Department of Information Science and Technology

The Planning and Creation of an E-Learning and Recreational Platform for Seniors

Ricardo de Freitas

Dissertation presented in partial fulfilment of the Requirements for the Degree of Master of

Computer Science and Business Management

Supervisor:

Professor Henrique O'Neill, ISCTE-IUL

January, 2013

Abstract

Europe is facing great demographic changes. It is predicted that seniors will represent almost 30% of the European population by the year 2050. Ambient Assisted Living (AAL) solutions may provide an answer to the challenges that these demographic changes bring.

AAL as a concept is to interconnect Information and Communication Technology (ICT) with certain devices in order to create products and services to assist its users in all periods of life (*e.g.* difficulty in climbing stairs can be compensated for by a mechanical stair lift).

One important area of AAL is lifelong learning which aims to allow continuous education during the course of a person's life. One way of enabling lifelong learning for seniors is by using electronic-learning platforms (E-Learning). These platforms enable their users to access learning content from almost any location. However, the level of complexity of these platforms may arise as an obstacle for seniors.

The Ambient Assisted Living for All (AAL4ALL) project was launched to create a wide range of AAL-related products and services. One of the services which will be offered by this project is an E-Learning and recreational platform especially designed for seniors. The objective of this dissertation is to plan and create the prototype of such a platform.

In order to develop a prototype of this nature, we required assistance from the senior population to carry out two different types of studies. First a requirements study was performed in order to gather feedback from our target group before moving on to the development phase. Once the development phase was complete, a usability study was performed to test how seniors interacted with the prototype.

Keywords: E-Learning, Seniors, Active Aging, Ambient Assisted Living, Interface Design, Lifelong Learning, Information and Communication Technology

Resumo

A Europa está a enfrentar grandes alterações demográficas. Está previsto que a população idosa representará quase 30% da população Europeia em 2050. O Ambient Assisted Living (AAL) pode oferecer soluções para responder aos desafios que resultam destas alterações demográficas.

O AAL significa a ligação de Tecnologias de Informação e Comunicação (TIC) com determinados dispositivos, visando a criação de produtos e serviços que permitem auxiliar os seus utilizadores ao longo das suas vidas (por exemplo: a dificuldade de subir escadas pode ser compensada pelo uso de um elevador de escadas mecânico).

Uma área importante do AAL consiste na aprendizagem ao longo da vida, que permite uma educação contínua no percurso da vida de uma pessoa. Uma forma de possibilitar a aprendizagem ao longo da vida à população idosa é através do uso de plataformas de E-Learning, as quais permitem aos seus utilizadores acederem a conteúdos de aprendizagem de praticamente qualquer local. Contudo, o interface utilizado neste tipo de plataformas tende a ser muito complexo para esta faixa etária.

Neste sentido, o projecto chamado Ambient Assisted Living for All (AAL4ALL) foi lançado para criar uma vasta gama de produtos e serviços do AAL. Um dos serviços que será disponibilizado por este projecto é uma plataforma E-Learning especialmente concebida para idosos. O objetivo desta dissertação é planear e criar o protótipo desta plataforma.

Com o intuito de desenvolver um protótipo desta natureza pedimos a colaboração de alguns seniores para realizar estudos de duas tipologias diferentes. Primeiro, foi elaborado um estudo de requisitos para obter as suas opiniões sobre o planeamento do protótipo. Por fim, após o desenvolvimento do protótipo, foi elaborado um estudo de usabilidade para testar como os idosos interagem com o mesmo.

Palavras-chave: E-Learning, Idosos, Vida Activa, Ambient Assisted Living, Interface do Utilizador, Aprendizagem ao longo da vida, Tecnologias de Informação e Comunicação

Acknowledgements

Several people played an important role in the completion of this dissertation and I would like to take this opportunity to thank each one of them for all their support and expertise.

First of all, I would like to express my sincerest gratitude to my supervisor, Professor Henrique O'Neill for his great kindness and generous guidance during this academic journey.

I would also like to thank my grandmother, Filomena Ferreira for inspiring me to choose this dissertation theme.

A special thanks to Monica, Sandra, Jose Manuel and Rute for never letting me down and to the rest of my wonderful family and friends for always believing in me.

I would also like to thank José Cabral for helping me develop the prototype and for teaching me so much during the time we worked together.

I am also very grateful to ADETTI-IUL for not only granting me this project but also for allowing me to use their resources and to all those who worked there that made me feel welcome.

I'd like to thank Busca Completa and the Universidade da Terceira Idade de Torres Vedras and all of their students who participated in my studies, if it had not been for their generosity and time the completion of these studies would not have been possible.

Most importantly, I would like to thank my parents for making me the person I am today and for their unconditional support in all aspects of my life. I would not have been able to reach this phase of my life had it not been for their wisdom and guidance, and for that I am extremely grateful.

To anyone else I might not have mentioned, who helped me directly or indirectly, please know that I am very thankful.

Table of Contents

List of Figures

List of Tables

Acronyms

AAL - Ambient Assisted Living

AAL4ALL - Ambient Assisted Living for All project

CMS - Content Management System

E-Learning - Electronic Learning

Email - Electronic Mail

eLiLL - E-Learning in Later Life

EU - State Members of the European Union

ICT - Information and Communications Technology

LiLL - Learning in Later Life

LMS - Learning Management System

Moodle - Modular Object-Oriented Dynamic Learning Environment

SCORM - Sharable Content Object Reference Model

U3A - University of the Third Age

VDG - Visual Design Guidelines

WCAG - Web Content Accessibility Guidelines

Chapter 1. Introduction

1.1 Problem

There has been a big demographic change during the last few decades. In the year 2000 it was reported that approximately 420 million people were 65 years of age or older, which amounts to roughly 7% of the world's total population. It is also predicted that in 2050 this percentage shall more than double to about 16%, representing almost 1,5 billion seniors worldwide [1]. In Europe these numbers are even more alarming with projections of around 28% of senior population by the year 2050 [2].

By 2008, life expectancy at birth in the European Union (EU) had increased, reaching an average of 82.4 years for women and 76.4 years for men [3]. Besides increased life expectancy there has also been a growing concern about the low birth rate (Figure 1). In 2007 the fertility level in the EU was under 1,56 children per woman which is below the replacement level of 2,1 [4].
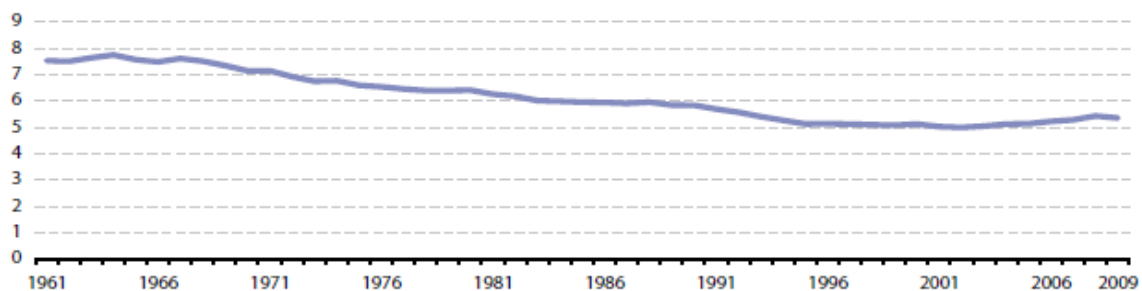
Figure 1 - Number of Live Births in EU 27 (Millions) [4]

If European countries do not look into this problem today, it could have enormous economic and social implications in a number of areas. For instance, labour markets and pension systems will be effected as a result of the increasing number of older people, while those of working age are gradually decreasing [4] [5].

Let's not forget about other implications such as national health systems. As people get older their health status normally deteriorates and as such the number of times a certain individual will require health assistance will increase substantially, resulting in increased government expenses.

In order to overcome many of these problems, there is an urgent need to find solutions that will enable people to live in their preferred environment for as long as possible no matter their

age or disability. This amongst other factors, will allow them to live a more autonomous lifestyle and increase their overall quality of life.

1.2 Theme

Imagine a person being able to check his or her blood pressure at home with an easy-to-use electronic device that automatically saves the results in a system that is wirelessly connected to the internet. Using such a device enables doctors or healthcare professionals to analyze those results directly from a hospital or clinic enabling them to verify if the patient has an adequate blood pressure level and to act accordingly.

Such a device could be used within the comfort of the patient's home as opposed to having to go to the hospital or clinic. Doing this would not only save the patient time and hassle but in some cases would also save governments money as they would not have to send a healthcare professional to monitor the person in need. These type of devices are especially useful for seniors who have a hard time getting to places due to limited mobility or for those who have no caregivers. Such a system is one of the many examples of what Ambient Assisted Living (AAL) is all about.

The whole idea of AAL is to help its users carry out daily activities (Figure 2) in a preferred living environment such as health and activity monitoring, getting access to social, medical and emergency systems and facilitating social contacts or even improving safety and security [5].

One important area of AAL is lifelong learning which aims to allow continuous education during the course of a person's life. A way of enabling lifelong learning to mobility impaired seniors is by using electronic-learning (E-Learning).

E-Learning platforms permit their users to access learning content from any location using an electronic device connected to the internet (*e.g.* computer) [6]. However, the level of complexity of these platforms may arise as an obstacle for seniors. Websites tend to be produced by young designers, who often assume that all users have perfect vision and motor control and know everything about the internet [52].
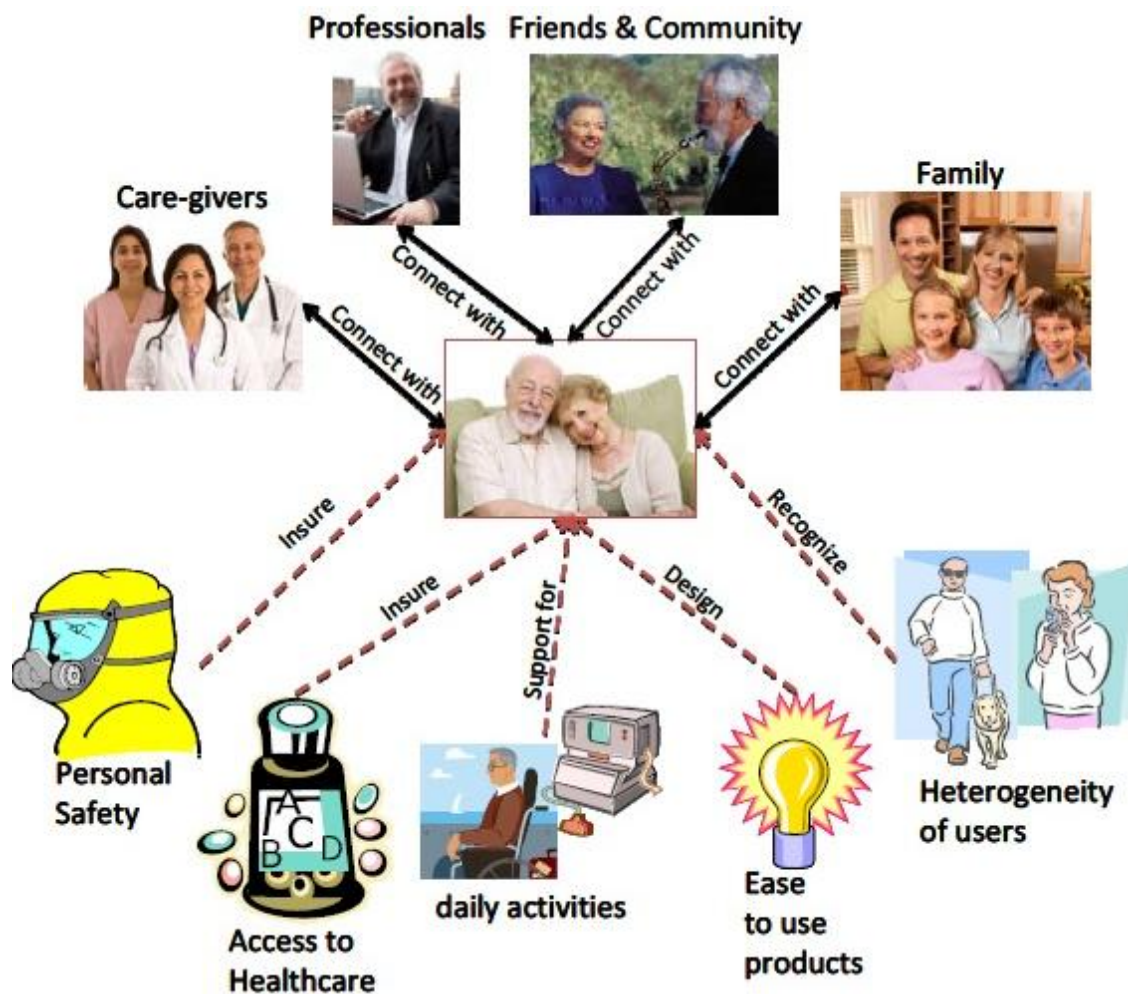
Figure 2 - Person-centric perspective of elderly needs [8]

If applied correctly this type of "assisted products" may have revolutionising effects on the way this target group spend their days. By combining Information and Communications Technology (ICT) with certain devices will not only allow people to live a more autonomous lifestyle but will also increase the period of time they can live in a place they feel most comfortable in.

1.3 Scope

Ambient Assisted Living for All (AAL4ALL) [9] is a project that was launched to create a wide range of AAL-related products and services associated to a business model and validated through a large scale trial.
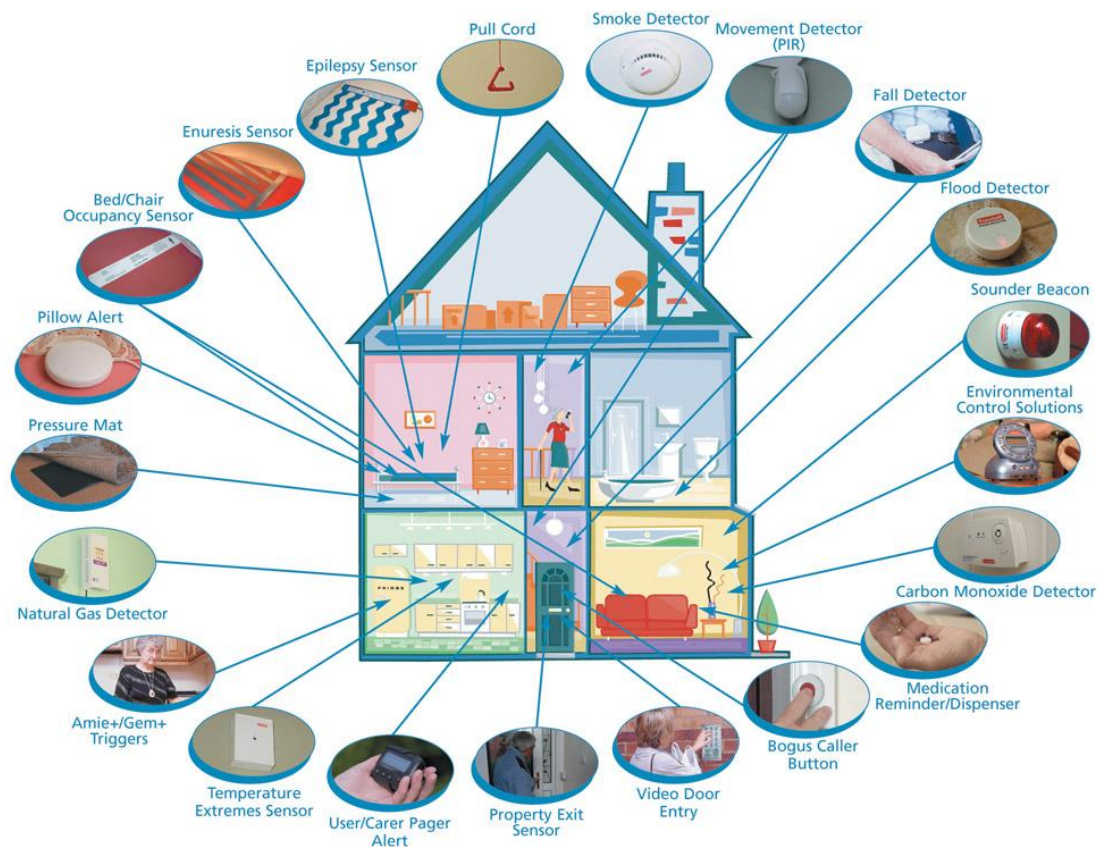
This 3 year project approved by QREN [10], started in 2011 and will end in 2014. Representing a total investment of 8.3 million Euro. This project is being developed in cooperation with 34 partners and there are plans to export the resulting products and services to other European countries.

This dissertation will be based on one of the educational services that will be offered by the AAL4ALL project. The main objective of this dissertation is to plan, create and test the prototype of an E-Learning and recreational platform especially designed for seniors. For the purpose of this dissertation the platform will be referred to as: **AAL4ALL E-Learning Platform**.

For the final product (not part of this dissertation), it is planned that learning institutes such as Universities of the Third Age (U3A) will be able to sell their courses to seniors using an E-Commerce website and letting these individuals access the course content using the AAL4ALL E-Learning platform (Figure 18).

1.4 Motivation

This theme really caught my attention the day my 75 year old grandmother walked up to me and asked me to help her open an account on the social networking website called Facebook [11]. She really enjoys playing Poker but since most of the family didn't have much time to play with her, someone suggested that she should start playing online using the social networking website.

This was a massive surprise to me as she had never worked on a computer in her life and didn't even know what a social network website was. I proceeded in helping her set up an account and explained some basic computer concepts to her. After some initial difficulties like using a mouse, I was astonished that in less than a week she was able to switch the computer on and with the use of a few shortcuts, she managed to login to Facebook and play the Poker application. The only time she asked for my assistance was when there was a problem with the internet connection.

Whilst before I thought a senior would never be able operate any "sophisticated" electronic devices, I now realise how wrong I was. This experience made me acknowledge the importance of incorporating technology in a senior's life, not only for recreational activities but also for other purposes. With this being said, when the opportunity presented itself I didn't think twice about enrolling myself into the AAL4ALL project.

1.5 Thesis Problem and Objectives

As established in the scope section of this chapter, the main purpose of this dissertation is to plan, create and test the prototype of an E-Learning and recreational platform especially designed for seniors[1].

This dissertation studies the following problem: "How to create an accessible online learning and recreational platform for seniors?"

