

FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO



FEUP

Serious Game for Integration in Higher Education

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Masters in Informatics and Computer Engineering

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“Meu andar não faz pegadas no chão,
mas deixa marcas nas alturas do buscar do aprender, do realizar.
Meu andar, agora, é renascer aquisições de existência;
Acrescentar-me; evoluir”

In João Carlos Pecci (1980)

Resumo

Quando alguém chega a um ambiente novo e diferente é necessário algum tempo para a adaptação à nova realidade. O mesmo acontece com estudantes que iniciam o seu percurso académico numa nova universidade ou faculdade, muitas vezes longe das suas casas.

A adaptação leva tempo, variando de pessoa para pessoa. Facilitar essa adaptação com o auxílio de jogos digitais é o foco principal desta dissertação, além de avaliar como os jogos sérios podem ajudar no processo de adaptação e quais as técnicas que promovem os resultados esperados. É também apresentado um motor de jogo para o desenvolvimento de um jogo multiplayer, jogo este que promove o trabalho de equipa e a cooperação entre os estudantes, traços psicológicos como liderança, assim como um melhor conhecimento do *campus*. A captura do melhor conceito de jogo para alcançar esse objetivo é uma das principais prioridades, levando a uma melhor compreensão de como desenvolver os objectivos propostos entre os estudantes do primeiro ano.

Esta dissertação analisa o conceito dos jogos sérios e dos jogos multiplayer, através de um estudo do estado-da-arte sobre este tipo de jogos. Uma análise à plataforma tecnológica também foi realizada de modo a comparar as principais características que oferecem, e escolher a melhor para ser aplicada. Este estudo permitiu encontrar soluções e perspectivas diferentes de serem implementadas, após o qual, foi construído um protótipo de um jogo sério como método de avaliação do trabalho desenvolvido, assim como a avaliação do mesmo junto do público alvo, com a participação de 10 estudantes, que permitiu perceber que a plataforma desenvolvida teve uma boa aceitação entre os estudantes, assim como permitiu encontrar os pontos-chave para tornar a ferramenta mais completa, eficiente e ir de encontro às necessidades pretendidas.

Abstract

When a person first arrives to a new and different environment he/she requires some time to adapt to the new situation. This also happens to students who initiate their academic studies in a new university or faculty, sometimes far away from their homes. This adaptation takes time, varying from person to person. Diminishing that time gap with the aid of digital games is the main focus of this thesis.

It tries to evaluate how serious games can help in the process of adaptation and which techniques promote the expected results. It is proposed a game engine to render the development of a multiplayer serious game that promotes teamwork and cooperation among students, psychological traits such as leadership, as well as a better knowledge of the campus. The capture of the best game concept to reach this objective is one of the first priorities, leading to a better understanding of how to develop the proposed objectives between the first year students.

This report analyzes the concepts behind serious games and multiplayer games, by a study of the state-of-the-art about this kind of games. A technological platform analysis was also performed in order to compare the main features they offer, and choosing the best one to apply. All this allowed finding different solution perspectives to be implemented. It also presents the prototype built as an evaluation method, as well as the evaluation made among the target audience, with the participation of 10 students, which allowed to realize that the platform developed had a good acceptance among students, and allowed to find the key elements to make the tool more complete and efficient, meeting the intended needs.

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Abbreviations and Symbols

AI	Artificial Intelligence
API	Application Programming Interface
DGBL	Digital Game-Based Learning
ECTS	European Credit Transfer System
FEUP	Engineering Faculty of Oporto University
ID	IDentification
GBL	Game-Based Learning
MMOG	Massive Multiplayer Online Game
MUVE	Multi User Virtual Environment
VICERAVI	Virtual Centre for the Rehabilitation of Road Accident Victims
WYSIWYG	What You See Is What You Get

Chapter 1

2 Introduction

The integration of newcomer students at university is crucial both for the student's motivation and grades. It is a needed step towards the success it is wished for the students to have. Bearing in mind the growing evolution and popularity of online communities, social networks, virtual worlds and online games, it seems legit the use of these technologies in aiding student integration, promoting collaboration among each other and well-being throughout their academic lives. Therefore, the main objective of this work consists in the development of a multiplayer digital serious game with defined characteristics conceived to help the main propose of integration and collaboration.

Digital games have a huge motivation capacity that enhances their use in teaching and learning. Throughout entertainment and challenging requests, players are motivated to overcome barriers and achieve goals, being encouraged to communicate and cooperate with other players, and their use in dynamization of groups allows great interactive capabilities and corresponding ease in integration of elements in a group [Men11].

This first chapter presents the context, motivation and objectives of this thesis, as well as the document structre and expected results.

20 1.1 Context and Problem Statement

The Engineering Faculty of the University of Porto (FEUP) provides a five weeks course named “*Projeto FEUP*” with 2 ECTS, with the objective of teaching students about what they will find at FEUP and teaching them to collaborate with each other. This course main objective is to promote integration between students and familiarize them with the campus and the faculty

Introduction

work patterns. The cost and the time spent in the integration process is wished to be significantly reduced with the use of a digital approach, since it represents a motivating way to make students collaborate, and bases on a group dynamization effort, meaning no need to focus on every single student individually.

These thesis aims to be implemented in the “*Projeto FEUP*” course, being an important pedagogic tool for teachers and supervisors. Not only it will be a serious game, but it can also be a way to improve student skills, analyzing their game results.

1.2 Motivation and Goals

The main motivation to this work is the creation of a tool that will be able to reduce the time needed for a new adaptation and help students who are having difficulties to fit in academic life, thus creating a greater in-group dynamics. Bearing in mind some previous work done [Men11][Cru11] about the subject, probably the most important motivation are the results that can be retrieved which can help answer how important to the students is the integration process and how can students benefit from it and what strategies can be used to help student’s adaptation in university through the use of a serious game.

The main goal can be achieved with the development of a serious game for students’ integration and better in-group dynamics. Within this general goal, there are the following specific goals:

- Elaborate a report with the state-of-the-art;
- Conceive a game concept that meets the objective of improving collaboration;
- Analyze the best platform to the development process;
- Develop a solution for the proposed problem;
- Develop an initial prototype (called **FEUP Game**);
- Implementing the integration between the Moodle platform and the game (after this thesis);
- Make it user-friendly;
- Testing and evaluation of the prototype.

Introduction

To achieve a better understanding on group dynamization, a collaboration with another student was performed during this thesis. A student from Psychology, Liliana Mendes, developed a platform idea that aims to help and rehab people that suffered from accidents using a virtual environment [Lil12]. This project is called VICERAVI (see chapter 5.2) and was executed alongside the prototype for the serious game. At the end, VICERAVI constituted an important comparison method between two different approaches on group's dynamization, because both can be adapted to serve the same purposes and audience.

1.3 Methodology

Firstly, a state-of-the-art analysis was conducted, followed by the definition of game concept, which should be compatible with collaborative tasks and group dynamics.

Additionally, concerning the state-of-the-art, an evaluation of the possible platforms took place, focusing on the specific needs of the project, which required benchmark analysis of similar works. After this step, a working prototype was established as a validation method.

After this first fase, starts the implementation simultaneously with the iterative development of the prototype. The development consists in the creation of assets and game programming.

Finally, the final tests, with prototype testing with student sample and results evaluation.

1.4 Expected Results

In the specific scope of this project it is intended that the developed game can be able to help students to adapt to the new reality in FEUP. More specifically it is intended to obtain a working tool to be held by *Projeto FEUP*'s teachers and supervisors. Ideally, the platform will be successful enough to start working the next school year with the *Projeto FEUP* course.

Additionally, it is intended to further investigate other possible usage that can leverage the platform created in this project.

1.5 Document Structure

The present document is divided into seven chapters: Introduction, Literature Review, Technological Plataforms, Game Design, Implementation, Tests and Results and finally Conclusions and Future Work.

This first chapter (Introduction) is an overview of the thesis' theme, presenting the context, the problem and what it expected with this work.

Chapter 2, the Bibliographic Revision, describes the state of the art in the area of multiplayer serious games and presents some related work.

In the next chapter (Technological Platforms), several technological platforms for prototype implementation are described.

In the forth chapter, is presented the game design for the solution implemented. In this chapter it will be addressed a theoretical on the subject of game design and the ways and ideas to implemented in order to achieve the objectives set.

Chapter 5 presents the implementation of both FEUP Game and VICERAVI.

The sixth chapter resumes the tests done after completing the prototype, analyzing the results obtained in order to make some assumptions and modifications needed to get a better and more useful serious game.

Finally, in the Conclusions and Future Work, will be presented the conclusions about the work done, the main ideas presented and what the future might hold for this work.

Chapter 2

Literature Review

This chapter describes the state-of-the-art on the area where this project is integrated. It addresses computer games, serious games (more specifically edutainment and game-based learning), the multi-user virtual environments, and finally the work related to the specific topic of this thesis.

2.1 Computer Games

A game is as a subset of both play and fun, recognised as organised play that gives us enjoyment and pleasure [Pre11]. Is rule-guided and involves some aspect of competition, even if that competition is with oneself. They motivate via challenge, fantasy and curiosity [Ran92].

Computer games can be characterised by six key structural elements which, when combined together, strongly engage the player [Pre11]. These elements are:

- Rules;
- Conflict/competition/challenge/opposition;
- Goals and objectives;
- Interaction;
- Outcomes and feedback;
- Representation or story.

Literature Review

Game types include action games, adventure games, fighting ‘beat ‘em up’ games, platformers (where game characters run and jump along and onto platforms), knowledge games, simulation/modelling/role-playing games such as management and strategy games, drill-and-practice games, logical games and maths games. Gameplay can be competitive, cooperative or individualistic [Mit04].

Computer games (and simulations) can be defined as interactive multimedia with dynamic elements that are under user control. They range from games that require simple, repetitive actions to complex digital worlds [Cit12a]. Unlike much of the currently available educational multimedia, games and simulations are highly interactive, with many user-controlled features [Llo05].

Although similar in many ways, games differ from simulations by including a goal or challenge. Alice Mitchell states that “games often involve or are conducted within simulated environments and themselves simulate environments, events, acts, processes, and procedures” [Mit04].

However, games tend to have extra facets in terms of the elements stated in Prensky’s list [Pre11]. These additional assets can be used by learning designers in achieving performance outcomes. For instance, adding elements of reward or recognition can uprise the learner’s motivation. It is when these additional elements start to be introduced that we move beyond either a *computer game* or a *pure simulation* [Mit04].

One reason for the use of computer games in teaching should be to whether these captivate users. Computer games are highly engaging, and there is great interest in how to harness their power to support learning [Cit12a]. Educational games and simulations have been found to be effective in motivating students to learn [Ke08].

Many reasons are cited for why computer games engage the users. Thus firstly, one has to be certain what is necessary for the development of a good game, meaning an attractive game able to keep players motivated. Previous work by David Mendes [Men11] was based upon:

- Ongoing challenge - a good game continually presents challenges, which always leads to new challenges in order to keep the players "stuck" and willing to continue playing;
- Interesting Script - a good guide may further encourage competition;

Literature Review

- Flexibility - is necessary to ensure that there are several different ways to achieve each objective. Each player (or team) should develop its own strategy to achieve the objectives, keeping the challenges and achieving the desired knowledge;
- Immediate rewards - reward successful players with new features, additional information or even a new task for exploring;
- Combine fun and realism - realism can be boring too, so if needing to enter premises often incorrect or unrealistic, rewarding behavior that normally would not be possible in the real world is encouraged.

Also Alice Mitchell [[Mit04](#)] states:

- Rich visual and spatial aesthetics draw the player into extravagant fantasy worlds that nevertheless seem very real on their own terms; these excite and also pleasure where environments have recognisable features [[Pol00](#)];
- Games are played to achieve a goal or to win. The key to motivation is winning while remaining challenged [[Bec10](#)]. They motivate via fun, and visual feedback [[Pre11](#)]. This is true both of complex games which have goals and subgoals as for mini-games;
- Unlike many other game environments, complex computer games provide a complete, interactive virtual playing environment [[Pre11](#)];
- Ambience information creates an immersive experience, sustaining interest in the game [[Pre11](#)];
- Prensky [[Pre11](#)] identified a combination of 12 elements that make computer games engaging. These are summarised in the figure below.

Characteristics of the computer game	How characteristics contribute to players' engagement
Fun	Enjoyment and pleasure
Play	Intense and passionate involvement
Rules	Structure
Goals	Motivation
Interaction	Doing (ie the activity)
Outcomes and feedback	Learning
Adaptive	Flow
Winning	Ego gratification
Conflict/competition/challenge and opposition	Adrenaline
Problem solving	Sparks creativity
Interaction	Social groups
Representation and a story	Emotion

Figure 1 : The elements that make computer games engaging.

2.2 Massive Online Player Games

A massively multiplayer online game (also called MMO¹ and MMOG¹) is a multiplayer video game which is capable of supporting hundreds or thousands of players simultaneously, interacting among each other and the environment, competing and collaborating in large scale. By necessity, they are played on the Internet, and usually feature at least one persistent world.

The MMOG term is used generically to describe the various kinds of online games targeted for multiple users, which are characterized by a persistent world where playing time is continuous, with or without interaction. It is also distinguished by its gameplay multiplayer aspect giving great relevance to group activities.

2.2.1 Multi User Virtual Environment

Multi-user virtual environments (MUEs) are a popular form of multimedia-based entertainment, destined to be used by several people in virtual online environments. However, recently attention has turned to exploring their use to support learning, and several research groups have been creating MUEs and investigating their effectiveness.

