



# Inclusão Digital em Cooperação com os Utilizadores para Estratégias Web: Plataforma de Boas-vindas para Estudantes

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**Digital Inclusion in Cooperation with its Users for  
Web Strategies  
Students Welcome Platform**

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# Resumo

A informação tem um grande impacto na vida dos cidadãos, como tal a qualidade, disponibilidade e forma de acesso condicionam o conhecimento e as oportunidades no futuro de cada indivíduo. Qualquer contribuição para minimizar as barreiras no acesso à informação promove a equidade. Nos dias que correm, o conteúdo da Internet ainda não está adaptado às pessoas com deficiências auditivas e visuais. O mesmo aplica-se à maioria dos websites das instituições de ensino superior, como é o caso do website do Instituto Superior de Engenharia do Porto (ISEP). Os websites institucionais têm a obrigação de disponibilizar a informação equitativamente entre os estudantes. Mesmo tendo em conta que as instituições de ensino superior dispõem de um espaço físico dedicado ao apoio e integração dos estudantes, a ajuda ou informação requerida não é normalmente disponibilizada atempadamente. O objetivo desta dissertação é apresentar uma proposta para a melhoria da integração dos estudantes do ensino superior através do desenvolvimento de uma plataforma web que promove a equidade. A plataforma web irá contribuir para a resolução de problemas relacionados com a integração e a ansiedade dos estudantes, ao fornecer meios que facilitam a comunicação entre os estudantes, de forma a que possam encontrar colegas predispostos a ajudar. Em alguns casos, estes estudantes terão exatamente as características que correspondem às necessidades de quem procura auxílio, como por exemplo, falar língua gestual ou outra língua verbal. Desta forma, os estudantes não precisarão de esperar pela orientação institucional no início do ano letivo. O conteúdo da plataforma web tem em conta a acessibilidade para estudantes com deficiência auditiva ou visual. O desenvolvimento desta proposta teve em consideração os resultados do inquérito realizado de modo a entender a perceção dos estudantes no que diz respeito à sua integração nas instituições de ensino superior que frequentam.

**Palavras-chave:** Instituições de Ensino Superior, Inclusão Social, Acessibilidade da Web, Design Inclusivo, Estudantes.



# Abstract

Information greatly impacts citizens' life, therefore the quality and timely access to it directly interferes in knowledge, and future opportunities. Any proposal aiming to contribute to minimize those barriers promotes equity. Nowadays, web content is still not prepared for users with hearing and visual disabilities. This occurs in most Higher Education Institutions' websites, such as the website of Instituto Superior de Engenharia do Porto (ISEP). The institutional websites should provide the information in such a way that it could be accessed equally by every student. Even though, the higher education institutions have at least a physical office dedicated to support students' integration, the help or information required is often not delivered in due time. The focus of this dissertation is to introduce a proposal to improve students' integration in higher education institutions through a web platform that promotes equity. The web platform will contribute to solve integration and anxiety issues most students face, by providing them with means to easily communicate with other students already predisposed to help, and, in some cases, with a set of characteristics matching their needs. This will allow students to get the help they need in time, without having to wait for formal institutional guidance in the beginning of the school year. The proposed web platform content was developed considering accessibility friendly issues for hearing and visual impaired students. Additionally, a survey was conducted to gather the students' insights about their integration in the higher education institution they are attending.

**Keywords:** Higher Education Institutions, Social Inclusion, Web Accessibility, Inclusive Design, Students.



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# Acronyms and Symbols

## Acronyms List

<b>ACAPO</b>	Portuguese Association for the Blind and Low Vision People ( <i>Associação dos Cegos e Amblíopes de Portugal</i> )
<b>ASP</b>	Association of the Deaf in Porto ( <i>Associação de Surdos do Porto</i> )
<b>GTAEDES</b>	Workgroup to Support Students with Disabilities in Higher Education ( <i>Grupo de Trabalho para Apoio a Estudantes com Deficiências no Ensino Superior</i> )
<b>SiAT</b>	Social Inclusion Assessment Tool
<b>PORDATA</b>	Database of Contemporary Portugal ( <i>Bases de Dados Portugal Contemporâneo</i> )
<b>SEF</b>	Foreigners and Border Service ( <i>Serviço de Estrangeiros e Fronteiras</i> )
<b>DGES</b>	Directorate General for Higher Education ( <i>Direção-Geral do Ensino Superior</i> )
<b>SECTES</b>	State Secretariat of Science, Technology and Higher Education
<b>FCT</b>	Portuguese Foundation for Science and Technology ( <i>Fundação para a Ciência e a Tecnologia</i> )
<b>SCTN</b>	National Scientific and Technological System
<b>W3C</b>	World Wide Web Consortium
<b>WCAG</b>	Web Content Accessibility Guidelines
<b>TGP</b>	The Paciello Group
<b>RNIB</b>	Royal National Institute of Blind People
<b>CMS</b>	Content Management Systems
<b>MCV</b>	Model-View-Controller
<b>FEI</b>	Front-End of Innovation
<b>NPD</b>	New Product Development
<b>MCCSIS</b>	Multi Conference on Computer Science and Information Systems
<b>SEI</b>	Computer Engineering Symposium ( <i>Simpósio de Engenharia Informática</i> )

**AHP**      Analytic Hierarchy Process

**VS**      Virtual Sign



# 1 Introduction

This document, referring to the Dissertation (TMDEI) curricular unit, aims to analyse and clarify social inclusion related issues in higher education, as well as to present the findings concerning the research focused on adopted Inclusive Design strategies in cooperation with diverse types of users. The final purpose of this research is to develop a web solution to address and overcome the identified issues.

## 1.1 Context and Problem

Information has a great impact on the life of individuals; therefore, access barriers to accurately and timely access it may limit the quality of knowledge, and future opportunities. Any contribution aiming at minimizing and overcoming those barriers promotes equity.

Currently, most of the existing web platforms are not prepared for users with hearing or visual disabilities. This is the case of most higher education websites, which so far are not required to provide information in an accessibility friendly way to all the students.

Social inclusion is another critical area that needs to be approached. Recently, international students' mobility has been transforming the higher education landscape, implying diverse benefits to students, institutions, communities, and ultimately to the involved countries. Even though most higher education institutions provide formal programs and institutional supervision for international students, several studies [1] have shown that foreign students have to go through extra challenges regarding the initiation in higher education, such as adapting to living in a different culture and to a new learning system, developing proficiency in another language as well as establishing relationships with local students.

National mobility students also face hardships regarding their inclusion in higher education, especially social related. These hardships become worse when a student is joining midterm, is starting a master's degree, or has been transferred from another course, since most social groups are already formed, and most are usually resistant to change.

Another group to consider includes students with accessibility problems who have their own specific challenges to overcome. For example, even though institutions also have official programs to help the integration of hearing-impaired students, the social inclusion of these students among their peers is not easy to achieve due to the language barrier [2].

If all the criteria are met, any student could benefit from enhancing his/her future employability, personal development, language acquisition, and greater intercultural sensitivity.

Having this background in mind, the web platform to be developed within the scope of this dissertation will contribute to continuously improve social inclusion of all students as well as to enable access to information considering accessibility friendly aspects for hearing-impaired and visual impaired users.

Students will not need to wait for formal institutional guidance in the beginning of the school year, which is often not delivered in time. The web platform will contribute to solve integration and anxiety issues students face, by providing them with means to easily communicate with other students already predisposed to help, who in some cases may have a set of characteristics actually matching their needs, such as, knowing Sign Language.

## 1.2 Objectives

The focus of this dissertation is to introduce a proposal to contribute for the improvement students' integration in Higher Education through the development of a web platform that promotes equity, as well as to research diverse strategies of inclusive design in cooperation with the users. All the web platform content will be accessibility friendly for hearing and visual impaired students.

During the development phase, the web platform will be tested with the target audience. As for visually impaired users, the testing sessions will be performed at ACAPO (Associação dos Cegos e Amblíopes de Portugal). Involving the deaf and hearing-impaired users, the Association of the Deaf in Porto (Associação de Surdos do Porto – ASP) will be contacted.

Regarding design choices, different user groups will partake on important decisions to check if the development of the web platform is within the parameters intended for each segment of the target audience.

The development will be performed according to the accessibility standards of W3C (World Wide Web Consortium), hence appropriate websites and frameworks will be analysed.

Moreover, we consider myriad scientific papers related to communication between visually and hearing-impaired users, inclusive and cooperative design methodologies, psychological aspects, such as, discriminatory patterns, social anxiety, and exclusion[2][3][4].

Therefore, the specific objectives of this dissertation are as follows:

- Understand the main causes related to the lack of motivation when it comes to accessing the information available on the web instead of resorting to physical means, by the users with accessibility issues.
- Appraise the level of social exclusion in universities, and its impact on students' life.
- Evaluate how challenging it is for the institutional services to accommodate the needs of a large number of students in a timely manner, considering that some students might have special needs.
- Explore the accessibility options available for the web.
- Assess the viability of designing a web platform in collaboration with its end users, concerning time and resources versus user experience.
- Deliver a web platform prototype that supports the maximum amount of functionality for hearing and visually impaired users.

Additionally, a survey will be held to gather the students' perspective about their integration in the higher education institution they are attending.

### 1.3 Project planning

This dissertation was planned using a Gantt chart, based on Henry Gantt's model developed in 1917, and considering the objectives referred to in the previous section (1.2). During the project development, every functionality and progress of the web platform were monitored by the advisors. Figure 1 illustrates the Gantt Chart for the first stage submission.

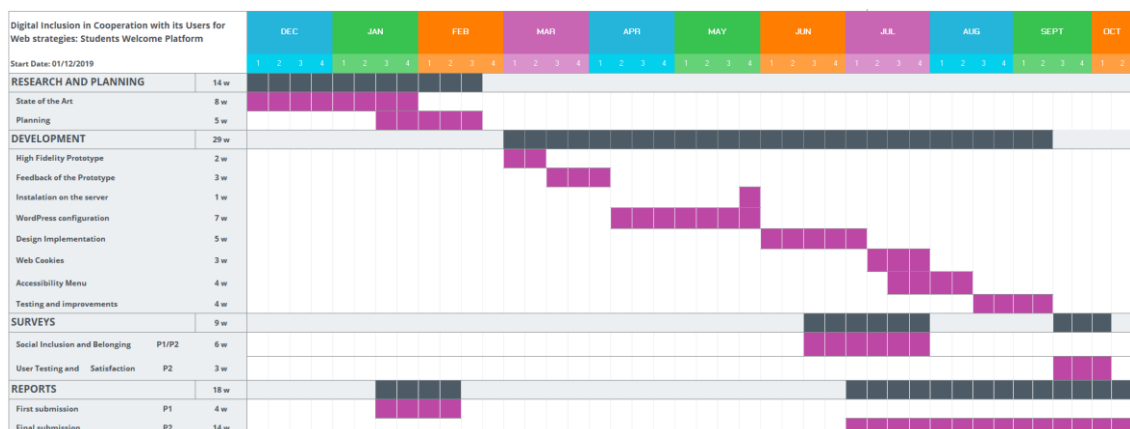


Figure 1 – Project Gantt Chart.

## **1.4 Document structure**

The document is organized in six chapters.

The first chapter, referring to section 1, contextualizes the understudied project, specifies the project's objectives, identifies the problem addressed in this dissertation, introduces the project development plan, and summarizes the structure of this document.

The second chapter, referring to section 2, scaffolds the research on the theme of this project. Subsequently, the state of the art is described, regarding students' integration in higher education institutions, inclusive design, accessibility-friendly websites, and content management systems.

The third chapter, referring to section 3, consists in the business value analysis and processes that validate the project. These processes consider the following criteria: innovation, accessibility, motivation, and simplicity.

The fourth chapter, referring to section 4, contains the analysis and assessment of alternatives in order to reach a consensus on the technologies to be used on this project development.

The fifth chapter, referring to section 5, presents the evaluation methods and hypothesis testing which complement the final solution.

The sixth chapter, referring to section 6, describes and demonstrates the project conception design, which includes the functionalities of the web platform and its architecture.

## 2 State of the art

This chapter contains research regarding social inclusion, most specifically in Higher Education, the description of a new collaborative design methodology, the analysis of websites that abide by the proper accessibility principles and a brief introduction to Content Management Systems.

### 2.1 Inclusion

“Inclusion” in Latin means “to shut in”, on the other hand, “exclusion” means “to shut out”. By thinking of inclusion as a circle where inside of it everything is included, exclusion, as antonym, keeps everything out of that circle. Thus, usually, people tend to promote inclusion because they believe in the possibility, or in a large circle in which almost all fits.

One of the newest and most controversial terms in today’s education is “inclusion”. Simply defined, it means including disabled students with non-disabled students in every aspect of education, from the same classroom to the same social activities and support groups. Disabilities, a phenomenon that encompasses stereotypes, myths, negative attitudes, and inappropriate behaviours, are a major barrier to the successful education and integration of students [5].

Implementation of inclusion was never easily achieved. Disagreements frequently occur between educational professionals, parents, students, and the Law. Many believe that inclusion should be geared towards everyone with a disability, while others believe it should be specific for each person depending on needs and circumstances. Disagreements also arise about how much extra attention should be given to an inclusive student [5].

### 2.1.1 Social Inclusion

The World Bank defines social inclusion in two ways. The first is a broad sweep to guide policy makers. It states that social inclusion is the process of improving the terms for individuals and groups to take part in society. The second definition considers how the terms of social inclusion can be improved and for whom. It articulates social inclusion as the process of improving disadvantaged people’s ability, opportunity, and dignity based on their identity, to take part in society [3].

People often find it easier to explain what social exclusion is. Yet, even social exclusion is often lumped with the related concepts of poverty and inequality. Social inclusion is also not the same as equality. The term social inclusion can add to the idea of equality, but much more importantly, it can explain why some inequalities exist or why some are particularly durable[3].

#### 2.1.1.1 Who gets excluded?

Individuals and groups are excluded or included based on their identity. Among the most common group identities resulting in exclusion are gender, race, employment status, ethnicity, religion, and disability status. These identities are complex, overlapping and they can change over time and vary by context.

Individuals can be members of different groups at once and may be excluded through one of their identities but not another.