With this problem statement in mind, the following objectives were defined:

1. Study literature related to lifelong learning, ICT and seniors, E-Learning and U3As;

2. After completing the previous objective, compose a list of visual design guidelines that should be considered when designing websites for seniors;

---

[1] Any reference to seniors, elderly or older people are to be considered citizens of both genders, 65 years of age or older.

3. Compose and specify the features that should be included in the AAL4ALL E-Learning platform;

4. With the knowledge gained after completing the previous objectives, plan and create mock-ups of the AAL4ALL E-Learning prototype;

5. For a sample of the elderly population, carry out a requirements study to gather as much feedback as possible from our target group before moving on to the development phase;

6. Choose appropriate development tools and implement the prototype of the AAL4ALL E-Learning platform;

7. With a sample of senior citizens, perform a usability study to test how seniors interact with the prototype.

Before moving on to the next section please note that these type of platforms are usually accessible by various types of users such as: Students, Professors, Administrators etc., however for the prototype version of the platform only the student's features will be implemented.

1.6 Methodology

In accordance with objectives 5 and 7, two types of studies will be carried out: Requirements Study and Usability Study.

Both studies have the same methodology which will be specified next:

1.6.1 Universe

The universe of both studies are Portuguese individuals of both genders that are 65 years of age or older.

1.6.2 Sample

A total of 5 to 10 individuals[2] will be selected to participate in the studies. A method known as convenience sampling (which falls in the non-probability sampling scheme) will be used to select the sample.

The criteria that will be used to choose these individuals are:

- The participants should have prior experience with computers and the internet. The level of

---

[2] According to Jakob Nielsen, a renowned website usability expert, using 5 users in such studies are enough to discover most of the usability issues [12].

computer skills of each individual is irrelevant since the main objective is to verify if the system is intuitive enough for this target group regardless of how good they are at using these type of technologies;

- The participants should not have any serious health impairments that prevent them from performing the tasks (*e.g.* they should be able to use the mouse or touchpad).

1.6.3 Data Analysis Techniques

To gather data, seniors will be required to complete a list of predefined tasks. An interviewer will take notes in order to register how these interviewees interact with the system and complete the predefined list of tasks.

After the tasks have been completed, a questionnaire will be filled out in order to gather basic details of the participants and to gain an understanding of their perspective of both E-Learning platforms.

1.7 Dissertation Structure

The remainder of this dissertation is structured as follows:

- **Chapter 2** presents a literature review in various areas, namely: lifelong learning, ICT and Seniors, E-Learning and U3As;

- **Chapter 3** is where all the information related to the planning and development of the AAL4ALL E-Learning platform is presented, including the details and results of the requirements study. At the end of this chapter a demonstration of the prototype can also be found;

- **Chapter 4** focuses on the details and results of the usability study;

- **Chapter 5** presents the thesis's conclusions and outlines areas for future work;

- **Appendix A** includes the full list of the Website Visual Design Guidelines;

- **Appendix B** contains the use-case diagrams of the primary features of two of the users of the AAL4ALL E-Learning platform: Professor (B1.1) and the Administrator (B1.2). Additionally a brief description of all of the students features will also be listed in this section (B2.1).

- **Appendix C** displays the full generic class diagram of the AAL4ALL E-Learning platform;

- **Appendix D** contains additional data from the requirements study, namely: Print screens of various Moodle course features (D1); Translated list of Moodle tasks (D2.1); Translated questionnaire (D2.2);

- **Appendix E** presents additional data from the usability study, which can be seen in the following order: Translated list of Moodle tasks (E1.1); Translated list of AAL4ALL E-Learning platform tasks (E1.2); Translated questionnaire (D2.1).

Chapter 2. Background and Related Work

2.1 Lifelong Learning

Lifelong learning refers to any type of education during the course of a person's life [13]. As mentioned throughout this dissertation, the share of older people is increasing at a rapid pace and with this trend comes the need to improve the well being and possibilities for integration in the knowledge society. In ageing communities, learning plays an important role in addressing challenges such as increasing social and health costs, re-skilling for employment and participation, and intergenerational sharing of experience and knowledge [14].

Learning is a great way for older people not only to learn but also to participate in society and to share the knowledge and experience gained during the course of their lives. Learning activities can be seen as a way to keep one's mind active and also a way to improve the quality of life of older people [15].

Specific learning activities can help to reduce the slowing down of cognitive processes and also help improve how older people deal with their everyday tasks [16]. Furthermore, lifelong learning could help keep senior citizens happy by providing intellectual stimulation and social interactions [7] [13] [17].

The need to learn for this age group is driven by their own needs and interests rather than by formal requirements. Health, background, social network activities and other personal aspects of these individuals as well as the surrounding environment are usually factors that motivate them to learn [14].

It is normal for cognitive abilities to decline with age, however learning skills do not decrease when getting older, the learning process may just take a little longer [14] [15]. With this being said, training programmes should be designed to take account of these cognitive and even sensory or physical changes [7].

It is also important not to consider seniors as an homogeneous group. There are different phases requiring different types of learning, for instance a pensioner with increasing handicaps may need a different type of learning approach in comparison to one with less or no disabilities [14].

2.2 ICT and Seniors

2.2.1 Digital Gap

When relating ICT with older people, one of the first things mentioned in the many articles read during the literature research phase of this project, was that there is a vast difference between the younger ICT users and the older ones. This difference is usually called or referred to as the "digital divide" or the "digital gap".

The digital gap between generations will remain significant for the next 20 to 30 years [17]. With this being said, it is of extreme importance to start trying to reduce this digital divide now because many of the younger adults will not face the problems the current 65+ adults are having since many of them are already gaining experience with ICT through their professions [18].

One may think that the level of education is the leading cause of the so called digital gap, but according to Regec (2007) [17] this is not the case, it is related more to age than to level of education or employment status. The same is said by Körting (2007) [18] and Stadelhofer et al. [19] who state that the digital divide in society is influenced by different factors which are: age (most influential), education level, gender, profession and geographical locations.

The statements of the above mentioned authors are confirmed by recent Eurostat (2011) [20] results, which show that the percentage of internet users in the 16 to 24 age group (91%), is more than double of those in the 55 to 74 age group (40%), and the 25 to 54 age group (76%) is also almost double of those in the older age group. It is important to note that even though the difference in the education level is not as great as in the age groups, it is still quite significant, with low education level at 45%, medium education at 71% and high education on top with 92% (Figure 4).
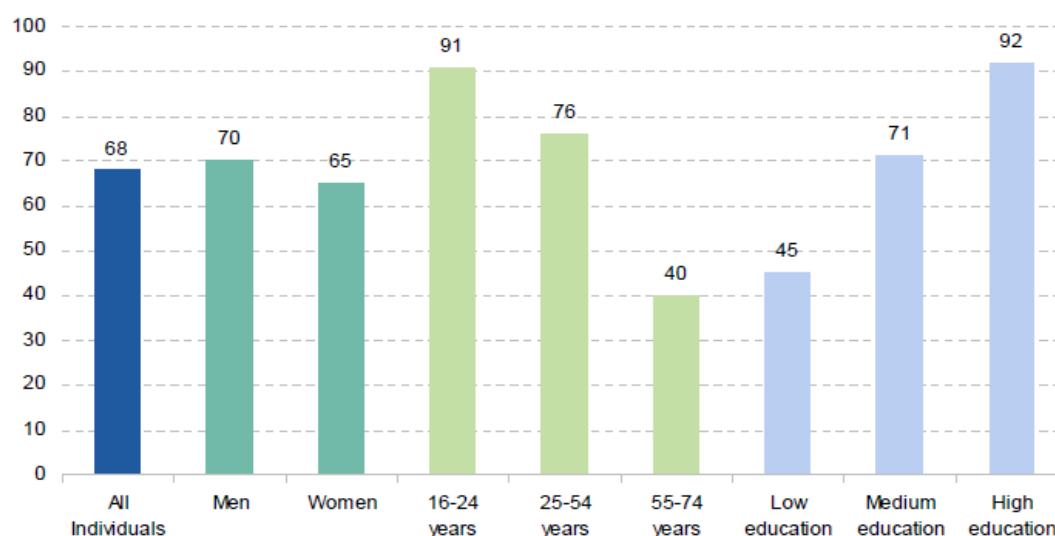
Figure 4 - Individuals who used the internet on average at least once a week, by gender, age group and level of formal education, EU27, 2011 (% of individuals) [20]

2.2.2 ICT Usability

As adults age, their vision, cognition and physical skills decline, with an impact on their ability to perform many tasks. An older adult's reading comprehension is affected by cognitive changes associated with normal aging as well as his or her education level and language proficiency. As such, vision, cognition, motor skills and literacy all play a role in the usability of ICT-related products by older adults [7] [21].

One major problem of these types of products is that they do not always offer user-friendly interfaces, which makes them less acceptable to many seniors who have never used anything similar. Many of the solutions available nowadays rarely address the interests and specific needs of the elderly. More attention should be paid in developing relevant and more user-friendly tools for them [14].

Certain website characteristics such as small buttons, small font size or even low contrast could intimidate people with restricted eyesight or difficulties in using their hands with precision. It's up to the web-developers to ensure that websites are created in a more "e-accessible" manner. A good example of an more accessible website is one which has larger font sizes and interfaces which are adapted for slower reaction times [14] [17].

There is increasing evidence that using design guidelines alone is an insufficient way to overcome the problems mentioned in this section. A suggested way to overcome the problems is by involving end users in the development process of websites [22]. This is not only useful

to understand these users needs but could also bring important new insights to the process [14].

In Dix *et al*. [23] it is stated that evaluation should occur throughout the design process and it is ideal that the first evaluation of a system be performed before any implementation work has started. If the design itself can be evaluated, expensive mistakes can be avoided, as the design can be altered prior to any major resource commitments.

2.2.3 Importance of ICT use by Seniors

Most authors stress the importance of knowing how to use the various ICT tools available (especially the internet). Stadelhofer *et al*. [19] go so far as to say that in this day and age, the acquisition of skills needed for the use of the internet is about to develop into a "fourth key qualification" like reading, writing and counting.

Older generations should grasp new technologies in order to reduce chances of isolation or even depression. These citizens may improve their quality of life and may also experience other benefits by using services that the internet and other basic information technologies have to offer [7] [17] [18] [24].

The use of ICTs among older people is hardly avoidable and moreover they are eager to learn how to use these tools if they are useful to them and if they are convinced of some form of personal benefit derived from their use [25].

2.2.4 ICT use by Seniors

In Körting (2007) [18] it was found that references to the internet in the media give rise to the feeling that relevant information and know-how can only be found there. Many seniors previously felt that useful information could be found from other types of media but now are beginning to realize that the information online is far more complete and interesting (*e.g.* websites that provide advice and information about leisure and health). It is also crucial that seniors feel that the website is secure and reliable to use [19].

Email is the main reason seniors start gaining some interest in using ICT [7] [19] [24]. Kantner *et al*. [24] also state that in many instances, seniors bought their computer because they wanted to communicate with their peers and children/grandchildren and saw email as a faster, more cost-effective way to do so. They were "missing something" without it. In some cases, children purchased a computer for the parent because "it's time to learn" or they wanted to contact via email with the parent. However, in a German study [18] it was stated

that older people are already beginning to purchase computers themselves.

In order for us to better understand what motivates seniors to use the internet in comparison to their younger counterparts, the next table is a summary of a study conducted in Germany in which the online activity of younger users was compared to those of the older age groups. On the top of the list for the 60+ age group is "Sending and Receiving Email" which complies with what has already been stated by the other authors mentioned in this section [18].

Activity	Age Group	
	14 - 19	60+
Sending and Receiving Emails	83%	67%
Search Engines (*e.g.* Health Related Searches)	90%	62%
Searching purposefully for Special Offers	38%	64%
Just surfing the internet	64%	34%
Home Banking	11%	27%
Download of Files	27%	18%
Forums, newsgroups, chats	59%	6%
Online auctions	16%	6%
Online shopping	11%	4%
Listening to Audio Files	32%	2%

<div align="center">Table 1- Internet Activity by Different Age Groups [18]</div>

2.2.5 Learning with the use of ICT

ICT can help in providing new and flexible learning opportunities and simultaneously allows users to interact with people all around the world. Binding learning activities with ICT can be particularly useful to assist people with certain disabilities or to provide learning content to those who live in rural areas [14].

E-Learning could also greatly enhance the lifelong learning experience by providing the learner with more information resources and new ways for students to interact between classes [17].

When creating online learning content for seniors, it's important that the content be as intuitive and easy to use as possible. Ala-Mutka *et al*. [14] state that if a lot of concentration is required just to use the website, it will make its users feel frustrated and conscious of their handicaps, in other words these tools do not create a positive and motivating environment for learning.

2.3 E-Learning

2.3.1 E-Learning Characteristics for Seniors

Körting (2007) [18] and Stadelhofer *et al*. [19] suggest aspects that should be taken into account when designing E-Learning courses and activities for people over the age of 50:

- Try to keep learning material **interactive**. Such material fosters active participation in the learning process which also makes it more likely for the student to have a successful learning experience. A couple of examples of interactive courses for seniors will be presented later in this chapter;

- Enable **communication** amongst students. The possibility of synchronised (chat, video conference, etc.) or desynchronised (forum, exchange of documents, etc.) communication to discuss joint results and to work on group projects enables the learners to make use of their competences and experiences and to profit from the participation in the project.

- **Consultancy and support** are very important factors of E-Learning. Not only in relation to technical and administrative issues but also in relation to the learning courses;

- The **combination of E-Learning** and **face-to-face meetings** (blended learning) is very helpful in the frame of cooperative learning. Face-to-face contact builds an important feeling of togetherness in a learning community;

- There should be **barrier freedom** meaning that not only seniors should have access to E-Learning content but also people with certain disabilities.

2.3.2 E-Learning Related Projects for Seniors

2.3.2.1 Learning in Later Life

The Learning in Later Life (LiLL) project [26] was a project funded by the European Commission which consisted of a network of U3As and other organisations from 15 different countries in Europe that offer academically-oriented continuous education for older adults.

According to the official LiLL website the main objectives of the project are as follows:

- Provision of information regarding the importance and possibilities of academic-oriented continuous education for older people in Europe;

- Exchange and cooperation of heads of institutions and experts in the field of academic-

oriented continuous education in Europe to conduct joint programs and actions for senior students;

- Creation of possibilities for making information available to older people who want to inform themselves about continuous education opportunities in Europe that fit their own requirements.

In this project's website, a large amount of active and complete senior-related projects including their respective sponsors and coordinators can be found, one of them being the E-Learning in Later Life Project (eLiLL) which will be described in the next section.

2.3.2.2 E-Learning in Later Life

The eLiLL project [27] started in February 2006 and ended in January 2008. It consisted of partners from the Czech Republic, Finland, Slovakia, Spain and Germany. eLiLL was supported by the E-Learning Program of the European Commission.

According to the official website, the aim of eLiLL project was to:

- Contribute to digital literacy of older adults in Europe with special focus on the use of the new media in lifelong learning;

- Collect, compare and distribute examples of good practice in the use of the ICTs in lifelong learning and to stimulate the application of the ICTs by providers of education for older adults;

- Foster active cooperation via the new media between organisations of seniors' education within the LiLL European project with other projects and seniors themselves;

- Promote beneficial forms of application of the new media and to contribute to active participation of older adults in all spheres of life in Europe.

This project was extremely useful during the elaboration of this dissertation because of the vast amount of resources it contains. Many articles related to seniors and E-Learning can be found as well as good examples of other projects or websites being developed in other European countries.

2.3.3 E-Learning Platforms

2.3.3.1 Moodle

Moodle (Modular Object-Oriented Dynamic Learning Environment) [28] is an open-source (or free) Learning Management System (LMS) developed by Martin Dougiamas which was first released in August 2002. It is widely used by educational institutions around the world to provide an organized interface for e-learning. As of the 1st of October 2012, it had a user base of almost 70,000 registered websites, serving over 60 million users in 6,6 million courses. It is also available in over 200 countries and in almost 80 languages.

A typical Moodle course page will include a list of participants (including the teacher and students) and a calendar with a course schedule and list of assignments. Other Moodle features include online quizzes, forums where students can post comments and ask questions, glossaries of terms and links to other website resources.

Since Moodle is open source, or freely distributed, it can be an attractive alternative to commercial e-learning options.

2.3.3.2 Blackboard

The Blackboard Learning System [29] is another renown LMS developed by Blackboard Inc. It is a commercial web-based learning environment used in many learning institutes around the world which enables educators to enhance the learning experience by bringing their course materials, class discussions, assignments and assessments to the internet.

This LMS has a series of different types of solutions and according to Blackboard's official website, they are:

- **Blackboard Learn**: is your home base for anything from posting materials online to a complete virtual learning environment and everything in between;

- **Blackboard Connect**: Use this solution to stay connected to your community– your single mass notification solution for delivering everyday updates and emergency notifications;

- **Blackboard Transact**: one-card system enables students and faculty to pay for meals, operate a vending machine or copier, open their dorm and classroom doors, or attend the big game;

- **Blackboard Analytics**: a comprehensive solution for unlocking your school's data and organizing it into dashboards, reports and information you can use;

- **Blackboard Mobile**: a complete mobile platform for your institution with two distinct faces: Blackboard Mobile Learn for your classroom and Blackboard Mobile Central for your campus;

- **Blackboard Engage**: get an easy-to-use all-in-one web-based information hub for the entire K12 learning community with this solution.

2.3.4 Interactive Courses for Computer Beginners

2.3.4.1 WebWise

The WebWise online course website [30] is a project created by the BBC. WebWise offers a wide variety of courses to meet the needs of computer beginners and also to those who have already mastered some basic computer skills such as using a mouse.

In the left part of the website 5 different learning themes can be found, which consist of interactive exercises as well as some useful guides to understand the many concepts related to the selected theme. Additionally to the right of the page, 4 online courses can be selected which consist of only interactive exercises most of which coincide with those located in the themes section at the left of the page, the only difference is that the same exercises may have different names, which could be confusing at first (Figure 5).

Figure 5 - WebWise Main Menu

An extensive glossary which describes many computer related terminologies in alphabetical order can also be found.

During the interactive challenges a virtual tutor helps the student by explaining all concepts

17

and basically assists the learner until the challenge is complete. The learner can also click on a button to easily toggle on and off the display of subtitles. The user also has the opportunity to pause the many exercises in case he or she feels the need to rest or to take notes, this should be particularly useful to people who can't keep up with the speed in which the lesson is being taught.

