, the students (represented by configurable avatars) get immersed into a civilization threatened to destruction by a terrible menace. In order to combat their enemy, selected members of the community are trained in the weapons of knowledge by competing among them to solve a mission, as it happens in "Ender's game", the book by Orson Scott Carr which serves as inspiration. Thus, the learning environment reproduces the training of the warriors in a multi user virtual reality environment which is provided with several tools needed for collaboration and problem solving by means of a connection with the Learning Management System database (we are currently using Moodle).

Our approach contributes to the research of new ways of learning in the following ways: first, it is connected to a LMS and the virtual reality is used as a 3D skin to access tools and data from the centralized database, therefore both tools work complementary. Second, it differs from classical game based learning in that we are not trying to disguise educational content as fun but turning the whole learning scenario into a multi player role game. Our idea is that solving problems and playing games share many features. In fact, from a certain perspective, what players must do to progress through a game is to solve the problems immersed in the narrative of the game, which is essentially what problem based learning is about. And third, we have developed an instructional framework aimed at changing student's attitude towards learning that has obtained very promising results in several testing performed in several actual learning contexts in the Spanish higher education context.

The rest of the paper is structured as follows: in section 2 the pedagogical background of our tool is presented; in section 3 the design of the framework developed for conducting the learning process in NUCLEO system is presented; in section 4 we present the development plan for the system together with an overview of the final results of phase one (section 4.1) and also an alternative metaphor for the prototype phase introduced based on cost requirements (section 4.2); finally some related work as well as several conclusions and our future work are outlined in section 5.

2. PEDAGOGICAL BACKGROUND

The changes that have occurred in accepted approaches to teaching and learning in recent years have been underpinned by the movement towards the constructivist and the socio-constructive views of learning, originally attributed to Piaget [18] and Vygotsky [25] respectively. All of the existing constructivist approaches of learning share the basic principle that learning happens through active interaction with the learning material (according to the maxim "learning by doing"). The socio-constructivism extended this idea to a sociological context within which learning occurs, so learning is understood as a product of the learning situation and the nature of learning activity [12].

Problem Based Learning (PBL) is one of the socio-constructive approaches that have demonstrated its educational effectiveness over the years both in face-to-face and in virtual settings. PBL approximations are often implemented in virtual educational settings under the name of CSCL (Computer Supported Collaborative Learning) environments, although many other virtual learning applications use PBL as their pedagogical basis, namely simulations and game based learning.

A PBL course is driven by problems rather than by presentations of the subject content (in the example presented at the introduction the problem would have been presented to teams without any previous explanation about cinematic). In the most common approaches, the students have to collaborate in small teams to solve a difficult, real-world, ill-structured problem and the teacher acts as a mere facilitator, guiding the students through the learning process by providing hints whenever he founds necessary. Educational literature has shown the benefits of using PBL and CSCL to improve students' thinking skills [10]. It has been demonstrated that it leads to deeper levels of learning, critical thinking, shared understanding, and long-term retention of the learning material. Furthermore, collaborative learning also provides opportunities for developing social and communication skills, acquiring positive attitudes towards co-members and learning material, and building social relationships and group cohesion [9]. Despite all these advantages, it is not easy to implement effectively a PBL approach, especially in a non face-to-face learning setting. Two of the reasons are:

- It relies very heavily for its success on group dynamics. Group cooperation and cohesiveness have been identified as significant factors [1].
- Social interaction appears to be the key to collaboration [7]. Nevertheless, just placing students into groups and giving support to some kind of communication among them does

not guarantee the emergence of the social interactions that lead to effective collaboration.

To overcome these problems, we apply three strategies each reinforcing and/or complementing the other. The first one, aimed at promoting social bonds among students and foster the creation of a community of practice [12], is a virtual world and a role game to set the learning scenario in order to immerse the learner in the situation requiring him or her to acquire skills or knowledge in order to solve the problem. In our approach, the structure of the game provides the motivation and the urge to solve the problems, creating at the same time a positive atmosphere that leads to a change in the students' attitude towards learning (from passive listeners to active warriors in the fight against "the Marsh"); the narrative provides the authenticity for engaging the students; and the characterization makes the player's role in the narrative believable helping to the learner's immersion [20].