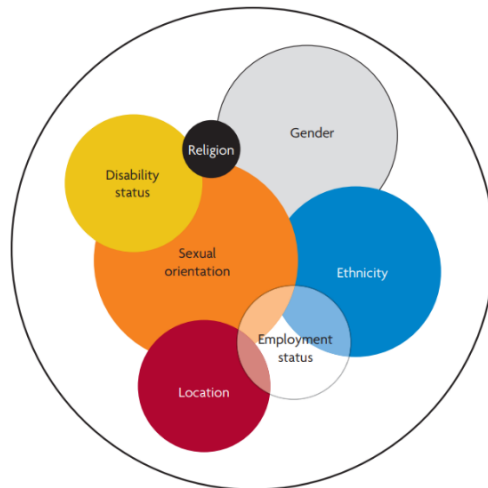


Figure 2 - Types of identities

Figure 2 presents diverse types of identities, illustrating their possible intersections and overlapping. The notion of “intersectionality” is based on the understanding that people are simultaneously situated in multiple social structures and realms. In figure 2, the size of each circle represents the importance of an identity, which can vary across individuals, groups, and

even the same individual over time. However, when they intersect, identities can produce a multiplication of advantage. For instance, the intersection of gender, age, ethnicity, and place of residence can have significantly worse effects than the effects of gender alone [3].

It is relevant to point out that this dissertation will not consider the effect of employment status, religion, and location as the analysis is made within the scope of students still enrolled in and attending a higher education degree.

### **2.1.2 Social Anxiety**

The Social Anxiety Association defines social anxiety as the fear of social situations that involve interaction with other people [4]. Everyone has moments of fear over their performance on contexts like university exams and projects or worry about whether they will please their teachers and peers. For those who suffer from social anxiety, however, concerns like these may not only impact their ability to learn, but also may lead them to make education or career choices different from those they would actually prefer.

Most high school graduates eagerly plan to meet new friends, enjoy parties, learn about their future degree field, and have the chance to live an independent life without having to follow rigid rules at home. For most teens, college represents a rite of passage, which means that it is a symbol of adulthood and independence. For someone suffering from social anxiety, though, the new world of being a college student is not so friendly. Instead, all they can see is an endless list of potential situations in which they will have to fight against their physical anxiety symptoms and battle to manage their anxious thoughts [6].

Students with social anxiety often avoid or do not participate in group projects or presentations due to embarrassment and self-consciousness, to fear of being criticized, or worrisome physical symptoms, such as sweating or stuttering. Research also indicates that socially anxious students judge their own competence poorly when participating in a project or presentation [7], and this worry continues regardless of their successful academic performance. In fact, social anxiety can make college life so terrifying that some studies have reported that students with social anxiety fail to complete school and drop out before graduating [8].

One of the functionalities of the web platform proposed to be developed within this dissertation is a message system for the users. In a texted conversation one can correct mistakes before they are known and keep track of what they have said. Face-to-face communication is based on more than just words. It includes a whole spectrum of non-verbal communication items, such as facial expressions and body language. Some studies even estimate that around 70 to 80% of communication is non-verbal [9].

The message system aims to lessen the pressure and anxiety of face-to-face communication. For students suffering from social anxiety or who are mostly on the introversion end of the spectrum, the system will be of great help since they have difficulty in vocalizing their thoughts.

### 2.1.3 Inclusion in Higher Education

Higher Education plays an important role in the development of societies, as well as in the leadership and in its transformation processes. However, perhaps this role has never been so recognized as it is today [10]. The World Declaration on Higher Education (1998) states that Higher Education is one of the fundamental pillars of human rights, democracy, sustainable development, and peace, and, therefore, it must be accessible to all throughout life.

On one hand, the University is the locus of knowledge, being within its capability the scientific production and articulation of different knowledge areas. On the other hand, it should be the locus of plurality, diversity, and respect towards differences [11].

So far, regarding the integration among students, there is no official data nor research that considers the student's point of view as the main subject. However, there are many studies, programs, tools, and policies devised from the governmental and institutional point of view. In this context, the following stand out: The Workgroup to Support Students with Disabilities in Higher Education (GTAEDDES), which is constituted by numerous public Higher Education Institutions; The Erasmus+ programme and the report Social Inclusion in Higher Education: Evidence from the EU[12].

### 2.1.4 Social Inclusion Assessment Tool (SiAT)

To assess how truthfully included a student feels, an anonymous survey was created to consider individual experiences. The survey at hand was inspired in a Harvard University initiative, which took place in the spring of 2019. For the first time in its history, Harvard conducted a survey to assess its community's perceptions in inclusion and belonging [13][14].

The structure of the survey was developed according to the Social Inclusion Assessment Tool (SiAT) [15], which is a methodology to assess social inclusion in projects, programs and policies. It is based on the axiom that asking the right questions is the key to find the right solutions. SiAT is divided into four steps, being each one based on a question as shown in Table 1.

Table 1 - SiAT step description

Order	Steps	Questions
1 <sup>st</sup>	Identification	Who is excluded?
2 <sup>nd</sup>	Analysis	How are they likely to be excluded?
3 <sup>rd</sup>	Actions	Why are they likely to be excluded?
4 <sup>th</sup>	Monitoring	What can be done towards greater social inclusion?

After obtaining the results of the survey, the next procedure is going through SiAT's approach from the first to the third steps to identify the characteristics that determine what type of student gets excluded, along with how and why they are likely to be excluded. The fourth and

final step will consist in initiating a course of action to facilitate the student's social inclusion in higher education.

Although no survey can clarify everything that needs to be changed and improved, nor prescribe all that could be done, it is an important first step towards understanding better the issues involved in including and belonging from the student's perspective.

## **2.2 Students**

By analysing the data presented by the Database of Contemporary Portugal (PORDATA), it was verified that the number of students enrolled in higher education has been steadily increasing in the last 5 years: approximately from 350.000 in 2015 to 385.000 in 2019 [16].

According to the most recent immigration report of Foreigners and Border Service (SEF), which was issued in 2018, there have never been so many foreigners living in Portugal. Consequently, the number of foreign students applying and attending higher education institutions is also increasing [17].

The number of students with special needs applying to higher education has also increased exponentially. Directorate General for Higher Education (DGES) reported that compared to 2015 those numbers have raised up to 158%. The implementation of the Inclusion for Knowledge Program [18] is the main cause of this exceptional growth. This program was created by the State Secretariat of Science, Technology and Higher Education (SECTES) in conjunction with the Portuguese Foundation for Science and Technology (FCT) and the DGES. It aims to promote the existence of adequate conditions for the inclusion of people with special needs as regards training, teaching performance, and research activities, active participation in academic life, social, sports and cultural initiatives, as well as general access to knowledge in the context of Higher Education Institutions (IES) and of the National Scientific and Technological System (SCTN). Moreover, in the school year of 2018/2019, for the first time, the special contingent for students with disabilities was extended to the second phase of the National Competition for Access to Higher Education. This measure allowed 45 more students to join the 186 who enrolled in the first phase of the competition [19]. The fact that one fourth of the students enrolled in the second phase demonstrates very clearly that the measure was of immense value.

### **2.2.1 Student Support Offices**

To better answer the needs of students, every Higher Education Institution has at least one physical office dedicated to support students' integration for free. These offices offer myriad types of services, such as: psychological and disability support, skills development opportunities, employability options, and career management advice.

However, due to the increasing flow of students in the last 5 years, most Higher Education Institutions, specifically their Student Support Offices, have been facing multiple new challenges. Essentially, attending to the very specific needs of international students and students with disabilities and ensuring the equality between them by fighting social bias and discrimination, along with the overall integration of so many students in a timely manner.

The proposed web platform developed within this dissertation will give students an alternative to the Support Offices. They will be able to find peers already predisposed to help and, in some cases, with a set of characteristics matching the student's needs, for example, knowing Sign Language.

## 2.3 Inclusive Design

Known as Design for All in Europe and Universal Design in the USA, the history of Inclusive Design goes back to the beginning of the social ideals in Europe that materialized after World War II, which include healthcare and housing for everyone [20]. On early approaches, its focus was in designing for disabled and elderly people as a sub-set of the population. In 2000, the UK Government defined Inclusive Design as products, services and environments that include the needs of the widest number of consumers [21]. However, as part of more recent international trends towards integration, it goes beyond older and disabled people by also focusing on other excluded groups to deliver mainstream solutions.

Most recently, Microsoft expanded the concept of Inclusive Design by defining it as a methodology, born out of digital environments, which enables and draws on the full range of human diversity. Most importantly, this means including and learning from people with myriad perspectives. Microsoft also presents two distinctions. The first refers to universal design as strong at describing the qualities of a final design, specifically as to the nature of physical objects. The second, originally from Treviranus, points out that universal design is one-size-fits-all while inclusive design is one-size-fits-one [22].

Accessibility criteria are the foundation of integrity for any inclusive solution [23] in which inclusive design has to be considered. The resulting designs, though for people with permanent disabilities, are often beneficial for a larger number of people. For example, automatic doors were created for the visually impaired community and for people with mobility issues, but they also benefit people with situational limitations such as an arm injury, or a parent holding an infant. Inclusive design does not always imply designing products to address the entire population's needs. Instead, it implies devising an appropriate design response to diversity in the population.

Designing environments to be inclusive impacts positively on individuals, on businesses, on society. Inclusive environments promote independence, empower the population and foster accessibility to content. These benefits lead exclusion and friction to be put aside and enable positive emotional contexts to blossom.

Personal computers and mobile devices have enormously enhanced autonomy and communication abilities of people with diverse disabilities; those are the devices where the web platform proposed with this dissertation will be accessed. The dissertation aims at an adequate user interface design which will have high impact on the users' social lives.

Approaching the creation of this web platform, focusing on a collaborative process during all its design phases, implies including blind and deaf people in a user centred design methodology. In this dissertation proposal, inclusive design expands with the audience, i.e., the development model for the environment interface embraces the users' feedback, evolves considering their perspectives along with our views.

The User Centred Inclusive Design Model represented in Figure 3 considers our target audience (user-centred), our purpose (to be inclusive), the way we act and perceive development (cooperatively), and our output (design).

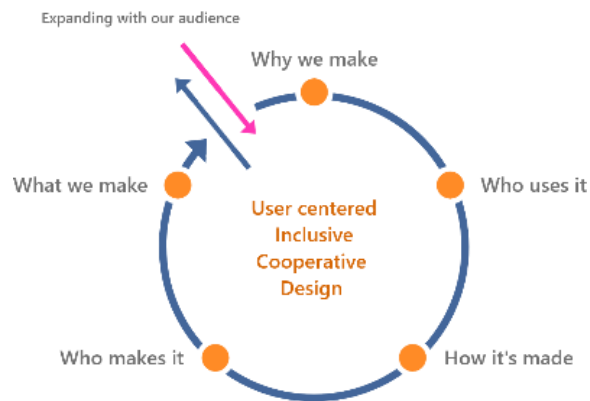


Figure 3 - User Centred Inclusive Cooperative Design

### 2.3.1 Persona Spectrum

The Persona Spectrum used by Microsoft to understand related mismatches and motivations across a spectrum of permanent, temporary, and situational scenarios is a useful easy-to-use tool that helps foster empathy, providing a possible scalable audience scenario in inclusive design thinking. Table 2 exemplifies that Persona Spectrum that will be applied to develop the web platform.

Table 2 - Persona Spectrum considered in the project scope.

Scenarios	Permanent	Temporary	Situational
<b>Vision</b>	Blind Colour blindness Farsightedness Partially visually impaired	Cataract Looking at a bright light Eye injury	Distraction When driving a car
<b>Hearing</b>	Deaf Hearing impaired	Mild ear infection Being exposed to loud sound/noise Excess of earwax	Bartender Music performer

After recognizing and accepting that different people have different needs for accessibility, it is easier to allow people to choose how they want to interact with an experience. The pyramid model of diversity, Figure 4, can be used to show how inclusive design aims at extending the target audience to include those with some kind of disability, while accepting that specific solutions may be required to satisfy the needs of those at the top of the pyramid [24].

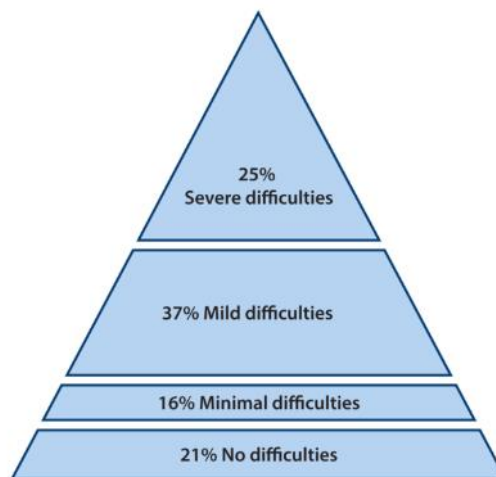


Figure 4 - Pyramid model of diversity

### 2.3.2 Cooperative Design

Cooperative Design is a collaborative design process, often considered an inclusive method deployed to gather data, by recognizing the participant as a partner not only during the data gathering phase, but also during implementation, delivery, and validation [25].

Approaching the creation of the user interface by focusing on collaborative process during all the phases of the design, implies the inclusion of people with disabilities within a user-centered design methodology.

Collaborative sessions or workshops are the main platform where participants cooperate with researchers. These sessions differ based on both context and needs; nevertheless, three basic stages are present in almost all participatory design research:

- **Stage 1: Initial Exploratory Work**
  - Designers and researchers meet the users and familiarize themselves with the ways in which the users work together. This exploration includes the technologies used, but also includes workflow and work procedures, routines, teamwork, and other aspect of the work.
- **Stage 2: Discovery process**
  - Designers, researchers and users employ various techniques to understand and prioritize work organization and envision the future workplace. This stage allows all parties to clarify the users' goals and values and to agree on the desired outcome of the project.
- **Stage 3: Prototyping**
  - Designers, researchers, and users iteratively shape technological artifacts to fit into the workplace envision in Stage 2. Prototyping can be conducted on site or in a laboratory, involving one or more users; and it can be conducted on-the-job if the prototype is a working prototype.

Inclusive design is not about creating “one thing for all people”, it is about creating diverse ways for people with accessibility problems to participate with a sense of belonging. Therefore, we consider that inclusive design expands with our audience. The best practice in inclusive design is to create the objects or environments with the participation of people with disabilities, or who have experienced any accessibility issue.

### 2.3.3 Historical Background

In the early 19th century, Pellegrino Turri, a skilled mechanic from Italy, built the first working model of a typing machine and invented carbon paper, which served as the machine's ink, inspired by his affection for the Contessa Fantoni, a childhood friend who was blind. Being blind, the countess was unable to write letters in private and autonomously, so Turri decided to create a mechanical solution to allow her to communicate with the world [26]. The result was a typing machine that associated a letter with a specific key that could be tapped to imprint on carbon paper, making writing accessible to blind people.

Centuries later, modern keyboards and mobile devices are in use. The touch-sensitive imaging technology grew out of Wayne Westerman's UD doctoral thesis. He developed the revolutionary computer interface technology with John Elias, who was at the time a UD professor in the College of Engineering. Westerman had tendonitis which motivated him to

tinker with different types of input technology. After some testing, he noticed that his hands had more endurance with zero-force input like optical buttons and capacitive touch pads than with force-actuating keys and buttons. Later, his company, the FingerWorks, created the first prototype of a touchpad for each hand to replace the keyboard, which was popular among people with hand disabilities and with temporary hand injuries. His work was so relevant that culminated in Apple buying the rights to the technology, which was used for developing the first gesture-controlled multi-touch interface for the iPhone [27].