All MUEs enable multiple simultaneous participants to access the virtual context wanted, interact with virtual objects, communicate with other participants (through avatars or text) and are part of experiments in which it is necessary to follow a particular model and guide in the resolution problems similar to those existing in real-world settings [Men11].

¹ Same as MMOG (Massively Multiplayer Online Game).

Educational MUVES are MUVES designed for the educational community embed tasks or problems within a virtual environment or context. Users can explore the environment and examine digital objects. Typically, it also means to communicate with other users and online agents. Users may select an avatar to represent them in the environment. Educational MUVES are designed to support inquiry-based learning and conceptual understanding. Usually there is no one “right” way to perform the task or solve the problem. Instead, several solutions are justified, although, as in real life, some solutions may be better than others. Importance is placed on the logic of students’ reasoning. Unlike MUVES designed purely for entertainment, students using educational MUVES often must gather information offline, and usually there is a final product that they must submit [Cit12b].

Research suggests that educational MUVES should not solely focus on the virtual environment; support from the teacher and time for self-reflection are also important. For example, in Revolution², a virtual community in which students can experience the American Revolution, students take on the roles of seven different characters living in the community. They also participate in teacher-led discussions that encourage reflection and sharing of ideas. Such teacher guidance is an important part of the learning process when using MUVES [Cit12b].

2.3 Serious Games

Today, the term *serious game* is becoming more and more popular. A Google-search on “serious games” renders about 315.000.000 hits [2012-02-05]. Serious games usually refer to games used for training, advertising, simulation, or education that are designed to run on personal computers or video game consoles. Game-based learning/serious games is all about leveraging the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills [Sus07].

A survey of the literature reveals that there are many definitions available, but most papers agree on a core meaning that serious games are (digital) games used for purposes other than mere entertainment.

Leaving aside the entertainment component, these games tend to guide the player to carry out or learning tasks and concepts that are not present in most of the rest. One of the main reasons for the success of these teaching methods relates to the use for educational purposes of

2 Revolution – An example of an MUVE game better described in the appendix.

challenging component inherent in any type of game [Men11] . In fact Corti argued serious games can have positive impacts on the players' development of a number of different skills [Cor06].

Susi [Sus07] states that today's "serious games" is serious business. The *serious games* market is now at \$20 million, and *digital gaming* is a \$10 billion per year industry and the market is expected to grow over the next decade. It is also predicted that "by 2008, 40 percent of U.S. companies will adopt serious games in their training" [Sus07].

Another question concerns the claimed positive effects of such games, or of applications from related and sometimes overlapping areas such as e-learning, edutainment, game-based learning, and digital game-based learning. In addition to obvious advantages, like allowing learners to experience situations that are impossible in the real world for reasons of safety, cost and timing.

2.3.1 Edutainment

Educational games did not come into wide use until the 90s with multimedia PCs, even though such games were created and used long before. At the time, educational games and other software evolved into "edutainment".

Edutainment refers to any kind of education that also entertains even though it is usually associated with video games with educational aims. It usually tries to teach throughout different forms of entertainment.

In this sense, it is obvious the use of digital games as a form of edutainment, as these are a natural form of entertainment, where you can develop knowledge and proficiencies. Educational computer games combine education and entertainment, and can be defined as an electronic medium with all the features of a game environment, which has educational objectives specifically targeted to certain groups of students as stated by Mendes [Men11].

Computer video games for non-entertainment purposes were developed long before the edutainment era, however, and as edutainment failed to prove profitable – and technical advancements in providing realistic settings grew, and multiplayer gaming developed – the concept of serious games was re-examined during the late 1990s. With the U.S. Army's release of the video game *America's Army* in 2002 (www.americasarmy.com), the serious games movement got started [Sus07].

Games in education are gaining more and more acceptance, but their use is not widespread, and it is still a controversial issue. Educational games are also faced with the challenge of providing evidence of the acclaimed benefits. “Despite the quick findings, research is showing positive effects of games as educational tools. Games can support development of a number of various skills: strategic thinking, planning, communication, collaboration, group decision-making, and negotiating skills” [Sus05]. There is also a number of concerns to consider in order to realise the game’s full potencial as educational tools: “resources (many schools have computers that are too old for new games, technical support, time for teachers to familiarise themselves with the game, etc.), difficulty in persuading school stakeholders to the potential benefits of computer games, etc” [Sus05].

2.3.2 Game-based Learning

Game-based learning (GBL) is described as a branch of serious games that deals with applications that have defined learning outcomes and are usually designed to balance the objectives of the game with the gameplay and the player's ability to retain and apply those objectives. Others consider game-based learning and serious games more or less the same [Cor06]. Corti says GBL has the potential of improving training activities and initiatives by virtue of its engagement, motivation, role-playing, and repeatability.

Digital game-based learning (DGBL) is closely related to GBL, with the additional restriction that it concerns digital games. In the words of Prensky [Pre11], DGBL is the newest trend in e-learning, because today’s students are ‘native speakers’ in the language of digital media and this generation has experienced a radically new form of computer and video game play, and this new form of entertainment has shaped their preferences and abilities and offers an enormous potential for their learning, both as children and as adults.

Summarizing, games-based learning is about using computer games influence to captivate end-users for a specific purpose, as example to develop new knowledge and skills. Games-based learning enables learners to undertake tasks and experience situations, which would otherwise be impossible and/or undesirable for cost, time, logistical and safety reasons [Sus07].

The application of the concept of GBL in this thesis arises from the need to train the best processes to integrate a working group through cooperation with your team members in achieving the objectives set, and competition from rival teams.

There are several elements that define an activity as a GBL, that are presented in Mendes [Men11]:

Literature Review

- Competition - by maintaining scores and scope of the condition of victory. It does not imply that players compete against each other, and in many games the players work together to overcome obstacles or opponents;
- Immediate Rewards - players receive points or prizes for victories or some sort of feedback as the goals are being met;
- Performance - Students should be challenged to test their abilities. Each class or activity is based on objectives that students should achieve, acquiring new knowledge;
- Motivation - motivating students through connections between the learned and the resolution of problems that can arise in everyday life.

2.4 Game Concept

In the *concept* phase, the designer, producer, or other vision person heading the project has an idea for a game.

Below, a theoretical look on the subject is presented.

2.4.1 Game Design

Several studies have discussed the basic process of game design in details, which are very helpful for new game designers. For example, Duke [Duk80] has proposed a paradigm for game design including the 9 steps listed below:

- Develop written specifications for game design;
- Develop comprehensive schematic representation of the problem;
- Select components of the problem to be gamed;
- Plan the game with the systems components / Gaming Elements Matrix;
- Describe the content of each cell in writing;
- Search some “repertoire of games” for ideas to represent each cell;
- Build the game;
- Evaluate the game (against the criteria of 1);
- Test the game in the field, and modify.

Literature Review

Generally speaking, these 9 steps can be categorized into the three phases proposed by Fullerton, Swain, & Hoffman [Ful04]: Conceptualization, prototyping, and play testing.

Conceptualization is the process of coming up with game ideas. In this process, game designers need to develop written specifications for game design and develop a comprehensive representation of the problem through ways such as brainstorming, literature review, and expert interviewing.

Prototyping is the process in which game designers create a working model of the game and test it. Improvements will be made according to the results of the test. “Prototyping can be conducted through physical prototyping, visual prototyping, video prototyping, and software prototyping” [Ful04]. This process help designers to formalize, visualize and develop ideas before the implementation of the final product.

Play testing investigates the different aspects related to the game. The *design team* discusses game features and proposes modifications in the design review. A quality assurance test evaluates and identifies *bugs* in the game. In addition, we can have a sample group of players play the game and collect their feedbacks in a focus group test. A usability test analyzes how players interact with the game interface and identifies problems during the interaction.

2.4.1.1 Primary Schemas of Game Design

According to Salen & Zimmerman [Sal03], there are three primary schemas in the framework of games: RULES, PLAY, and CULTURE (See figure below).

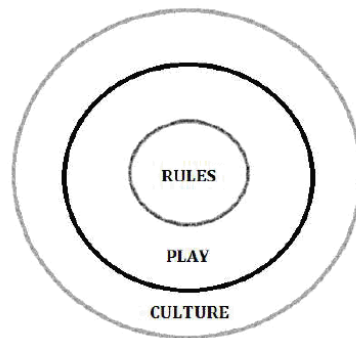


Figure 2 : Three primary schemas of game design (Salen & Zimmerman, 2003).

RULES focus on the formal, intrinsic structure of a game. They form the organization of a game. There are six basic characteristics of rules [Sal03]:

Literature Review

- Rules limit player action;
- Rules are explicit and unambiguous;
- Rules are shared by all players;
- Rules are fixed;
- Rules are binding;
- Rules are repeatable.

Trefy [Tre10] has proposed a guideline for writing game rules:

- Be concise and exact;
- Be firm;
- Be positive;
- Write instructions;
- Avoid too many special cases;
- State the game's goal upfront;
- Tell the rules like a story;
- Give examples;
- Organize play into phases.

The **PLAY** schema focuses on player's experience in a game. It includes players' interactions with the game and other players [Jia10]. According to Jiang some literature includes theories of how players learn to play the game [Sia03], theories of fun [Csi07] [Cow08], game design models that take players' needs and preferences into consideration [Ran08] [Cha05], game usability and playability testing [Fed02].

Compared to **RULES** and **PLAY**, which focus on the quality of games, the **CULTURE** schema focuses "on the relationship between games and the larger context in which they are played" [Sal03]. Games are said to provide a context that reflect the cultural values of a society. At the same time, games also provide a way to pass on values and ideologies. Therefore, "games are social contexts for cultural learning" [Sal03].

2.4.1.2 The Proposed Model

The model to be employed for researching and creating the prototype for the game consists of four phases: Data Gathering, Creative, Testing and Evaluation, and Prototype. Each phase utilizes a set of processes employing different forms of design generation. The model should not be seen as a step-by-step process [Jia10]. The four phases of research making up the model fit within it fluidly and are intermeshed with one another, depending on the designer's context (Figure 3).

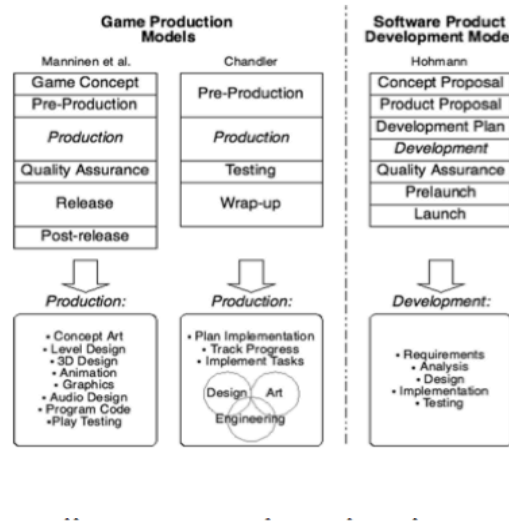


Figure 3 : Comparison between two game production models and a product developer model

2.4.1.3 Data Gathering: Literature Review

Literature review constituted the data-gathering phase, with particular attention to serious games design and concepts related to games. After analyzed all the data collected, the next step consisted in conceptualizing ideas to incorporate into the game concept.

2.4.1.4 Creative: Design Development of Concept Prototype

Researchers state that a prototype should not looks too well, as users would more likely participate in the game's creation if it had a bad appearance. They state that if the concept prototype appears too finalized, it was possible that users could feel their *input* would only complicate ongoing production of the final game. The end result should be a prototype clear enough for users to understand, but "loose enough that there was no particular visual style applied to anything, and lots of elements remained handmade" [Jia10].

Literature Review

For serious games to be considered useful tools to educators, they must provide progress *tracking* and *feedback*. The results of the testing must be recognizable within the context of the education. One of the best progresses tracking mechanism is game level. Starting with easy ones up to harder ones demonstrates that when all have been surpassed, mastery of what the game has taught so far is achieved [Jia10].

Testing requires knowing beforehand what students already know, in order to have a valid sample of knowledge and skills to compare afterwards. The serious game needs to be able to show this proof of learning.

To help the testing, serious games need to include:

- Extensive, detailed logging of all players chooses and actions;
- Review/Replay Controls (also known, in military terms, as After-Action Review);
- Easy customization of material to be tested on, with set goals.

Serious games promote a further opportunity to test students beyond questions and answers and multiple choices, nevertheless must follow some criteria to judge the usefulness of the game like stimulation and involvement of all players, enough realism to convey essential truths, clarity of consequences and their causes in both rules and gameplay, repeatability and reliability of the entire game.

It is also essential, bearing in mind the use of the game in a classroom, that apart for what stated early there are still other features that can help, such as observer mode, for students and teachers, coaching options, pause/play. The observer mode permits other students (and teacher) to watch the game while not playing it. The coaching options permit making changes by the teacher in order to make the game evolve, as he wants. Finally, the pause/play helps to solicit *feedback* from teacher or other colleagues. Along with all the considerations above, the element of fun must be present, turning a game into a stronger motivating tool. The goal is to be an entertaining game but also educational.

2.4.1.5 The difference between this game and others

Serious games are still games and therefore share many design and develop issues as entertainment games. Nevertheless, there are some differences to have in account like the integration with an existing course (in this specific case the course will be *Projeto FEUP*),

testing and assessment, as well as support to specific tasks in order to become a useful tool for the educators.

2.4.1.6 Game Evaluation

Game designers to evaluate the quality of games, ranging from quantitative to qualitative and from objective to subjective, have used a number of methods. As reviewed by Davis, Stury, & Pagulayan, [Dav05], these include focus group, retrospective surveys, beta testing, usability testing, and physiological measurement. Some of this methods will be used to evaluate the game created.