The other two strategies aim to improve group dynamics (see section 3.2 for more details). The first one is to form heterogenic teams in which the stronger students can lead the weaker ones in the problem solving process. The rationale for ability heterogeneity in teams is defended in several research works [15]. In our system the stronger and the weaker students are identified by means of Vermunt's Inventory of Learning Styles [25], a 100 question inventory which students must complete before starting the course. The last strategy is based on using functional roles to structure collaboration among team members in order to improve group dynamics. Functional roles are concrete responsibilities assigned to individuals to reach a common objective, designed to be inter-dependent in order to promote collaboration, thus fostering group cohesion and responsibility.

3. DESCRIPTION OF THE INSTRUCTIONAL STRATEGY IN NUCLEO SYSTEM

3.1 The backstory

The metaphor takes the student to the NUCLEO, an artificial universe populated by a special kind of living beings in the form of Artificial Intelligences (AI). There are three tribes in the NUCLEO civilization. The *Evians* are specially qualified AI with powerful minds trained in strategies and logics. They inhabit the metropolis of the NUCLEO. The *Ruks* are an itinerant tribe native of the peripheral regions of NUCLEO. It is mainly composed by pirates and mercenaries. The *Exters* are strange and unpredictable AIs that have evolved in extreme conditions. They are mutants with odd forms and strange powers difficult to control.

The civilization of these AI is threatened to extinction by a mysterious virus that is destroying their entire virtual world (they call it "the Marsh"). To confront this terrible menace, the Arcanes (the NUCLEO's superior council formed by the widest and oldest AI) decide to train specially qualified individuals in the weapons of knowledge. The training simulates a real attack from the enemy (in the form of a mission) which the aspirants must repel clustered in small combat units (conforming the crew of symbiotic spaceships, usually composed by 3 or 4 members). Student's avatars play the role of these champions and their type of participation, duties, and skills in the crew are conditioned by their role (the different roles used and their responsibilities are explained in section 3.2). The different crews compete among them to obtain the best solution. At the end of the training period, only the best ones will reach the grade of Paladines to fight in the real war against "the Marsh".

We have checked that presenting this learning scenario at the beginning of the course certainly puzzles the students. Our intention is to create a reaction that forces the students to abandon their passive role, placing them at the centre of the learning experience by saying to them "we have a common enemy that we have to fight together. You are no longer a passive listener but a warrior. I am no longer a sage on the stage teacher, but a guide for you in dark times".

3.2 Teams or crews

A number of research works have demonstrated that group composition has a strong impact on the success of collaboration processes [17]. Belonging to an unmotivated, disorganized group can turn a positive experience into a negative one. As already mentioned in section 2, the NUCLEO system combines two strategies to promote group cohesion:

- Formation of heterogenic teams to avoid the unfairness of allowing strong students to cluster on one side and the weak students grouped together on the other side, leading to an impoverishment of the learning environment. This way, weak students are provided with good modelling for effective learning approaches and tutoring from strong students, and strong students benefit from teaching others. In our system, students are pre-classified in four categories by means of Vermunt's Inventory of Learning Styles: "Meaning Directed" –MD–, "Application directed" –AD–, "Reproduction Directed" –RD– and "Undirected" –U–. The first two profiles correspond to students with most effective learning strategies while RD and U profiles are more ineffective. Teams (or crews using the terminology of the metaphor) are formed by three or four members, among whom there is at least one MD or one AD student.