These are only two examples that people tend to think in numerous creative ways to do what they enjoy or value, and work to develop the means they need to reach it.

## 2.4 Websites

When it comes to the internet, people with disabilities are usually left out. When a website is commissioned, the creator, or the commissioner, rarely take impairments into account. By meeting with ACAPO in 2019, it was concluded that their members are unmotivated to access the web, due to the lack of optimized websites. From 2009 to 2017, mobile screen readers usage increased from 12% to 88% [28]. This is just one of many reasons why accessibility should be a priority.

Furthermore, websites are not merely for viewing, they also require a certain degree of interactivity, and considering both inclusion and accessibility, not everyone will interact with a website in the same way.

### 2.4.1 Inclusive Design Web Principles

In order to make a website accessible and user-friendly for the visually impaired, the World Wide Web Consortium (W3C) has developed what is known as the Web Content Accessibility Guidelines (WCAG). These guidelines explain how to make web content accessible to people with disabilities.

The Paciello Group (TGP) is a world-class accessibility consultancy with a reputation of excellence. They help clients achieve end-to-end accessibility in their digital assets (websites, applications, documents, and so on), as well as assist in embedding accessibility into their processes and procedures [29]. TGP is a member of W3C, together they defined some of the WCAG 2.0 principles [30]. The platform proposed in this master's project will be designed upon the following seven accessibility principles defined by TGP:

- **Provide comparable experience:** Whether out of circumstance, choice, or context people are diverse. As people use different approaches and tools to read and operate interfaces, what the interface offers each user should be comparable in value, quality, and efficiency. Having a basic alternative, whether it is alt text, a transcript, audio description, or sign language makes the content accessible to all users.

- **Consider situation:** People can be first time users, established users, users at work, users at home, users on the move, and users under pressure. All these situations can have an impact. For users who already find interaction challenging, such as those with disabilities, this impact may make usage particularly difficult. Having colour contrast and colour change options makes the interface content clearer for colour blind users.
- **Be consistent:** Familiar interfaces borrow well-established patterns. Universal navigation patterns for the various types of accessibility are crucial for those users since they are not required to learn new usage paradigms. Using consistent page architecture across templates helps users navigate key content.
- **Give control:** Not suppressing or disabling the ability to change standard browser and platform settings such as orientation, font size, zoom, and contrast gives the user a sense of control.
- **Offer choice:** There is often more than one way to complete a task. One cannot assume what someone's preferred way might be. Providing layout alternatives such as, grids, lists, graphics, or tables offers the users choices that suit them and their circumstances.
- **Prioritise content:** Interfaces can be difficult to understand when core features are not clearly exposed and prioritised. Thus, the content and features should be progressively revealed allowing users to focus on one aspect at a time.
- **Add value:** Features should add value to the user experience by providing efficient and diverse ways to find and interact with content. Such as, the integration of the Virtual Sign avatar which translates text to Sign Language and content optimization so it can be translated properly by external text-to-speech software.

#### 2.4.2 Portuguese Association for the Blind and Low Vision People (ACAPO)

A good example to see some of these guidelines in practice is ACAPO. Not all visually impaired people are fully blind, hence various degrees of visual disabilities need to be considered.

As we can see on the ACAPO website, the first evident characteristics are the choices of large fonts and strong contrasting colours; these increase legibility for those who can still rely on their eyesight.

If we look closer to the colour palette being used, we notice an emphasis on the blue and yellow part of the colour spectrum. About 99% of colour-blind people have Protanopia, or Deuteranopia, also known as red and green weakness, respectively. Both these conditions affect the opposite sides of the blue and yellow colour spectrum, allowing the person to see these colours almost exactly as they are intended. A very small percentage of people suffer from Tritanopia, also known as blue and yellow colour blindness, but unlike the other two conditions mentioned earlier, these individuals are still able to see the blue colour, although

with shifted shades. Therefore, blue is a very good colour to be used in our palette, as it will be identifiable by most individuals [31].

Another fact to highlight is the lack of images and animations. Although it is common knowledge to consider that “a single image is worth a thousand words”, these “words” are nevertheless meaningless if the image cannot be actually seen or understood. Be that as it may, the use of images is not forbidden, howbeit their placement should be strategic, and always accompanied by the necessary alternative text to aid the user. Complex animations, on the other hand, can obscure content, or make certain parts of the user’s experience unpleasant if they are unable to discern what they are looking at, or have issues with perceiving motion; therefore, these should be avoided.

An important feature of ACAPO’s website is its optimisation to be navigated through simple button presses. The entire website can be navigated with only two buttons, allowing the user to go over the content by repeatedly pressing a single button, followed by another button press to confirm and access links, for example, Tab and Enter, respectively.

### 2.4.3 Royal National Institute of Blind People (RNIB)

The Royal National Institute of Blind People<sup>1</sup> (RNIB) is another website example worthy of analysis considered in this research. All the pages of this website display large fonts, which make it easier to read, while all buttons and links have stout and colourful contrasting highlights.

Whilst the website is optimised for people with low vision, it does not have colour blindness in mind. The colour palette includes pink, blue, yellow, and green. From this selection, both the pink and this specific shade of blue are only visible by people who have Tritanopia. Conversely, the yellow is only visible to individuals with Protanopia and Deuteranopia. The worst offender, however, is the green because neither of them will be able to perceive it.

Another aspect that was noticed was the large amount of pictures all over the website. Most of these images are correctly accompanied by relevant alternative text, which helps describe what is being portrayed. However, most of those images link to other locations that do not have an alternative text, hindering some users from access to their context.

Regarding interactability, from our point of view and experience, it is easy to navigate with the keyboard, although some issues were found with the scalability and responsiveness. For the most part, on more common screen sizes [32], there are no issues. However, on bigger displays, the previous benefit of the large font is lost, as there seems to be a cap to the font scaling. In contrast, the images do not appear to have any constraints and will stretch beyond their boundaries, to the point where they are no longer identifiable. These issues can impact navigation and interactability, depending on the user’s disabilities.

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<sup>1</sup> Royal National Institute of Blind People - <https://www.rnib.org.uk>

#### 2.4.4 Virtual Sign

The Virtual Sign (VS) project aims to reduce the linguistic barriers between the deaf community and those not suffering from hearing disabilities. This system is a real time, bidirectional translator that takes advantage of the benefits of engineering to cross technological innovation potentialities with Portuguese written language and the Portuguese Sign Language [33]. Since 2015, when first disseminated, VS has grown to the point that in 2020 it became able to translate from five different languages, as specified in Table 3.

Table 3 - List of Sign Languages available in Virtual Sign

Language	Sign Language	Acronym
Portuguese	Portuguese Sign Language	LGP
	Brazilian Sign Language	Libras
English	British Sign Language	BSL
German	German Sign Language	DGS
Greek	Greek Sign Language	GSL
	Cypriot Sign Language	CSL
Slovenian	Slovenian Sign Language	SSL

Additionally, Virtual Sign was adapted to the web as a plugin, enabling it to be used in any website. Considering that hearing-impaired users' mother tongue is a sign language, having this plugin available is of great value.

## 2.5 Content Management Systems

Presently, a wide variety of applications can be used to assist web developing, considering criteria such as time investment, programming knowledge, security, and budget. Taking this into account, using a CMS was the approach chosen for this project.

Firstly, it is necessary to determine the type of application, Content Management System (CMS) or Framework. CSM is of modular architecture: by using pre-existing features, any user, regardless of the programming skills level, can build a solution with little time investment, consequently, stifling creativity and customization as offered by a Framework. We can even consider them opposites in these regards [34].

A CMS can be defined as a software platform that supports building and maintaining a dynamic website during its life cycle, intended for users with unsubstantial software programming skills. Using both plugins and template integration, results into steady and agile development, thus allowing earlier publishing for the website. CMS offers a convenient and simple interface

allowing the management of the website's content, employing functions such as add, publish, edit, and remove, based on scripting languages such as PHP. In addition, the user will be provided an abstract view of server-based functionalities, such as a connection to the database.

The large share of these applications in the current market share similarities and advantages for its users as follows:

- **Simplified use:** Altering, adding, and removing content through an admin portal.
- **Templates:** Diversity of templates, consisting in widgets and CSS stylesheets, grants consistent change of the visual aspect of the website.
- **Localization Support:** Ability to store and provide content in multiple languages.
- **Extensions:** Extending code through plugins or toolkits, adding functionality to a certain context.

In a standard development framework, changing content, functionalities or user experience is intertwined with the technical knowledge of its user, considering the operations required to change the HTML tags throughout the HTML document. In a CMS approach this scenario is not applicable, the user will require access to the admin portal, and select the specified page for the required changes needed.

### 2.5.1 WordPress

WordPress is an Open Source Software based on PHP, being the predominant CMS worldwide presently. Founded in 2003 by Matt Mullenweg and Mike Little as a fork of *b2/cafelog*, the platform was initially designed as a blog builder. Throughout the years, aided by a variety of plugins, emerged as a tool for the development of higher complexity systems. By applying plugins, it is possible to handle every aspect of building, organizing, and adapting the website, thus improving the user interface effortlessly. The community and its ecosystem have shown growth over the last years due to the free membership and simple interface, becoming the most used CMS on the internet with over 13000 plugins. The White House and the OpenJS Foundation websites are two examples of websites developed using this CMS [35].

Unlike common CMS, WordPress allows both PHP and HTML to be edited by the user from an administrative interface; enabling advanced customization, installation can be done either manually or by pre-packaged installers. By making use of Microsoft IIS server and Microsoft Web Platform Installer, any inconsistencies are detected before applying WordPress; moreover, plenty of hosting companies provide automated installations through their control panel [35].

### 2.5.2 Joomla!

Joomla ranks as one of the most powerful Open Source CMS. It is the second most used worldwide, having over 4500 extensions and modules to enhance the website's features website, while having an active community that has contributed with over 2000 free templates. Two notable uses of Joomla! are the Harvard University and IKEA websites.

Making use of Model-View-Controller (MVC) design pattern for advanced components, Joomla! facilitates the development of modern user interfaces. Given its object-oriented programming features, any objects and controllers can be replicated and reused within any application, while allowing modification without impacting other sections. Together, along with community support, it becomes possible for the user to add a variety of functionalities (e.g. Social networking) and build increasingly complex websites [34].



## 3 Value analysis

In this chapter, the reliability and value of this project is assessed, as well as the aspects behind the development of this proposal.

### 3.1 Value Proposition

Harvard describes value proposition as the kind of value a company will create for its customers [36]. It is also considered a declaration of intent or a statement that introduces a company's brand to consumers by telling them what the company stands for, how it operates, and why it deserves their business [37]. This must not be confused with slogans and catchphrases, as these do not convey the benefits of a company nor of its products, being solely intended to attract customers [38].

According to the Business Model Generation by Alexander Osterwalder & Yves Pigneur, a "Value Proposition creates value for a Customer Segment through a distinct mix of elements catering to that segment's needs. Values may be quantitative (e.g. price, speed of service) or qualitative (e.g. design, customer experience)" [39].

Finding a unique value proposition usually involves a new way of segmenting the market, consequently expanding it.

#### 3.1.1 Longitudinal Value Perspective

Perceived value is defined by the customer's perspective on the product, it can be influenced by the price and quality of the return the customer received after a sacrifice. Each perspective will vary with each approach as, individually, one might prioritize different aspects, such as low price, higher quality, or having their needs fulfilled [40].

Differing from quality, this value is more individualistic and personal. In a sense, it can be perceived as an emotional payoff resulting from an exchange of transactions in which one gives to receive. In many concepts getting is considered as the quality aspect, although factors such as religious beliefs, preferences, benefits and other criteria are factor in on the quality option of the customer [40].

The essential idea is that the individual creates an opinion of the information gathered at various levels. Having these aspects in mind, a chain of benefits can be depicted illustrating a concept named emotional payoff (Figure 5).

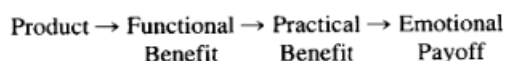


Figure 5 - Chain of benefits

Given that the customer’s opinion changes along the course of time, so does the perceived value. Figure 6 is a timeline depicting the changes affecting this value [41]:

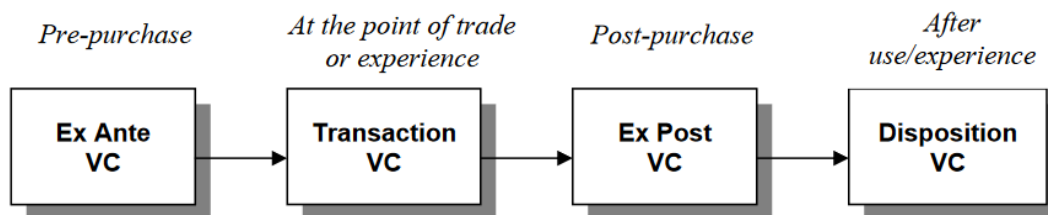


Figure 6 - Bellow timeline

Our product is focused on bringing students together through a platform, with the result of creating student groups in a straightforward and agile way, which will benefit all kinds of users, offering an advantage over emails, and social networks. The purpose is to aid students in finding others who fit a certain profile and are able to provide information about university facilities, residency, study groups, and subjects.

The potential benefits for the user must be clear, whether inferior alternatives exist, or the lack of alternatives altogether, its value must be felt and understood clearly to avoid unreal expectations or project an inferior product.

During and after signing up (Purchase and Post-purchase), it is paramount that the user’s expectations and needs are met. Development must be without error, both technical and conceptual, so that the user has access to a product that will enable him/her to reach his/her objectives with minimal delay and maximum efficiency, obtaining the best value possible from the product.

## 3.2 New Concept Development Model

In order to establish innovation, according to P. Koen et al., bringing a new product or idea to the market requires three phases [42].

The first, designated as the *Front-End of Innovation (FEI)*, involves coming up with the idea, designing and engineering the details of the product. This stage begins when an opportunity is first considered worthy of further conception, ultimately ending when a firm decision to invest in the idea and commit significant resources to its development.

Subsequently, the second phase is known as *New Product Development (NPD)*, which comprises extensive market research and business analysis, leading up to the actual product development.

Finally, there is the commercialisation. Given that the previous studies and testing have been favourable, a business model is established. Usually, the product is first deployed in small to medium scale, later being expanded when there is more confidence, capital, and capacity. Figure 7 illustrates the phases implied in FEI.