An example of one of the many courses offered is how to use an email account which is particularly useful for seniors, because as mentioned in this chapter it is one of the main reasons seniors gain interest in ICT (Figure 6).
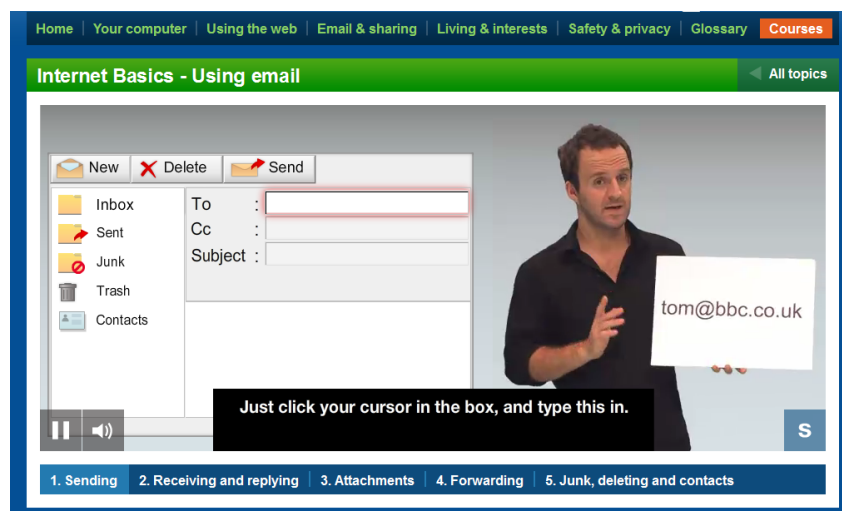

Figure 6 - WebWise Email Course

It is important to note that not all WebWise courses were tried out as not all were available in my geographic region.

2.3.5 E-Learning Standards

2.3.5.1 SCORM

Sharable Content Object Reference Model (SCORM) is a well known set of technical standards for e-learning software products. SCORM defines how programmers should write their code so that it can function correctly with other e-learning software. In other words, SCORM controls how online learning content and LMSs communicate with each other [31].

A good way to understand SCORM is to use a simple analogy. A great example of an analogy are the use of DVD players. When purchasing a traditional DVD, there is no need to verify if it will play on the DVD player we have at home. A regular DVD will play on a Samsung the same as it will on a Toshiba. This is because DVD movies are produced using a set of

standards. Without these standards, studio releasing a new movie on DVD would have a big problem. They would need to make differently formatted DVDs for each brand of DVD players. This is how online learning used to be before SCORM was created [31].

This means if people create learning content (*e.g.* quizzes) in accordance to SCORM standards, they can use this content in any SCORM compliant LMS.

2.4 Universities of the third age

With the purpose of understanding what is currently being offered by U3As and to better comprehend their priorities, the results of a European survey were analyzed. This survey was carried out by partners in 5 different countries, namely: Spain, Slovakia, Czech Republic, Germany and Finland [13]. Professionals and heads of institutions were asked about the new media and the internet in their study programmes. The questions asked referred to the course types and the importance of using ICT in their study plans. The replies came from 72 institutions of senior education in Europe and were done from 2006 to 2008.

The age groups of students who attend these U3As can be seen in table 2.

	Spain	Slovakia	Czech	Germany	Finland	Mean
Under 50	0%	17%	22%	8%	4%	10,2%
51 - 60	22%	30%	38%	15%	4%	21,8%
61 - 65	28%	30%	25%	39%	14%	27,2%
66 - 70	19%	18%	10%	20%	45%	22,4%
Over 70	9%	5%	4%	12%	33%	12,6%
Unknown	22%	0%	0%	5%	0%	5,4%

Table 2 - Age Groups of Students who Attend U3As

When asked about the use of ICT in their education programmes 74% of the institutions stated that they use internet in their education programmes. Those who use ICT were also asked to specify the area in which they use ICT, which can be seen in the table below.

	UTA Spain	UTA Slovakia	UTA Czech	UTA Germany	UTA Finland	Mean
Courses on the Internet	65%	78%	66%	67%	40%	63.2%
Internet search	53%	22%	63%	44%	60%	48.4%
Platform for self- presentation	18%	22%	25%	44%	40%	29.8%
Online distant education	12%	0%	3%	11%	0%	5.2%
Blended learning	29%	0%	28%	22%	0%	15.8%
Internet for communication	35%	33%	19%	11%	0%	19.6%
Learning platforms - e.g. Moodle	12%	0%	3%	11%	0%	5.2%
Others	6%	11%	6%	11%	0%	6.8%

Table 3 - Areas of Use of ICT in U3As

"Courses on the internet" (63,2%) and "Internet search" (48,4%) have the highest mean values however "Blended learning" (15,8%) ,"Online distant education" (5,2%) and "Learning

platforms" (5,2%) present some of the lowest values.

Another question asked in the survey was: " For what do your senior students use the new communication and information technologies?" and the mean results have been documented below.

	UTA Spain	UTA Slovakia	UTA Czech	UTA Germany	UTA Finland	mean
Creation of texts	41%	78%	78%	78%	80%	71%
Picture processing	12%	78%	69%	78%	20%	51%
Statistical data processing	0%	56%	44%	44%	40%	37%
Internet search	53%	89%	78%	89%	60%	74%
Internet-based-research	12%	11%	44%	67%	20%	31%
e- mail	47%	78%	75%	89%	60%	70%
Chat	24%	44%	44%	56%	20%	38%
Forums	24%	33%	34%	56%	0%	29%
Mailing lists	29%	33%	44%	67%	20%	39%
WebCam	0%	11%	38%	44%	0%	19%
Learning environments	12%	11%	25%	33%	0%	16%
Other	0%	11%	3%	22%	0%	7%

<div align="center">**Table 4 - Areas of ICT use by Students in U3As**</div>

It is interesting to see that email is yet again one of the main reasons seniors use ICT even in U3As with a mean value of 70%. "Internet search" has the highest mean value (74%) while "Creation of texts" (71%) represents the second highest mean.

Chapter 3. Planning of the AAL4ALL E-Learning Platform

3.1 Website Visual Design Guidelines for Seniors

Based on the findings of the previous chapter, it became evident that before designing and developing the E-Learning platform, a list of guidelines needed to be established.

The Web Content Accessibility Guidelines 2 (WCAG) [50] are a reliable set of accessibility guidelines that can be used as a reference when creating websites for seniors. For this dissertation it was decided not to use the WCAG 2 guidelines but to instead enlist another simplified set of guidelines based on other reliable authors and projects. It is possible however that some of the guidelines in this section might coincide with those of the WCAG 2.

These chosen guidelines or visual design guidelines (VDG) do not apply solely to E-learning platforms but to senior websites in general. These best practices should help to determine what aspects should be considered when drawing the initial mock-ups or when implementing the prototype. **Since the prototype is only a demonstration of the final product, not all of the guidelines were used.**

In order to simplify the reading of these best practices only some of the guidelines will be included in this section. For the full list of best practices (including those in this section) please refer to appendix A1.1.

It was possible to divide the list into 10 categories, namely: Layout and Style, Scrolling, Colour, Menus and Navigation, Buttons and Styles, Search Function, Language and Terminology, Multimedia, User Customization and Documentation and Feedback. The guidelines will be enlisted next:

Layout and Style

- Use a sans serif typeface (Arial, Verdana, Helvetica etc.) that is not condensed. Avoid the use of serif, novelty, and display typefaces [32] [33] [34] [37] [38] [39].

- Use 12 point or 14 point type size for body text [32] [34].

- Avoid flashing and blinking graphics [35] [41].

Scrolling

- Avoid automatically scrolling text. If manual scrolling is required, incorporate specific scrolling icons [32] [34].

- Horizontal scrolling should be avoided [39].

Colour

- Adjacent colours to avoid would be orange and red as they do not offer a high level of differentiation to the aging eye [35]. It is also suggested to avoid yellow, blue and green in close proximity [34] [37] [38].

- Use dark typeface or graphics against a light background (high contrast), or white lettering on a black or dark-coloured background [37] [38] [39].

Menus and Navigation

- Avoid using pull down menus [34] [37] [38].

- Incorporate buttons such as "Previous Page" and "Next Page" to allow the reader to review or move forward [34].

- An easy to identify "Home" button should be present on every page [32].

Buttons and Styles

- Incorporate text with the icon if possible (label), and use large buttons that do not require precise mouse positioning for activation [32] [33] [34] [35] [37] [38].

- In order to aid older adults to identify buttons as clickable the cursor or button may change when hovering over a button [32] [33] [37] [41].

Search Function

- A search functionality offered on a web site should tolerate spelling mistakes or should offer suggestions for improved search results [32] [37].

- Search results should be arranged according to relevance [32].

Language and Terminology

- Use vocabulary familiar to your readers, *e.g.* avoid technical vocabulary or foreign language expressions if possible [32] [33] [38] [41].

- Present information in a clear and concise way to reduce the number of inferences that must be made [32] [34] [42].

Multimedia

- Give the user the possibility to control the speed of animations, videos, etc. (*e.g.* pause/stop buttons) [32] [41].

User Customization

- There should be a button to change font type size [33].

Documentation and Feedback

- Provide a "Frequently Asked Questions" (FAQ) section, which has to be updated and reflect the feedback of the visitors about problems they experienced [32].

3.2 E-Learning Features

After the VDG had been established for the project the next step that needed to be taken was to find out what type of features renown E-Learning platforms offer their users and to select those that best suit the needs of this project. The chosen E-Learning platforms to be studied were Moodle and Blackboard. We also took into consideration our findings in chapter 2 and the guidelines listed in the previous section, to complement the list of chosen features.

After a careful analysis, it was concluded that the platform should have 3 types of users, namely: **Student**, **Professor** and **Administrator**.

As mentioned in the "Thesis Problem and Objectives" section, the prototype version of the platform will only be implemented for the student, so only this user's features will be specified (Table 5). However, please refer to appendix B1.1 and B1.2 to see the use-case diagram[3] of the professor and administrator's primary features respectively.

After careful analysis, the student features were divided into three sections: <u>Primary</u>, <u>Secondary</u> and <u>Accessibility</u> features which can be seen in the next table.

---

[3] The main purpose of a use-case diagram is to display all the functions and services of the various types of users of a system.

Primary Features	Secondary Features	Accessibility Features
Grades	List of all Enrolled Courses	Increase/Decrease Text Size
Course Content and Recorded Lessons	Notifications/Announcements	Increase/Decrease Contrast
Submit Project	Calendar	Bigger Scrolling Buttons
Chat	Login/Logout	Video Player Designed for Seniors
Account Details and Settings	Enable SCORM Certified Courses	
Forum	Frequently Asked Questions (FAQ)	
Timetable	Help Section	
Virtual Classroom (Web-Conference)	Language Selection Button	
Course Study Programme	Privacy Statement Section	
Send and Receive Messages	Institution Contacts	
Exams/Quizzes (Online)	Sitemap	
Events	Search Box	
Groups		

Table 5 - Primary, Secondary and Accessibility Features of the Student User

For a brief description of all of the above features please see appendix B2.1.

Before continuing to the next section, please note that due to time limitations only the features in the purple coloured cells will be implemented for the prototype.

3.3 AAL4ALL E-Learning Platform Specifications

3.3.1 Overview of all the Student Features

In order to better visualize all of the student's chosen features, a use-case diagram of all the primary planned features of the student can been seen in figure 7.
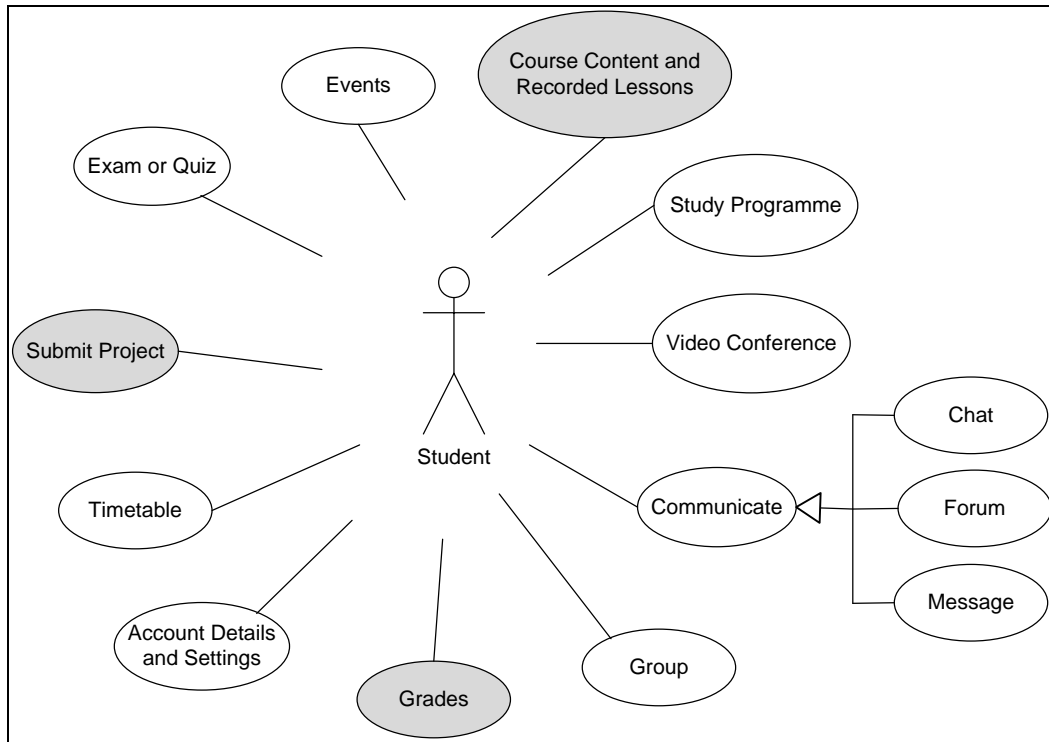
Figure 7 - Use-Case Diagram of Primary Student Features

After all the features and requirements had been established, sufficient information had been gathered to start sketching all the main mock-ups for the prototype. The following diagram depicts the main sequence of events when entering the prototype and their corresponding mock-ups.
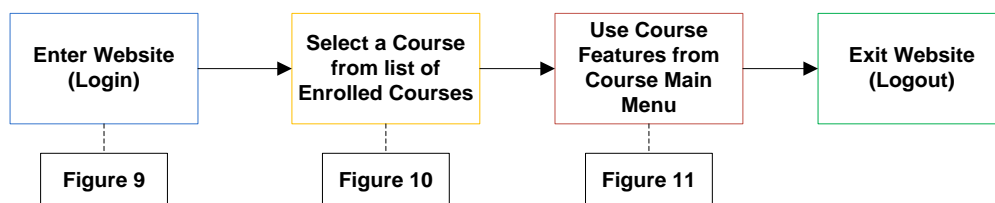
Figure 8 - Main Sequence of Events when Entering the Prototype
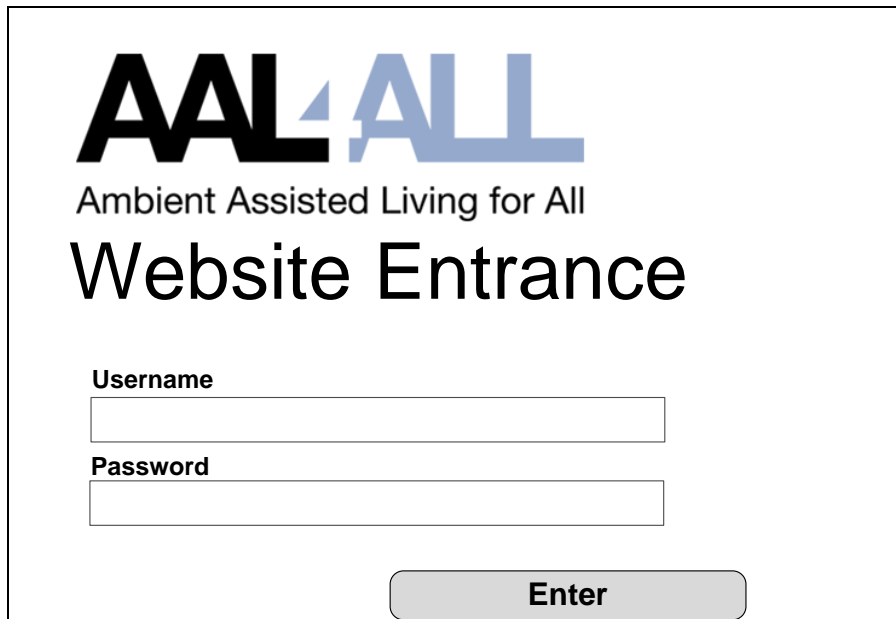
Figure 9 - Mock-up of Website Entrance
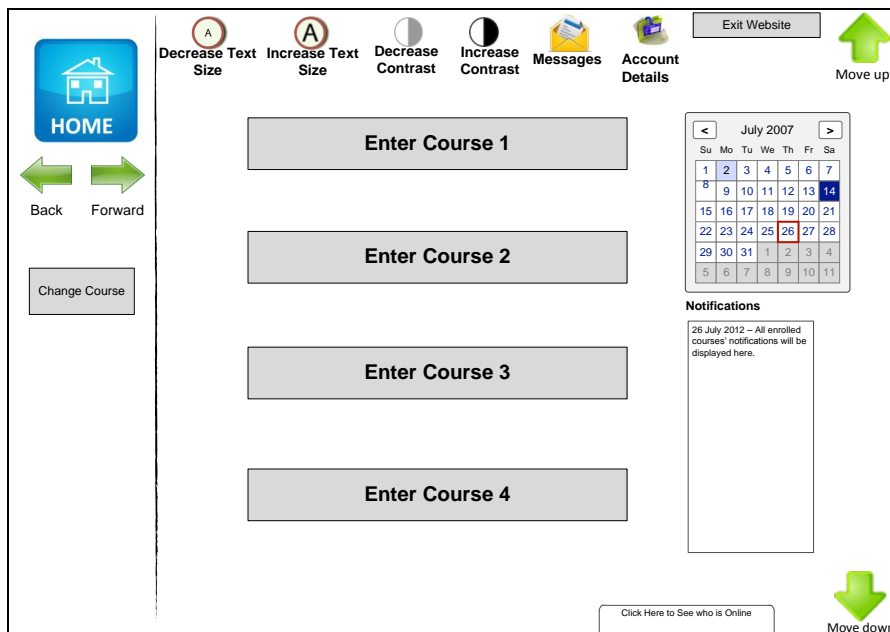
Figure 10 - Mock-up of Course Selection Webpage