Figure 1. The three different races in NUCLEO (from left to right: exters, ruks and evians)

- Group performance effectiveness strongly depends on the handling of increased coordination. We use functional roles to afford the work organization and communication between members. Roles appear to be most relevant when a group pursues a shared goal requiring a certain level of task division, coordination and integration of individual activities [23]. In our system, we use three different roles which are linked to the student profile (MD, AD, RD or U) and that are embedded in the game metaphor (some of the duties presented in the following roles are taken from Strijbos' suggestions in [23]):

- Captain of the crew (assigned to MD or AD profiles). This role is in charge of project planning and project progress monitoring. His duties are: recording the activities to be performed and their deadlines; supervising that all the members comply with their assigned activities; report the group progress on a regular basis to the rest members of the team; arrange an agenda for discussion and compose an overview of all the suggestions and the decisions taken.
- Knowledge Integrator –KI- (assigned to RD profiles). He is in charge of controlling and supervising that all team members acquire the required knowledge. If the team decides to split the work of solving the problem in different tasks assigned to different people, the KI will make sure that everyone acquires the knowledge for constructing all of the parts including the ones he / she has not personally developed. His duties include: maintain an distribute a logbook in which all team members keep track of their progresses; set up tests an sessions in which all team members explain the progresses of their own work and ask questions to their mates about their work on a regular basis; report the failures of the task distribution to the captain of the crew if he detects any.
- Responsible of Communications –RC- (assigned to U profiles). This role is in charge of managing the communication among team members and the tutor. He will make an inventory of questions and problems that team members experience during the mission, transmit it to the tutor or ask for help to other crews, and communicate the answers to the remaining team members; he will also report team malfunctions or conflicts among members and he will try to act as a mediator (in case he is not involved in the conflict otherwise, he will just report the problem).

3.3 Missions and activities: The design of the learning process

In the NUCLEO system, the learning process is structured following the classical PBL schema as it was depicted by Neufeld and Barrows more than 30 years ago [14]. Knowledge is gained through collaboration procedures designed to solve ill-structured, open-ended problems. The main difference is that problems in NUCLEO are embedded in the game narrative (they are called missions) and solving them is part of the game.

Thus, within the game context, a mission (which is really a complex practical case immersed in the game narrative) is an event in the competition to become a Paladine at the NUCLEO Training Academy (NTA). It simulates a real danger situation which Paladines must solve in the fight against "the Marsh" and teams compete among them to obtain the best solution.

In NUCLEO system the learning process follows a cyclic structure:

- A course is made up of several missions determined by the tutor. Each mission represents a learning objective included in the curriculum.

- Each mission is composed by several activities defined by a collaboration script [5]. Usually, the end of each activity is marked by the production of a certain result (usually in the form of a conceptual model or schema for the solution, a report, a document, etc) which has to be delivered to the Arcanes for its evaluation. The resultant products of one activity often work as the starting point of the next one to be performed.

- Before starting a new mission, the teams are reviewed and, if necessary, re-configured. The same process is applied to the roles the individuals hold inside the team. Re-configuration of the teams and re-assignation of the roles depend on the results obtained in the previous missions by means of an adaptation cycle and a user modelling process.

- At the end of every mission, the Arcanes evaluate the final results and distribute the individual and the team rankings (see section 3.4 for more details about the evaluation mechanisms).

Social interaction in NUCLEO takes place at two levels, intra-group (among the members of the same team) and inter-group (among different teams), and it can be divided in two different types of relationships:

- Collaboration (at intra-group level): The members of the same team have to collaborate to reach the best solution they can. All team members play a predefined role with concrete duties and responsibilities in the fulfilment of the activities as it was explained in section 3.2.

- Competition (at inter-group level and individually): We think that competition is a powerful incentive to motivation in games and also in real life [6]. At NUCLEO learning system, competition is also posed at two levels, between individuals and between teams, because the essence of the game is to get the maximum individual score in the final ranking in order to become a Palladine. So teams compete in one particular mission, but students play individually in the game. Social recognition is a very powerful propelling force inside a community of learning [1], so avatars in NUCLEO acquire physical distinctions whenever the student achieves an intellectual challenge (in the same way meritocracy games do).

To support these two levels of social interaction, the virtual world within which the learning takes place reproduces the NTA (NUCLEO Training Academy), where all inter-group interactions take place, and the symbiotic spaceships, where the members of a crew interact. All course members have access to the common places inside the Academy (there are different places that hold for different pedagogical purposes, see figure 2 for the areas in the prototype), but only the members of the crew can get inside a symbiotic spaceship (although all the interactions are recorded and tracked by the system in order to update the students' profile and to follow the learning process).