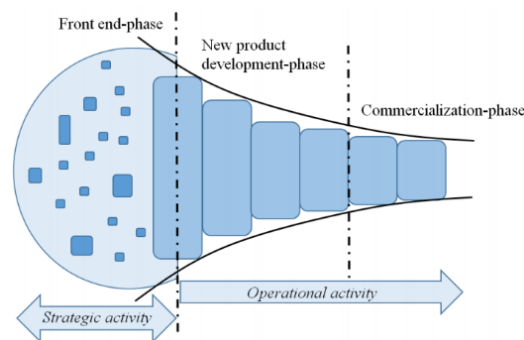


Figure 7 - Front-End of Innovation

All the research done during the FEI establishes a foundation upon which the second stage will be built. R. C. Cooper & E. J. Kleinschmidt note in their studies that *“the greatest differences between winners and losers were found in the quality of pre-development activities”* [43].

P. Koen et al. created a non-sequential model called New Concept Development (NCD), which allows project managers to respond with more flexibility to uncertainty. Figure 7 shows us the model, which consists of the engine, the five activity elements and the outer influential factors. In the middle of the model, we can see the engine that represents the leadership, business strategy and culture of the organization. These are the determining factors that actuate the five activity elements surrounding the engine (Figure 8).

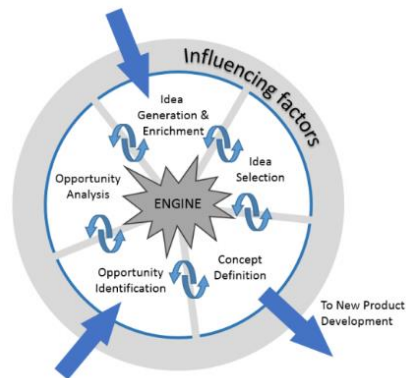


Figure 8 - New Concept Development

The five activity elements consist of opportunity identification, opportunity analysis, idea generation and enrichment, idea selection and concept definition. The two arrows that are pointing into the model are the starting activities of innovation, while the arrow pointing outward portrays the best concepts that will eventually become part of the NPD. The model was given a circular shape with the purpose of indicating how “...ideas are expected to flow, circulate, and iterate between and among all the five elements. The flow may take any order or combination and may use one or more elements more than once.”

The NCD model was envisioned as a way to solve the existing issues of sequential processes like the Stage-gate model, which was known for creating delays and additional expenses with reiteration. With FEI, however, iteration and looping back are essential to determining the concept; if the concept is not adequately iterated, then the project time might increase, as well as the costs involved.

Regarding this project, by applying Koen’s model, the following was concluded:

1. **Opportunity Identification** – Presently, there is no way for students to form subject groups besides resorting to social platforms or the course email listings. There are also no complementary activities to integrate students that enrol in the second or third phases of the National Competition for Access to Higher Education. The students face hardships on obtaining general institutional information. Finally, ISEP’s website is not optimised toward visual and hearing accessibility.
2. **Opportunity Analysis** – Subsequently, we reached the conclusion that developing a web platform which fulfils the students’ needs, would be a great asset to ISEP. It would relieve students’ anxiety and stimulate their studies. Lastly, ISEP’s information will be accessibility friendly.
3. **Idea Generation and Enrichment** – Myriad ideas regarding inclusion of underrepresented groups were debated to reach an interesting concept. The first idea was a framework where blind/visually impaired and deaf/hearing impaired individuals could communicate through digital art. This idea gave rise to a scientific paper titled

*“Inclusion through digital arts: An integrative arts practice community”*, which was published in the 13<sup>th</sup> Multi Conference on Computer Science and Information Systems (MCCSIS 2019). The second idea is the understudied project, which is a web platform to improve the integration of students in ISEP. The web platform will be optimized for blind/visual impaired and deaf/hearing impaired users. This idea is being published in the 15<sup>th</sup> Iberian Conference on Information Systems and Technologies. Additionally, a survey was created with the purpose of assessing the situation from the perspective of ISEP students. The third idea was a software for haptic recovery, optimized for hearing and visual impaired individuals. The third idea also gave rise to a scientific paper named *“Inclusive Game Design Methodologies for Haptic Recovery”*, presented on ISEP’s 1<sup>st</sup> Edition Computer Engineering Symposium (SEI).

4. **Idea Selection** – The Analytic Hierarchy Process (AHP) was utilized with the purpose of assisting the idea selection process. The criteria selected to calculate the most viable idea through AHP, were the following: innovation, flexibility, motivation and simplicity.
5. **Concept Definition** – The business plan was developed with expandability in mind. Initially, the web platform will only host ISEP students but may be scaled to other educational institutions. By gathering information about possible competition, we may gauge the state of the market.

### 3.3 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a multicriteria model developed by Thomas Saaty [44], this method consists of a methodology for comparing alternatives by structuring criteria into a hierarchy. By focusing in the use of pairwise comparison approach for analysing complex decisions, AHP allows a more accurate ordering of priorities for decision making [45]. These priorities are defined through qualitative and quantitative criteria during the evaluation process. Structuring any decision problem hierarchically in an efficient way of dealing with complexity and identifying major components of the problem.

Saaty divided the definition of hierarchy into three major steps:

1. The first step is modelling the decision at hand. It consists of the overall goal, related alternatives, and relevant criteria for both the goal and the alternatives.
2. The second step is evaluating the alternatives and the goal through a series of pairwise comparisons.
3. The third and final step, after all the calculations are concluded, is the overall evaluation of each alternative through the structured hierarchy.

To provide a numerical judgment in making pairwise comparisons, Saaty defined a reliable and workable scale. The scale ranges from one to nine where one implies that the two elements are the same or are equally important. On the other hand, number nine implies that one element is extremely more important than the other one in a pairwise matrix. The pairwise scale and the importance value attributed to each number are illustrated in the Table 4.

Table 4 - Saaty's intensity of importance scale

<b>Intensity of Importance</b>	<b>Definition</b>	<b>Explanation</b>
1	Equal importance.	Two activities contribute equally to the objective.
3	Weak importance of one over another.	Experience and judgment slightly favour one activity over another.
5	Essential or strong importance.	Experience and judgment strongly favour one activity over another.
7	Demonstrated importance.	An activity is strongly favoured, and its dominance is demonstrated in practice.
9	Absolute importance.	The evidence favouring one activity over another is of the higher possible order of affirmation.
2, 4, 6, 8	Intermediate values between the two adjacent judgments.	When compromise is needed.

### 3.3.1 1<sup>st</sup> Phase: Development of the Decision Hierarchy tree

In this phase, the Decision Hierarchy tree is defined. The first phase consists in decomposing the problem into a hierarchy, which is composed by the goal, the criteria and the myriad chosen alternatives. Figure 9 represents the understudy project themes.

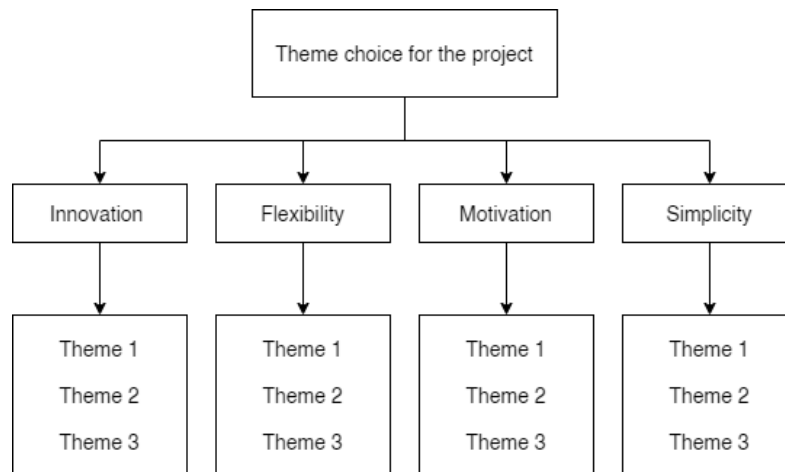


Figure 9 – Hierarchical division (AHP)

The four criteria illustrated in Figure 9 (Innovation, Flexibility, Motivation, Simplicity), were logically chosen according to the three themes initially defined.

- **Innovation** – Innovative projects are essential nowadays by combating critical social risks and threats. By being innovative, one can stand out from competitors, meet customer needs and help underrepresented groups.
- **Flexibility** – The project should be able to adapt to changes in both environment and usability requirements without encompassing structural changes.
- **Motivation** – Pursuing an idea without motivation is one of the worst approaches. One must be predisposed to develop a project.
- **Simplicity** – Simple ideas have better chances of succeeding, because they provide an opportunity to build something and try it out in the short term.

### 3.3.2 2<sup>nd</sup> Phase: Alternative and criteria comparison

The second phase consists in establishing priorities between the chosen criteria through a comparison matrix. In this phase, it is essential to determine a scale to compare the values. This scale, defined by Thomas Saaty, as specified in Section 3.5, Figure 9, should not exceed the total of nine factors in order to maintain the consistency of the matrix.

In this case, where the goal was to choose the most viable of three themes by using the criteria defined in the hierarchical division (Table 5), the following comparison matrix was developed and illustrated in Matrix A (1).

Table 5 – Criteria comparison matrix (AHP)

Criteria	Innovation	Flexibility	Motivation	Simplicity
Innovation	1	1/2	2	3
Flexibility	2	1	3	2
Motivation	1/2	1/3	1	1/2
Simplicity	1/3	1/2	2	1

$$\text{Comparison Matrix } A = \begin{bmatrix} 1 & 1/2 & 2 & 3 \\ 2 & 1 & 3 & 2 \\ 1/2 & 1/3 & 1 & 1/2 \\ 1/3 & 1/2 & 2 & 1 \end{bmatrix} \quad (1)$$

### 3.3.3 3rd Phase: Priority regarding each criterion

In this phase, the priority regarding each criterion is calculated by summing the values from each column, as illustrated in Table 6. It is necessary to firstly sum the values so they can be afterwards normalized.

Table 6 – Second level matrix of criteria comparison

Criteria	Innovation	Flexibility	Motivation	Simplicity
<b>Innovation</b>	1	1/2	2	3
<b>Flexibility</b>	2	1	3	2
<b>Motivation</b>	1/2	1/3	1	1/2
<b>Simplicity</b>	1/3	1/2	2	1
<b>Sum</b>	23/6	7/3	8	13/2

Table 7 - Second level normalized criteria matrix.

Criteria	Innovation	Flexibility	Motivation	Simplicity
<b>Innovation</b>	6/23	3/14	1/4	6/13
<b>Flexibility</b>	12/23	3/7	3/8	4/13
<b>Motivation</b>	3/23	1/7	1/8	1/13
<b>Simplicity</b>	2/23	3/14	1/4	2/13

By dividing each value by its respective column sum, the normalized matrix is obtained, as shown in Table 7. The objective of this procedure is to match all criteria to the same unit.

The next procedure is identifying the order of importance of each criterion. For this, the arithmetic average is calculated through the values of each line of the normalized matrix, as presented in Table 8.

Table 8 -Second level criteria normalized matrix with relative priority

Criteria	Innovation	Flexibility	Motivation	Relative Priority	Relative Priority
<b>Innovation</b>	6/23	3/14	1/4	6/13	0.29
<b>Flexibility</b>	12/23	3/7	3/8	4/13	<b>0.40</b>
<b>Motivation</b>	3/23	1/7	1/8	1/13	0.12
<b>Simplicity</b>	2/23	3/14	1/4	2/13	0.18

By analysing Table 8, we can conclude that Flexibility is the main criteria regarding the choice of the project's theme.

#### 3.3.4 4<sup>th</sup> Phase: Evaluate the relative priorities consistency

The fourth phase consists in calculating the Consistency Ratio (CR) to measure how consistent the judgments were as to the large samples of completely random judgments. If the CR is greater than 0.1, the judgments are not reliable and will not produce consistent values.

In order to calculate the CR, it is necessary to firstly obtain the Consistency Index (CI) and the Random Index (RI), as shown in the following formula.

$$CR = \frac{CI}{RI} \quad (2)$$

The IC is obtained though the following equation:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (3)$$

In the previous equation  $\lambda_{max}$  is the matrix eigenvalue and  $n$  is the number of criteria.

$$\begin{bmatrix} 1 & 1/2 & 2 & 3 \\ 2 & 1 & 3 & 2 \\ 1/2 & 1/3 & 1 & 1/2 \\ 1/3 & 1/2 & 2 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0.29 \\ 0.40 \\ 0.12 \\ 0.18 \end{bmatrix} = \begin{bmatrix} 1.27 \\ 1.7 \\ 0.48 \\ 0.71 \end{bmatrix} \quad (4)$$

To obtain the average of the previous values, we must perform a division between the matrix lines and the priority vector. The result of this operation is  $\lambda_{max}$ , as shown on the following equation:

$$\lambda_{max} = average \left\{ \frac{1.27}{0.29}, \frac{1.7}{0.40}, \frac{0.48}{0.12}, \frac{0.71}{0.18} \right\} = 4.14 \quad (5)$$

After obtaining  $\lambda_{max}$ , it is necessary to calculate the CI by using the following equation:

$$CI = \frac{4.14 - 4}{4 - 1} = \frac{0.14}{3} = 0.05 \quad (6)$$

The last step of this phase is calculating the Consistency Ratio using the correspondent  $n$  value from Thomas Saaty's index table (Table 9).

Table 9 - Saaty's index table

n	1	2	3	4	5	6	7	8	9	10	11
RI	0.00	0.00	0.58	<b>0.90</b>	1.12	1.24	1.32	1.41	1.45	1.49	1.51

As all the necessary values were obtained, we can now calculate the RC, which was previously designated. The RI is correspondent to  $n = 4$ , where  $4$  is the criteria number.

$$CR = \frac{0.05}{0.90} \approx 0.04 \quad (7)$$

Since the RC is  $0.04 < 0.0$ , we can conclude that the values assigned to the relative priorities are consistent.

### 3.3.5 5<sup>th</sup> Phase: Development of the parity comparison matrix for each criterion

The previous procedures regarding the development of the comparison matrix and the determination of the relative priority of each criterion must be repeated. But in this case, those procedures are relative to the alternatives and the criteria initially presented.