2.5 Related Work

The foundation of the related work of this thesis resides on two previous works, by André Cruz and David Mendes. The first created the FEUP Adventure game for *Projeto FEUP* students [Cru11], while the other developed a procedural generation approach to generate game levels for this game [Men11].

There are many related works, namely, FEUP Adventure, Eduteams and Discover Babylon, and there are some more game references related with the design of collaborative games or with some sort of an integration procedure. They are presented independently of the platform in which they were implemented and can be seen at the Appendix A.

2.5.1 FEUP Adventure

FEUP Adventure is the result of the thesis developed by a former student of the Masters in Multimedia [Cru11], which analyzes the potential use of a digital game in the integration of new students.

The game consist in a number of levels built into Second Life integrated in “*Projeto FEUP*”, involving coordination between the students, so that each team can score. By way of example, in one of three levels, each team must move boxes for their platform, while simultaneously trying to prevent the opposing team to be successful.

In a test conducted with students of “*Projeto FEUP*” observed that their use promoted teamwork and there is increasing cooperation and communication throughout the levels, both in terms of teamwork in the virtual world as in the level of communication in the classroom.

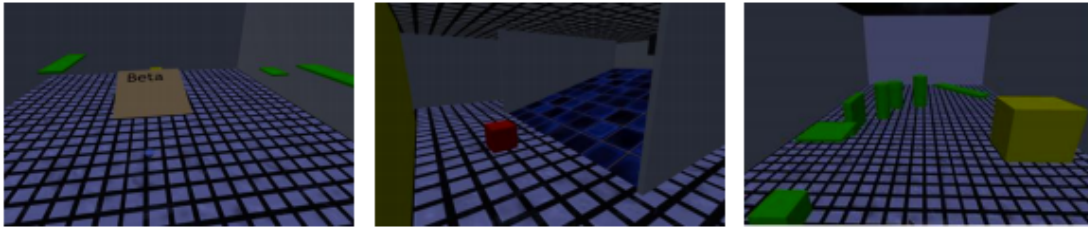


Figure 4 : FEUP Adventure Game.

2.5.2 EduTeams

EduTeams is an immersive team-based software package built to broaden the core skills and enterprise skills for young people.

That includes teamwork, communication, planning, problem solving and logical thinking. Following an activist methodology (learning by doing), the result was a multiplayer system with several team-based activities.

EduTeams, as mentioned above, is a multiplayer system, specifically designed for groups of pupils to play on individual PCs (or Macs) over a network. Teams can be made up of pupils within the same class, in different classrooms and even different buildings.

During the evaluation of the game, teachers reported some benefits in classroom. They perceived that some students became more motivated, talkative and better aware of the importance of teamwork. There were also published three final reports where some conclusions were drawn: Computer games can potentiate the learning process of soft skills. All reports pointed that the communication between students improved.

In a previous report it is stated that, as a curious state, the behaviour of a student that tried to impose his leadership slowly shifted to a more teamwork attitude after verifying that his group results were the lowest, an introverted student, that although clever and very hardworking, hadn't enough confidence to speak in classroom. With the game, his teachers observed that the student had become the team leader and his confidence and participation in classroom had increased [Cru11].

2.5.3 Discover Babylon

Discover Babylon is an educational game, that targets ages from 8 to 14, and features Mesopotamia's contributions in writing, mathematics, literature, etc. Located in what is now modern Iraq, Mesopotamia was the birthplace of written language, the first city, the concept of the 360° circle and the 24-hour day and the earliest known laws and literature. Discover

Literature Review

Babylon uses realistic digital environments to engage the learner in challenges and mysteries that can only be solved through developing an understanding of Mesopotamian society.

Discover Babylon facilitates the understanding important contributors for culture, science and math (<http://www.fas.org/babylon/the-game>), being relevant as an example of a game with good interaction that proved to teach students whom used it.



Figure 5 : Discover Babylon Interface.

2.6 Summary

Computer games have great potential for use in learning and education, as players are immersed in the environment offered by the game, with great involvement and concentration in fulfilling the tasks and objectives. Massively Multiplayer Online Games were analyzed, as the possibility of operating a virtual environment by several players simultaneously, working and/or competing as a team. The use of a Serious Game is applied to develop a game that helps promote and improve the processes of integration and dynamization of user groups. Concept Design is fulcrum to achieve a good game, fun, but simultaneously educative. The related works have numerous sources of inspiration for the project, and help draw numerous lessons from them, such as that students can become more motivated when interacting with a digital platform, teamwork and communication can be improved, and that they must be fun and challenging to keep the motivation levels high.

Chapter 3

Technological Platforms for Prototype Development

A critical step in performing a digital game has to do with the analysis tools existence for the construction thereof. Due to the huge variety of game engines available, the choice should be based on objectives to be achieved and the technical requirements for the desired context and intended use. Because of the multiplayer and the need for use in a network, it should be borne in mind engines that allow such engine game features. Simultaneously, it should be possible to obtain documentation and support easily.

There are several options available, but according to the above, the engines selected were Flash, Unity3D, UDK, Gamebryo and CryEngine as well as the Second Life and OpenSim platforms (although not a game, still a 3D virtual multi-user environment which may be used as a development platform).

3.1 Adobe Flash

Adobe Flash is a multimedia production platform, especially designed for 2D animation. Nevertheless, it possesses a robust object-oriented-programming language (Actionscript), that enables the development of games through scripting. Content implemented in Flash can be viewed and played essentially in any system, device or browser. This application is very flexible for the creation of 2D games, but it is also possible to use 3D in Flash through third-party classes, or a recent upgrade called Stage3D. It has an easy distribution for the majority of systems, and works pretty good with 2D, the same not happening with 3D.

Technological Platforms for Prototype Development

Alternativa3D

Alternativa3D is a 3D engine that allows developers to work with 3D graphics and physics in Adobe Flash.

Getting started with Alternativa3D

Away3D

Away3D is a realtime 3D engine for Flash in ActionScript 3.0.

Creating 3D games with Away3D 4 and Stage3D – Part 1:
Setting up a 3D project in 30 minutes

EasyAGAL

EasyAGAL is an open source ActionScript library that simplifies coding assembly language shaders. Advantages include: Code completion and hinting, easier-to-read code, macro libraries (including all the blend modes in Photoshop, ready to use in your own shaders) and more.

FIVE3D

The FIVE3D initiative is an open source code for the conception of interactive vector-based 3D animations.

Flare3D

Flare3D is a complete solution (tool and engine) to allow developers and designers to leverage 3D in Flash.

Figure 6 : Some 3D third party flash classes (www.adobe.com).

3.2 Cry Engine

CryEngine is considered one of the best game engines [IGN11]. It permits real time editing, bump mapping, static lights, network system, integrated physics system, shaders, shadows and a dynamic music system are just some of the state-of-the-art features it offers. The CryEngine comes with all of its internal tools and also includes the Sandbox world editing system. Nevertheless is considered to be hard [IGN11] for someone making one's first game.



Figure 7 : Cry Engine 3 Graphic Example.

3.3 Unreal Developer Kit (UDK)

UDK is a high-end game engine powered by Unreal Engine 3 technology. This application can be used free of charge for non-commercial projects. There are available an enormous amount of features like a complete editing environment, real-time shaders, real world physics, artificial intelligence, cinematic animation, built-in networking, particle effects, scripting, etc.



Figure 8 : Unreal Developer Kit Platforms' Example.

It's a very complete system that allows top graphical results, but is also complex and very resource demanding. The publishing options are also limited, as for the time of this work only the Windows version was available. UDK has high performance engine with top graphic capabilities, and a long list of features. On the other hand it is not possible to distribute game for multi-platform systems (now mobile is available), and not possible to publish on browser. This feature along with the initial difficulty to learn, make it a non-solution for the project [Dev10a] [Too11].

3.4 GameBryo

Gamebryo's website (<http://www.gamebryo.com/features.php>) states that, at its core “the Gamebryo engine is a suite of modular, foundational C++ libraries. Game developers can extend these libraries to create custom functionality specific to their title. And more importantly, unlike engines which attempt to provide a "one size fits all" solution around a fixed workflow, Gamebryo's modularity makes it possible to easily mix and match different components”.

Gamebryo's "strength lies in its modular nature and access to its source code. The engine is interoperable with many middleware solutions, and the engine is well-equipped to handle complex scripting. This approach makes it ideal for building large, dynamic worlds.

Due to its modular access, Gamebryo games are essentially the sum of their parts. With different middlewares, systems, codebases, and scripting languages, conflicts can and will occur, leading to both gameplay and stability *bugs* that can be hard to identify and remedy" [Max11].

This engine have some well-known issues, such as scripting errors, broken quests, animation loops, and other strange interactions that take place on a regular basis. Despite significant improvements, even the Creation Engine has no DirectX 11 features. Lack of an integrated advanced physics and interaction system leads to extensive problems with clipping and collisions [IGN11].

3.5 Unity 3D

Unity 3D is a cross-plataform game engine which has a large community of users and a good collection of documentation to support the development. It is a game development tool with an optimized pipeline for DirectX and OpenGL graphics with an easy-to-use editing environment in words of its own website (www.unity3d.com). Content developed in Unity is usually aimed for web browsers, but recently the distribution options in this platform have become broader, allowing its use in mobile devices and even consoles. This platform is available in a commercial and non-commercial version.

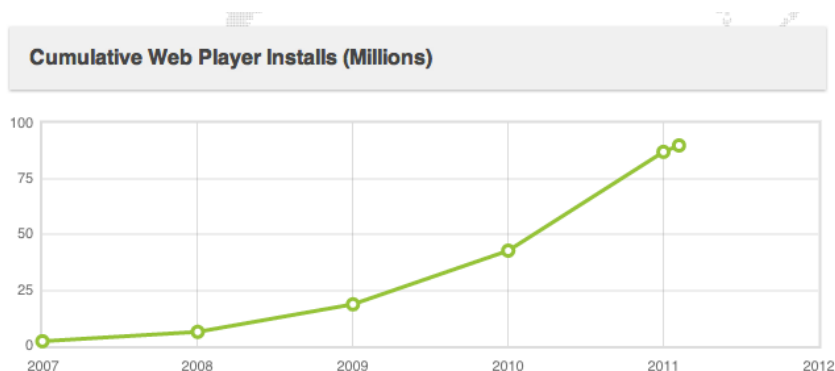


Figure 9 : Number of Unity Web Players Installed.

More and more people are using Unity (see figure above), and it looks like that movement will continue as more game companies and publishers see the capabilities of Unity 3D to deliver immersive 3D experiences in the browser. It is also becoming a choice for online web based 3D

Technological Platforms for Prototype Development

MMOs such as [Fusion Fall](#) and [Marvel Super Hero Squad](#) (two examples of online games entirely made with Unity).

Free/Basic Licenses (www.unity.com)

- A brand new multi-threaded renderer. Unity will offload rendering to a separate core;
- Inspector finally supports multi-object editing;
- Low-level audio buffer access. Custom filters/real-time sound generation;
- Webcam and microphone support;
- Prefab connections are no longer broken when adding or removing components;
- Find References of assets in your current scene;
- Built-in iAd, Compass and Push notification support on iOS;
- Fully pluggable Social API with out-of-the-box iOS GameCenter support;
- XCode 4.0 “Build & Run” support;
- Quality Settings can now be specified per platform and are more flexible;
- Updated MonoDevelop, including enhanced editing performance;
- Google Chrome Native Client support – the Unity Web Player plays automatically in Chrome without requiring an install.

Pro/Advanced Licenses

- Automatic navigation mesh generation, path-finding, and crowd simulation;
- High dynamic range rendering with built-in tone mapping;
- Occlusion Culling has been rewritten from scratch to make baking reliable and much faster. Gates can be opened and closed at runtime;
- Built-in level-of-detail support;
- Light probes for lighting dynamic objects and characters with high-quality baked lighting;

Technological Platforms for Prototype Development

- Area lights for lightmap baking;
- Directional lightmaps which enable bump and specular effects on surfaces lit by direct and indirect light;
- GPU profiling on a per-object basis;
- Text based scene and prefab formats make it possible to merge scene files;
- .meta file support;

Team License

- The Team License is the new name for the Asset Server license, that contains the Asset Server;
- Cache Server – massively decreases import times when working in teams or switching platforms;
- Version control API;
- .meta file support.

Unity 3D is “great to create 3D videogames as well as other types of animations. What it differentiates this engine from the others is its graphical interface, through which the development system is done in a simpler way. Besides, it can design games for Windows, Mac, Linux, Wii, iPad, iPhone and Android” [Tool1].

Unity is considered by nuverian.net [Nuv], “probably the best choice for indie developers right now, that want a multiplatform development without complications. With Unity, it is possible to develop and prototype games with true WYSIWYG capabilities. Unity’s rendering and lighting capabilities are state-of-the-art, supporting differed lighting, occlusion culling and many post-processing effects. It presents some unique features (like Beast Lightmapping or Allegorithmic Substance systems), improved debugging process, and it gives the developers the possibility to share their game assets and scripting tools through the Asset Store”.

Unity has physics support from rigid bodies to soft bodies and cloth. Programming can be done in C#, JavaScript or Boo but Unity can also be extended as it has already been done with some great addons. There exist vast resources and tutorials to get you started and a great community [Nuv].

These features, as well as the new Google Chrome Native Client support and the easy learning, makes Unity a great choice for this project. Nevertheless, it has a lot of restrictions and flaws, especially in the matter of team work and version control, which is essential in bigger projects, but in the context of this project that is not to be considered.



Figure 10 : An online game by Lego interely on Unity.