3.4 Evaluation mechanism

One of the key issues in collaborative learning environments is trying to ascertain the contribution of each individual student to the group work. To tackle this problem, in NUCLEO system two different student's features are subject to evaluation: her knowledge and her performance inside the team, that is, how do her team mates evaluate her work and how successfully her role has been performed according to her team mates' perception.

To asses these two aspects the NUCLEO system counts with two levels of evaluation:

- Group Evaluation: it is a measure of the student's gain of knowledge where only the technical aspects are assessed. The result of this assessment is assigned to the whole team as a group, and it is based on the quality of the solution of the mission delivered to the Arcanes. The solutions of the different teams are scored comparatively, so the best solution gets the maximum score and the rest are ranked in comparative terms. This means that the score one team gets depends on what the other teams have done, which is a way to foster the competition as well as a way to avoid cheating.
- Individual Evaluation: it is a measure of how good one member's work is perceived by her team mates. At the end of each mission a peer-evaluation questionnaire is distributed among all participants. The questions are related to ascertain how she has perceived her mates efficacy while performing their assigned role. According to the answers given to nine questions, the student has to give a grade to her mates among: excellent, very good, satisfactory, ordinary, marginal, deficient, unsatisfactory, superficial and no show.

The individual score of each student is calculated as a fraction of the group score depending on her team performance, following the rules given by Oakley in [15].

To promote social recognition and the competition atmosphere, at the end of each mission, the individual and the team scores are published in the NTA public posts. At this point, the avatars are also awarded with physical features linked to student's personal achievements.

4. DEVELOPMENT PLAN FOR THE NUCLEO SYSTEM AND CURRENT STATE OF DEVELOPMENT

The approach described in this paper is based on the assumptions of several hypotheses that need to be experimentally proved. These hypotheses are:

1. The backstory and the game narrative have a positive influence on student's motivation and the student's drop off rate is reduced.
2. We can reach the specific learning objectives contained in the subject curriculum following the instructional method proposed here.
3. Using functional roles as a way to structure collaboration improves team work performance.
4. Competition is an incentive and increases student's motivation.
5. Social recognition from the community is also a powerful incentive.
6. Vermunt's framework is suitable for determining the composition of the teams, specifically:
   a. Students with MD or AD profiles are good captains.
   b. Students with RD and U profiles benefit from the guiding the captain exerts.
7. Setting the learning scenario in a virtual world in which students are represented by configurable avatars helps to form social bonds among the student community which leads to a more effective collaborative learning process.

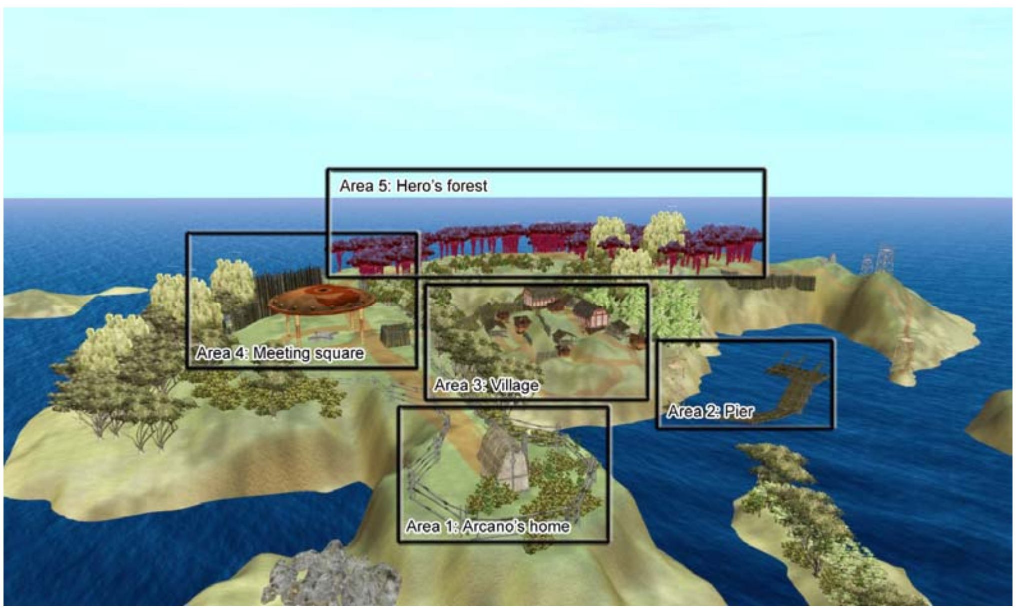

Figure 2. Overview of the different areas in "The Oclun Island" for the MareMonstrum prototype