**Innovation:** Tables 10 and 11.

Table 10 - Innovation Criteria matrix

Innovation	Theme 1	Theme 2	Theme 3
Theme 1	1	2	3
Theme 2	1/2	1	2
Theme 3	1/3	1/2	1
Sum	11/6	7/2	6

Table 11 - Innovation Criteria normalized matrix

Innovation	Theme 1	Theme 2	Theme 3	Priority Vector
Theme 1	6/11	4/7	1/2	0.54
Theme 2	3/11	2/7	1/3	0.30
Theme 3	2/11	1/7	1/6	0.16

**Flexibility:** Tables 12 and 13

Table 12 - Flexibility Criteria matrix

Flexibility	Theme 1	Theme 2	Theme 3
Theme 1	1	1/5	2
Theme 2	5	1	2
Theme 3	1/2	1/2	1
Sum	13/2	17/10	5

Table 13 - Flexibility Criteria normalized matrix

Flexibility	Theme 1	Theme 2	Theme 3	Priority Vector
Theme 1	2/13	2/17	2/5	0.22
Theme 2	10/13	10/17	2/5	0.59
Theme 3	1/13	5/17	1/5	0.19

**Motivation:** Tables 14 and 15.

Table 14 - Motivation Criteria matrix

Motivation	Theme 1	Theme 2	Theme 3
Theme 1	1	1/3	1/2
Theme 2	3	1	1/2
Theme 3	2	2	1
Sum	6	10/3	2

Table 15 - Innovation Criteria normalized matrix

Motivation	Theme 1	Theme 2	Theme 3	Priority Vector
Theme 1	1/6	1/6	1/10	0.17
Theme 2	1/2	1/2	3/10	0.35
Theme 3	1/3	1/3	3/5	0.48

**Simplicity:** Tables 16 and 17.

Table 16 - Simplicity Criteria matrix

Simplicity	Theme 1	Theme 2	Theme 3
Theme 1	1	4	1/3
Theme 2	1/4	1	1/3
Theme 3	17/4	3	1
Sum	6	8	5/3

Table 17 - Simplicity Criteria normalized matrix

Simplicity	Theme 1	Theme 2	Theme 3	Priority Vector
Theme 1	4/17	1/2	1/5	0.31
Theme 2	1/17	1/8	1/5	0.13
Theme 3	12/17	3/8	3/5	0.56

To conclude this phase Figure 10 summarizes all the information obtained.

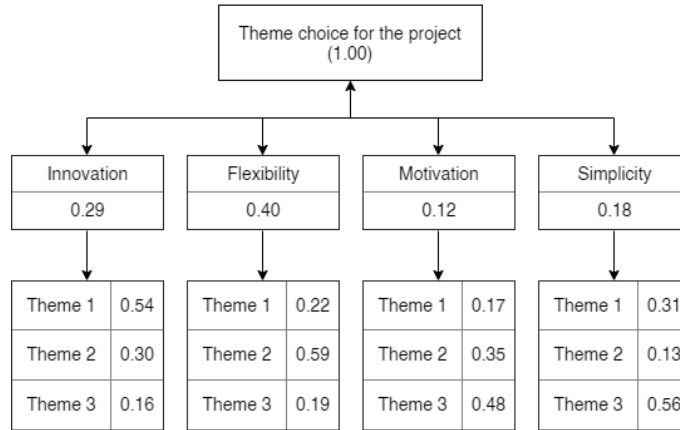


Figure 10 - Priority comparison diagram

### 3.3.6 6<sup>th</sup> Phase: Obtain the composed priority for the alternatives

The sixth phase is the last involving calculus. By multiplying the values obtained during the fifth phase through the priority matrix, by the priority vector, we obtain the final values correspondent to each alternative. The alternative that holds the highest value is the recommended choice.

$$\begin{bmatrix} 0.54 & 0.22 & 0.17 & 0.31 \\ 0.30 & 0.59 & 0.35 & 0.13 \\ 0.16 & 0.19 & 0.48 & 0.56 \end{bmatrix} \cdot \begin{bmatrix} 0.29 \\ 0.40 \\ 0.12 \\ 0.18 \end{bmatrix} = \begin{bmatrix} 0.31 \\ \mathbf{0.39} \\ 0.29 \end{bmatrix} \quad (8)$$

### 3.3.7 7<sup>th</sup> Phase: Choice

Finally, given the results obtained in the sixth phase, according to the defined criteria and their respective importance, we can conclude that option 2 is the best project theme with a final weight of 0.39, which is superior to the other alternatives.

## 3.4 The Business Model Canvas

The Business Model Canvas [46], is a strategic management tool to quickly and easily define and communicate a business idea or concept. The canvas is a one-page document which works through the fundamental elements of a business or product, structuring an idea coherently. The right side of the canvas focuses on the customer while the left side focuses on the business. Both sides meet around the value proposition, which is the exchange of value between the business and the costumers [47]. This model is segmented as follows:

**Key Partners** – List of external companies/suppliers needed to achieve they key activities and to deliver value to the costumer.

**Key Activities** – Actions that the business undertakes in order to achieve a successful value proposition for the costumers.

**Key Resources** – Necessary resources for the business model to properly work. These resources can be financial, intellectual, physical, or human.

**Value Proposition** – It is the foundation of any business or product. Hence, it is the fundamental concept of the exchange of value between the business/product and the customers, having a direct correlation between attractiveness and innovation.

**Customer Relationships** – It is defined as how a business interacts with its customers segments.

**Customer Segments** – The customer base is divided into groups of individuals based on their similarities.

**Channels** – Means by which the customers come in contact with the business.

**Cost Structure** – Monetary cost of operating as a business.

**Revenue Streams** – Way by which the business converts the Value Proposition into financial gain from each Customer Segment.

Within the scope of this project, a Business Model Canvas was defined as follows (Table 18).

Table 18 - Canvas

<b>Key Partners</b> <ul style="list-style-type: none"> <li>• ACAPO;</li> <li>• GILT;</li> <li>• ISEP;</li> <li>• Student Support Offices.</li> </ul>	<b>Key Activities</b> <ul style="list-style-type: none"> <li>• Survey to assess inclusivity in higher education institutions;</li> <li>• Web platform mockup;</li> <li>• Develop the web platform;</li> <li>• Test and validate the web platform.</li> </ul>	<b>Value Proposition</b> <ul style="list-style-type: none"> <li>• A web platform that promotes inclusivity and belonging in higher education. As well as equal opportunities.</li> </ul>	<b>Customer Relationships</b> <ul style="list-style-type: none"> <li>• Online support;</li> <li>• Presidential or email support;</li> <li>• Telephone.</li> </ul>	<b>Customer Segments</b> <ul style="list-style-type: none"> <li>• Higher Education Institutions;</li> <li>• High schools.</li> </ul>
	<b>Key Resources</b> <ul style="list-style-type: none"> <li>• Research Team;</li> <li>• Test Devices.</li> </ul>		<b>Channels</b> <ul style="list-style-type: none"> <li>• Presidential customer meetings;</li> <li>• Digital marketing;</li> <li>• Higher Education events and Inclusivity events.</li> </ul>	
<b>Cost Structure</b> <ul style="list-style-type: none"> <li>• Web platform development;</li> <li>• Server Hosting;</li> <li>• Marketing.</li> </ul>			<b>Revenue Streams</b> <ul style="list-style-type: none"> <li>• Sell the web platform as a product.</li> </ul>	



## 4 Evaluation of Existing Solutions

In this chapter an evaluation of the approaches identified in the State of the Art regarding Content Management Systems will be carried out. The decisions referring to technologies will be justified, and alternatives shall be considered.

### 4.1 Technologies

For the implementation of the web platform, a possible alternative is using a framework, which is a platform for developing software applications [48]. On the one hand, a framework gives complete freedom of action, it is very flexible, one can implement any idea without conflicting with the engine, and it performs much better when compared to a CMS. On the other hand, developing using a framework takes much longer than developing using a CMS, the website edition sections need to be written independently, which implies the creation of an Admin Control Panel which makes it more complex. Nevertheless, there is no requirement for highly complex functions, taking that into account, along with the reduced timeframe given to produce a pilot, a CMS is the best approach.

#### 4.1.1 WordPress vs Joomla

Regarding the choice of a CMS, compared to Joomla, WordPress is objectively the best choice of the top CMS offered by the present market. As specified in Table 19, WordPress is more user-friendly, has by far the largest ecosystem of plugins and themes, and considers a huge support community. Joomla is more complex and less user friendly.

Table 19 - WordPress and Joomla.

	<b>WordPress</b>	<b>Joomla</b>
<b>Simplicity</b>	User-friendly with a small learning curve.	More complex, takes time to learn.
<b>Appearance and Extensions</b>	Millions of extensions.	Good number of extensions.
<b>Support</b>	Community, forums, pay for support.	Community, forums, official documentation.
<b>Security</b>	Frequently updated, security plugins.	Frequently updated, security plugins.
<b>Multilingual options</b>	Should use 3rd party services.	Great multilingual support by default.

WordPress was also chosen considering the networking plugins available. BuddyPress<sup>2</sup> is the only open source community plugin for WordPress that includes all the features expected from any online community, such as user profiles, groups, activity streams, notifications and more.

In order to provide accessibility, namely to hearing and visual impaired users, it is essential that the web platform supports accessibility tools. Since the beginning of this project, the use of the Virtual Sign web plugin was suggested to be used to aid hearing impaired users. Having been developed in GILT Research Group (see section 4.1.2), this plugin is the only option available in the market to translate text to Sign Language, hence, no alternatives were considered.

Concerning the database, it shall store all web platform data, either locally or online. During the first weeks of the pilot development the database was stored locally since it does not involve the costs of a web server. Taking into account the scalability and main goal of the project, the web platform was migrated to an online server.

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<sup>2</sup> BuddyPress - <https://buddypress.org>

# 5 Design and Development

In this chapter the conceptual design will be described including the functionalities of the web platform and its architecture.

## 5.1 Design Approach

The web platform interface design is based on inclusive design considering its users' feedback. This implies including blind and deaf users in all the phases of the design process, following a collaborative user-centred design methodology (see Section 2.3.2).

Due to external circumstances, such as the social distancing and the restriction of social contact, all the user collaboration was done through email and video calls. Consequently, the collaborative methodology process proved to be challenging due to delayed responses and the abstract feedback of the users. Thus, we decided to simplify the process by only sending high fidelity design prototypes of the web platform main pages, as illustrated on figures 11 to 16.