3.6 Other Examples

3.6.1 Esenthel

Esenthel Engine is a complete game development suit allowing to create fully featured AAA titles (big budget games). It has been designed for professional game development, which has been “achieved by giving the developers full control over the game code mechanics, next generation graphics and a rich toolset drastically simplifying the game development process. While mainly targeted for the professional market, the engine is easy enough that it can also be used by independent teams or small companies with no prior game development experience” [Essen].

3.6.2 Torque 3D

The *Torque Game Engine* (TGE) is a fully featured game engine with award winning multi-player network code, seamless indoor/outdoor rendering engines, state of the art skeletal animation, drag and drop GUI creation, a built in world editor, and a C-like scripting language.

Unlike most commercial game engines, as part of the low cost license, all C++ source code to the engine is given, so any additions you need for the game can be done [Dev10c].

3.6.3 Panda 3D

Panda3D is a game engine, “a framework for 3D rendering and game development for Python and C++ programs. Panda3D is Open Source and free for any purpose, including commercial ventures, thanks to its liberal license” [Dev10b]. It is considered one of the best free games engines [Cro10].

3.6.4 Irrlicht

The Irrlicht Engine was considered the best free game engine [Cro10] [Too11]. It is an “open source high performance realtime 3D engine written in C++. It is completely cross-platform, using *Direct 3D*, *OpenGL* and its own software renderers, and has all of the state-of-the-art features which can be found in commercial 3D engines”.

“It features a high level API for creating complete 3D and 2D applications such as games or scientific visualizations. It integrates all state-of-the-art features for visual representation such as dynamic shadows, particle systems, character animation, indoor and outdoor technology, and collision detection. All this is accessible through a well designed C++ interface“ [Irr12].

Alternative terrain renderers, portal renderers, exporters, world layers, tutorials, editors, language bindings for Java, Perl, Ruby, Basic, Python and Lua, can be easily found on the web, completely free.

3.6.5 Possible Future Stars

Delta Engine, Game Start Engine, Stencyl and Impact are considered by Odyssey [Ody] the most promising engines of 2011.

3.7 MUVes

3.7.1 Second Life

Second Life is a 3D virtual world developed by Linden Lab, available online free of charge (although the purchase of land is necessary if we want to build something) where users navigate and interact with the environment through their avatars.

Currently there are millions of users worldwide that access to this environment over the Internet. It has resources for both the construction, as a 3D environment for interpersonal interaction.

It has an immersive environment that achieves player's engagement, where users interact with objects and with each other.



Figure 11 : Second Life Video-classes example (melhoresvideoaulas.com 2011).

3.7.2 OpenSimulator

OpenSimulator is an open source multi-platform, multi-user 3D application server. “It can be used to create a virtual environment which can be accessed through a variety of clients, on multiple protocols. OpenSimulator allows virtual world developers to customize their worlds using the technologies they feel work best. OpenSimulator is written in C#, running both on

Technological Platforms for Prototype Development

Windows over the .NET Framework and on Unix-like machines over the Mono framework“ ([Open Sim website](#)).

Features (cited from [Open Sim website](#)):

- Supports online, multi-user 3D environments as small as 1 simulator or as large as thousands of simulators;
- Supports 3D virtual spaces of variable size within one single instance;
- Supports multiple clients and protocols - access the same world at the same time via multiple protocols;
- Supports realtime Physics Simulation, with multiple engine options including ODE;
- Supports clients that create 3D content in real time;
- Supports inworld scripting using a number of different languages, including LSL/OSSL, C# and VB.NET;
- Provides unlimited ability to customize virtual world applications through the use of scene plugin modules.



Figure 12 : OpenSim Interface on a Second Life Client.

3.8 Comparison

After analyzing the main advantages and limitations, resumed in the figure below, some conclusions were made, for instance with Unity a game can be developed to any platform, unlike the other engines. From the most famous engines described in the chapters above the most important variable is the cost due to financial limitations, being Unity, Essentel and UDK the best options. The game and graphical features presented in the figure do not constitute a necessity for this project, although some level of detail is needed to represent the playing field and give players the feel they are not playing an outdated game. Apart from the cost, the ease to learn and community *feedback* was taken at consideration, being Unity, UDK and CryEngine the ones with the bigger communities. With all this variables in play, Unity became the one that could have all the features needed and variables stated before.

Name	Platforms							API's		Game Features			Editors			
	Windows	Mac	Android	iOS	X360	PS3	Wii	C++ Interface	Graphics API	Physics Engine	Built-in MMO	Path Finding	Unlimited Sized Worlds	World Editor	Collaborative World Editing	Version Control Server
BigWorld	Yes	No	No	No	No network only	No network only	No	Indie: No (Python) Pro: Yes (+Python)	DX 9	Custom	Yes	Yes	Yes	Yes	Yes	No
CryEngine 3	Yes	No	No	No	Yes	Yes	No	Yes (+Visual Script)	DX 9, 10, 11	Custom	No	Yes	Yes	Yes	No	No
Essentel Engine	Yes	Yes	Yes	Yes	No	No	No	Yes (C++ and Essentel Script)	DX 9, 10, 11 OpenGL	PhysX Bullet	Yes	Yes	Yes	Yes	Yes	Yes
Gamebryo	Yes	No	No	No	Yes	Yes	Yes	Yes	DX 9, 10, 11	PhysX	No	Yes	Yes	Yes	No	No
Hero Engine	Yes	No	No	No	No	No	No	Indie: No (Hero Script) Pro: Yes	DX 9	PhysX	Yes	Yes	?	Yes	Yes	Yes
Source Engine	Yes	Yes	No	No	Yes	Yes	No	Yes	DX 9 OpenGL	Custom	No	Yes	No	Yes	No	No
Unity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No (C#, JavaScript)	DX 9 OpenGL	PhysX	No	No	No	Yes	No	Yes
Unreal (UDK)	Yes	No	No	Yes	No	No	No	No (Unreal Script)	DX 9	PhysX	No	Yes	No	Yes	No	No
Unreal Engine 3	Yes	No	No	Yes	Yes	Yes	No	Yes (+Unreal Script)	DX 9, 10, 11	PhysX	No	Yes	No	Yes	No	No
Vision Engine	Yes	No	No	No	Yes	Yes	Yes	Yes	DX 9, 10, 11	PhysX Bullet	No	Yes	No	Yes	No	No

Graphics Features					Physics Features			Destructible Objects	Price
Gui Editor	Deferred Renderer	Forward Renderer	Ambient Occlusion	Parallax Mapping	Per Object Motion Blur	Physical Clothing	Ragdolls		
No	No	Yes	No	Yes	No	No	No	No	Indie: 299\$/year Pro: ?
No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	1,000,000\$?
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Free Personal: 150\$ Company: 750\$ Pro: 3,000+4,000\$?
No	No	Yes	No	Yes	No	No	Yes	No	4,995\$ + Royalties Pro: ?
No	No	Yes	No	No	No	No	Yes	Yes	?
No	Yes	Yes	Yes	Yes	No	No	Yes	No	Free 1,500\$...
Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Free 99\$ + 25% Royalties ...
Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	1,000,000\$?
No	Yes	Yes	Yes	Yes	No	No	Yes	No	?

Figure 13 : Essentel's Engine Comparison (<http://www.esentel.com>).

3.9 Summary

In this chapter was conducted an analysis of possible platforms for prototype development. The selection must have in consideration the objectives of the project, its restrictions and beneficial features.

The utilization of Unity emerges as the best option as it contains a fast learning curve, works perfectly in browsers, and contains a large community, indeed it is one of the most popular game development engines – it has more than 500 000 registered users and 150 000 of these users are active monthly users, representing well over a million hours of game development every month.

Chapter 4

Game Design

This chapter describes the game concept process and the mechanics that were developed accordingly to the proposed objectives. Concept art is also supplied focused on player's avatars, exterior environments, props, and structures.

4.1 Game Concept

The prime objective of this work consists in the development of a multiplayer digital serious game with defined characteristics conceived to help the main propose of integration and collaboration, gaining knowledge about the campus and academic life.

FEUP Game is a MMOG where players explore the faculty campus, interacting through an avatar. Its main objective is to help new students to get to know each other and get a greater in-group dynamics. The game main purpose is to be played online to ensure the presence of all players simultaneously. The overall concept for this game is based in the definition of peddy-paper, which is a team pedestrian orientation game, consisting of a path associated with questions or tasks corresponding to different intermediate points (or positions) and that can determine the transition to the next part of the route. It is also a play activity often linked to the acquisition of knowledge about a certain topic, and for that reason it fits perfectly in the main purpose of the game.



Figure 14 : Concept Art for the Game.

4.2 Objectives

This serious game has as its main objective the increment of the capacity for individuals to work as a group, therefore helping in the process of group's dynamization. However, this major objective is divided in a few minor ones, namely:

- **Quests' Resolution** – For an improvement in the skills of the players they must complete quests successfully. Its resolution can be performed individually, although there are quests that can only be obtained playing as a team;
- **Campus' Exploration** – To complete some quests a basic knowledge of the college campus will be needed;
- **Team Work** – All players are encouraged to work together, knowing themselves better, and getting better results through the teamwork.

4.3 Game Mechanics

The game mechanics is based in a *capture-the-flag* style of game, meaning there are two teams, playing one against the other, trying to find the flag and gaining possession of it. Once the flag is captured the next step consists in returning to the team's base to win a point, while the other team tries to avoid it. During this process players are incentivised to realize *quests*, which if successfully completed, will grant the player *upgrades* that will help them winning the game.

4.3.1 Lifecycle

This section briefly introduces the lifecycle of the game. First, *login* is required at the beginning of the game in order to keep tracking player's performance and behaviors in the game.

A short instruction of the game will be presented after a successful *login*. Players can also choose to skip the instruction and start playing the game immediately. Before entering the first round of the game, players will see a short introduction of the game context they are going to play. The game officially starts when all users dismiss the context introduction. After that, players will be able to play the game until the game timer runs out or a minimum score is obtained by one of the teams.

When the game ends, players will see a game over screen with career statistics of their performance in the last game and their career records. The winner team will also be granted with upgrades to their characters. Players can choose to debrief the game, which shows their answers and correct answers done in quests, also many decisions made during the game. The game officially ends when the teacher wishes.



Figure 15 : Game Concept Art representing the players and the interface.

4.3.2 How to Play

The game is a multi-player online game. Players can move their avatars along the playing field, using the keyboard and mouse. Along the way to achieve victory a team of players must work together to capture the other team's flag, dragging it all the way back to their home base. Some skills are required to make a team stronger, which can be obtained through several challenges in order to get upgrades (Figure 16). During the game some random events appear to difficult the tasks (this events can also be triggered by the teacher) and in conform to them, players must adapt. These events include timers, changing of bases, exchange of captain or force fields. Players are required to work together to reach and to solve some quests, hoping to improve their ability to work as a team.

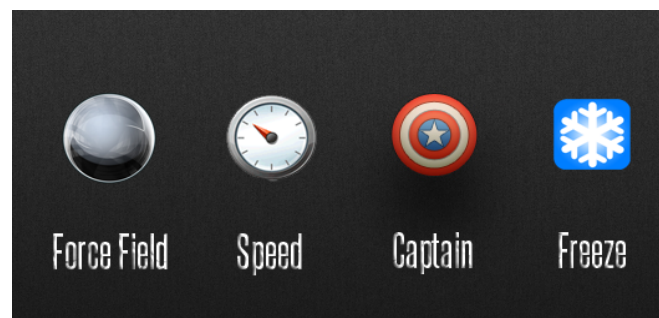


Figure 16 : Upgrades.

Upgrade meanings:

Force Field – A force field will be targeting both teams' main camp, allowing no players in or out, making time for them to complete quests;

Speed Up – the velocity within every player's move can be upgraded, making him faster, carrying the flag around the environment in a faster way;

Captain – With this ability the player can distribute the upgrades and cannot be frozen;

Freeze – the ability to make other players stop in time. They aren't allowed to move for a certain time, unless someone unfreezes them.

4.3.3 Winning Condition

The game is a capture-the-flag based game. The specific winning condition can be changed from a required time or score (by default is score). The game will end when the game timer runs out or the score achieves a requested number. The goal of the player is to capture the enemy flag more times than the other team, conquering points with that action. The initial length for the game timer is 5 minutes or a score that must reach 5. During quests players earn some upgrades by providing correct answers or lose them by submitting wrong answers. The rewarding and punishing scheme is chained, which means players can get different upgrades if they get correct answers in a row. On the contrary, if they provide wrong answers consecutively, they might lose the advantage.

4.3.4 Debriefing

When a game ends, players will be able to debrief the actions they made. In the debriefing screen, players' quest answers in the game are displayed on the left side and correct answers are displayed on the right side. Some statistics are also displayed demonstrating the players performed on the former round.

4.3.5 Achievements

The game will have an overall leader board with the teams with higher points represented. Also a player trophy hierarchy including the ranks of *Caloiro*, *Semi-Puto*, *Doutor*, *Veterano*, *Duques* (meaning: Rookie, Wannabe, Star, MVP, and Hall of Fame). Players will be assigned trophies progressively based on their skills in the game.



Figure 17 : Player Trophies.

4.4 Algorithms and Quests

The location of the bases will be randomly chosen, with an optimum distance between them. The place of the quests will also be random. In order to give extra usefulness to the game the first map to be played will be FEUP, but changed to other option when exhausted or teacher feels to. The quests are mostly in a simple Q&A form, in order for players to meet and talk to each other, knowing themselves better. In order to make this, players are asked to introduce information about themselves in the beginning of the game. It will be necessary to implement a simple algorithm for players to have options from where to choose and answer these questions.