8. Linking distinctive physical features of the avatars (as dresses, wings, potions, weapons) to intellectual achievements promotes motivation as a way to get social recognition from the community.

In order to gradually prove the set of hypotheses presented, we have designed a development plan for the system divided in 4 phases (see figure 3). Every phase is initiated over a proved set of hypotheses experimented in the previous one. This is a way of optimizing the development costs, one of the key issues in the development of systems like the one presented here, requiring a wide use of multi-user virtual reality technology. For practical reasons, we have chosen as cases of study subjects related to the area of computer programming because some of the members of the research team of this project also provide higher education for subjects in this domain of knowledge. The phases depicted are:

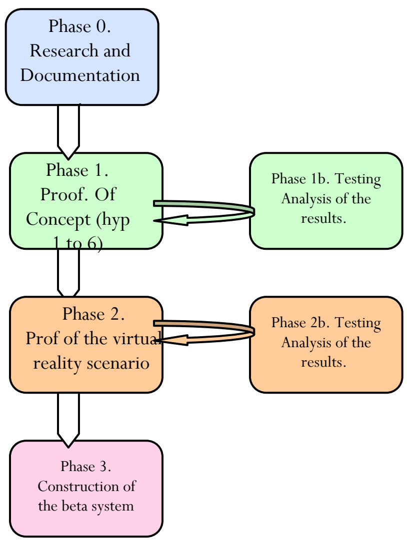

Figure 3. Phases of development for NUCLEO system

- Phase 0: Research for the determination of the pedagogical strategy and the instructional design. This is a purely documental phase with zero investment in software development. It is aimed at researching the different pedagogical and technological strategies for e-learning systems in order to determine the instructional design of our system as it was presented in section 3. In this phase the basic hypotheses were also outlined as well as the backstory and the game narrative. The main conclusions obtained in this phase are exposed in this paper.

- Phase 1: Proof of concept. This phase requires a minimal investment in software development as it makes use of free collaborative software to support the learning environment. It is aimed at verifying hypothesis from 1 to 6 based on which most part of the assumptions over which the system is built are derived. The results obtained for this phase are briefly sketched in section 4.1.

- Phase 2: Proof of the effectiveness of the virtual scenario and development of an interface between NUCLEO and an LMS database (Moodle). The main objective of this phase is to verify hypothesis 7 and 8, both related to the impact some aspects concerning the virtual scenario and the avatars have on student's motivation. In order to invest the lowest budget compatible with our defined objectives, we decided to use a free game engine with plenty of graphical resources (Multiverse) and use these resources in the prototype construction. Due to the graphical restrictions that using Multiverse graphical library set, we had to adapt the original metaphor and create a new one just for the prototype called MareMonstrum (see section 4.2).

- Phase 3. Development of the beta system. It requires a high development effort and high investments. In this phase a complete system will be developed and distributed for beta testing in different learning contexts, due to its large investment requisites, we wanted to assure certain key functionality features in the previous phases.

We are currently in the middle of phase 2. The MareMonstrum prototype has been already developed but the testing phase has not yet been completed.

4.1 Overview of the results obtained in Phase1

As said before, the goal of this phase was to verify whether our theoretical framework was valid. This is captured in the six first hypotheses. Our methodology consisted on using the framework presented here in three different subjects related to computer programming (two of them in a university context, and the third one in intermediate teaching).

Although the formal results are out of the scope of this paper, they demonstrate that the setting held by the metaphor has an incredible positive effect in the students' motivation. Sentences such as "the NUCLEO has let me teach myself at the same time that I enjoyed" were common in the final survey. Also, the student attendance was higher in those groups where the PBL approach was being used, what serves as an indirect indicator of the motivation increase and drop-off rate reduce.