Figure 11 - Mock-up of the Student Main Menu

3.3.2 Prototype Class Diagram

A generic class diagram of all the implemented features of the prototype will be displayed next. The purpose of this class diagram is to specify the structural makeup of the system, in other words, it helps us better understand what type of data or information is needed to implement each feature.
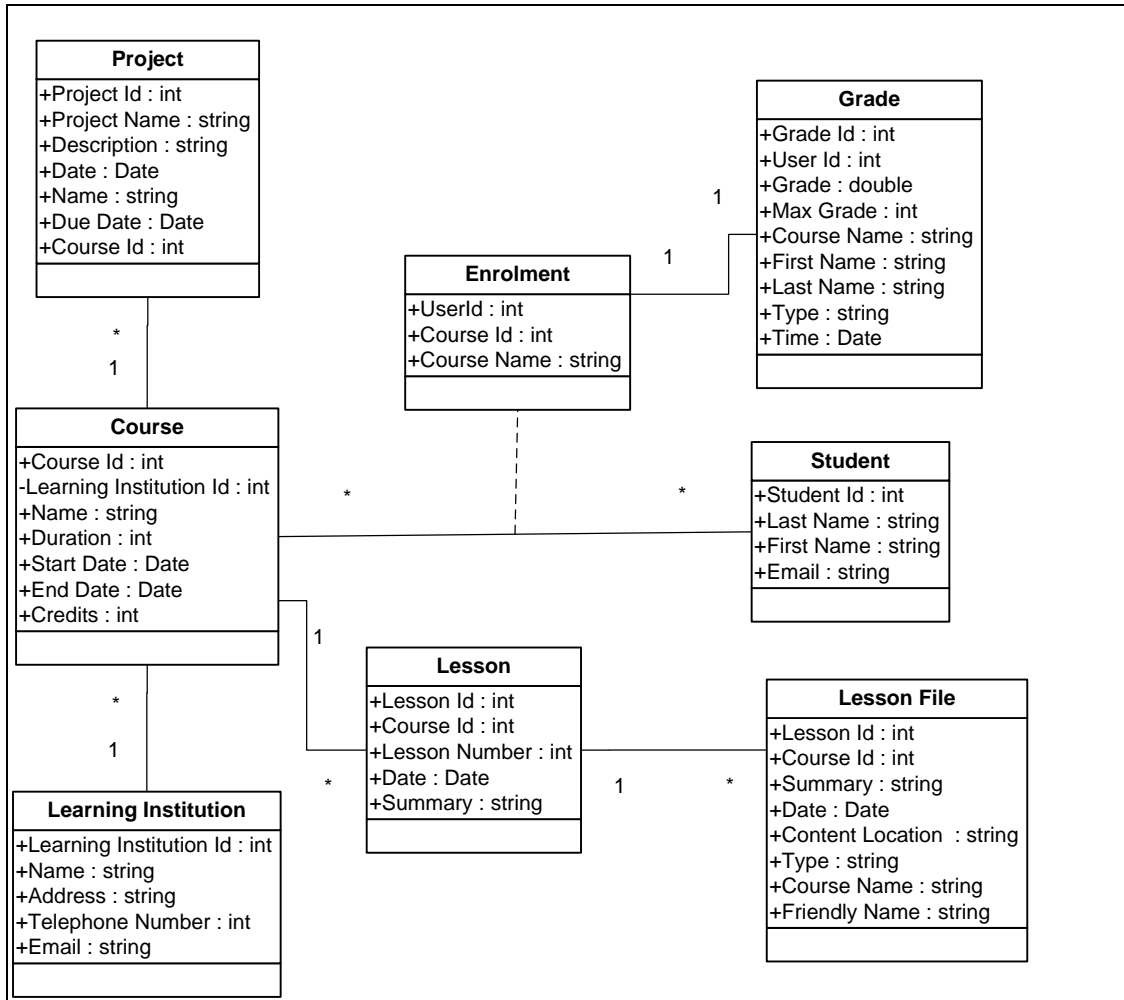
Figure 12 - Prototype Class Diagram

For a demonstration of the full generic class diagram of all of the platform features please see appendix C1.1.

3.4 AAL4ALL E-Learning Chosen Primary Features Specifications

In order to provide a better understanding of each of the chosen primary features, a usage scenario with a sequence of possible tasks of each of these features has been listed below. Additionally a mock-up of each of the features will be displayed to better visualize how they should look in the prototype.

3.4.1 Course Content and Recorded Lessons

A possible sequence of tasks for the "Course Content and Recorded Lessons" feature is illustrated below:

Task Number	Task Description
1	The student logs into his/her account.
2	The student is presented with a list of enrolled courses.
3	The student selects a specific course.
4	The "Course Content and Recorded Lessons" icon is then selected.
5	A page with all the available lessons is displayed.
6	The student selects a lesson.
7	The selected lesson's content and recorded videos will be on display.

Table 6 - Possible Task Sequence for the "Course Content and Recorded Lessons" Feature

The mock-up of the "Course Content and Recorded Lessons" feature can be seen below:

Figure 13 - Mock-up of the "Course Content and Recorded Lessons" Feature

3.4.2 Grades

A possible sequence of tasks for the "Grades" feature is illustrated as follows:

Task Number	Task Description
1	The student logs into his/her account.
2	The list of courses the student is enrolled into will be on display.
3	The student selects a specific course.
4	The student clicks on the "Grades" icon.
5	A table with the student's grades for that course will then be displayed.

Table 7 - Possible Task Sequence for the "Consult Grades" Feature

The mock-up of the "Grades" feature can be seen below:

Figure 14 - Mock-up of the "Grades" Feature

3.4.3 Submit Project

A possible sequence of tasks for the "Submit Project" feature can be seen next:

Task Number	Task Description
1	The student logs into his/her account.
2	A list of courses the student is enrolled into will be on display.
3	The student selects a specific course.
4	The student then clicks on the "Submit Project" icon to view the project upload screen.
5	The student then clicks on the "Search for Project" button to search for the project stored in the computer.
6	After selecting the file the student will then click on the "Submit project" button to save the project which will make it viewable to the professor of that specific course.

Table 8 - Possible Task Sequence for the "Submit Project" Feature

The mock-up of the "Submit Project" feature can be seen below:
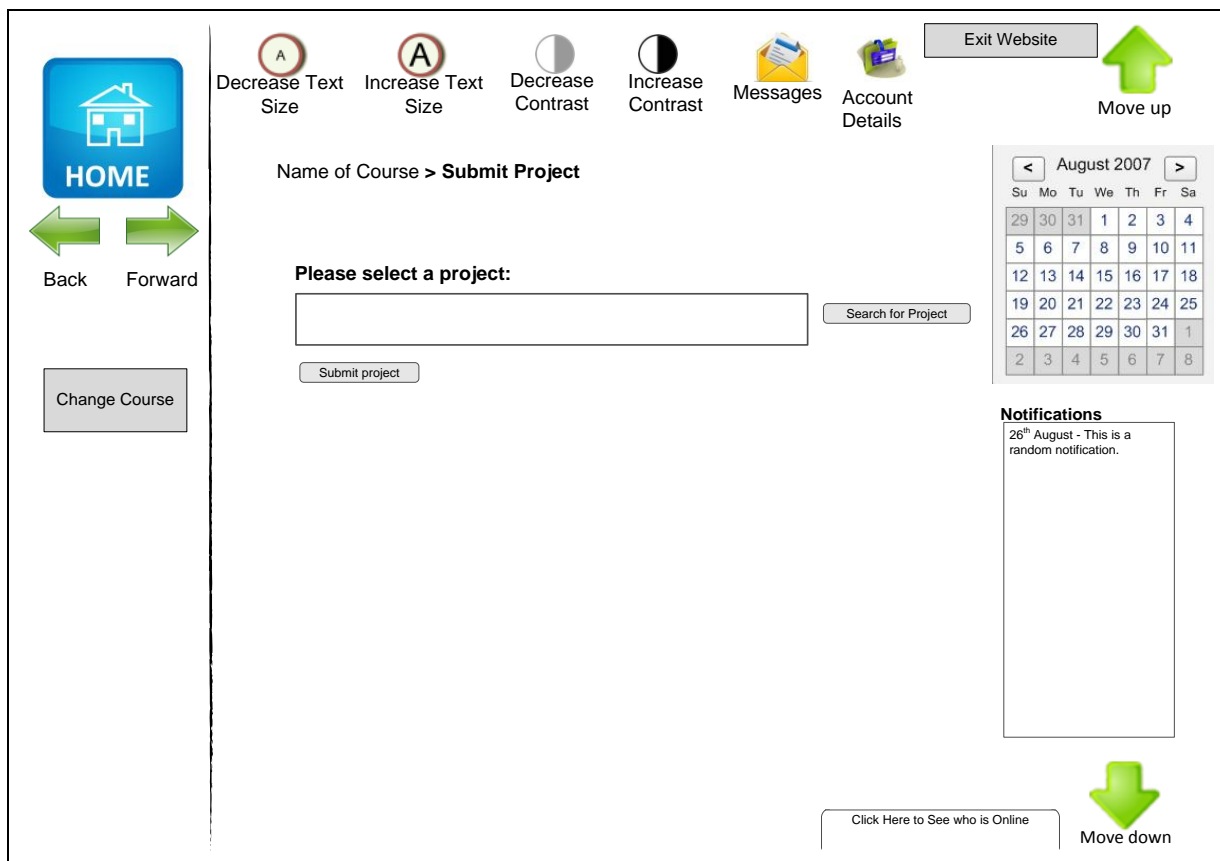
Figure 15 - Mock-up of the "Submit Project" Feature

3.5 Requirements Study

As mentioned in chapter 2, some authors state that seniors (end users) should be included as much as possible during the planning and creation of any senior-related website.

Given that some of the mock-ups have been sketched and since all the planning has been based mainly on the literature review (chapter 2), it was decided that it was best to take the authors' advice to involve seniors by gathering their thoughts on the mock-ups and adjusting them accordingly before moving on to the development phase.

After a brief description of the objectives of the study, the interviewees were given a list of tasks to be performed on Moodle in order to familiarize them with the E-Learning concept.

The default Moodle theme called "Standard" was used for the course. To get an idea of what the Moodle Main Menu looked like please refer to figure 16. Please see other print screens of the Moodle course features in section D1 of the appendices[4]. For the translated list of Moodle tasks please refer to appendix D2.1.

Figure 16 - Moodle Course Main Menu

While the tasks were being performed the interviewer had a paper available to take notes as the seniors carried out each of these tasks. The purpose of these notes was to register the participants reactions while performing the various tasks. The operating system that was used for this study is Windows 7 and it was done using a laptop with a 16 inch monitor. The internet browser used was Mozilla Firefox version 17.

---

[4] Since this dissertation will be presented in English, all of Moodle's interface menus were switched to the English language, however all of the courses contents were not translated to English.

After completing the tasks, the seniors should have a better understanding of what an E-Learning platform is. The participants were then presented with all of the AAL4ALL E-Learning platform mock-ups. Since the target group are Portuguese seniors, all mock-ups were translated into Portuguese.

Finally the participants were asked to complete a questionnaire. The questionnaire had questions about the Moodle and the AAL4ALL E-Learning platforms. The interviewer was next to the participants while they filled out the questionnaire to assist them when necessary. Please refer to appendix D2.2 to see the translated version of the questionnaire.

3.5.1 Participants of the Requirements Study

The studies were all carried out within the Torres Vedras region (Portugal), one of which was done at the residence of the interviewee and the others were done at a computer training centre which was made possible thanks to a training company called "Busca Completa" [43].

For this study a total of 7 people were interviewed, of which 3 are male and 4 are female. As mentioned in chapter 1, all of the participants are seniors with no or few physical limitations and with some computer or internet experience.

The number of participants of this study, arranged according to age group can be seen in the table below.

Age Group	Number of participants	Percentage of participants
65-69	3	42.86%
70-74	2	28.57%
75-79	2	28.57%
80+	0	0.00%

Table 9 - Number of Participants of the Requirements Study Arranged According to Age Group

In terms of experience, all of the study participants classified themselves as **less experienced**, meaning that they usually only perform 1 or 2 different tasks when using the computer (*e.g.* using social networks or sending an Email).

In the questionnaire the participants were also asked to state the number of times they use a computer per week and the results can be seen below.
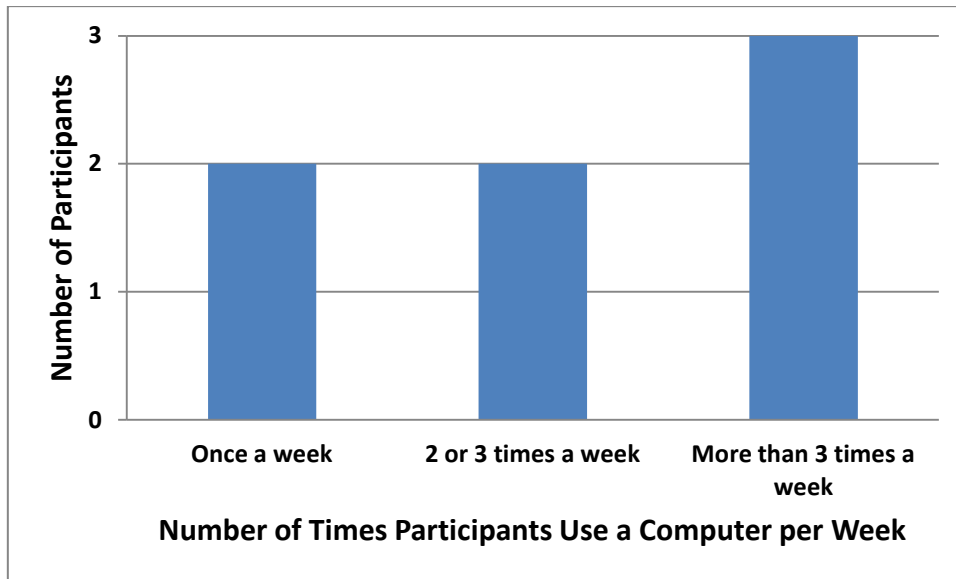
Figure 17 - Number of Times the Participants of the Requirements Study use a Computer per week

3.5.2 Results of the Requirements Study

According to the questionnaire, all of the participants liked the concept of being able to access learning content from any location. **All 7 participants preferred the planned layout of the AAL4ALL E-Learning platform in comparison to the layout of the Moodle course created for this study.**

After analyzing the notes and the results of the questionnaires, the following tables were composed to summarize all of the key findings of the requirements study.

Moodle	
Negative Aspects	**Positive Aspects**
- Links are too close to each other. - Pop-ups were confusing. - The scroll-bar is too small. - No one knew how to log out, they use to close the window instead. - Too many links confused the participants (many of the links did the same thing). - Small text size. - Participants didn't know whether or not they had to click on icons or their respective labels.	- Top breadcrumb menu was useful.

Table 10 - Negative and Positive Aspects about Moodle discovered during the Requirements Study

AAL4ALL E-Learning Platform (Mock-Ups)	
Negative Aspects	**Positive Aspects**
- Some seniors did not know what "Submit project" meant. - Many did not like or understand the purpose of the contrast buttons.	- Positive feedback about the icons in course main menu. - The chosen colours were very appealing. - Positive feedback about the labels used in the mock-ups. - Easy and intuitive. - Website is well organized. - The images used for each icon were well associated to their labels. - Many loved the idea of being able to modify text size. - They understood all of the terminology.

Table 11 - Negative and Positive Aspects of the AAL4ALL E-Learning Platform Mock-Ups

Many of the difficulties experienced with the Moodle course could have been avoided if the VDG had been applied.

It was also noted during the realization of the Moodle tasks that many users were familiar with the purpose of the "Back" and "Forward" buttons situated on the browser's top menu. This was a good indicator that the large green "Back" and "Forward" buttons planned for the AAL4ALL E-Learning will be easily understood by its future students.

It was interesting to note that all users understood that the red "X" is used to close windows. Additionally, it was also interesting to see that some users preferred to use the laptop's touchpad and others preferred the mouse and even made use of the mouse's scroll wheel.

We also asked the participants why they valued the breadcrumb menu so much and many said it's because it helped them remember where they were located in the website.

A lot of positive feedback was given in relation to the mock-ups presented to the participants, some of them even showed their interest to use the website when the final version is launched. This was a good indicator that the planned layouts could have positive results.

All available features displayed on the mock-up of the course main menu were understood by all of the participants except the video conference feature, but after explaining the purpose of the feature to them they all approved of the idea. Many of the participants were educated and all stated that the platform had everything a "virtual school" would need.

Based on the results, only minor changes will be made to the mock-ups:

Modifications to be made to the AAL4ALL Mock-ups
- All references of "Submit Project" will be changed to "Send Project".
- The contrast buttons will be removed, which is not critical because it is possible to change contrast level using most monitors' configuration menu.

Table 12 - Modifications to be made to the Mock-ups

After these minor modifications, it was possible to start implementing the prototype which will be described in more detail next.

3.6 Implementation of the Prototype

After completing the requirements study, it was possible to proceed with the implementation of the prototype. It was at this stage that an extra person experienced in website-development joined the project to assist in developing the AAL4ALL E-Learning prototype. Even though the final product shall be available in more than one language it was decided to develop the prototype solely in Portuguese based on the fact that it was going to be tested in Portugal.

In order to start the development process it was necessary to select the appropriate development tools to create the platform. The 3 main development tools chosen to create the platform were: **DotNetNuke - 6th Version (DNN)** [44], **Microsoft Visual Studio 2010 (VS)** [45] and **Microsoft SQL Server 2008 (SS)** [46].

The purpose of each of these tools is to:

- **DotNetNuke:** DNN is an open source portal and Content Management System (CMS), based on Microsoft's .NET technology. DNN offers a robust, extensible and fully functional framework for the development of a broad range of portal applications;

- **Microsoft Visual Studio 2010:** VS is a suite of applications created by Microsoft to give developers a compelling development environment for the Windows and .NET platforms;

- **Microsoft SQL Server 2008:** SS is a computer application used to create database applications.