ID	Description	Type
1	Take a ticket at the Secretary	Location
2	Borrow a Book	Location
3	What is the group's favourite music genre?	Q&A
4	What is _____(player) favourite movie?	Q&A
5	Choose a group's nickname.	Q&A

Table 1 : Quests to be available in the game.

4.5 Avatar and Bases

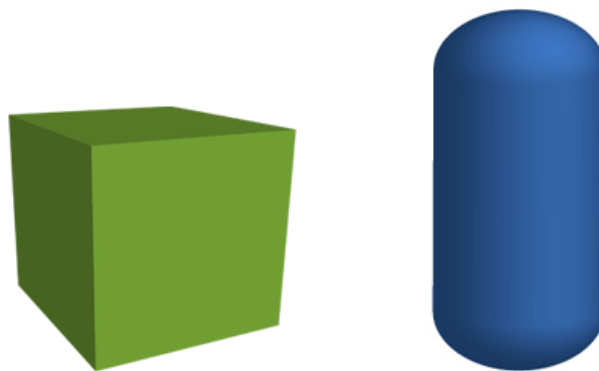


Figure 18 : Player Avatar

The avatar represents the player in the game. One player is capable of controlling his own avatar and only his, interacting with the virtual world through him. The first idea brought up to represent the player's avatar was a biped character, simulating the human bone and muscle structure as authentic as it could. It would allow the player to identify with his avatar and be

Game Design

able to personalize accordingly to his preferences. Although it is a great idea, for prototype effectiveness the strategy adopted consists in representing a player by a common solid (which in the future will be more detailed) with different types of solids and colors between teams. So team one is represented by a Green Cube, and team two by a Blue Capsule. In order to personalize a bit the avatar, it will contain a texture with the player's photo, to better represent the player, as well as to make it feel more attracted to the game.

Another situation needing the identification of a player is if he is carrying the flag. To identify the flag's carrier the avatar turns to red color, changing back to normal if he loses his flag or hits the base.

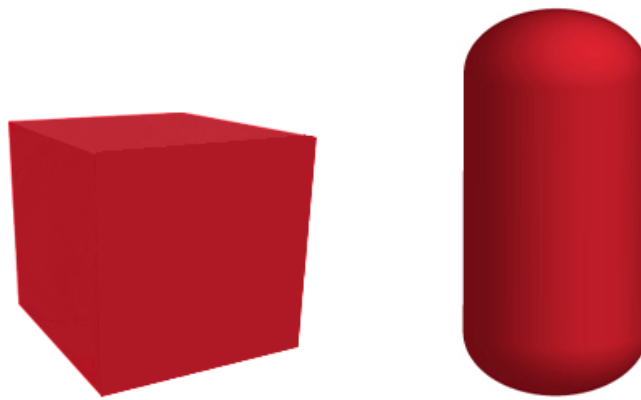


Figure 19 : Player Avatar (Captured Flag).

In order to identify different bases, each base is represented by a flare corresponding to the team's main color (Green for team one and Blue for team two).

4.6 User Interface

During the game there is a set of information available to players. This information is available in various places and various forms and aims to facilitate interaction in the game.



Figure 20 : Game Interface.

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ID	Name	Description
1	Name Tag	Represents the name of the player in the game. This name tag is always attached to the top of the player's avatar, which will also include a photo of the player in the front face of the avatar
2	Player's Avatar	Represents the player in the game. Is through the avatar that the player is represented in the world. It is able to move forward, rotate and interact with other game objects by colliding with them. After capturing the flag it's material color is changed to red
3	Upgrade Icons	Shows the upgrades that can be used by the player
4	Overall Score	Shows the total score of the game
5	Base	Where the player's are supposed to drop the flags. Each team has a different base represented by a flare of the team's avatars color
6	Flag	The flag represents each team main objective. By capturing it and reach the team's own base the score is incremented
7	Quest Icon	Represents the quests in the world. Player's can activate them by colliding with them with their avatars
8	Captured Flag Icon	When the flag is being carried by the player, this icon appears. Later on, the actual flag can be attached to the player's avatar.

Table 2 : Game's List of Information.



Figure 21 : Game Interface (Captured Flag).

4.7 Controls

The interaction in FEUP Game will be made through the keyboard and mouse. They can be used together or individually, depending on situations.

With the keyboard, see Figure 22, the player can enter his *login* information, move his avatar and choose which upgrades the player wants to use. Using the mouse, see Figure 23, the player can select the opponent who he wants to hit, if he had selected some upgrade to the effect, and answer multiple choice quests.

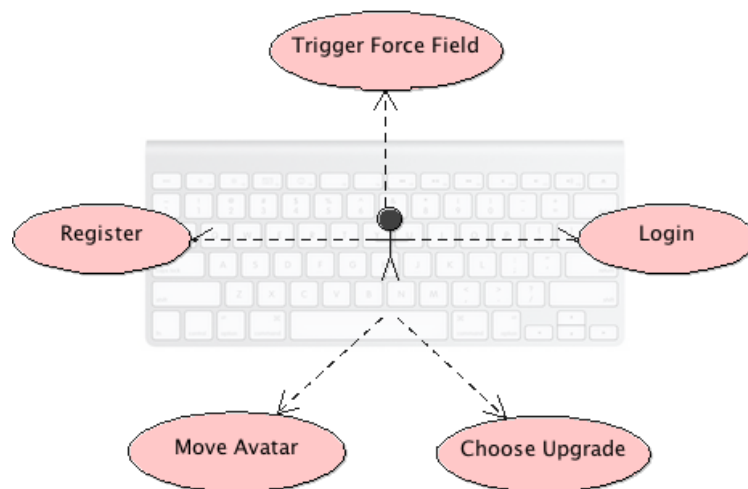


Figure 22 : Keyboard Controls.

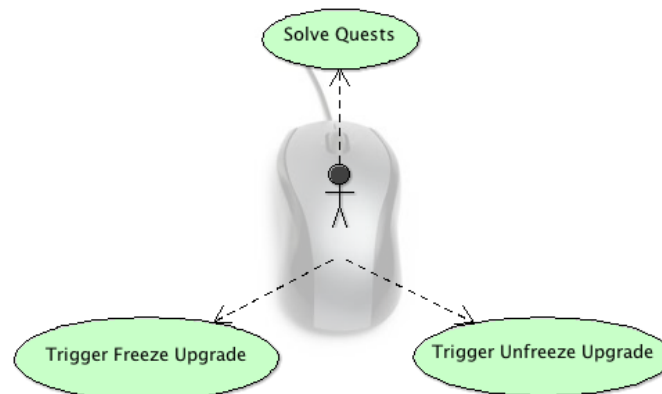


Figure 23 : Mouse Controls.

4.8 Architecture

The FEUP Game architecture is client / server, allowing the game to be accessed by several players at the same time and communication between them.

Each client can control his avatar in the game interface and perform a set of actions that will later be sent to the server where the game is hosted.

The server receives these actions, applies changes to the world and then notifies the other clients of the changes occurred. The server is also responsible for notifying the other players on the entry and exit of other players [BS09][Adm12].

Other aspects to consider when designing a network game has to do with the connection from client to server, and how information is transmitted.

There are two approaches to this end:

- Authoritive Server - The server is responsible for making the whole world simulation, applying the rules of the game and player *input* processing.
- Non-Authoritive Server - The server does not control the *inputs* from players. Its up to each client to process the inputs and game's logic, afterwards sending the result of some actions to the server. The server becomes the one responsible to make the synchronization of actions in the virtual world.

For the prototype implementation of the FEUP Game was chosen, a non-authoritative server, because it has greater ease of implementation and allows the server to handle less processes, making it faster. The server acts only as an intermediary for exchanging messages between clients [Adm12].

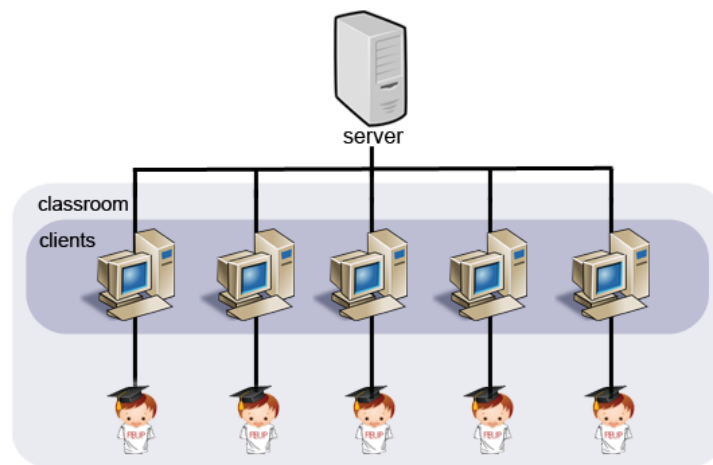


Figure 24 : Game Architecture.

4.8.1 Communication with the Server

Since the game will communicate with the server via a digital network (as mentioned in the previous [section](#)), it is needed to set how that conversation is going to be made (Table 3).

ID	Name	Description
1	<i>Authentication</i>	Receives the user request, and returns the game menu
2	<i>Username</i>	Sets the user's avatar name as the username given. It is also used to identify player's throughout the game
3	<i>Movement</i>	Everytime the player moves, its position is received and sent to the other players
4	<i>Rotation</i>	Everytime the player rotates, its rotation is received and sent to the other players
5	<i>Team</i>	This value grants the avatar's color
6	<i>Freeze</i>	Represents if a player has been frozen
7	<i>Flag</i>	Represents if the player has the flag or has reached a base. If <i>true</i> alert all players to destroy their local flags, if <i>false</i> alert the other players to create a new flag
8	<i>favMovie</i>	Optional beginning variables to allow the server to know the favourite movie of the players

Table 3 : Server Communication Variables.

4.9 Technologies and Tools

As stated on chapter [3.9](#) the technology that was best suited for this game was Unity 3D. The Pro version implies some costs and the benefits that may come from it were not necessary for the implementation of this project. During the project there was also a need to work with server/client architecture. In order to simplify this task an online server technology was used. **Smart Fox Server** was the elected between the three main choices explored (Photon, SmartFox or Unity). It provided many examples for beginners and various solutions that can benefit a future implementation of more social communications between players, such as chat rooms, and different game rooms depending on the decisions of teachers (rooms based on specific classes or subjects).



Figure 25 : Smart Fox Server Logo.

4.10 Summary

In this chapter was conducted an analysis of the game concept and design phase, which is based in a *capture-the-flag* style of game (meaning there are two teams, playing one against the other, trying to find the flag and gaining possession of it, completing quests throughout the game), along with many issues that concerns the specific requirements of the project, such as the visual of the prototype interface, its controls and architecture (client/server).

Many of the choices stated on this chapter are based on the need for the game to be educational but also fun and motivating.

Chapter 5

Implementation

As part of this dissertation a working prototype of FEUP Game was developed in order to be able to assess whether the insights obtained could be implemented, and if in fact could improve the dynamics of groups. This section demonstrates the options made when implementing this prototype, as well as the prototype of project *VICERAVI*³, used in this project as a comparison between different approaches.

5.1 FEUP Game

5.1.1 Virtual World

The Virtual World is mainly composed by the below elements with which the players can interact:

Terrain / Campus – The virtual “physical” world is an adapted version of the virtual model of FEUP;

Avatars and Bases – The avatar represents the player in the game. It has a *collider* that makes the player able to collide with the objects present in the game, making it more real and appealing;

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Quests – The quests are represented by an old map icon (Figure 26). When the player collides with it triggers a random quest. All players can do these quests, since they are done locally and do not affect the overall game in the other player's client.

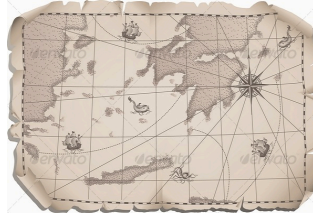


Figure 26 : Quest Icon.

5.1.2 Implementation

As stated, Unity3D is best suited to achieve the objectives set for this dissertation, with the added benefit of being able to provide an online version.

This technology has many important concepts mainly the *GameObject* concept. Through *GameObjects*, you can group complex objects, making them easier to manage and reuse. Other concepts include:

Scenes - A scene is where the game is played and objects are set, very useful to separate different areas of a game allowing distributing content efficiently and testing them individually;

ID	Scene	Description
1	<i>Log In</i>	The <i>login</i> menu, where the user inserts his information
2	<i>Game</i>	The game itself

Table 4 : FEUP Game Scenes.

Components - Using components, you can add and change the behavior of *GameObjects* such as adding collision detectors and other elements (scripts are components too);

Scripts - The scripts allow expanding and adding features, creating the game mechanics and logic;

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ID	Script	Description
1	<i>Base</i>	The base script deals with the flares based on what team the base represent, as well as being aware if any player has collided with it
2	<i>ConnectionGUI</i>	The login menu of the game and where the initial connection between Server and Client is handled
3	<i>Firescript</i>	Deals with all the capabilities of the avatar (powers/upgrades)
4	<i>GameManager</i>	The main script of the game where all communication between server and client is made
5	<i>Quest</i>	Contains a collider detector that triggers a random quest
6	<i>SimpleRemoteInterpolation</i>	Identifies the other player's movement in the client side
7	<i>SmartFoxConnection</i>	Handles the connections between server and client
8	<i>PlayerController</i>	This is the script that gives the avatars their movement and rotation

Table 5 : FEUP Game Scripts.