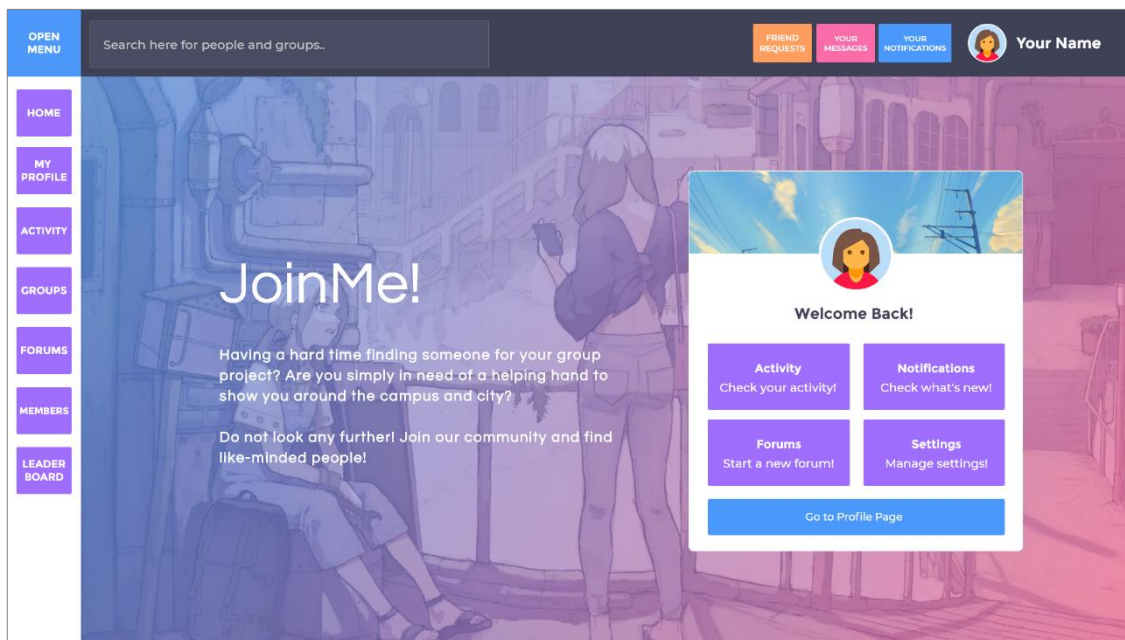


Figure 11 - Project prototype: Home Page

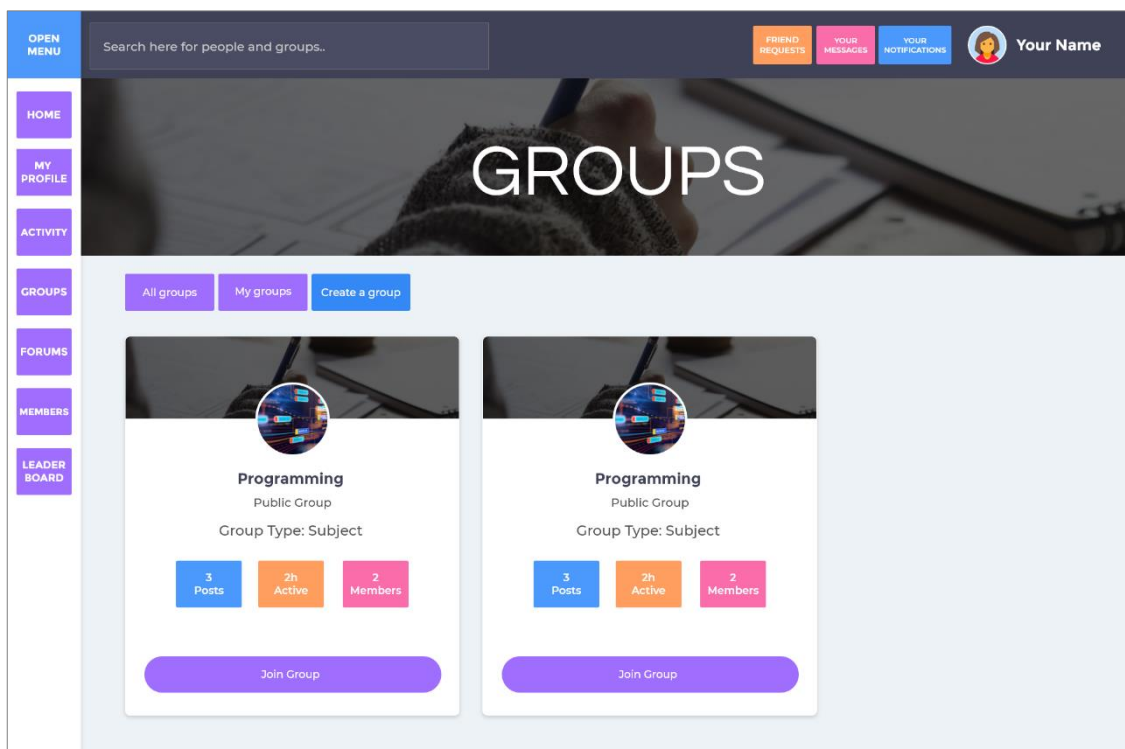


Figure 12 - Project prototype: Groups Directory Page

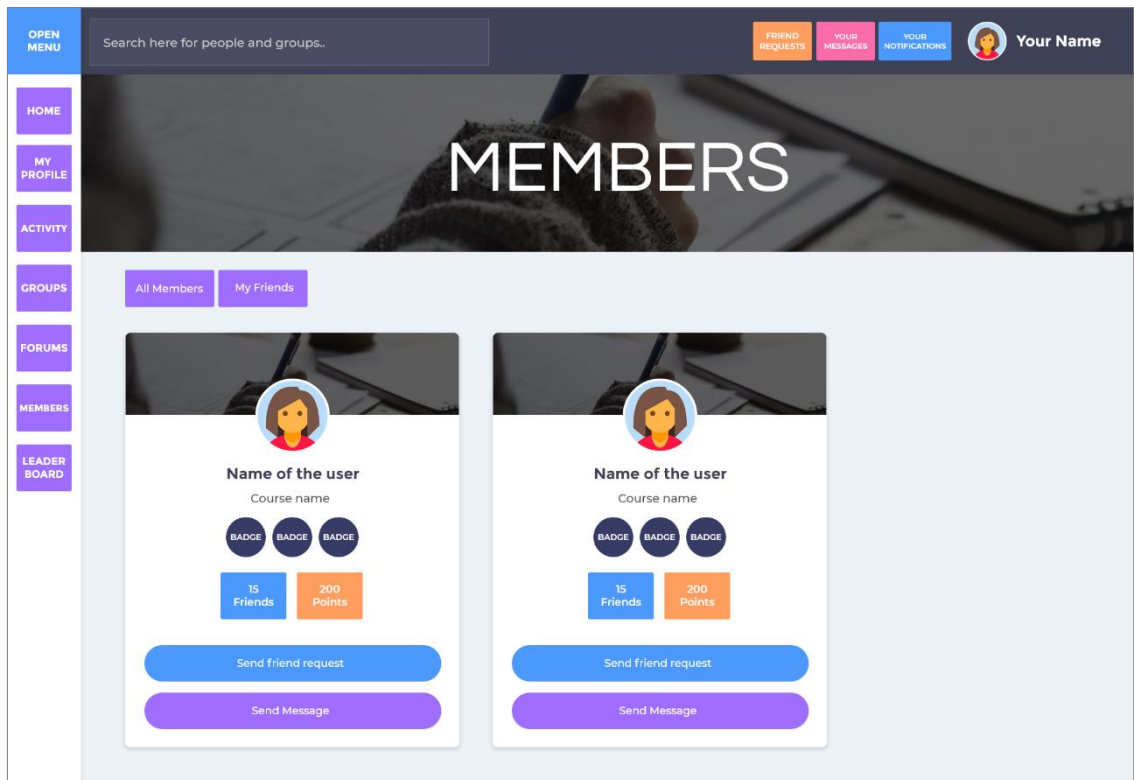


Figure 13 - Project prototype: Members Directory Page

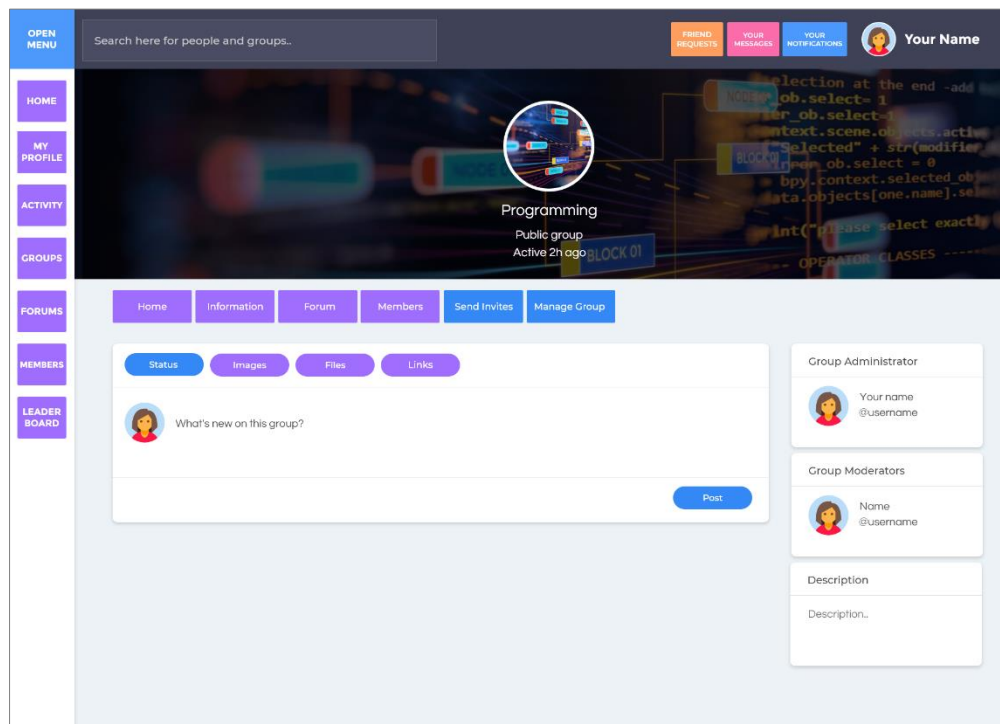


Figure 14 - Project prototype: Group Page

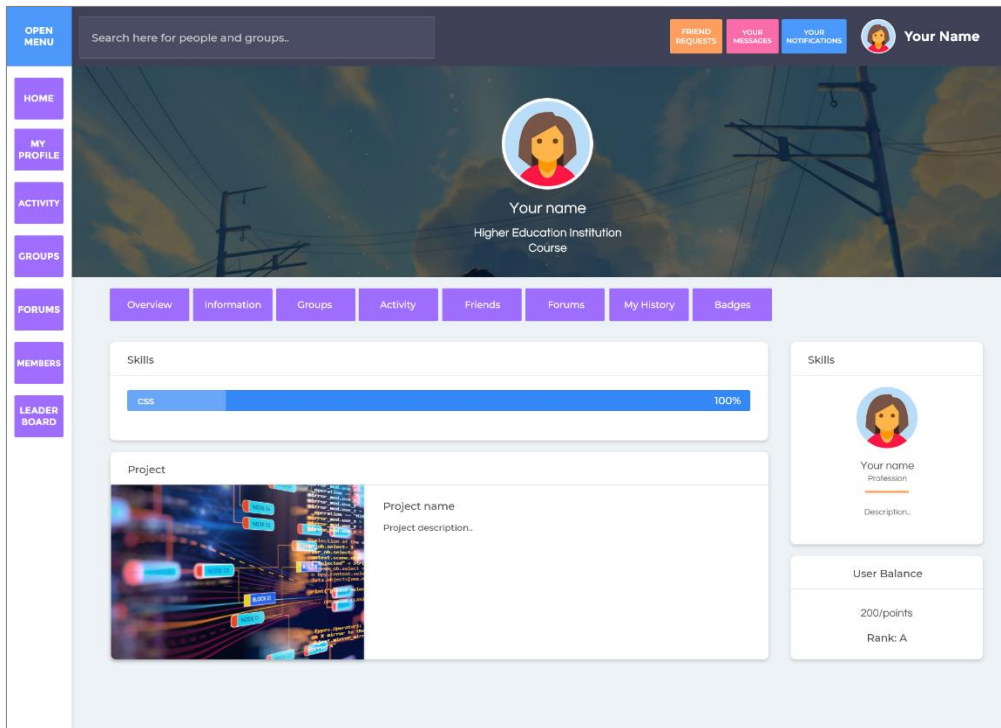


Figure 15 - Project prototype: Profile Page

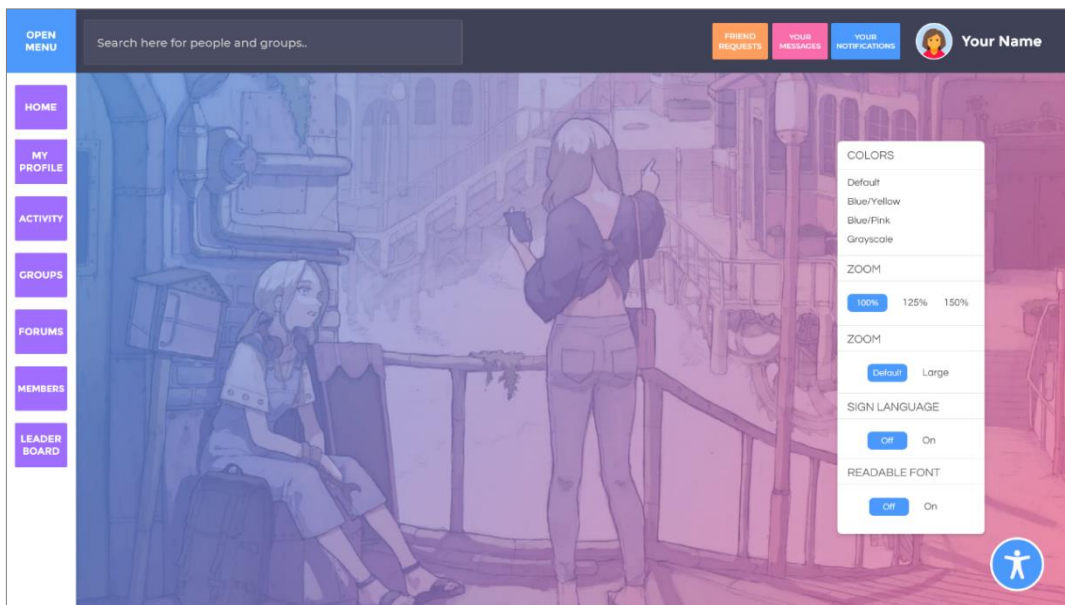


Figure 16 - Project prototype: Accessibility Menu

Regarding accessibility, after the analysis of various websites, we reached the conclusion that developing a web platform that befits all types of users simultaneously is not the optimal approach. Instead, we chose to incorporate a variety of optional features suited to individual needs and preferences, as show in Figure 16.

Since only a few of the 38 students that chose to participate on the design process (see section 6.3.1) gave us a response, there was barely any feedback. After gathering the students' feedback, only minor changes were made, such as adding the dyslexic type font.

## 5.2 Architecture

In order to develop the proposed project, it is necessary to conceptualize a high-level architecture specifying the communication between the different components inherent to the solution, as shown in Figure 17.

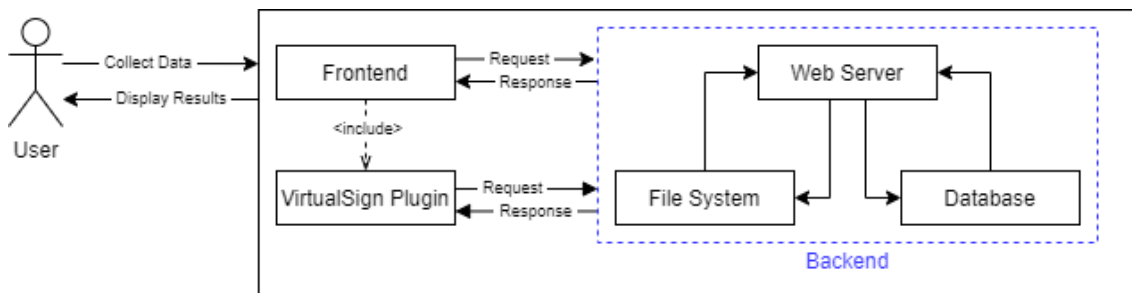


Figure 17 - Project's Architecture

The Frontend component is referent to the webpages that are managed by the CMS, which in this case is WordPress. The webpages will include the Virtual Sign plugin which enables the translation of the content to sign language. The backend component is referent to a remote server, this server hosts the various services needed for the hosting both the webpage, database and any other related.

### 5.2.1 Functional Requirements

Functional requirements define the basic system behaviour. In other words, a functional requirement will describe a particular behaviour of function of the system when certain conditions are met. In the context of this project, the following functional requirements were defined:

- The user must be able to register and then login/logout.
- The user must be able to view, edit and delete his profile.
- The user must be able to create, edit and delete a group.
  - Regarding the group members, the user must be able to invite members to the correspondent group, change the members role (admin and moderator), remove/ban members, and accept or deny member applications.
  - Users must be able to interact by posting content on the activity wall of the group.
  - The group admins must be able to enable the group forum.

- A user must be able to send messages to other users, as well as to delete his own messages.
- The user must be able to accept or deny friendship requests.
- The user must be able to earn points by completing specific actions.
  - Consequently, by earning points, the user will earn badges and ranks.
- The user must be able to search for other users, groups, groups forums and group forum topics.
- The web platform must give the user the option to choose accessibility options:
  - Change the colour scheme.
  - Change the text font.
  - Increase the mouse cursor.
  - Enable the text to sign language translator.
  - Increase the zoom of the pages.

Figure 18 illustrates the web platform use case diagram resultant of the previously defined functional requirements.

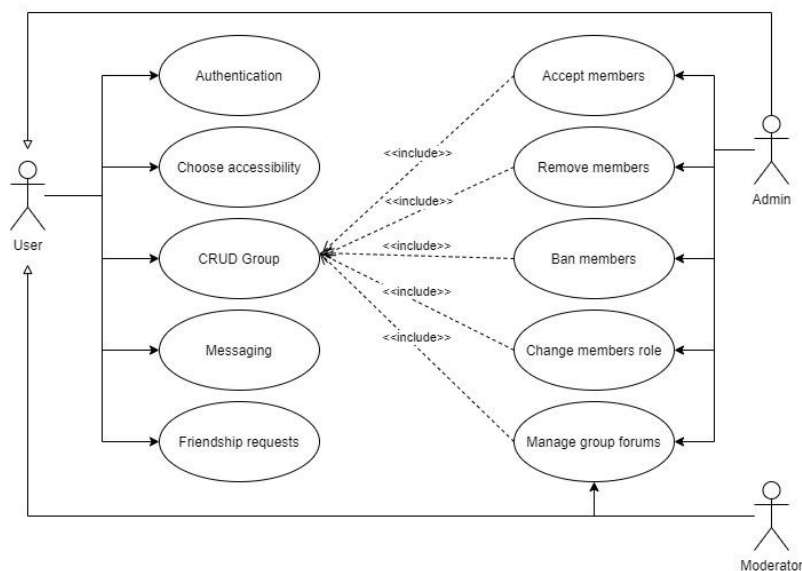


Figure 18 - Project use case diagram.

### 5.2.2 Flowchart

Figure 19 illustrates the web platform flowchart by showing the structure and makeup of the planned project. A website flowchart is useful for giving a broad overview of its content as well as for sketching out future additions.