The main reason the above mentioned tools were chosen is mainly because Microsoft is one of the partners of the AAL4ALL project, thus guaranteeing continuous support for these tools.

Another reason these tools were selected is because the E-Learning platform will need to interconnect with the AAL4ALL E-Commerce platform to sell courses (Figure 18). Since the

E-Commerce development team decided to also use the 3 aforementioned tools, it was important to use the same tools to facilitate the binding of both platforms.
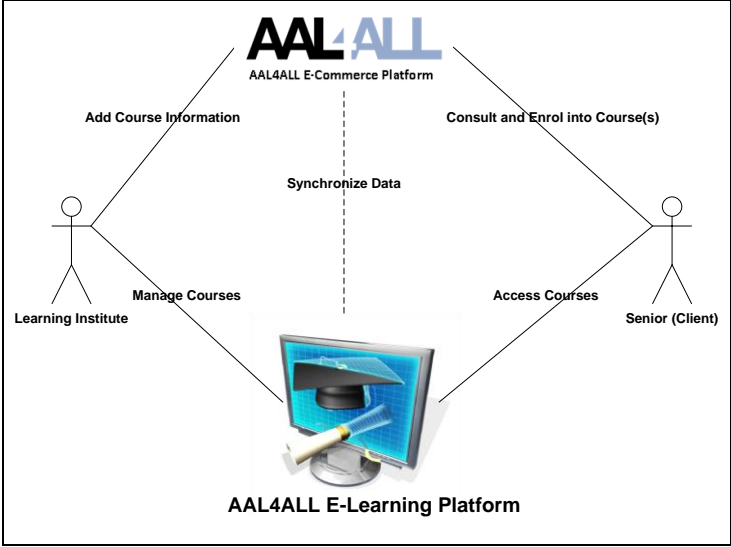
Figure 18 - Binding of the AAL4ALL E-Learning and E-Commerce Platform

3.7 Demonstration of the Prototype

The prototype was finalized after 3 months of development. This section will demonstrate various print screens of the prototype and construct a scenario demonstrating the many features of the website. Seeing that the platform was developed in Portuguese, most of the print screens will be presented in this language.

To start off this scenario we are going to need to log into the system using the entrance or login webpage (Figure 19) by typing in our username and password.
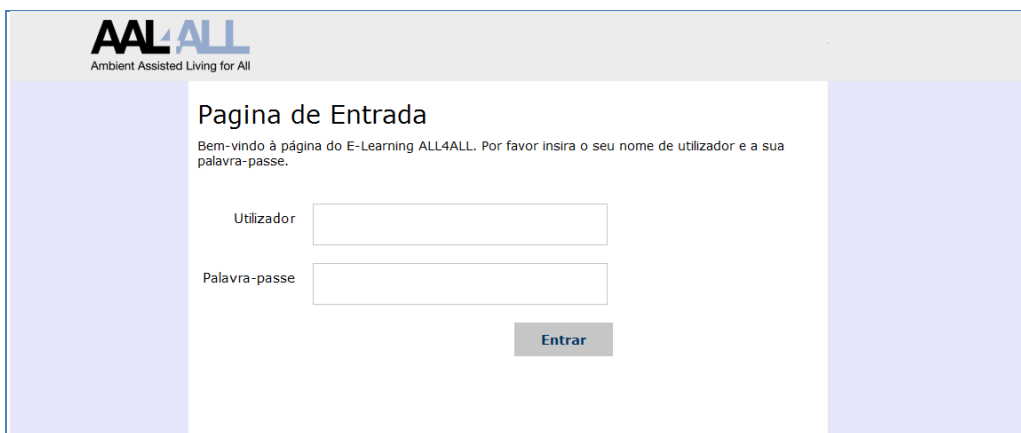
Figure 19 - Entrance/Login Page of the Prototype

After entering a valid username and password, the course selection webpage (Figure 20) will appear with a list of all of the courses the student is enrolled in.
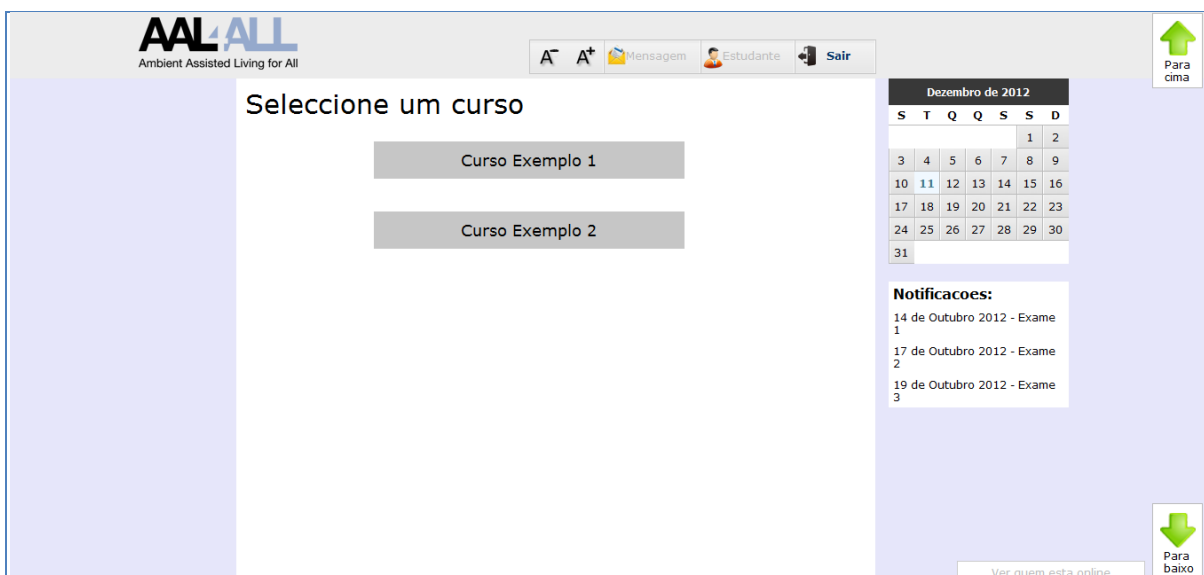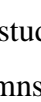
Figure 20 - Course Selection Webpage of the Prototype

After selecting a course, the course main menu (Figure 21) will appear with a list of all the available features of the selected course. As explained before, only 3 features will be available

in the prototype version: "Grades", "Course Content and Recorded Lessons" and "Send Projects".

Noteworthy features include the accessibility buttons: Decrease/Increate text size (A⁻ and A⁺) and the large green scrolling buttons (⬆, ⬇).

There are also a number of shortcut buttons available on the left pane: Go to previous page (⬅) and go to next page (➡). It is also possible to return to the course main menu by clicking on the button with the home icon (🏠). When necessary, it is also possible for the student to change to a different course by click on the left "Change course" (Mudar de curso) button. Alternatively the senior can simply click on the ⬅ button to navigate to the course selection webpage.

On the right pane the student can see the current month's calendar and beneath it all the notifications of any selected day.
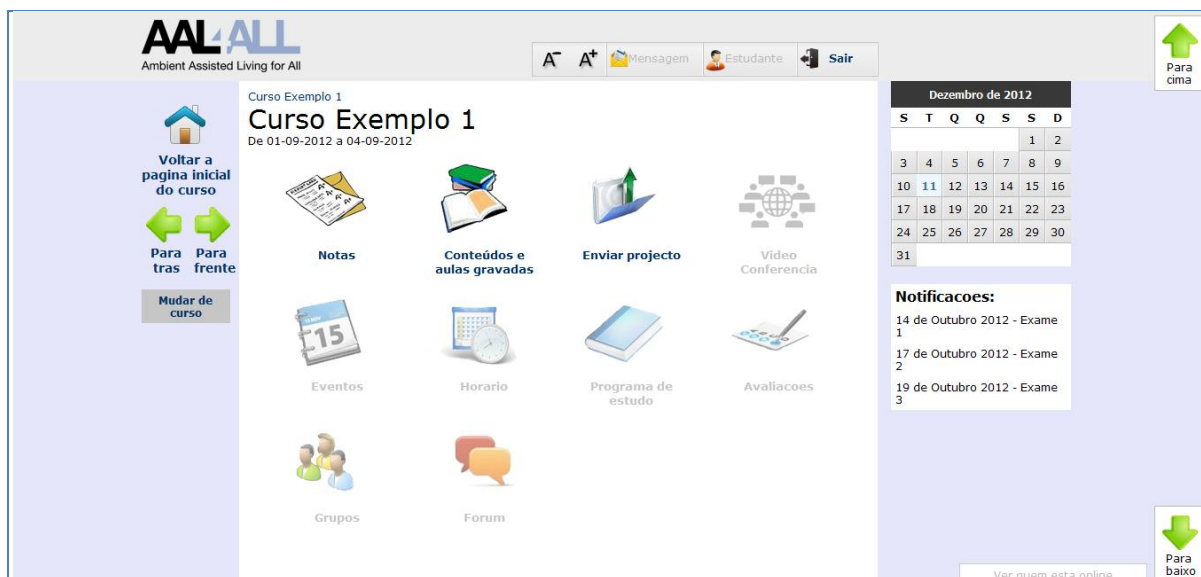
Figure 21 - Course Main Menu

Let's explore the "Grades" feature first by clicking on ✎ . In this window (Figure 22) it is possible to see all the student's exams or tests grades in this course. Exam or test information is divided into 4 columns: Type of exam, Date of exam, Grade and Percentage. The system automatically calculates the final grade when applicable.
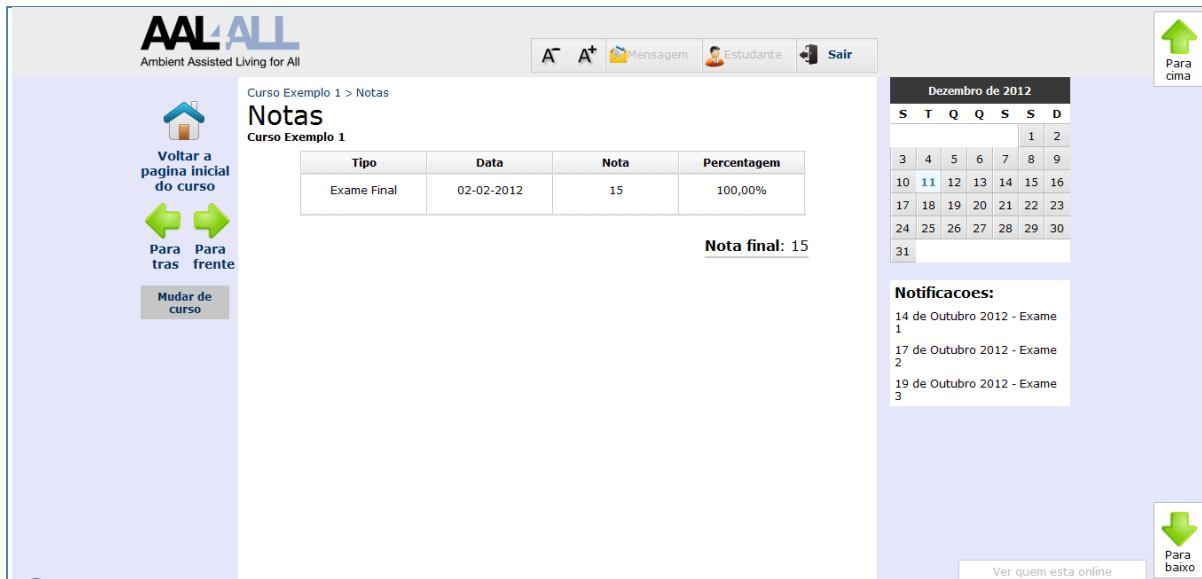
Figure 22 - Grades Feature of the Prototype

To return to the course main menu we can click on the ⬅ button or on the 🏠 button.

Let's now have a look at the "Send Project" feature by clicking on 📤. This feature (Figure 23) should be very easy to use since it only provides two buttons: "Search for Project" (Procurar projecto) to browse for a project on the user's computer and the "Send Project" (Enviar projecto) button to send the project so that the professor can view it.
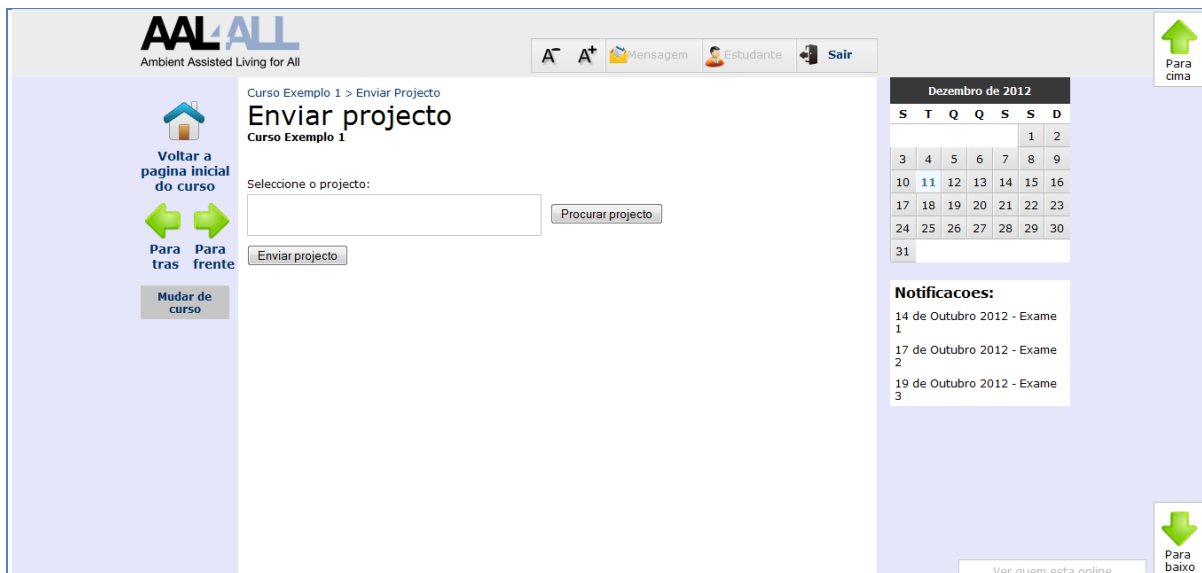
Figure 23 - Send Projects Feature of the Prototype

To view the "Course Content and Recorded Lessons" feature we need to return to the course's main menu and select 📝 which will open up the lesson selection webpage (Figure 24).
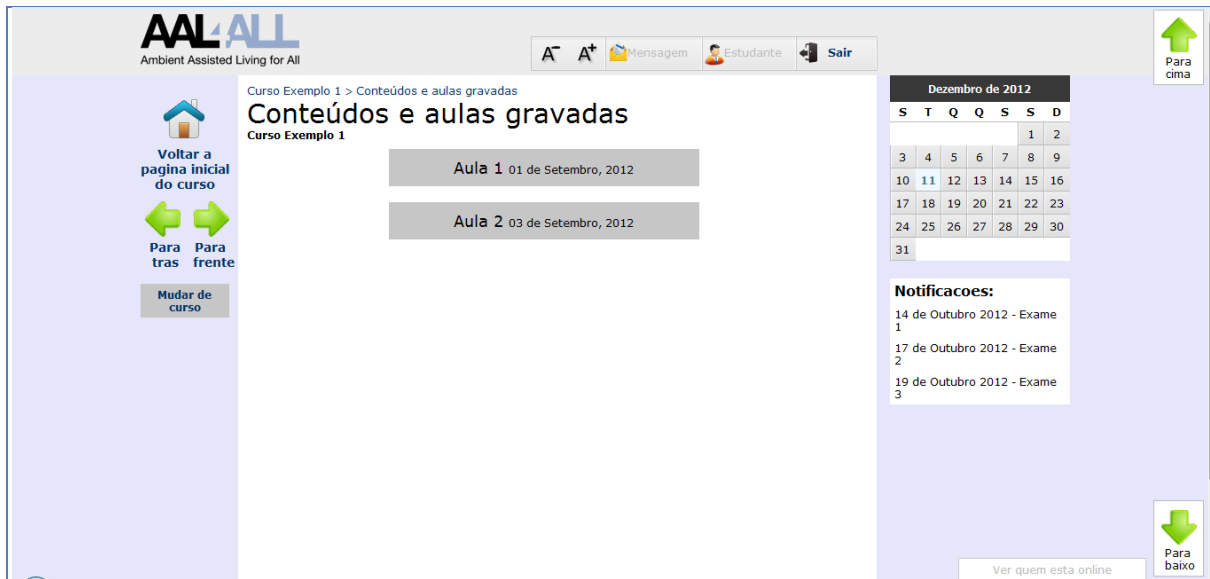
Figure 24 - Lesson Selection Webpage

When the students enter each lesson they can have access to a variety of different content types, namely:

- Word Files

- Pdf Files

- Video Files

- Powerpoint Presentations

- SCORM Certified Course[5] (*e.g.* Interactive course about planet Earth)

For the sake of this scenario let's assume that the selected lesson contains all of these content types (Figure 25).

---

[5] The SCORM player was not implemented in the prototype. The SCORM certified course was linked to the prototype using an URL which was provided by an external SCORM player [27].

Figure 25 - Course Lesson with many types of Content

When clicking on any of the available content the student can opt to open it in a new window by clicking on [Abrir numa nova janela] or by simply clicking on the link itself to open up the content within the platform (Figure 26).