PreFabs - The reuse of objects is made through prefabs and is always ready to be used at any time;

ID	PreFab	Description
1	<i>Base</i>	The base of each team
2	<i>Captured_Flag</i>	The icon representing if a player has captured the flag
3	<i>Collider</i>	Makes the playable area smaller, by having four rectangles surrounding the campus
4	<i>FEUP</i>	The building representing FEUP, and the main playing field
5	<i>Flag</i>	The flag that players aim to capture
6	<i>Fogo_Azul</i>	Represent the visual effect of a player being froze
7	<i>ForceField</i>	Represent the visual effect of a base being closed
8	<i>Icons</i>	The top left corner upgrades (powers) icon
9	<i>MainCamera</i>	The game's main camera
10	<i>ParticleSystem</i>	Represent the visual effect of a player being unfroze
11	<i>Player</i>	The avatars and name tags
12	<i>Quest</i>	The quest icon and its yellow halo

Table 6 : FEUP Game Prefabs.

Resources - Sounds, textures and other resources used in the game.

5.1.3 Overall Game Operation

The game starts by an introductory menu where player's are asked to *input* their username and team. For the prototype effectiveness security measures were not applied. In case a player decides to not *input* any of these fields, once again for effectiveness instead of a warning or error message, the player is allowed to enter as a *Guest* but does not have a team.

All the players have a common startup point, created in the middle of the playing field from where the game starts. From that point players are free to explore the world, being the game's winning condition the first "five points winning" team, with a point corresponding to reach the player's team base with the flag. See Diagrams.

5.1.3.1 Guided tour of the game

[Video](#)

5.2 VICERAVI

The VICERAVI (Virtual Centre for the Rehabilitation of Road Accident Victims) [Lil12] is a project conducted by Liliana Mendes, a psychology student from Minho University, for a rehabilitation virtual system involving 30 participants of both sexes, with brain injury due to road accidents. This system will be tested on a multi user virtual environment (*OpenSimulator*) to simulate tasks of everyday life, enabling participants to perform cognitive and social skills training through their avatars. This project main innovation is the possibility of administering neuropsychological rehabilitation at distance, via ecological virtual environments [Lil12].



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Figure 27 : VICERAVI Main View.

The platform is specifically designed for the administration of neuropsychological rehab tasks, both for individuals and groups and will enable:

- Real-time communication between avatars;
- Cooperative/competitive gaming as a means to achieve the rehabilitation of neurocognitive functions;
- The recording of performance measures, in order to allow the evaluation of the effectiveness of the system and its validation for the neuropsychological rehabilitation.

This virtual environment consists of an area divided into three rooms (Figure 27). The first room (Figure 28) allows avatars to access serious games intended for the training of cognitive functions. The training will be conducted through a set of computer-based tasks for cognitive stimulation and two games that were specially designed for the training of attention and memory, as these are the most important cognitive functions for the neuropsychological rehab. The second room (Figure 29) is intended to be used for group sessions aiming the training of social skills.

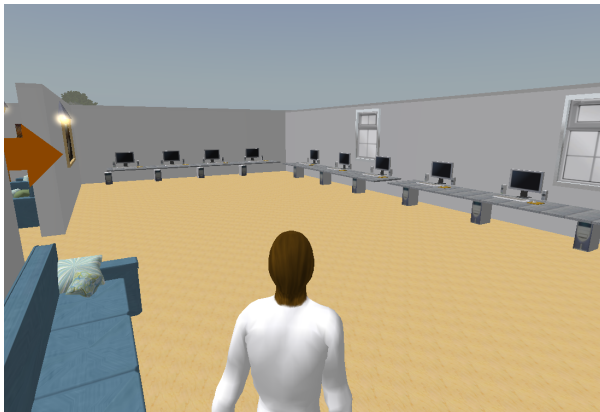


Figure 28 : Computer Room.



Figure 29 : Group Session Room.

This VICERAVI OpenSim World was created during the execution of this thesis and aims to be a comparison between two different approaches in the subject of group dynamization.

Chapter 6

Tests and Evaluation

To evaluate the quality of the game and as a proof of concept, surveys were made and the prototype developed during this dissertation was tested with different types of students.

6.1 Implementation Results

From the specification designed for this platform, some components (*unfreeze* and more *quests*) have not been possible to implement due to time constraints governing this dissertation, however everything else was successfully implemented.

As a consequence of not implementing some parts of the platform, it is not yet fully complete and it is not possible to test the platform at its maximum potencial. However, a prototype designed to test the features implemented has been elaborated, which was tested by a group of students from FEUP, others who didn't know the campus and a *Tester*.

6.2 Design of the Test

This test was fundamentally based on a survey and the gameplay of the game. Players had to endure some tasks, evaluate the platform and finally compare it with VICERAVI.

The main objective was to find out the players preferences between both platforms and to understand what they value the most in such games.

- Challenge 1 – Score a point;
- Challenge 2 – Fulfil a quest successfully;
- Challenge 3 – Freeze two players;
- Challenge 4 – Enter the web on VICERAVI.

During the entire process players were being watched in order to find out how they react while playing the game and also to take note of problems, opinions and reactions.

On Appendix [B](#) is described the script used for this test.

6.3 Results Analysis

6.3.1 How it was performed

This test was performed in two parts. The first part was carried out by completing a questionnaire and the second by testing the platforms. At the beginning of the session was held a presentation of the parties and the test, followed by the completion of the questionnaire.

In the second part participants were divided into experts and non-connoisseurs of the game map, proceeding then with the presentation of the challenges and the game itself.

Finally, information about the test was collected. Each participant gave his opinion about the preference for one environment over another, explaining their reasons and proposing improvements.

The result of this test is presented in the next section.

6.3.2 Analysis

The results obtained after the test, can be viewed in the next infograms, with more detailed graphics and tables in Appendix [B](#).

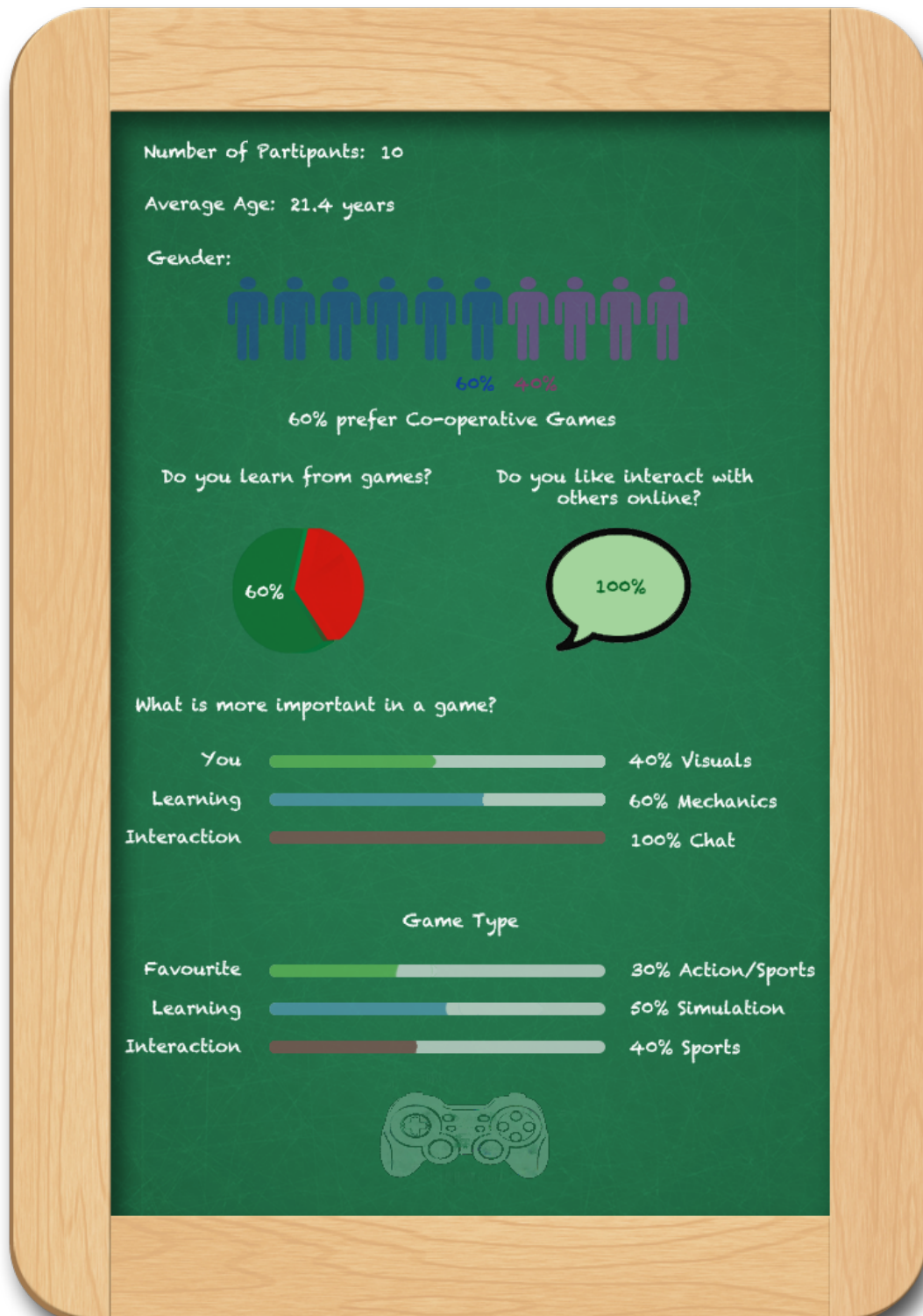


Figure 30 : Infogram Part I.

This part of the survey, based on the information presented in the figure above shows that the majority of the participants prefers Multiplayer games, in particular Co-Operative modes where players work together for their mutual benefit and entertainment. All the participants said

Tests and Evaluation

they interact with others online, either via chat or games. This particular point is representative of the emerging importance of communication at distance.

What the participants felt more important in a game, for them, for learning or for interacting shown very different responses, but all strongly agreed that a chat is crucial for interaction between players, the game mechanics is the foundation of a good game for learning and that simulation style games fit more accurately in this category.

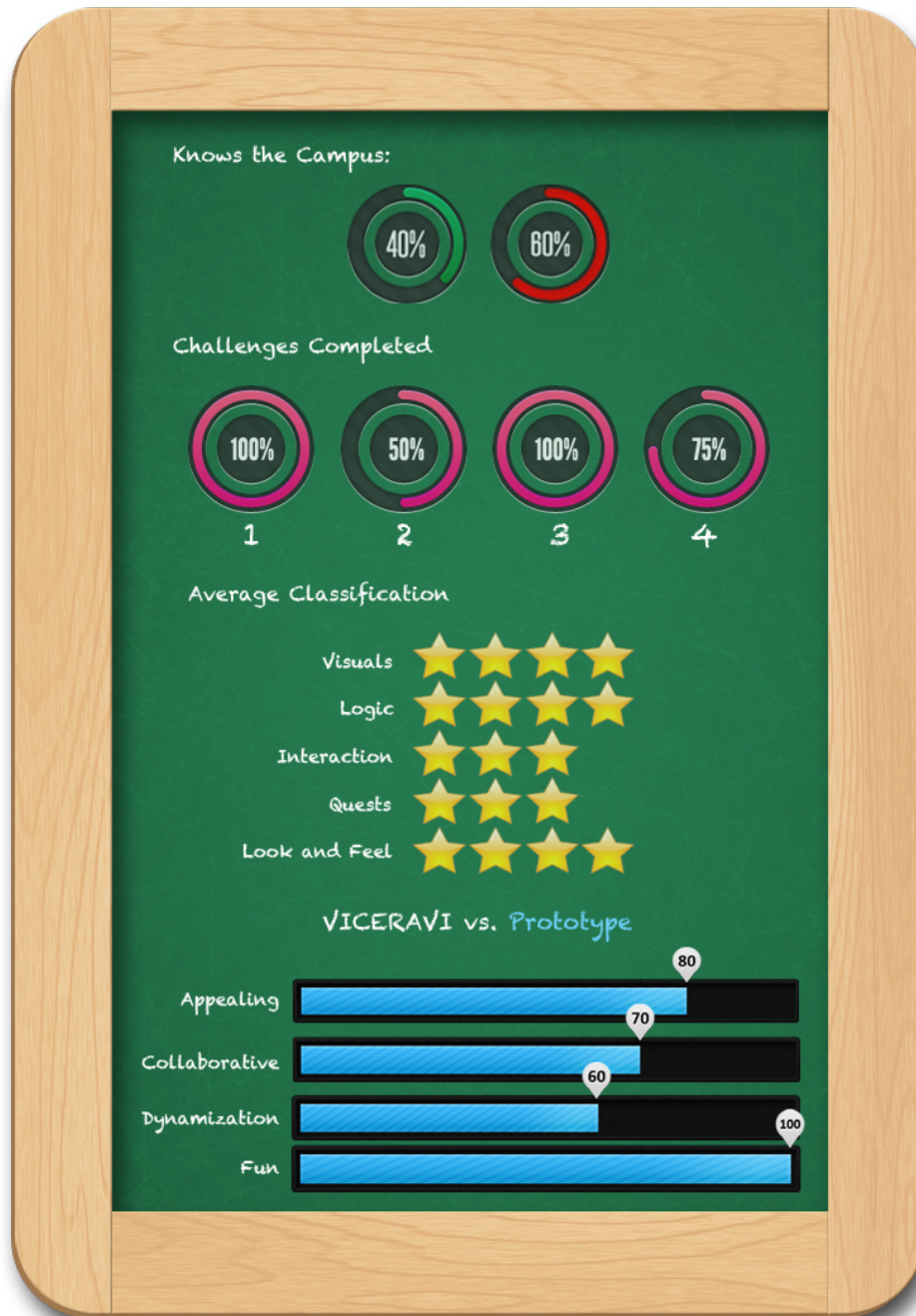


Figure 31 : Infogram Part II.