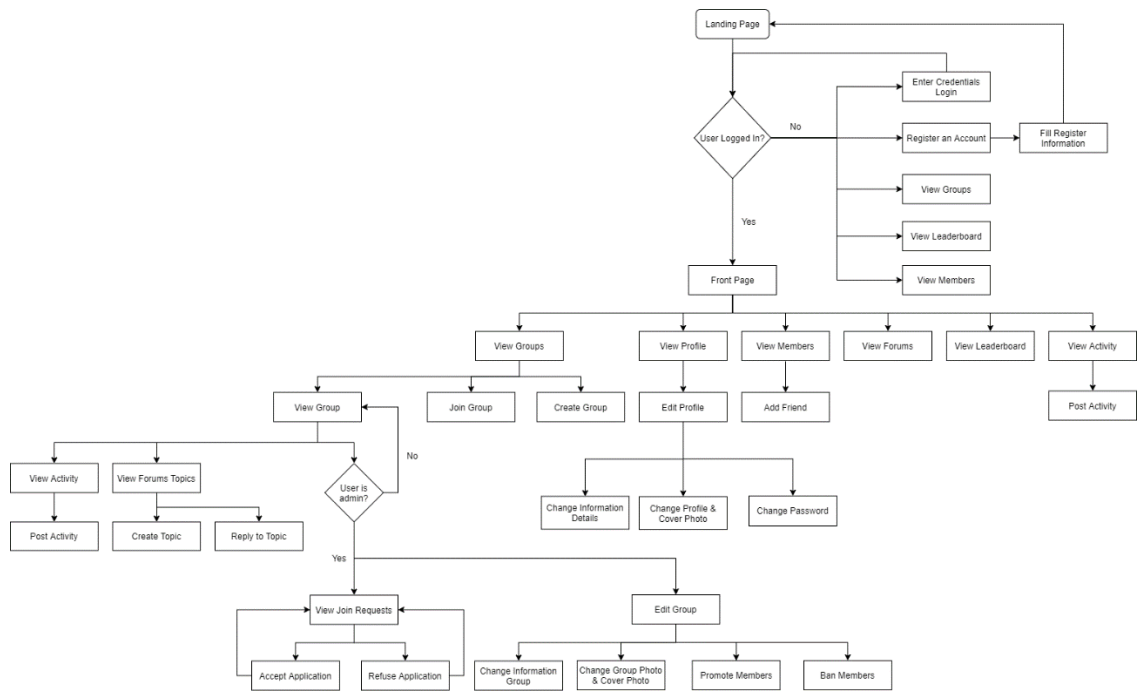


Figure 19 – Project website flowchart.

As soon as the user registers on the web platform, he will be able to take full advantage of the functionalities. Simultaneously, if the user does not have an account, the web platform provides a registration option.

Additionally, the accessibility options are available within all the steps of the flow, meaning that the users can enable or disable these options as intended.

### 5.2.3 Database

In the context of this project, the existence of a database is crucial to enable the web platform functionalities. Even though WordPress has twelve default tables to manage the different sections, features and functionalities, it is possible to create more tables according to a project’s functionalities. The following Figure 20 illustrates the database used in order to manage the user information, groups, notifications and messaging system.

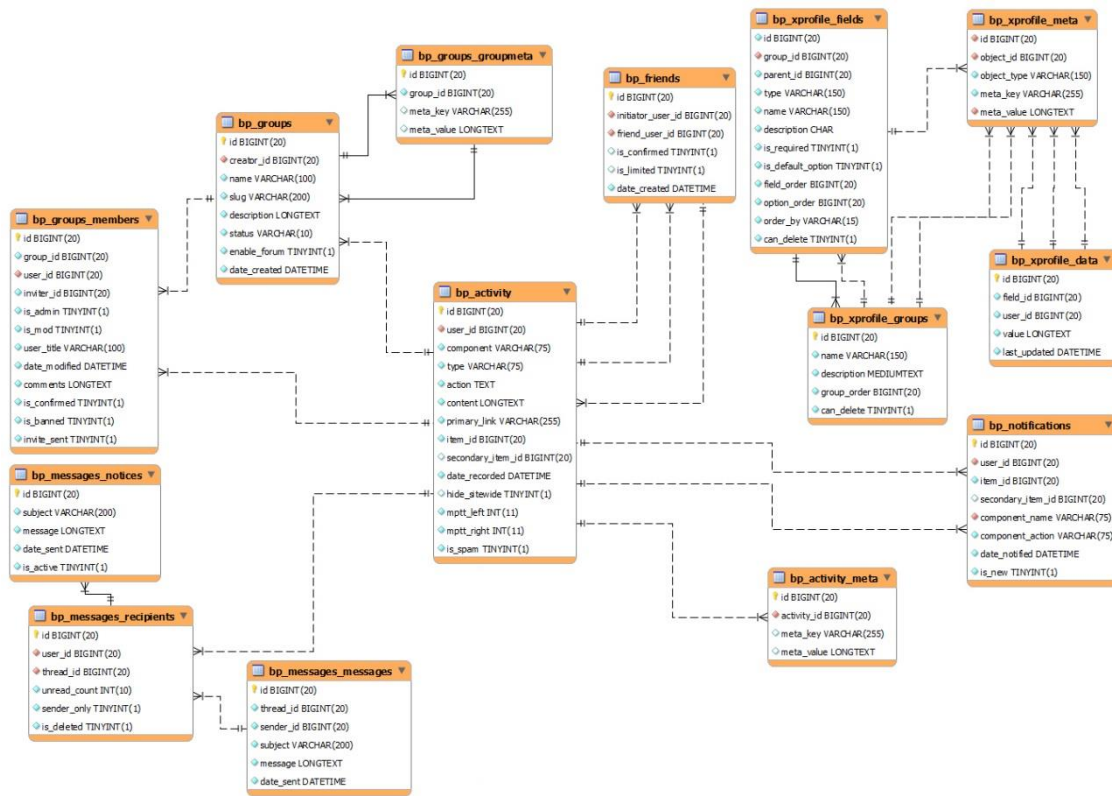


Figure 20 - Project Database.

The table *bp\_xprofile\_fields* and its related tables, *bp\_xprofile\_meta*, *bp\_xprofile\_groups*, *bp\_xprofile\_data* contain all the user information, for example the users' name, email, institution, etc.

The table *bp\_friends* represents the relationship between two users. The field *initiator\_user\_id* refers to the user that sends the friend request and the field *friend\_user\_id* refers to the user that receives the request. The acceptance of a friendship is represented by the field *is\_confirmed*, where "0" represents a request not accepted and a "1" represents an accepted request.

The table *bp\_groups* and its related tables, *bp\_groups\_meta* and *bp\_groups\_members* stores all the information regarding the groups. The field *enable\_forum*, when enabled, value "1", allows the creation of a forum directly associated with the correspondent group. The table *bp\_groups\_members* represents the members of a group and contains the roles related to each member, such as the group admin (*is\_admin*) and group moderator (*is\_mod*).

The table *bp\_messages\_messages* and its related tables *bp\_messages\_recipients* and *bp\_messages\_notices* contain the messages sent between users.

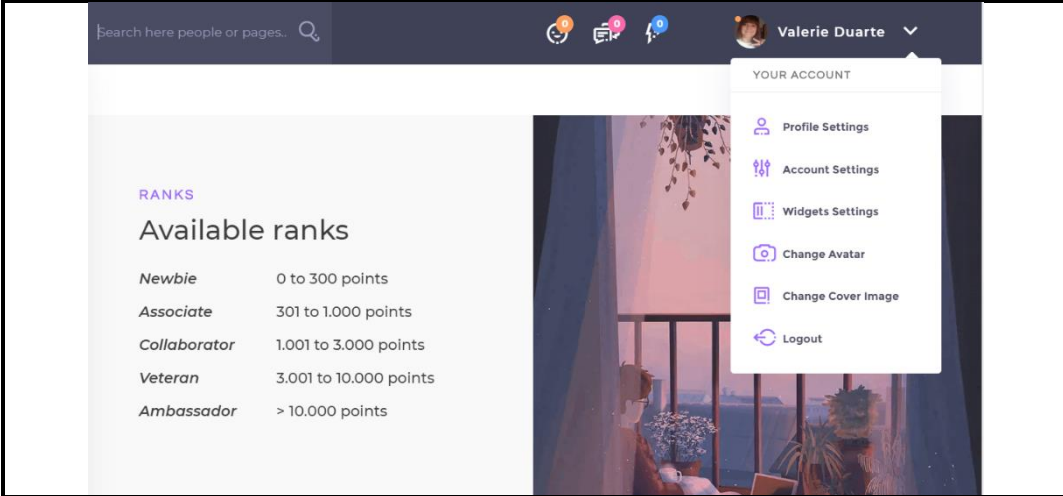
The table *bp\_notifications* represents the user notifications, such as friendship requests, group requests, replies to forum topics, etc.

Finally, the table *bp\_activity* and its related table *bp\_activity\_meta* is the agglomeration of all the previous described tables, which represents the user activity within the web platform.

## 5.3 Development

In this chapter, the technical content will be presented and discussed accordingly. The entire project was developed based on the guidelines previously defined on the State of the Art (see Section 2) regarding inclusive design and the use of a CMS (WordPress).

### 5.3.1 Storyboard



Section:	Top header.
Description:	The top header is shown on all the pages, it contains the main search input, notifications, and a shortcut dropdown of the user account. Regarding the notifications, the first icon shows the users' friendship requests, the second icon shows the users' unread messages, and the third icon shows the users' general notifications.
Interaction:	By writing on the search box the user will be shown a list of members, groups, forums, and forum topics related to his written text. 1 <sup>st</sup> icon: By mouse hovering the first icon, the user will be shown his pending friendship requests and consequently, deny or accept the requests. 2 <sup>nd</sup> icon: By mouse hovering the second icon, the user can preview the unread messages and click on "View all messages" to be redirected to his inbox. 3 <sup>rd</sup> step: By mouse hovering the third icon, the user can delete his notifications, mark them as "read" and click on the "view all" button to be redirected to the notification list. By mouse house hovering the users' name, the user will be shown a list of shortcuts to configure his profile and the logout button.

Figure 21 - Top header.

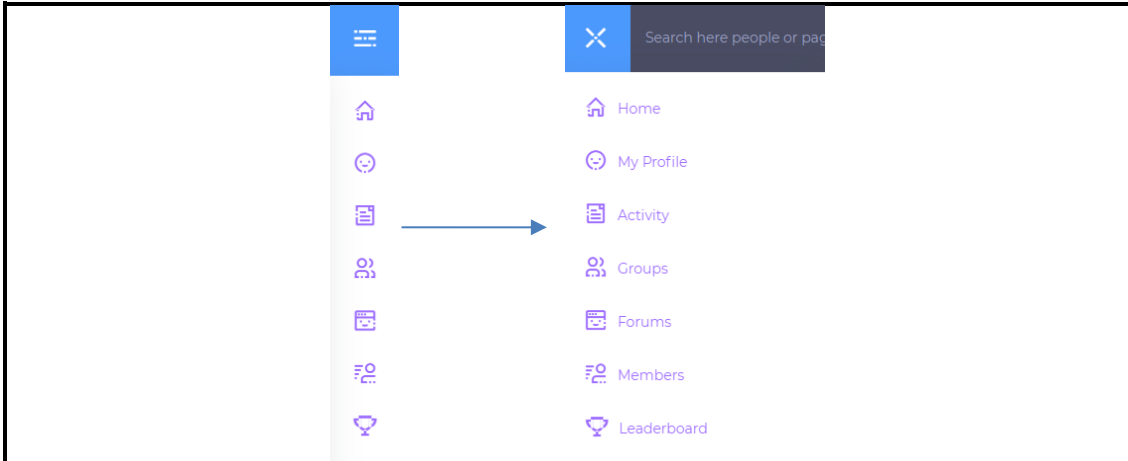
	
Section:	Left menu.
Description:	The left menu contains the main shortcuts of the web platform, which are the following: Home page, user profile page, activity, group directory, user forums, member directory and leader board page.
Interaction:	By clicking on the top left icon, the user can expand the menu as illustrated above.

Figure 22 - Left menu of the web platform.