To return to the list of content available for this lesson, the student can click on the ✖ button or on the ⬅ button.
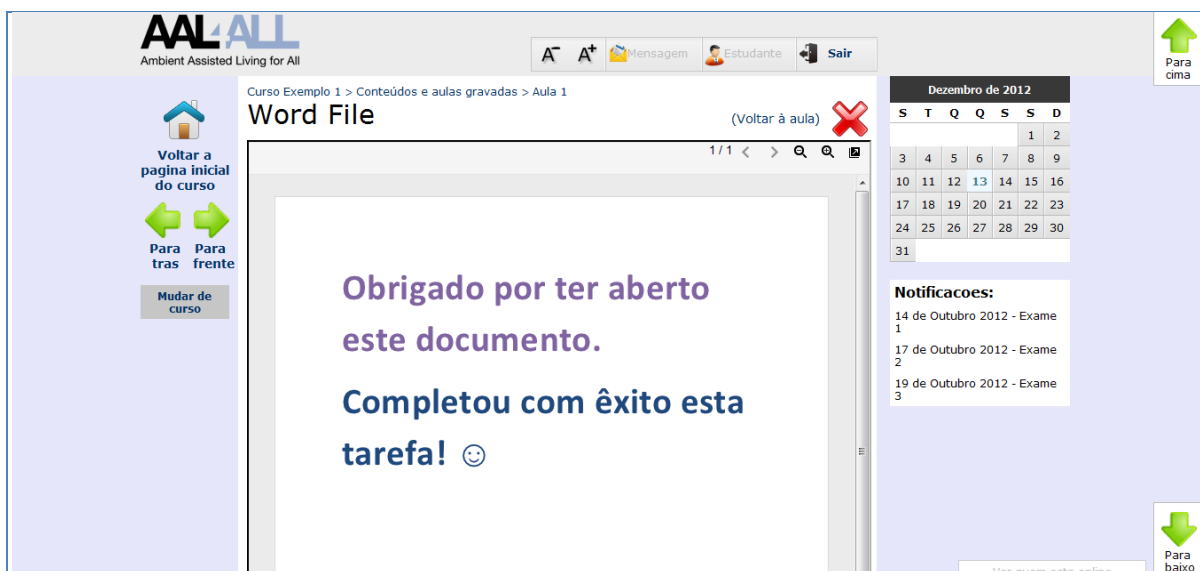
Figure 26 - Opened Content Within the AAL4ALL E-Learning Platform

As part of the accessibility features, a special video player was designed for seniors (Figure 27).

Figure 27 - Special Video Player for Seniors

To complete the scenario, figure 28 presents an example of a SCORM certified interactive course about planet Earth.

Figure 28 - Example for a SCORM Course

To end the current session, the student can simply click on the [Sair] button (Exit in English) located on the top menu.

Chapter 4. Usability Study

After the prototype was fully functional it was possible to test it with yet another group of seniors. The purpose of this study was to understand how the study participants interact with the system in order to improve it. As mentioned in the methodology section, the target group of this study are seniors with no or few physical limitations and with some computer or internet experience.

The way this study was carried out is very similar to the requirements study just that now the participants will also have the opportunity to perform tasks on the AAL4ALL E-Learning platform instead of just looking at the mock-ups. In comparison to the requirements study, only a few alterations were made to the proposed tasks and course content. The Moodle theme used was the same as the one used in the previous study.

After a brief description of the objectives of this study, the interviewees were given a list of tasks to be performed on Moodle in order to familiarize them with the E-Learning concept and for them to have something to compare the prototype with. Please see appendix E1.1 for translated list of Moodle tasks.

Following this introduction, they were asked to carry out the same tasks on the AAL4ALL E-Learning platform. Please see appendix E1.2 for the translated list of AA4ALL E-Learning platform tasks. These tasks were only slightly different to those of the Moodle platform and this is due to the fact that both platforms used distinct terminologies.

Please refer to figure 16 and section D1 of the appendices section to get an idea what the Moodle interface looked like and section 3.7 of the previous chapter to see how the AAL4ALL E-Learning platform looked like.

As the seniors carried out each of the tasks, the interviewer once again had a paper available to take notes. The purpose of these notes was to register the participants reactions while performing the tasks. The operating system used for this study was Windows 7 and was done using a laptop with a 16 inch monitor. The internet browser used was Mozilla Firefox version 17.

After both of the E-Learning platforms had been experimented on, a questionnaire about these systems was handed out. The questionnaire contained questions about the Moodle and the AAL4ALL E-Learning platforms. The interviewer was next to the participants while they filled out the questionnaire to assist them when necessary. Please refer to appendix E2.1 to

see the translated version of the questionnaire. Many of the questions of the questionnaire were based on the Questionnaire for User Interface Satisfaction (QUIS) [48].

It is important to note that 2 questions arose while developing the prototype:

	Question	Current State
First Question	Should there be a "View" button next to each of the content names in the "Course Content and Recorded Lessons" section? (Figure 25)	To access the content the user will need to click on the name of the content, in other words, the student will click on a link instead of a button.
Second Question	After viewing content should the user click on the ✖ button or the ⬅ button to view the lesson's content? (Figure 26)	Currently both buttons return to the lesson's content.

<div align="center">Table 13 - Questions 1 and 2 to be answered in the Usability Study</div>

While the participants did the tasks on the AAL4ALL E-Learning platform we asked them the two above questions.

4.1 Participants of the Usability Study

This study was carried out at a U3A in the centre of Torres Vedras called "Universidade da Terceira Idade de Torres Vedras" [49]. All students who agreed to take part of the study were enrolled into computer courses at the university and had no serious health impairments.
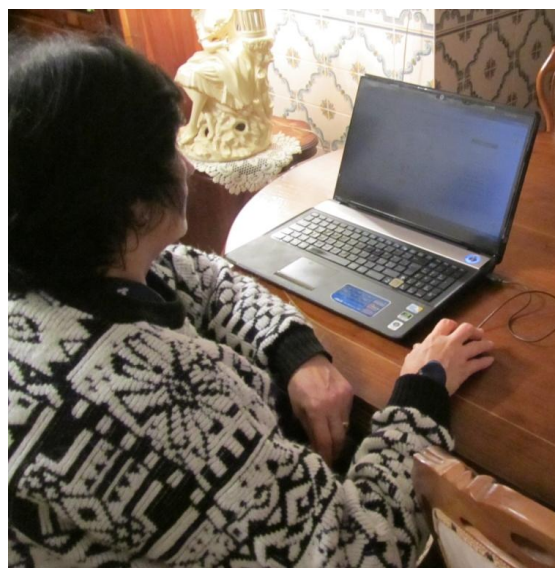
<div align="center">Figure 29 - One of the Participants of the Usability Study</div>

For this study a total of 10 people were interviewed, of which 5 are male and 5 are female. The number of participants of this study, arranged according to age group can be seen in the table below.

Age Group	Number of participants	Percentage of participants
65-69	6	60.00%
70-74	3	30.00%
75-79	1	10.00%
80+	0	0.00%

Table 14 - Number of Participants of the Usability Study Arranged According to Age Group

In terms of computer experience (figure 30), most participants classified themselves as "highly experienced" (5) followed by "average experienced" (3) and then by "less experienced" (2).
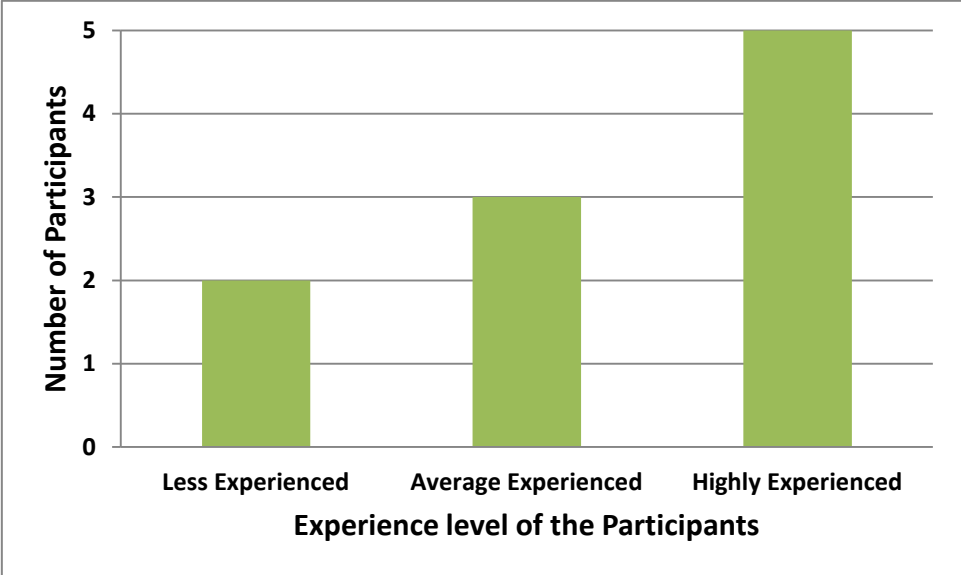
Figure 30 - Computer Experience of the Participants of the Usability Study

In the questionnaire the participants were also asked to state the number of times they use a computer per week and the results can be seen below (Figure 31). Based on the answers to this question, it was clear that most of the interviewed seniors were used to doing various types of tasks on the computer during their free time.
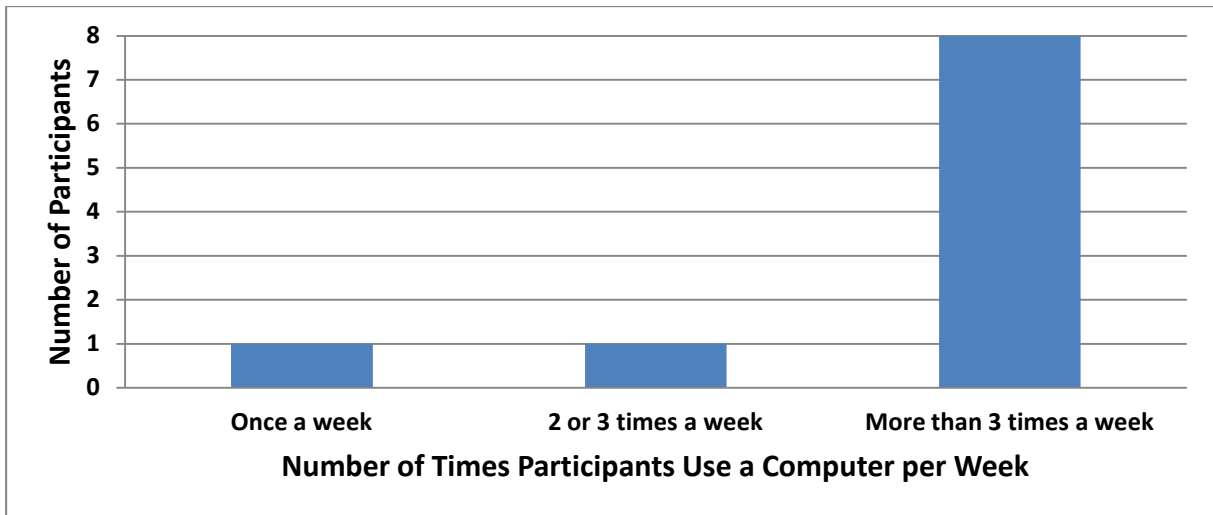
4.2 Results of the Usability Study

As seen in the questionnaire (appendix E2.1), there were 5 questions that the participants had to rate in a scale from **0** to **9**:

Q1 - Reading the letters or viewing the objects on screen is: Difficult (0) Easy (9)

Q2 - Performing the proposed tasks were: Difficult (0) Easy (9)

Q3 - Finding what you were looking for on the webpage was: Difficult (0) Easy (9)

Q4 - Using the E-Learning platform was: Frustrating (0) Satisfying (9)

Q5 - This E-Learning platform is: Less Appealing (0) More Appealing (9)

In order to compare the results of both platforms, the average results of all of these questions were calculated and can be seen in the figure below.
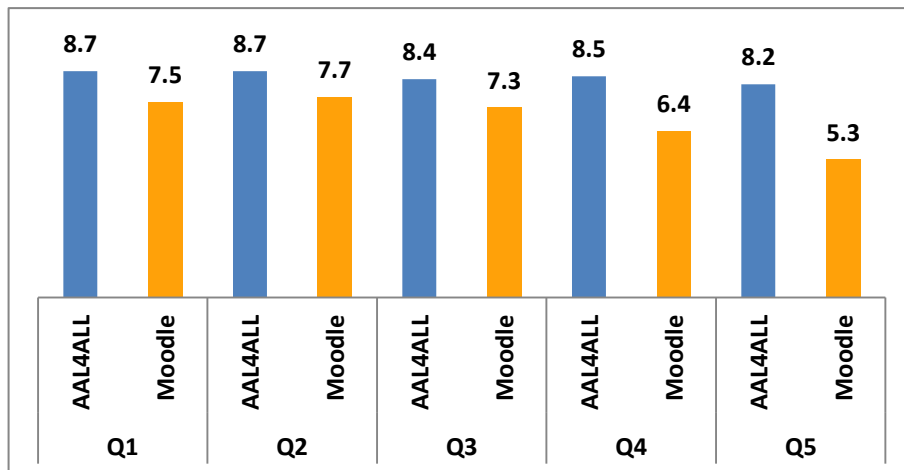
Figure 32 - Average of ratings of questions Q1, Q2, Q3, Q4 and Q5

47

According to the above graph, the AAL4ALL E-Learning platform scored higher points in all of the questions in comparison to Moodle.

A bigger difference was registered in question Q5 (2,9 points), meaning that on average the participants thought that the AAL4ALL website was more appealing. The second largest difference noted was question Q4 (2,1 points) which indicated that on average the participants found the AAL4ALL platform more satisfying to use.

After carefully analyzing all the notes taken during the realization of the tasks and the results of the questionnaire it was possible to summarize the positive and negative aspects of both platforms in the following tables.

Moodle	
Negative Aspects	**Positive Aspects**
- Links were too close to each other. - All participants needed assistance when performing the tasks. - Titles and normal text were hard to tell apart. - Participants didn't know whether or not they had to click on icons or their respective labels.	- Breadcrumb menu was useful.

Table 15 - Negative and Positive Aspects about Moodle discovered during the Usability Study

AAL4ALL E-Learning Platform	
Negative Aspects	**Positive Aspects**
- There should be labels under each of the video player's buttons. - The "Open in New Window" and "Change Course" buttons should be more appealing. - When opening content within the AAL4ALL E-Learning platform, the scroll buttons were too small to use properly. - Breadcrumb menu was not clickable. - Video player's progress bar was missing.	- Some of the participants used the shortcuts on left pane. - Many participants couldn't stop complimenting the interface. - Most of the colours used were very appealing. - Most of participants needed no assistance whatsoever when performing tasks.

Table 16 - Negative and Positive Aspects of the AAL4ALL E-Learning Platform discovered during Usability Study

It was interesting to note that the Moodle results were very similar to those of the requirements study, which is a indicator that the problems experienced with this platform are common problems experienced by our target group. In general, due to the fact that these seniors were more experienced with computers, we noted that many completed the tasks on both platforms with less difficulties.

In relation to both platform's video players, all of the participants claimed that they preferred the AAL4ALL's video player. In the VDG it is suggested that labels should be incorporated with buttons, however labels were not added beneath the buttons of the video player because we thought that seniors would associate them with a video-recorder remote control's buttons.

In relation to questions 1 and 2 (table 13), the results can be seen in the next table.

		Question	Result
First Question		Should there be a "View" button next to each of the content names in the "Course Content and Recorded Lessons" section? (Figure 25)	**3** participants preferred the link and **7** would have preferred to click on a "View" button.
Second Question		After viewing content should the user click on the ✖ button or the ⬅ button to view the lesson's content? (Figure 26)	**1** participant preferred to click on the ✖ button and **9** participants preferred to click on the ⬅ button.

<p style="text-align:center;">Table 17 - Answers to questions 1 and 2 of the Usability Study</p>

In table 17 we can see that most participants preferred to have a "View" button instead of a link to open course content. With regards to the second question, only 1 person preferred the ✖ button so this will be removed. Most participants were sceptical about clicking on the ✖ button because they were afraid it would exit the whole website.

Finally, at the end of the study, the seniors were asked which platform they preferred and **all** preferred AAL4ALL E-Learning platform. Some of the participants were so interested that they even asked me if it was available online yet.

Building on the findings of the usability study, the main adjustments to be made to the prototype can be seen in the following table.

Main Adjustments to be made to the Prototype User Interface
- Use a "View" button next to content name instead of using a link.
- Remove ✖ button.
- Add labels under video player buttons.
- Add video player's progress bar.
- Make breadcrumb menu clickable.
- Create larger scroll buttons for when content is opened within the prototype.
- Make "Change Course" and "Open in New Window" buttons look more appealing - Use brighter colours and add images to the buttons.

Table 18 - Main Adjustments to be made to the Prototype's User Interface

Chapter 5. Conclusions and Future Work

5.1 Conclusions

After the literature review (chapter 2) was complete, one of the main issues highlighted by various authors are the complexity of many websites available nowadays. Websites tend to be produced by young designers, who often assume that all users have perfect vision and motor control and know everything about the internet. More attention should be paid to designing websites with certain characteristics to make them more "senior-friendly".

Building on these findings, it became evident that before planning and developing the E-Learning platform, a list of design guidelines needed to be established. This being said, a list of VDG were set (chapter 3) to help understand what sort of characteristics needed to be accounted for when designing websites for seniors. After selecting the platform features that best suited the needs of the project and with the use of the VDG it was possible to sketch some initial mock-ups of the AAL4ALL E-Learning platform.

It was also found that using design guidelines alone is an insufficient way to overcome website usability issues. To try and resolve these issues, it is important to also involve the end users (seniors) throughout the design process in order to obtain better final results. With that in mind, we required assistance from the senior population to carry out two different types of studies: a requirements study and a usability study.

First a requirements study was carried out to gather as much feedback as possible from our target group before any development took place. In this study the participants had to perform a few tasks on Moodle to familiarize them with the E-Learning concept. While performing these tasks they were observed and notes were taken to register how they managed to complete the tasks. Once all the tasks were completed, they were asked to analyze the AAL4ALL E-Learning mock-ups and complete a questionnaire.

According to results of the questionnaire and the notes taken during the study, many of the difficulties experienced by the participants while performing the tasks could have been avoided if Moodle was designed with the VDG in mind. A few examples of issues found in this study were: disorienting pop-up windows, small scroll-bar buttons and the use of inappropriate text size.

As for the AAL4ALL E-Learning platform, all of the participants preferred the mock-ups of

this platform in comparison to the Moodle platform. Based on the findings of this study, only a few minor modifications needed to be applied to the mock-ups before commencing with the development phase.

Once the prototype development was complete, a usability study took place with a different group of seniors. This study commenced in a very similar manner to the requirements study but this time the AAL4ALL E-learning platform was complete. As such seniors were able to perform tasks on both platforms making them easier to compare.

The objective of this study was to analyze how the study participants interacted with the system and to verify if any additional changes needed to be applied to the prototype. After analyzing the results of the questionnaire and the notes, just like the requirements study, the seniors gave a lot of positive feedback in relation to the AAL4ALL E-Learning platform and experienced few difficulties while completing the tasks on this platform.