As for the second part (Figure 31) the majority of the sample had no knowledge of FEUP campus', which revealed a 50% failure on the second challenge that was meant for player's to find FEUP secretary department. The percentage of the last challenge corresponds to 6 out of 8 participants because 2 of them had to leave the test due to personal reasons. As of the classification given to the prototype, participants felt that the interaction paradigm and the quests made should be improved, specially the number of playable quests.

The final comparison between VICERAVI and the prototype shows a clear 100% in the *fun* variable for the prototype. It was considered a more relaxed approach on the subject of dynamization then the VICERAVI platform. Visually the prototype was far more appealing but participants stated that the FEUP structure and the map used should be more filled with content such as trees, people (non-playable characters) and that some quests could be presented by teachers.

6.3.3 Suggestions

The suggestions by the individual *Beta-Tester*:

- As a FEUP student, he didn't find hard distinguishing and recognizing the places and buildings of the college, so the structure is well designed and intuitive;
- It's a bit difficult to understand the objective of the game without a help menu and the challenges that must be completed. Even within the college, it is difficult to understand;
- Triggering the force field while a player is on it will cause the player's avatar to *blow up in the air*.

The suggestions by the *Focus Groups*:

- More quests;
- *Help menu*, clarifying the objectives and the controls;
- The *unfreezing* option seems very important to interaction;
- Implementation of a chat and rewards;
- The groups felt the game is very promising but is not fully complete.

6.4 How to Improve FEUP Game

Bearing in mind all the suggestions made, the test, survey and other opinions, many considerations were made in order to improve the work done. Firstly the concept was well accepted and shown positive responsiveness. However it was not completed. In order to get the game to its full extent and capacity:

- The *captain* upgrade (unfreeze), the flag drop and all quests must be completed;
- Statistics should appear at the end of each game, as well as a better reward system;
- Implement a chat;
- Give the players capacity to personalize their avatars;
- Non-playable characters to interact with, teaching students what they should do, or even giving them quests. A storytelling component can be effective as stated in *Revolution* (see Appendix [A](#));
- Help Menu;
- Control options of the game to teachers.

One of the things that took most time was the implementation of the server. The SmartFoxServer seemed an excellent option and is very promising for future implementation of game rooms based on different styles of gameplay. However, it took much time to implement due to the fact of many deprecated help documents and difficult installation of Unity crossdomain policies.

With all these ingredients mixed up a strong and powerful dynamization tool can be achieved to further help young FEUP students.

Chapter 7

Conclusions and Future Work

A game is in fact a powerful tool to keep people motivated. Generally the concept of learning and interaction appears in our mind in such places as classrooms, but aligning both of them with games is possible and provides good results.

The game proposed in this dissertation may support the development of serious games for students and will hopefully promote better student integration. Furthermore it can also be extended to more group dynamization activities.

During this report a study of the state-of-the-art was presented in terms of creation and game design, having been assessed different *game engines* and virtual environments. Serious games were also analyzed, verifying its importance for learning and integration, as well as to study their characteristics in order to learn how to make a good game that meets the needs of the project.

It was thus developed a prototype that aimed to apply the knowledge obtained. As a prototype, there were only implemented the critical functionalities, therefore the foundations have been established. The entire creation process of the foundations was successful and will support a robust platform for dynamization and integration of groups. With this good results obtained after the prototype's evaluation, it is believed that it can have a positive effect on integration activities, such as falling within the course *Projeto FEUP*.

The platform has huge potential as a tool for students and teachers capable of imparting knowledge while stimulating the fun and relaxation between its users.

7.1 Goals Achievement

The initially proposed objectives were partially met, a game design document was created, and a prototype was implemented as proof of concept for the ideas suggested. Finally a validation of the prototype was performed with the target audience of the game. This validation was positive and a proof of concept that the game achieved its main goals. With this project it was also possible to verify that a game can be rather serious but also fun, thus engaging the player while addressing the challenges.

The game concept and mechanics applied were a good option (although not optimal as seen in the [results](#)) for promoting communication between the team players, which is a prime element in social interaction and integration. On the other hand, the quests must be more challenging and in bigger number, so they must pass through a re-thinking in order to improve.

7.2 Future Work

Future work involves the completion of the game, namely to develop the points specified in section [4.4](#). With the prototype complete, the next step would be to improve aspects that depict the test results as negative and enriching the experience that the game provides, expanding the objects, mechanics and graphics.

In the future, the possibility of extending the game space beyond FEUP, using different levels will be studied. Finally, an aspect which should also be taken into account in future development that could make the game more attractive is the use of sound, a key element for greater dynamism and realism in any game, as well as creating more visually challenging visual effects and upgrades.

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Appendix A

Related Works

10.1 Serious Games

There are numerous projects on serious games targeted at the most diverse areas. Some of them will be presented below.

10.1.1 MindRover

MindRover was developed by *CogniToy* to help players learn how to program. Specifically, players encode artificial intelligence for robotic vehicles to help them navigate through obstacles and to overcome some other challenges. The programming interface involves dragging the logic of mechanical parts of robots and set parameters for each one without coding. The game encourages an exploratory approach, helping players to have their programs up and running, so they can interact and learn [[Loki](#)].

10.1.2 AstroEngineer: Moon Rover

It is a project designed to teach high school students about science, technology, engineering and math. The game is set in the year 2040 and humanity has created several bases on the lunar surface and in its orbit, which makes it objective to gather resources, explore and develop a base of operations for future missions to other planets. The game helps students develop and test solutions to problems with certain criteria. It was developed by *WisdomTools* and aided by various partnerships [[Tools](#)].

10.1.3 Energy 4 Life

The *Energy for Life* online game, designed by *Inovaworks*, is a role-playing game with educational objectives, which seeks to teach important social causes combined with the power of computer games. The game focuses on one of the most pressing issues facing our planet: the use of renewable energy as a tool to combat poverty, reduce consumption of natural resources and the impact of climate change.

The game *Energy for Life* contributes to the joint creation of a shared sense of European identity and, by placing great emphasis on energy efficiency, providing tools and building skills that prepare younger generations for taking vital role in safeguarding the future of the planet.

Since December 2011, *Energy for Life* became the basis for a school competition among students of secondary education in Italy, Spain, Portugal, Malta and Germany. The game is available in five languages (English, Italian, Spanish, Portuguese and German) [[Inova](#)].

10.1.4 Phoenix Quest

Phoenix Quest is multimedia adventure developed by the *EGEMS* project (Electronic Games for Education in Math and Science) at the University of British Columbia. The *EGEMS* research and development process involved over 20 university educators and teachers as well as nearly 500 students during a three year time.

The intent of *Phoenix Quest* is to make mathematics appealing to young girls from ages 9 to 14 by incorporating activity elements that girls find interesting, challenging and demanding. *Phoenix Quest* is a serious game with an exotic storyline set in mythical islands near Hong Kong, that contains intriguing fantasy and teen characters able to communicate. It encourages cooperative play and group problem solving.

10.1.5 Revolution

Revolution is a serious game that gathers students in a virtual world. The main objective is to give players better perceptions of the American Revolution, granting the possibility to interact as an inhabitant character of a colonial city. This game uses role-playing principles and provides a narrative story determined by the player's choices, resulting in a complex simulation of the social and political system of that time.

This is a multiplayer game with an exact length of 45 minutes where the authors recommend that students play simultaneously, in a way to provide rich interacting experiences through the role of character in that historical context. In a very fast pace, the narrative will

Related Works

present different situations and problems where players must take important decisions. Learning from this example the narrative story seems to be a key element when creating serious games based on historical events.

In the end, this game turns itself into a complex social/political simulation, with several elements of role-playing and a strong storytelling component [[Men11](#)].

The game implements a multiplayer with a very descriptive content, having a story and a past to each character, seeking to generate empathy in the player and thus achieve a better understanding of their motivations. The players can even talk to each other and solve problems together. Once again the strong storytelling component mixed together with a multiplayer experience can give players a deeper thought and knowledge of any kind of events.

10.1.6 eLECTIONS

eLECTIONS is free 3D multimedia game as well as a powerful online learning experience that demonstrates how broadband technology can support active, meaningful and memorable learning, in words of its official website.

It was created by *Cable in the Classroom* (CIC) in partnership with CNN Student News, C-SPAN. *eLECTIONS* is the second title in a series showing the learning power of high-speed internet. It was inspired by a classic board game where players role-play their own virtual candidates running for American President. The single or multi-player game is both educational and entertaining. The children can play with their parents, students with teachers. Users of all ages can play with a friend, classmate, or with an AI opponent.

10.1.7 Power Up

PowerUp is a free, online, multiplayer game that allows students to experience the world and the diversity of today's engineering.

While playing the game, students work together in teams to investigate the 3D game virtual world and learn about the environmental disasters that threaten the game's world and its inhabitants. Players meet engineer characters along the way and experience the diversity of the field of knowledge. Engaging interactive activities and conversations with the characters allow players to explore the ways engineers build systems to create and deploy ways to use renewable energy sources as alternatives to fossil fuels.

Related Works

Players take the role of Engineers, working together designing and building energy solutions to save the world [Power]. This example contains an important message for the players but also for the aim of this thesis, as it is mainly constited by topics related to engineering.

10.1.8 Lure of the Labyrinth

Lure of the Labyrinth is a digital game for middle-school pre-algebra students. It contains many challenging math-based puzzles surrounded by a storytelling game in which players have to find their lost pet, while saving the world. *Lure of the Labyrinth* can add an important motivation to students. “The game gives students a chance to think like mathematicians” [Thi11].

10.1.9 Atlantis Remixed

Atlantis Remixed (ARX) claims to be designing a way for learning, which sits at the intersection of education, entertainment, and social action [ARX11]. It has an huge number of followers ranging the 50,000 registered members worldwide. The project intendes to engage children from 9 to 16 years in a form play with both online and offline activities, involded in a storyline inspiring a disposition towards social action [ARX11].

The core elements of ARX are a 3D Multi-user virtual environment, the learning quests, storyline (presented through an video, novel and comic book) involving mythical characters, a wide community of participants, and a narrative programming toolkit for remixing user-created stories. The activities of ARX take place in registered centers, usually schools, under the direction of teachers who have undergone professional development and training. ARX includes both curricular and optional projects online or offline, as children work alone or together to accomplish tasks within the international community [ARX11].

10.2 MUVES

Also for MUVES there are several projects and applications, including its use in schools and universities. In the following subsections are some of these virtual environments.

10.2.1 New Medium Consortium

New Media Consortium is a community of many universities, colleges, museums and research centers. It aims to stimulate and promote the exploration and use of new technologies

for learning. *The New Media Consortium* campus is the largest educational structure in Second Life and organizes events, lectures and exhibitions.

10.2.2 Sloodle

Sloodle stands for *Simulation Linked Object Oriented Dynamic Learning Environment*, and is an open-source project that integrates the virtual environment of Second Life with the learning management system Moodle. It offers a wide range of learning tools within the virtual world, which are fully integrated with the management system web based Moodle. Students can take tests, research papers, record conversations and monitor their progress through a system of points through Second Life. This feature about the integration with the platform Moodle is an important source of knowledge and learning, as an objective of the thesis is to held a serious game within the same platform in FEUP.

10.2.3 The River City Project

River City is a MUVE with educational applications for high school students to learn distinct themes. The *River City* virtual world consists of a old city crossed by a river, with different forms of terrain that influence water flow, several neighbours, industries and institutions such as universities. The students themselves populate the city, along with computer-based agents, digital objects that can include audio or video clips, and the avatars of instructors. The avatars of the instructors is an excellent concept that can be applied in FEUP Game in the future.

10.2.4 Whyville

Through a web interface, users can communicate via chat and via *Whyville Times*, a newspaper with articles created by users, learn math, science and history through interactive activities and build a virtual identity. *Whyville* was the first virtual world targeted at children. Nevertheless, it presented some problems like the chat, where much attention went, when it wasn't supposed to, distracting the young users.

10.3 Multiple Game Sites

These sites offer plenty of serious and educational games that touch on a variety of topics from literature to social awareness. Based on Colleges Website [[Csi11](#)]:

Related Works

Nobel Prize Educational Games - From treating a diabetic dog to blood typing, these games teach from literature to science and everywhere in between;

Thinking Worlds - The games provided are a sample of the good educational games throughout the Internet;

Super Smart Games - The games here range from academic to health and fitness to social awareness and are available on multiple platforms and for all different age groups;

Filament Games - The games here are dedicated to teaching. Topics range from science to civics and challenge players to think through problems and have fun at the same time.

Appendix B

Questionnaire

11.1 Context

This test consists in presenting the platform to all participants, followed by the verification of the gameplay, using three *Focus Groups* and a *Beta-Tester*. The first and second *Focus Groups* are composed of 6 players who don't know the campus and 4 others that know. The last group is mix-up of the previous ones made of people who know the campus but never interacted with each other.

The Beta-Tester job is to explore the environment and find out if it can be played individually (singleplayer), just for someone to interact with the world with no problems. His job was to give suggestions and find out some bugs. The *Focus Groups* are meant to test the game with its primary users (students).

11.2 Virtual World

The world is the prototype of the game developed in this dissertation. It is a virtual world where each student with his avatar can interact with the game and with the other players, overcoming challenges and trying to get the winning end of it.

11.2.1 Challenges

- Challenge 1 – Score a point;
- Challenge 2 – Fulfil a quest successfully;
- Challenge 3 – Freeze two players;

Questionnaire

- Challenge 4 – Enter the web on VICERAVI.