Motivation creates a positive result because students tend to spend more time with the subject. Social pressure, time limits and the positive mood created by the role playing scenario make students ask and reply questions themselves, instead of listening to the teacher's explanations for issues that they don't feel they need. This demonstrates that the students become active participants at the centre of the learning process, instead of passive listeners in a teacher centred approach. The delicate matter here is creating missions that do not break the metaphor magic. If teachers manage to keep this enchantment, nearly any subject can be taught.

An important aspect of our PBL approach is in the team creation. As said before, the decision of student arrangement is of paramount importance because an unbalanced team usually generates unbalanced learning and, even worst, student rejection. The experiment has proved that Vermunt test is rather accurate to identify correctly MD and AD categories, whose individuals become good captains according to our final peer evaluation. RD and U categories are, unfortunately, blurred and it is more difficult to identify which pupils belong to each of them. At any case, the role assignment has demonstrated to have a good impact in the collaborative processes, because students do not need spend time trying to find their place in the group.

4.2 The MareMonstrum prototype

Phase 2 was conceived as a cost-effective way to verify hypothesis 7 and 8, that is: do role game-based learning conducted in a virtual reality scenario foster the creation of social bonds that lead to the formation of communities of practices inside the learning community? And, how does social recognition expressed in terms of physical distinction of the avatars affect the student's motivation?

On the other hand, the final NUCLEO system is conceived to be used within the context of a LMS, so the prototype developed in this phase was also intended to serve as a testing platform to check the connect-ability between a multi-user virtual reality scenario and the LMS and what possibilities this connection offered concerning both the pedagogical and the technical aspects.

Although LMS used today in higher education offer a wide range of communication features, like online chatrooms, discussion forums or assignment file drop-boxes, for the most part, LMS are commonly used as document repositories [13] where the educational content is usually stored in static documents (often as PowerPoint slides or Word documents). On the other side of our equation we have a MUVE, and it is certainly the case that these environments are very poor document repositories and lack some key features to manage a long-life-learning process as LMS nowadays are able to provide. Integrating our game into a LMS would certainly extend the learning environment with new forms of interaction while at the same time enrich the game giving access to typical LMS resources and tools through a virtual reality skin (particularly content repositories and collaboration tools), and giving at the same time persistence to the data generated during the game process as they can be stored in the LMS database.

The prototype developed in this phase, which we have called MareMonstrum, is connectable to Moodle and uses Moodle's tools (chat, discussion forum, content repositories) within the game scenario as elements of the environment (see figure 4). This means what students are really using is Moodle features with a 3D clothing.

Due to cost requirements we have adapted our original futurist metaphor to the medieval aesthetics of the elements included in the graphical libraries available in Multiverse platform. The essence of the narrative in the prototype remains, as well as all the elements in the instructional design described in section 3. But in MareMonstrum we have changed spaceships for sailing boats, NTA for an Island (The Oclun Island -see figures 2 and 4 -) where the warriors are confined and the NUCLEO AI civilization for an extinct Viking civilization which is also menaced by a terrible enemy they have to combat.

This prototype will be used to teach several computing subjects next course at the Complutense University of Madrid in order to verify the above mentioned hypothesis.

Figure 4. The public forum and the information panel in the public place at "The Oclun Island"

5. CONCLUSIONS

In this paper, we have presented the NUCLEO system, a problem based learning approach where the student is immersed in a multi player role game where the exercise and lecture session's mood are embedded.

Students are confronted to challenging exercises without previous theoretical sessions, forcing them to develop abilities such as learning auto-regulation and social skills. Although these advantages are inherited from the PBL approach, we overcome its main problems (group dynamics and collaboration difficulties) using a motivating background story and creating the student teams with the well known Vermunt's Inventory of Learning Styles.

With these ideas, we are proving our hypothesis in a running four phases plan. The proof of concept has demonstrated to be a full success, with a promising student support, both spontaneous and statistical. Now we are working in the phase 2, where a more elaborate software development has been accomplished and a new experiment will be carried out.

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