It was interesting to note that many of the difficulties experienced with the Moodle platform in the requirements study were also present in the usability study which was an indicator that these difficulties are common within our target age group.

Once the study was complete, we found that only a few alterations needed to be applied to the prototype which will be suggested as future work.

5.2 Future Work

For future work, it is firstly suggested to adjust the prototype according to table 18 and then to plan and implement the remainder of the student features and those of the other two remaining users: Professor and Administrator. Furthermore, it is important to acquire or develop an incorporated SCORM player and not use an external player like the one being used in the prototype.

When all this is done, the system needs to be interconnected with the AAL4ALL E-Commerce platform to enable the selling of courses (Figure 18). It would also be interesting to create a business plan to study how to promote the AAL4ALL E-Learning platform for U3As. The business plan can equally help understand why some of these institutions don't use this type of platform and find ways to overcome this problem.

It is also suggested that once all the features of the platform are complete, it's important to re-test it with a more representative sample to get more precise results. As for the professor and

administrator features, it would be interesting to inquiry professors and administrators of U3As to get some feedback from them as well.

Finally, when the re-testing is complete, it is strongly suggested to translate the platform into other widely used European languages, namely: English, Spanish, French and German.

References

[1] UN Department of Economic and Social Affairs: Population Division. "World Population to 2300". New York: United Nations, 2004. Available from: http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf

[2] Lanzieri, G. "The greying of the baby boomers: A century-long view of ageing in European populations". Eurostat: Statistics in focus, 2011, no. 23/2011,. Available from: http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-SF-11-023

[3] Eurostat, "Demography Report 2010: Latest figures on the demographic challenges in the EU". Eurostat Press Office, 2011, no. 50/2011. Available from: http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/3-01042011-BP/EN/3-01042011-BP-EN.PDF

[4] Eurostat, Europe in figures: Eurostat yearbook 2011. Luxembourg: Publications Office of the European Union, 2011. Available from: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-CD-11-001/EN/KS-CD-11-001-EN.PDF

[5] Steg, H; Strese, H; Loroff, C; Hull, J; Schmidt, S. "Europe Is Facing a Demographic Challenge: Ambient Assisted Living Offers Solutions". Germany: VDI/VDE-IT, 2006. Available from: http://www.aal-europe.eu/Published/reports-etc/Final%20Version.pdf

[6] "How E-learning Works" (2001). Obringer, L. A. [viewed 20 December 2012] Available from: http://people.howstuffworks.com/elearning1.htm

[7] S. J. Cutler. "Technological Change and Aging" in Handbook of Aging and the Social Sciences. 6th Ed. Academic Press, 2006

[8] Bridging Research in Ageing and ICT Development (BRAID) project. "Taxonomy". N/A, 2010, pp. 13. Available from: http://auseaccess.cis.utas.edu.au/sites/default/files/D1.1%20Taxonomy%20Final.pdf

[9] "Ambient Assisted Living for All (AAL4ALL) Official Website". AAL4ALL. [Viewed 19 October 2011]. Available from: http://www.aal4all.org/?lang=en

[10] "Quadro de Referência Estratégico Nacional (QREN) Official Website". QREN. [Viewed 20 October 2011]. Available from: http://www.qren.pt/np4/home

[11] "Facebook Official Website. Facebook". [Viewed 9 October 2011]. Available from: https://www.facebook.com/

[12] "Why You Only Need to Test with 5 Users" (2000). Nielsen, J. [Viewed 25 May2012]. Available from: http://www.useit.com/alertbox/20000319.html

[13] Šemberová, J. "Opportunities and perspectives of lifelong learning in older age: The results of the survey from the project eLearning in Later Life - eLiLL ". Crech Republic: University of South Bohemia in České Budějovice, 2007. Available from: http://www.elill.net/pdf/survey07_elill_en.pdf

[14] Ala-Mutka, K; Punie, Y. "Ageing Societies, Learning and ICT". EuroPACE, 2007. Available from: http://www.lill-online.net/online/documents/publications/elill_publ/media14198.pdf

[15] Boulton-Lewis, G. M; Buys, L; Lovie-Kitchin, J. "Learning and Active Aging, Educational Gerontology". Routeledge: Taylor & Francis Group, vol. 32, no. 4, 2006, pp. 271-282. Available from: http://www.tandfonline.com/doi/abs/10.1080/03601270500494030

[16] Willis, S. L; Tennstedt, S. L; Marsiske, M; Ball, K; Elias, J; Koepke, K. M; Morris, J. N; Rebok, G. W; Unverzagt, F. W; Stoddard, A. M; Wright, E. "Long-term Effects of Cognitive Training on Everyday Functional Outcomes in Older Adults". JAMA, Vol. 296, no. 23, 2006. Available from: http://lang.dailynews.com/socal/dnfiles/jama.pdf

[17] Regec, M. "Opening Information Technology to Senior Populations", Slovak Republic: Comenius University in Bratislava - Faculty of Philosophy, 2007. Available from: http://www.lill-online.net/online/documents/publications/elill_publ/bratislava_opening_information_technology_to_senior_population.pdf

[18] Körting, G. "Older Learner Needs and Requirements for Learning with ICT". Germany: University of Ulm, 2007. Available from: http://www.lill-online.net/online/documents/publications/elill_publ/ict4t_wp2_report.pdf

[19] Stadelhofer, C; Marquard, M. "The Internet as a chance for continuing education of seniors in a united Europe" in Proceedings of the European Conference - Learning in Later Life - November 25th -28th. N/A, 2005. Available from: http://www.uni-ulm.de/uni/fak/zawiw/lill_05/content/papers/pdf/abs/stadelhofer_marquard_abs-eng.pdf

[20] Seybert, H. "Internet use in households and by individuals in 2011". Eurostat: Statistics in focus, 2011, no. 66/2011, pp. 3. Available from: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-066/EN/KS-SF-11-066-EN.PDF

[21] Becker, S. A. "A Study of Web Usability for Older Adults Seeking Online Health Resources". Florida Institute of Technology, 2004. Available from: http://delivery.acm.org/10.1145/1040000/1035578/p387-a_becker.pdf?ip=193.136.189.3&acc=ACTIVE%20SERVICE&CFID=166840722&CFTOKEN=51374582&__acm__=1357569895_42dfc8dd926b83e028d14e3888e92ed3

[22] Newell, A; Arnott, J; Carmichael, A; Morgan, M. "Methodologies for Involving Older Adults in the Design Process" in Proceedings of HCI International 2007 Conference - Beijing, China, 22nd - 27th July 2007, vol. 5, pp. 982-989. Germany: Springer-Verlag, 2007. Available from: http://www.computing.dundee.ac.uk/staff/jarnott/HCI2007-Method-pre.pdf

[23] Dix, A; Finlay, J; Abowd, G. D; Beale, R. "Human-Computer Interaction". 3rd Ed. Essex: Pearson Education Limited, 2003

[24] Kantner, L; Rosenbaum, S. "Usable Computers for the Elderly: Applying Coaching Experiences" in Proceeding of IPCC 2003 - The annual conference of the IEEE Professional Communication Society, 21st-24th September 2003. Tec-Ed, Inc.,2003. Available from: http://teced.com/wp-content/uploads/2011/06/ipcc_2003Accessibility.pdf

[25] Miralles, F; Tena, M; Lopez, J. P; Petter, C; Schneider, R; Nerney, O. "Usability and methodology studies for SeniorLearning – Adapting e-learning techniques for integrating senior citizens in the new digital world". CRIC; IFS; ZAWiW; IPIC, N/A. Available from: www.seniorlearning.eu/site/SeniorLEarning%20Paper_UsabilityDay_Dornbirn_final.doc

[26] "Learning in Later Life Official Website (LiLL)". [Viewed 2 February 2012]. Available from: http://www.lill-online.net/online/?startseite.en

[27] "e-Learning in Later Life (eLiLL) - a European Project". [Viewed 2 February 2012]. Available from: http://www.elill.net

[28] "Moodle Official Website". [Viewed 6 June 2012]. Available from: http://moodle.org/

[29] "Blackboard Official Website". [Viewed 6 June 2012]. Available from: www.blackboard.com

[30] "Webwise Official Website". [Viewed 2 October 2011]. Available from: http://www.bbc.co.uk/webwise/0/

[31] "Rustici Software Official Website". [Viewed 25 March 2012]. Available from: http://scorm.com/scorm-explained/

[32] MFKK - Invention and Research Center Ltd. "Web 2.0 Best Practices for Senior Citizens". N/A, 2011. Available from: http://www.geengee.eu/geengee/geengee-docs/contenuti/comune/web%202%200%20seniors_v9.pdf

[33] Redish, J; Chisnell, D. "Designing Web Sites for Older Adults: A Review of Recent Research". AARP, 2004. Available from: http://assets.aarp.org/www.aarp.org_/articles/research/oww/AARP-LitReview2004.pdf

[34] NIA; NLM. "Making your website user-friendly - A Checklist". NIA; NLM, 2002. Available from: http://www.nlm.nih.gov/pubs/checklist.pdf

[35] Agelight - Technology & Generational Marketing Strategies. "Interface Design Guidelines for Users of All Ages". AgeLight LCC, 2001. Available from: http://www.agelight.com/webdocs/designguide.pdf

[36] Reich, K; Petter, C; Helling, K. "Usability and Ergonomics Considerations on eLearning of Older Adults". Austria: Institute for Future Studies, 2007. Available from: http://www.seniorlearning.eu/site/Output%202%20-%20usability%20and%20ergonomics%20report.pdf

[37] Kurniawan, S; Zaphiris, P. "Research-Derived Web Design Guidelines for Older People" in Proceedings of the 7th International ACM SIGACCESS Conference on Computers and Accessibility. USA: New York, pp. 129-135, 2005. Available from: http://www.soi.city.ac.uk/~zaphiri/Papers/assets2005.pdf

[38] Immersion Active. "Interactive Design Preferences of 50-Plus Users". Immersion Active, 2006. Available from: http://www.immersionactive.com/files/whitepaper/DesignPref50PlusUsers721.pdf

[39] Bernard, M. "Criteria for optimal web design (designing for usability)". Wichita: Wichita State University - Software Usability Software Lab, 2003. Available from: http://uwf.edu/ddawson/d3net/documents/web_usability/optimal%20web%20design.pdf

[40] IMS. "IMS Guidelines for Developing Accessible Learning Applications". IMS Global Learning Consortium, Inc., 2002. Available from: http://web4all.atrc.utoronto.ca/IMS_docs/IMS%20Accessibility%20Guidelines/imsacc_guide v1p0.pdf

[41] "Section 508 Standards Guide". [Viewed 7 May 2012]. Available from: http://www.section508.gov/index.cfm?fuseAction=stdsdoc

[42] "Ten Usability Heuristics" (1995). Nielsen, J. [Viewed 10 May 2012]. Available from: http://www.nngroup.com/articles/ten-usability-heuristics/

[43] "Busca Completa Official Website". [Viewed 4 November 2012]. Available from: https://www.facebook.com/busca.completa?fref=ts

[44] "DotNetNuke Official Website". [Viewed 25 July 2012]. Available from: http://www.dotnetnuke.com/

[45] "Visual Studio Official Website". Microsoft. [Viewed 20 July 2012]. Available from: http://www.microsoft.com/visualstudio/en-gb

[46] "SQL Server Official Website". Microsoft. [Viewed 19 July 2012]. Available from: http://www.microsoft.com/sqlserver/en/us/default.aspx

[47] "SCORM Proxy Player". SCORMpool [Viewed 17 July 2012]. Available from: http://scormpool.com/search/player.aspx

[48] "Questionnaire for User Interface Satisfaction" (1988). Chin, J.P; Diehl, V.A; Norman, K.L. [Viewed 20 November 2012]. Available from: http://hcibib.org/perlman/question.cgi?form=QUIS

[49] "Information about Universidade de Terceira Idade de Torres Vedras". RUTIS. [Viewed 1 September 2012]. Available from: http://www.rutis.org/cgi-bin/reservado/scripts/command.cgi/?naction=7&usr=035

[50] "Web Content Accessibility Guidelines (WCAG) 2.0". W3C. [Viewed 1 April 2012]. Available from: http://www.w3.org/TR/WCAG/

[51] "Telecare". [Viewed 2 October 2012]. Available from: http://www.lifelinkresponse.com.au/telecare/

[52] "The web should net all" (2003). Nielsen, J. [Viewed 3 March 2012]. Available from: http://www.guardian.co.uk/technology/2003/jan/16/comment.onlinesupplement

Appendices

Appendix A - Website Visual Design Guidelines

A1.1 Full list of Website Visual Design Guidelines

Layout and Style

- Use a sans serif typeface (Arial, Verdana, Helvetica etc.) that is not condensed. Avoid the use of serif, novelty, and display typefaces [32] [33] [34] [37] [38] [39].

- Use 12 point or 14 point type size for body text [32] [34].

- Limiting the use of bold to emphasize a title or a key word is recommended [35].

- Body text in upper and lowercase letters [32] [34] [37] [38].

- Reserve all capital letters and italics for headlines only [32] [34].

- Heading should be between 18 and 24 point type size [33].

- Reserve underlining for links [32] [34] [35] [38].

- Double space body text [32] [33] [34] [37].

- Left justified text is optimal for older adults [32] [34] [35] [37] [38].

- Add more relevant information on top of the screen to avoid scrolling as much as possible [35] [37].

- Avoid flashing and blinking graphics [35] [41].

- Avoid excessive pop-up windows and advertisement banners [35] [37] [39].

- Use white space to help direct users' attention by grouping items on a page so that users can see at a glance how items are related [32] [33].

- Row and column headers shall be identified for data tables (when applicable) [41].

- Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue (Create shortcuts) [42].

- Use index layout over a cascading layout [39].

- Bulleted items should be clickable [33].

Scrolling

- Avoid automatically scrolling text. If manual scrolling is required, incorporate specific scrolling icons [32] [34].

- Horizontal scrolling should be avoided [39].

Colour

- Adjacent colours to avoid would be orange and red as they do not offer a high level of differentiation to the aging eye [35]. It is also suggested to avoid yellow, blue and green in close proximity [34] [37] [38].

- Use dark typeface or graphics against a light background (high contrast), or white lettering on a black or dark-coloured background [37] [38] [39].

- Avoid patterned backgrounds [32] [34] [35].

- Warm colours and harmonic colour schemes are more suitable than cold colours and strange colour combinations [32] [35].

- Coloured images are more easily remembered than black and white images [39].

- Already visited links should change colour, normally to purple [33].

Menus and Navigation

- Avoid using pull down menus [34] [37] [38].

- Incorporate buttons such as "Previous Page" and "Next Page" to allow the reader to review or move forward [34].

- An easy to identify "Home" button should be present on every page [32].

- Consider including hyperlinks within longer pages so viewers can "jump" from section to section with a single click [35].

- Users perform better with shallower hierarchies [32] [33] [37] [38] [39].

- The organisation of the web site should be simple and straightforward [32] [37] [38] [39].

- Carefully label links [32] [34] [37].

- Use single mouse clicks to access information, wherever possible [32] [34] [37].

- Use a standard page design and the same symbols and icons/buttons throughout the website. In other words, maintain a consistent layout between pages [32] [34] [38] [40] [41] [42].

- Label each page in the same location with the title of the webpage [32] [34].

- Provide a sitemap to show how the site is organized [32] [33] [34] [37] [38].

- Avoid dynamically changing menu structures [32].

- Implement a breadcrumb menu showing where the user is located within the site [32] [37] [38] [39] [14].

- Change colours of links in order to mark already visited pages [32] [37] [39].

- Never expect a user to click on a moving graphic element/banner or text [35] [37].

- Group information and menus into meaningful categories [37] [38] [39].

- Make all functionality available from a keyboard [40] [41].

- There should be clear distinction between what is clickable and what is not (*e.g.* use black font for normal text and blue font for clickable links) [33].

Buttons and Styles

- Buttons should be logically arranged [32].

- Incorporate text with the icon if possible (label), and use large buttons that do not require precise mouse positioning for activation [32] [33] [34] [35] [37] [38].

- An easy to read font (preferably sans-serif: *e.g.* Arial, Helvetica, Tahoma, etc.) should be used for text labels [32] [33] [34] [37] [38] [39].

- The colour chosen should have sufficient contrast to the background [32] [37] [38] [39].

- Icons should be simple and meaningful [32] [33] [37].

- Space between buttons and other elements on the interface should be sufficient [32] [33].

- Buttons could be linked to an audio signal, *e.g.* keystroke. In order to provide optimal audio output for older adults affected by varying degrees of hearing loss, spoken language should be loud, clear and audible [32] [33].

- In order to aid older adults to identify buttons as clickable the cursor or button may change when hovering over a button [32] [33] [37] [41].

Search Function

- Search form should be clearly differentiated from other content of a web site and should be labelled with the word "Search". A magnifying glass icon can be a helpful hint [32].

- Help and important instructions for using the search functionalities should be provided [32].

- A search functionality offered on a web site should tolerate spelling mistakes or should offer suggestions for improved search results [32] [37].

- Search results should be arranged according to relevance [32].

Language and Terminology

- Present information in a clear and concise way to reduce the number of inferences that must be made [32] [34] [42].

- Use active voice [32] [33] [34].

- Write short, straightforward/simple and clear sentences and keep paragraphs as short as possible [32] [33] [34] [35] [37] [38].

- Use lists [32] [33].

- Use vocabulary familiar to your readers, *e.g.* avoid technical vocabulary or foreign language expressions if possible [32] [33] [38] [41].

- Avoid contents stigmatising or discriminating age but point out positive approaches, creative solutions, demanding products, success stories, etc. instead. In other words use positive statements [32] [34].

Multimedia

- Use style-sheets [35].

- Give the user the possibility to control the speed of animations, videos, etc. (*e.g.* pause/stop buttons) [32] [41].

- Use captioning for videos [33].

- Be aware that plug-ins or additional software needed may not be installed on the computer [32].

- The printing of all information should be possible. Many older adults prefer to read information on printed paper [32].

- Graphics should be relevant and not for decoration [37].

- Images should have alt tags [35] [37] [39] [41].

- Use text-relevant images only [32] [34].

User Customization

- Provide basic information on how to adjust the browser or operating system settings [35].

- There should be a button to change font type size [33].

- Allow for customization based on user preference [40].

Documentation and Feedback

- Provide a "Frequently Asked Questions" (FAQ) section, which has to be updated and reflect the feedback of the visitors about problems they experienced [32].