11.2.2 Script

The script followed is listed below:

- Favourite style of games?
- SinglePlayer, Co-Op or Competition?
- What is more important in games?
- Do you learn something when playing games?
- What do you think of the overall idea of interacting with people through online games?

Survey

Name			
Age			
Sex			
Do you prefer			
SinglePlayer			
Co-Operative			
Competition			
Do you learn from games?			
Yes		Can you give an example?	
No			
Do you like interact with others online?			
Yes			
No			
What is more Important in a game?	For You	For Learning	For Interaction
Avatar			
Chat			
Mechanics			
Upgrades			
Visuals			
Other			
What is	Favourite Game Genre	Best suited for learning	Best suited for interaction
Action			
Adventure			
RPG			
Racing			
Sports			
Strategy			
Simulation			
Other			

Figure 32 : Survey Part I.

Show the prototype.

Questionnaire

Explain the challenges.

Let Players Explore.

Challenges	Completed
1	
2	
3	
4	

Do you know FEUP Campus?	Do you recognize the campus on the game?
Yes	
No	

Did you understand the objectives?
Yes
No

How do you classify	Bad	Normal	Good
Visuals			
Logic			
Interaction			
Quests			
Look and Feel			

Overall Opinion

The one you find most	Appealing	Colaborative	Best for dynamization	Fun
Prototype				
VICERAVI				

Figure 33 : Survey Part II.

Show VICERAVI.

Comparing both platforms with the same criteria and afterwards with four new:

- Appealing
- Colaborative
- Best suited for dynamization
- Fun

During this entire event notes and suggestions have been taken in order to understand deeply what the users thought of the platform.

11.3 Results

The tests were very successful in terms of interaction between participants and overall results. Their ages ranged from 18 to 23 and there were a majority of the male gender.

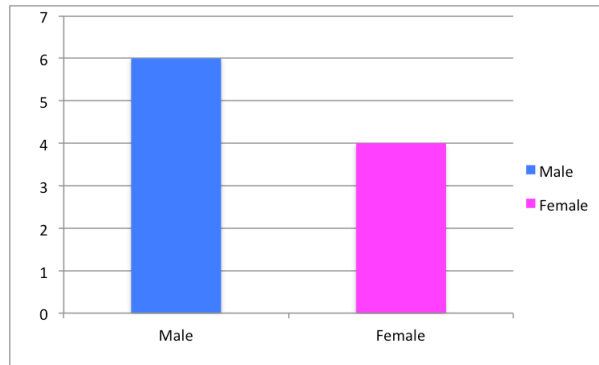


Figure 34 : Participants Gender.

In terms of preference in single or multi-player games the results show a preference for interaction with others, even better, cooperation with others.

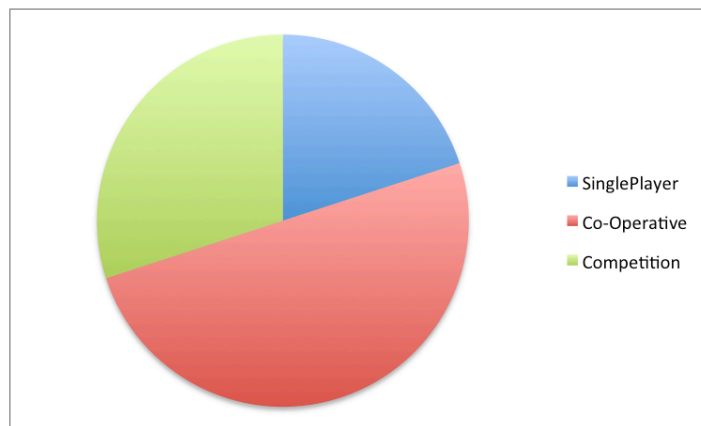


Figure 35 : Survey's game style preference.

When it comes to the question if players learn from games or not the most answered option was *Yes*, but when asked to give an example fewer have responded. Some of the answers were *WoW* (World of Warcraft) and *Age of Empires*.

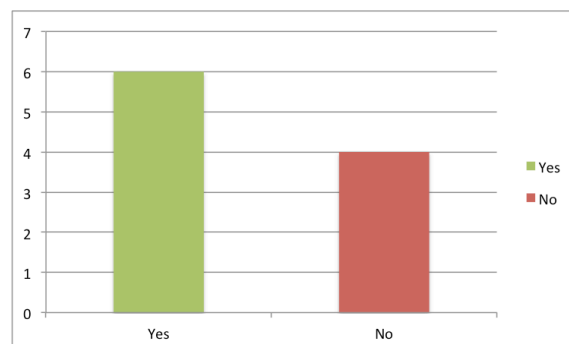


Figure 36 : Do you learn from games?.

Questionnaire

Every one of the participants claimed they interact with others online giving an huge 100% in that field. But when it is about the users' preferences on game types and on what is more important for them, the results show different opinions, which is comprehensible due to the vast game genres there are.

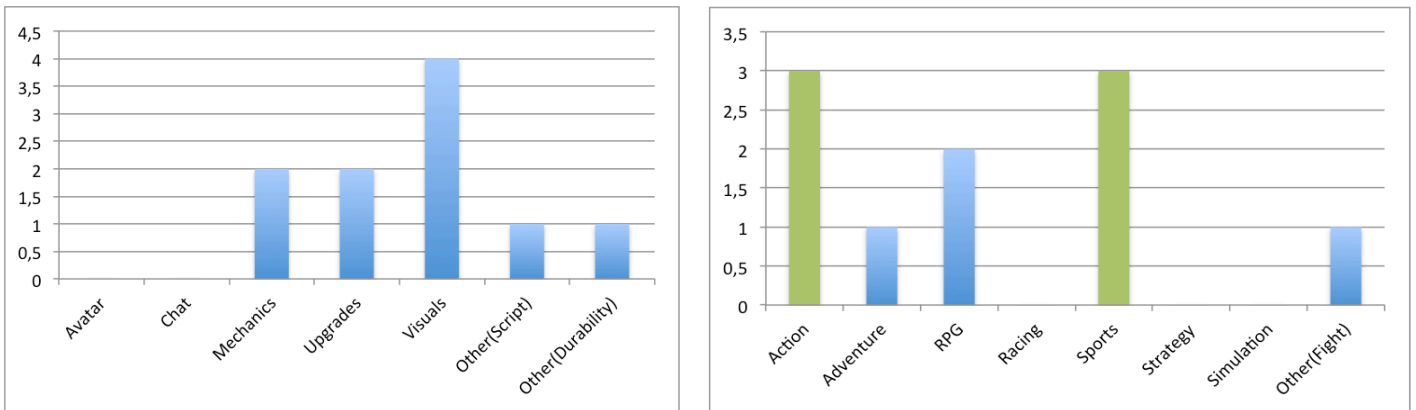
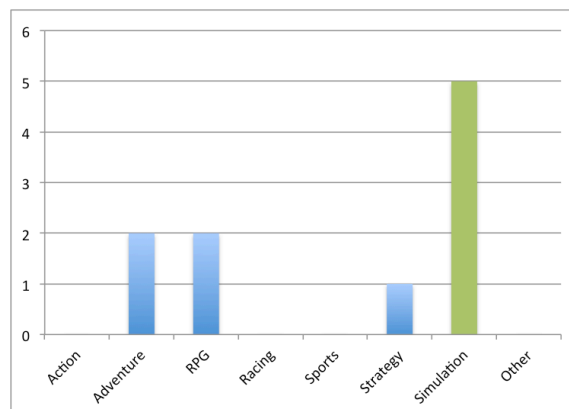


Figure 37 and 38 : Participants preferences.

On the other hand, when it comes to learning and interaction the results became more unanimous.



Figure 39 and 40 : Most Important for Interaction(left) and Learning(right).



Questionnaire

Figure 41 : Preferred Game Type to Learning.

In the survey second part the challenges were simple and the only problems encountered was for the *non-FEUP* students to find out some of the places. Relatively to the VICERAVI platform all of them thought it was well design, but only one participant has heard of Second Life or OpenSIM, some of the others have related the platform to *The Sims* game.

The participants felt the prototype can be a lot improved and made some suggestions that were described on section [6.3.3](#). Their overall opinion was very positive and encouraging.

About the comparison made between the prototype and VICERAVI the participants felt that the prototype can be more challenging in terms of dynamization *on the go* between players while VICERAVI was better to keep people talking but without game action, which took away some fun.

Appendix C

Diagrams

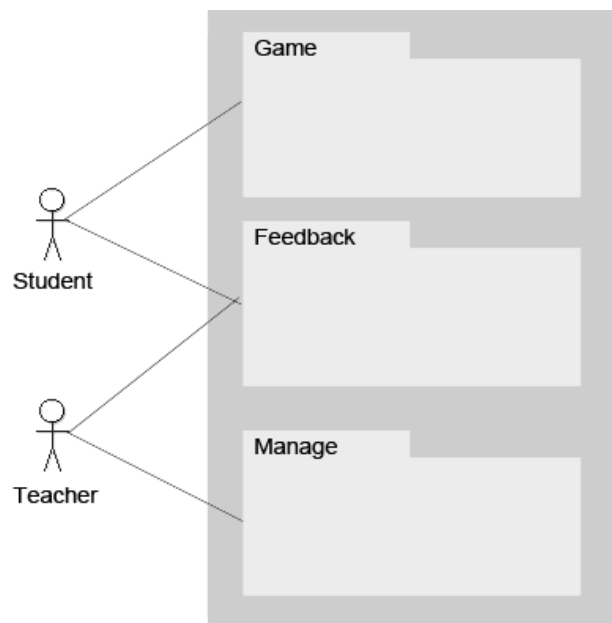


Figure 42 : Game Management Use Case

Diagrams

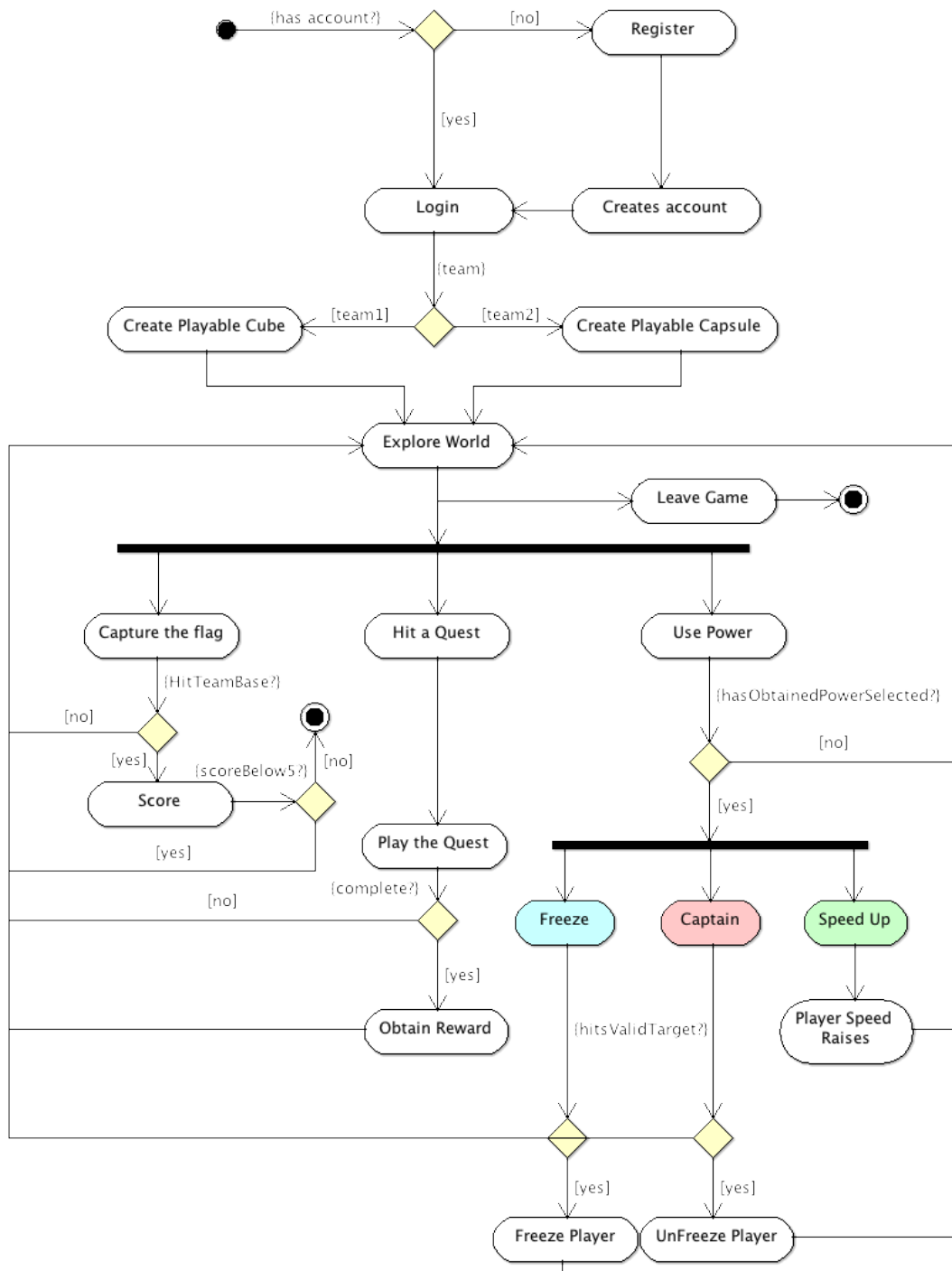


Figure 43 : Game Concept Activity Diagram.

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