- Include direct assistance on what to do and explain errors in a simple manner [32] [37].

- For complex environments offering a series of different functionalities it is recommended to include a short tutorial to teach visitors how to use it [34] [37] [40].

- Provide a feedback form for persons seeking help [34] [37].

- Offer a telephone number for those who would prefer to talk to a person responsible or provide an e-mail address for questions or comments/suggestions ("Contact us" section) [34].

Appendix B - Use-Case Diagrams

B1.1 Use-Case Diagram of the Professor's Primary Features
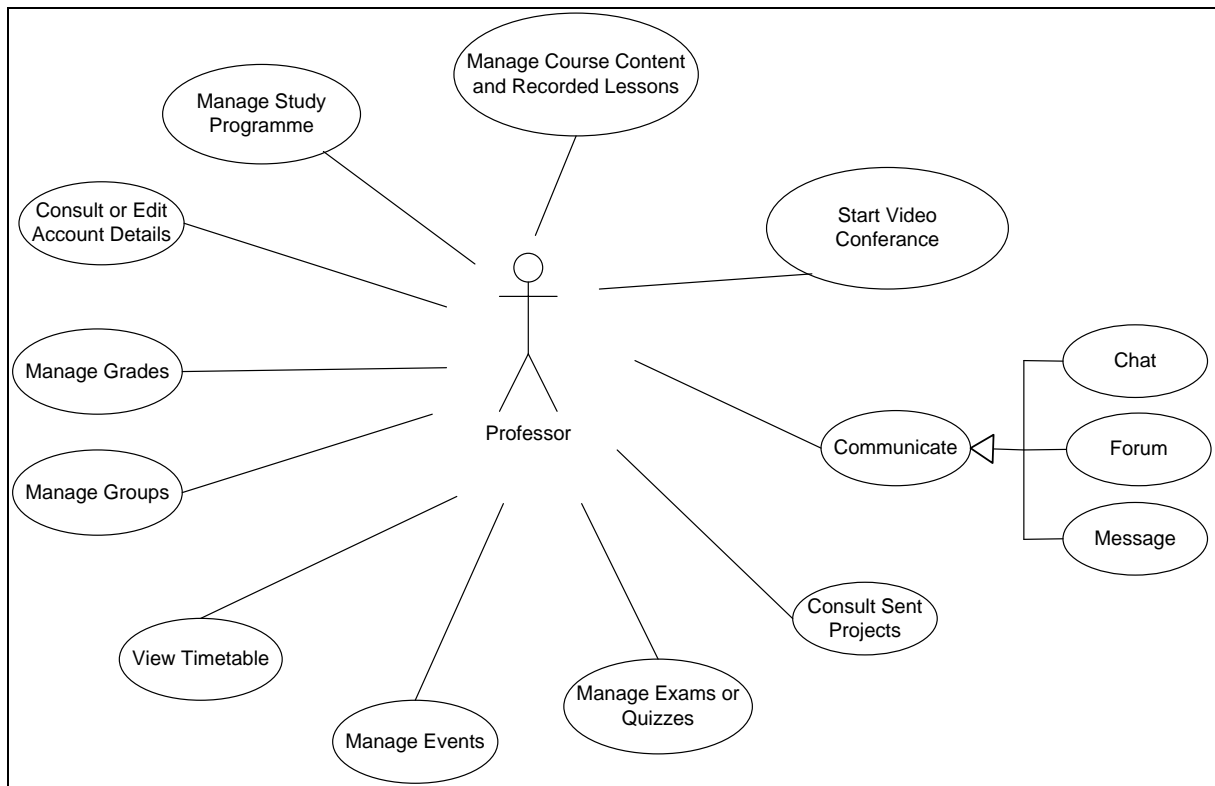
B1.2 Use-Case Diagram of the Administrator's Primary Features
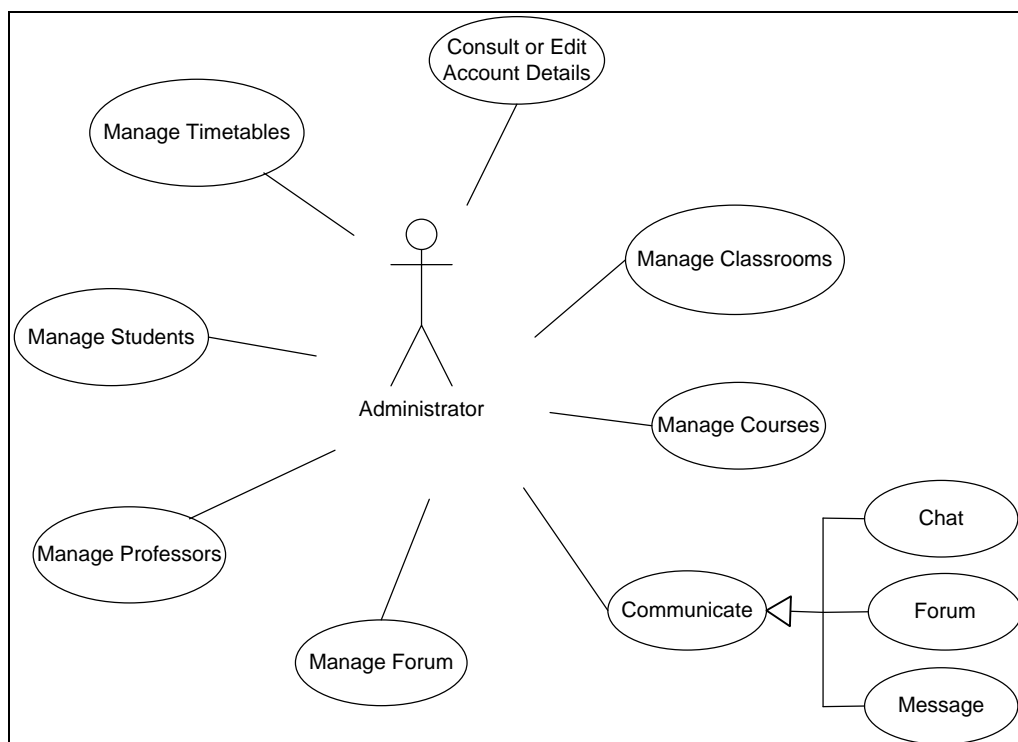
B2.1 Brief Description of all of the Student's Features

Primary Features	Description
Grades	Displays all of the student's grades of the selected course.
Course Content and Recorded Lessons	Contains all course content and recorded videos of each of the lessons of the selected course.
Submit Project	Enables students to upload projects so that the professor can view and evaluate them.
Chat	Enables users to chat with all logged in users of the selected course (including professors and administrators)
Account Details and Settings	Displays the user's account details and allows the user to modify some of the details (*e.g.* change e-mail address).
Forum	Let's all users of a selected course create topics and to discuss them using posts.
Timetable	For those students who want to attend the lesson in person, the timetable section lets them view the timetable to see which classrooms the lessons will be taught in.
Virtual Classroom (Web-Conference)	With the use of microphone and webcam, this feature will enable students to view the teacher lecturing and also enables them to chat to the teacher and other logged in users (via voice or text).
Course Study Programme	Permits students to view the study programme of the selected course.
Send and Receive Messages	Enables all users of the system to exchange messages within a specific course.
Exams/Quizzes (Online)	Permits students to perform online exams (*e.g.* multiple choice exams).
Events	Permits the students to view a specific course's planned events.
Groups	Lets the student view all members of his or her group.
Secondary Features	
List of all Enrolled Courses	Enlists all courses the logged in student is currently enrolled into.
Notifications/Announcements	Displays all the student's notifications and announcements (including events).
Calendar	A clickable calendar which lets students select a specific day to view the notifications and announcements of the selected day.
Login/Logout	Login and logout lets the student enter and exit the website respectively.
Enable SCORM Certified Courses	A SCORM course player that executes SCORM certified courses.
Frequently Asked Questions (FAQ)	A section with all the frequently asked questions and respective answers.
Help Section	A help section with useful information.
Language Selection Button	Lets the user switch the current platform's language.
Privacy Statement Section	A section with all information regarding privacy (*e.g.* information such as what information is shared with others).
Institution Contacts	Contacts of the institution that teaches the selected course.
Sitemap	A sitemap outlines the various sections of the website.
Accessibility Features	
Increase/Decrease Text Size	Text can be resized with a simple click of a button.
Increase/Decrease Contrast	The contrast can be modified with a simple click of a button.
Bigger Scrolling Buttons	Displaying of larger scrolling buttons.
Video Player Designed for Seniors	A video player with special buttons to make the viewing of videos simpler for seniors.

Appendix C - Class Diagram

C1.1 Full Generic Class Diagram of all of the Platform Features

Appendix D - Requirements Study Additional Data

Appendix D1.1 Moodle Entrance Webpage

Appendix D1.2 Moodle Course Selection Webpage

Appendix D1.3 Moodle Grades Feature

Curso Exemplo 1: View: Overview report

Home ► My courses ► Curso Exemplo 1 ► Grade administration ► Overview report

Navigation ▬▮▯

Home
▫ My home
▸ Site pages
▸ My profile
▸ My courses

Settings ▬▮▯

▾ Grade administration
　▤ **Overview report**
　▤ User report
▸ Course administration
▸ My profile settings

Overview report ▾

Overview report - Estudante .

Course name	Grade
Curso Exemplo 1	15
Curso Exemplo 2	-

Appendix D1.4 Moodle Video Player

Curso Exemplo 1

Home ► My courses ► Curso Exemplo 1 ► Aula 2 - Data: 03 Setembro 2012 ► Video Exemplo

Navigation ▬▮▯

Home
▫ My home
▸ Site pages
▸ My profile
▸ My courses

Settings ▬▮▯

▸ Course administration
▸ My profile settings

Share ⬇ More info

Reproduzido....

Calendar ▬▮▯

◀　January 2013　▶

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Events key

👁 Global　　👁 Course
👁 Group　　👁 User

Appendix D1.5 Moodle Project Feature

Appendix D2.1 Moodle Tasks (Requirements Study)

Moodle Tasks - Requirements Study

1 - Please enter the Moodle platform using the following username and password.

Username: **Estudante**

Password: **Estudante2012***

2 - Please enter the course called: "**Exemplo de aprendizagem à distância**"

3 - In the "**Aula 1 - 01 Setembro 2012**" section, please perform the following tasks:

3.1 - Click on the file: "**Ficheiro de formato excel**". Save this file on your computer. Open the file and please do what is instructed on the file.

3.2 - Click on the video names "**Vídeo de exemplo**". Click directly on the video to play it.

3.3 - Return to the course's main menu.

3.4 - Click on the link named: "**Website do Correio de Manhã**".

3.5 - Return to the course's main menu.

4 - In the "**Aula 2 - 03 Setembro 2012**" section, please perform the following tasks:

4.1 - Click on the file: "**Ficheiro de formato word**". Save this file on your computer. Open the file and do please what is instructed on the file.

4.2 - Click on the image called: "**Imagem de uma sénior**".

5- End your current session.

Thank you so much for your collaboration. ☺

Appendix D2.2 Questionnaire (Requirements Study)

Requirements Study Questionnaire

* Mandatory

General Questions

Please state your gender. *
◯ Male
◯ Female

Please state your age group. *
◯ 65 - 69
◯ 70 - 74
◯ 75 - 79
◯ 80 +

How often do you use a computer or the internet? *
◯ Once a week.
◯ 2 to 3 times a week.
◯ More than 3 times a week.

In accordance to the number of tasks you perform, in your opinion how would you rate your computer or internet experience? *
Example of computer tasks: Composing and sending E-Mails; Using Social Networks
◯ Less Experienced (1 or 2 tasks)
◯ Average Experienced (3 to 5 tasks)
◯ Highly Experienced (More than 5 tasks)

After completing Moodle Tasks

Please indicate which tasks were harder to perform?
Please state negative aspects you may have noticed.

Please indicate which tasks were easier to perform?
Please state positive aspects you may have noticed.

After viewing AAL4ALL E-Learning mock-ups

What is your general opinion about the mock-ups?
For example: Do you like the location of the buttons? Do you like the use of icons or even the colours being used?

Were there any characteristics or features that you did not understand?

Would you suggest to change anything in the images you just viewed?
Please state suggestions or criticisms about the images.

Based on the images displayed, do you think it would be easy to use the AAL4ALL E-Learning platform?
◯ Yes
◯ No

If you answered no to the previous question, please state why?
If possible please suggest ways to make the platform easier to use.

Do the various images displayed correspond to the mental images in your mind?
For example: When you think of a timetable, does the picture of a calendar come to mind?

Do you think you would ever use the buttons located on the top menu?
Font size buttons and contrast buttons.

Appendix E - Usability Study Additional Data

Appendix E1.1 Moodle Tasks (Usability Study)

Moodle Tasks - Usability Study

1 - After entering the E-Learning website, please enter the following username and password:
Username: **Estudante**
Password: **Estudante1***

2 - Please enter the course named: "**Curso Exemplo 1**" to view the course's main menu.

3 - Have a look at the grades section.

3.1 - After looking at the grades please return to the course main menu.

4 - Please try to send a file using the: "**Enviar Projecto**" feature.

4.1 - After sending the file please return to the course's main menu.

5 - Have a look at lesson 1 (**Aula 1 - 01 de Setembro 2012**) and proceed in doing the following tasks:

5.1 - Open the file called: "**Ficheiro Word**".

5.2 - After closing the file please return to the course's main menu.

6 - Have a look at lesson 2 (**Aula 2 - 03 de Setembro 2012**) and complete the next two tasks:

6.1 - Play the video called "**Video Exemplo**".

6.2 - Pause the video then replay it until it ends.

7 - Now please return to the list of courses and select the course named "**Curso Exemplo 2**" and in lesson 1 (**Aula 1 - 04 de Setembro 2012**) please carry out the following tasks:

7.1 - Please click on the "Entrar" button to enter the interactive course named: "**Curso sobre a Terra**". Please note that it may take a few seconds to load.

7.2 - You may explore the content of the course if you like.

8 - Please end your session (logout).

Thank you so much for participating in this study. ☺

Appendix E1.2 AAL4ALL Tasks (Usability Study)

AAL4ALL Tasks - Usability Study

1 - After entering the E-Learning website, please enter the following username and password:
Username: **Estudante**
Password: **Estudante1***

2 - Please enter the course named: "**Curso Exemplo 1**" to view the course's main menu.

3 - Have a look at the grades section.

3.1 - After looking at the grades please return to the course main menu.

4 - Please try to send a file using the: "**Enviar Projecto**" feature.

4.1 - After sending the file please return to the course's main menu.

5 - Please enter the "**Conteúdos e Aulas Gravadas**" feature and have a look at lesson 1 (**Aula 1 - 01 de Setembro 2012**) and proceed in doing the following tasks:

5.1 - Open the file called: "**Ficheiro Word**".

 5.2 - After closing the file please return to the list of lessons.

6 - Have a look at lesson 2 (**Aula 2 - 03 de Setembro 2012**) and complete the next two tasks:

6.1 - Play the video called "**Video Exemplo**".

6.2 - Pause the video then replay it until it ends.

7 - Now please return to the list of courses and select the course named "**Curso Exemplo 2**" and then enter "**Conteúdos e Aulas Gravadas"** and in lesson 1 (**Aula 1 - 04 de Setembro 2012**) please carry out the following tasks:

7.1 - Enter the interactive course named: "**Curso sobre a Terra**". Please note that it may take a few seconds to load.

7.2 - You may explore the content of the course if you like.

8 - Please end your session (logout).

Thank you so much for participating in this study- ☺

Appendix E2.1 Questionnaire (Usability Study)

Usability Study Questionnaire

* Mandatory

General Questions

Please state your gender. *
◯ Male
◯ Female

Please state your age group. *
◯ 65 - 69
◯ 70 - 74
◯ 75 - 79
◯ 80 +

How often do you use a computer or the internet? *
◯ Once a week.
◯ 2 to 3 times a week.
◯ More than 3 times a week.

In accordance to the number of tasks you perform, in your opinion how would you rate your computer or internet experience? *
Example of computer tasks: Composing and sending E-Mails; Using Social Networks
◯ Less Experienced (1 or 2 tasks)
◯ Average Experienced (3 to 5 tasks)
◯ Highly Experienced (More than 5 tasks)

USABILITY QUESTIONS (MOODLE)

NA - Not Applicable

Reading the letters or viewing the objects on screen is:

	0	1	2	3	4	5	6	7	8	9		
Difficult	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	**Easy**	**NA**

Performing the proposed tasks were:

	0	1	2	3	4	5	6	7	8	9		
Difficult	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	**Easy**	**NA**

Finding what you were looking for on the webpage was:

	0	1	2	3	4	5	6	7	8	9		
Difficult	○	○	○	○	○	○	○	○	○	○	Easy	NA

Using the E-Learning platform was:

	0	1	2	3	4	5	6	7	8	9		
Frustrating	○	○	○	○	○	○	○	○	○	○	Satisfying	NA

This E-Learning platform is:

	0	1	2	3	4	5	6	7	8	9		
Less Appealing	○	○	○	○	○	○	○	○	○	○	More Appealing	NA

USAILITY QUESTIONS (AAL4ALL)

NA - Not Applicable

Reading the letters or viewing the objects on screen is:

	0	1	2	3	4	5	6	7	8	9		
Difficult	○	○	○	○	○	○	○	○	○	○	Easy	NA

Performing the proposed tasks were:

	0	1	2	3	4	5	6	7	8	9		
Difficult	○	○	○	○	○	○	○	○	○	○	Easy	NA

Finding what you were looking for on the webpage was:

	0	1	2	3	4	5	6	7	8	9		
Difficult	○	○	○	○	○	○	○	○	○	○	Easy	NA

Using the E-Learning platform was:

	0	1	2	3	4	5	6	7	8	9		
Frustrating	○	○	○	○	○	○	○	○	○	○	Satisfying	NA

This E-Learning platform is:

0	1	2	3	4	5	6	7	8	9

Less Appealing ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ **More Appealing   NA**

After completing tasks on both platforms

Which platform's video player do you prefer?

Moodle ○   AAL4ALL ○

Which E-Learning Platform do you prefer?

Moodle ○   AAL4ALL ○

Questions solely about the AAL4AAL E-Learning platform

Please indicate positive aspects (if any):

Please indicate negative aspects (if any):

Do you have any suggestions on improving the AAL4ALL E-Learning platform?