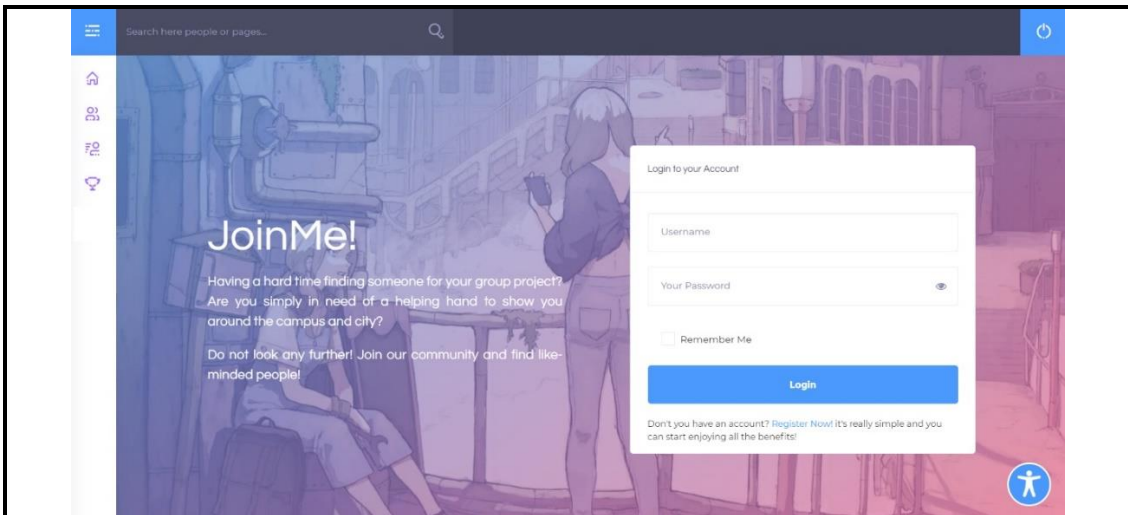
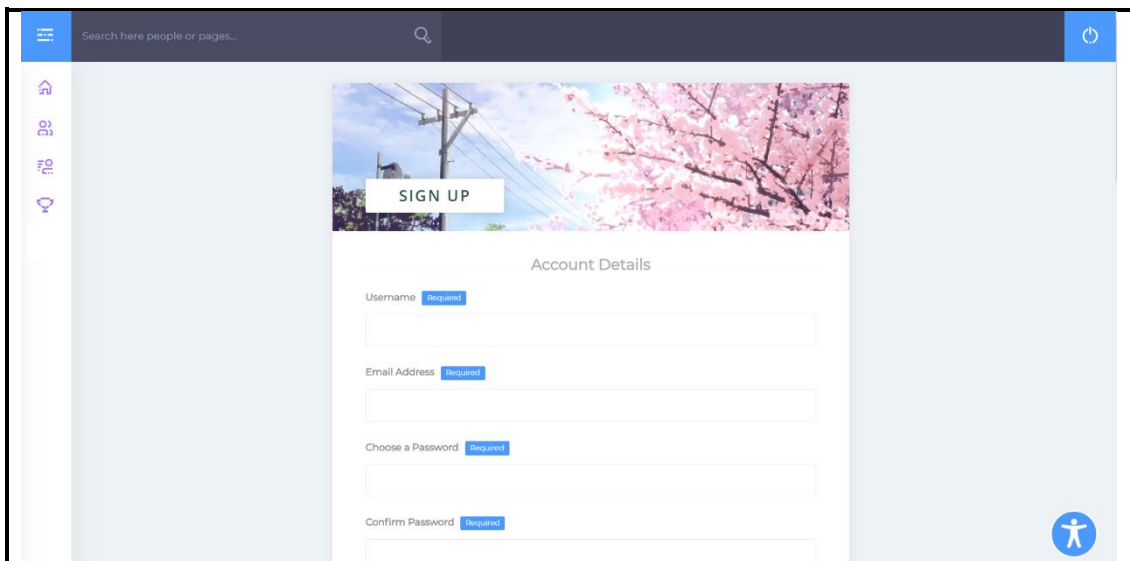
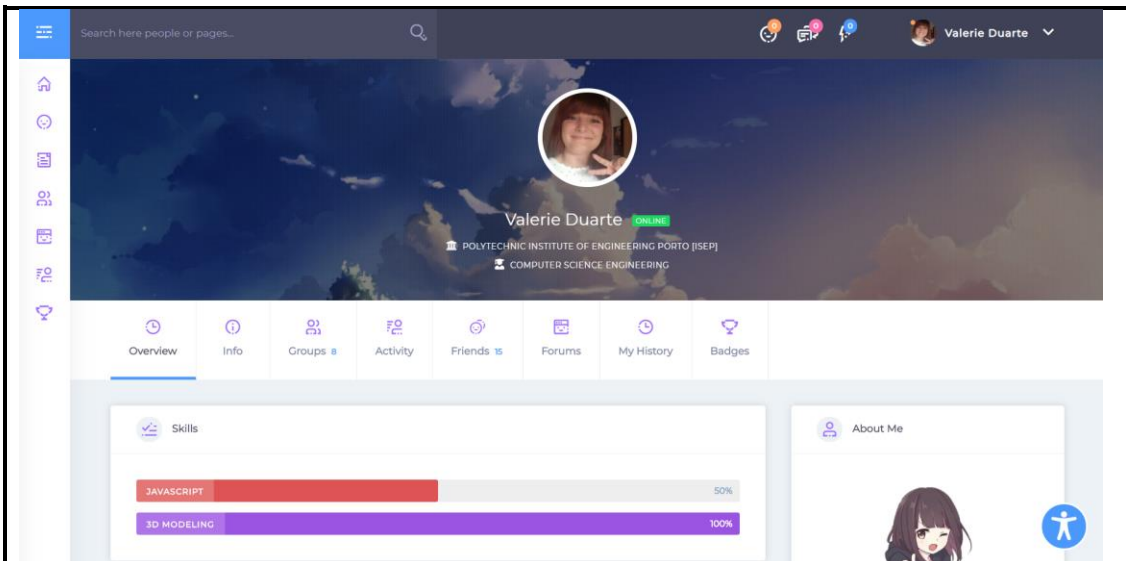
	
Page:	Frontpage for anonymous users.
Description:	The frontpage is divided into four main sections. The first section, as shown on the figure, is where the user can login and choose to register. The second section contains a summary of each feature available to the user. Finally, the third and fourth section contain an explanation of how the user can obtain badges and consequently, achieve a specific rank.

Figure 23 - Frontpage.



Page:	Signup page.
Description:	The signup page contains a form that will subsequently represent the user profile. The form is divided in two sections, account details and profile details.
Interaction:	The user will be able to input his account details (username, email, password and the confirmation of the password). On the second section, profile details, the user will be able to input the following fields: name, email, city, birthdate, mother tongue and other languages. Every field that has the tag "required" are mandatory. Additionally, the user can choose the visibility of his birthdate and his email towards other users.

Figure 24 - Signup page.



Page:	User profile page.
Description:	<p>The profile page is the culmination of the user information, as described on the following list:</p> <ul style="list-style-type: none"> <li>• Tab “Overview”: Contains the overview of the user own profile, which is his skills, projects, services, quote, biography, and points.</li> <li>• Tab “Info”: Contains the user personal information and education information.</li> <li>• Tab “Groups”: Contains a list of groups that the user joined.</li> <li>• Tab “Activity”: Contains the actions that the user previously executed, such as, changing his profile picture, cover image, etc.</li> <li>• Tab “Friends”: Contains the users’ friends.</li> <li>• Tab “Forums”: Contains the group forums that the user chose to engage in.</li> <li>• Tab “My History”: Contains the user points log.</li> <li>• Tab “Badges”: Contains the badges that the user earned.</li> </ul>
Interaction:	<p>Tab “Overview” and “Info”: When the user mouse hovers a section, such as skills, he will be presented with the option to directly edit the section.</p> <p>Tab “Groups”: The user can order the groups accordingly and leave the group.</p> <p>Tab “Activity”: The user can choose which activity he wants to see, pin a specific activity, or delete his own activity.</p> <p>Tab “Friends”: The user can directly unfriend another user or send a</p>

Figure 25 - User Profile Page.

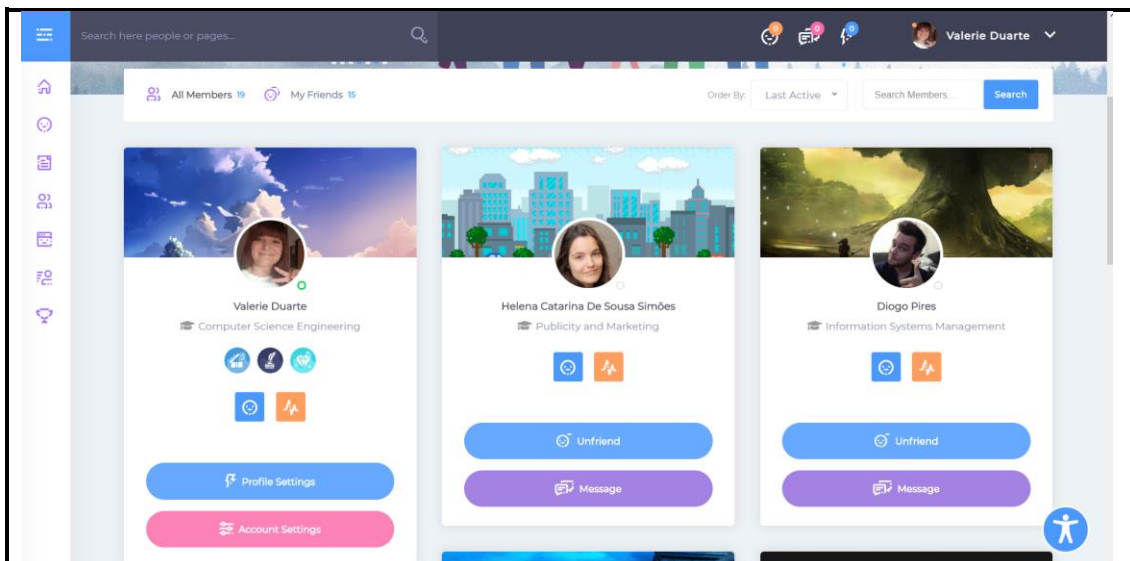
Page:	Group directory page.
Description:	The group directory page contains the created groups. The user can inspect the total posts of a group, when was the last time a group was active and how many members are in a group.
Interaction:	In this page the user can filter the groups by type (miscellaneous, tutoring, tourism, event, housing, course, study, and subjects), join a group, leave a group or manage a group if he has the role of admin within the group. Additionally, a user can create his own group by clicking on “Create a Group” and view the list of the groups he previously joined by clicking on “My

Figure 26 - Group Directory Page.



Page:	Group page.
Description:	<p>The group page contains all the information and activity regarding a group, as described on the following list:</p> <ul style="list-style-type: none"> <li>• Tab “Home”: Contains the group activity, the list of the administrators, the list of the moderators and the description of the group.</li> <li>• Tab “Info”: Contains the description of the group.</li> <li>• Tab “Forum”: Contains the list of the existent forum topics.</li> <li>• Tab “Members”: Contains the list of the group members.</li> <li>• Tab “Send Invites”: Contains the list of the user friends which he can invite.</li> <li>• Tab “Manage”: This tab is only available for users that have the administrator role of the group. In this tab the user can manage the group itself, such as, the posted content, members, customization, and forum.</li> </ul>
Interaction:	<p>Tab “Home”: The user can post content for the other members of the group, such as text, photos, quotes, gifs, files and links. Additionally, the user can tag friends that are part of the group on his posts.</p> <p>Tab “Forum”: The user can create new topics, subscribe to topics, view and reply to existing topics.</p> <p>Tab “Members”: The user can search for members and order the members accordingly. The user is also able to unfriend/send a friendship request to members and send them private messages.</p> <p>Tab “Send Invites”: The user can select multiple users and send them an invite to join the group.</p> <p>Tab “Manage”: The user, can change the group details, settings, photo and cover image. Furthermore, the user can manage the groups members (promote/ban/remove), accept/deny membership requests, enable/disable the group forum and delete the group.</p>

Figure 27 - Group Page.



Page:	Members directory page.
Description:	The member directory page contains the list of registered users. The user can inspect the total friends and points that a member has, the three last badges the user acquired and his current course.
Interaction:	In this page the user can search for member, change the filter order, unfriend/send a friendship request to a user and message a user. Additionally, the logged user profile is shown on the first card of the directory, with that, the user can go to his profile settings and account settings. Regarding the list itself, the user can also choose to only see his friends by clicking on he “My Friends” button or all the members by clicking on the “All members” button.

Figure 28 - Members Directory Page.

Page:	Leaderboard page.
Description:	The leader board page contains the list of members ordered by the amount of points earned.

Figure 29 – Leader board Page.

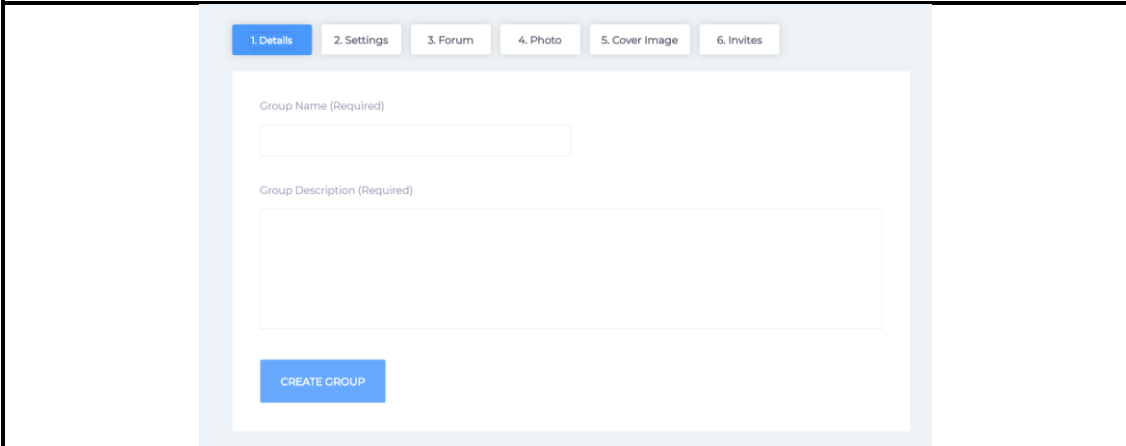
	
Page:	Group creation page.
Description:	The group creation page is divided in six steps in which the user can configure the group according to his preferences
Interaction:	<p>1<sup>st</sup> step: It is mandatory for the user to fill out the form with the group name and group description.</p> <p>2<sup>nd</sup> step: In this step the user needs to choose one of the three privacy options regarding the group, which are the following:</p> <ul style="list-style-type: none"> <li>• Public Group: Any member can join the group, the group will be listed in the groups directory and search results, the group activity and content will be visible to anyone.</li> <li>• Private Group: Only users who request membership and are accepted can join the group, the group will be listed in the groups directory and the search results, the content and activity will only be visible for members of the group.</li> <li>• Hidden Group: Only users who are invited can join the group, the group will not be listed on the groups directory or search results, the group content and activity will only be visible to members of the group.</li> </ul> <p>Additionally, the user can choose the type of the group and which members of the group are allowed to invite others.</p> <p>3<sup>rd</sup> step: In this step the user can enable or disable the group forum.</p> <p>4<sup>th</sup> and 5<sup>th</sup> step: In these steps the user can upload the photo and cover image of the group.</p> <p>6<sup>th</sup> step: Finally, the last step is optional, the user can directly invite users that he already has on his friend list to the group.</p>

Figure 30 - Group Creation Page.

#### 5.3.1.1 Accessibility

The accessibility section, development wise, is the main focus of this dissertation, since the approach previously chosen was to incorporate a variety of optional features suited to users' individual needs and preferences. The accessibility features are illustrated in Figure 32 and were drawn upon the following:

### Colour blind users:

A user that is colour blind cannot see certain colours the way most people do or may not see colour at all. There are three types of colour blindness as explained below:

- **Red-green colour blindness:** According to the National Eye Institute [49], it is the most common type of colour blindness, it implies that the person has difficulty telling the difference between red and green. Moreover, there are four types of red-green colour blindness:
  - Deuteranomaly: Which is the most common type of the four, it makes green look more red.
  - Protanomaly: Makes red look more green and less bright.
  - Protanopia and Deuteranopia: Both imply that the person is unable to tell the difference between red and green at all.
- **Blue-yellow colour blindness:** It is the less common type of colour blindness, it implies that the person has difficulty telling the difference between blue and green, and between yellow and red. There are two types of blue-yellow colour blindness:
  - Tritanomaly: Makes it harder to tell the difference between blue and green, and between yellow and red.
  - Tritanopia: Implies that the person is unable to tell the difference between blue and green, purple and red, and yellow and pink. It also makes colours look less bright.
- **Complete colour blindness:** People who has complete colour blindness cannot see colours at all. It also known as monochromacy and its quite uncommon. Depending on the type, the person may also experience trouble seeing clearly and be more sensitive to light.

Regarding our solution, for Red-green colour blindness we opted for a blue and yellow colour palette, and for the Blue-yellow colour blindness we opted for a blue-pink colour palette. Taking into consideration the complete colour blindness we opted for a monochromatic colour palette with an increased contrast. As illustrated on Figure 31.



Figure 31 - Accessibility: Colour Schemes.

### Visually Impaired users:

For visually impaired users we opted for a zoom option, that will enlarge the content of the page, an optional cursor significantly larger than the default one, and a readable font that replaces the default font for a larger and clearer font.

### Hearing Impaired users:

For hearing impaired users, as already mentioned in the State of the Art (see section 2), we opted to use the Virtual Sign web plugin, which translates text to sign language.

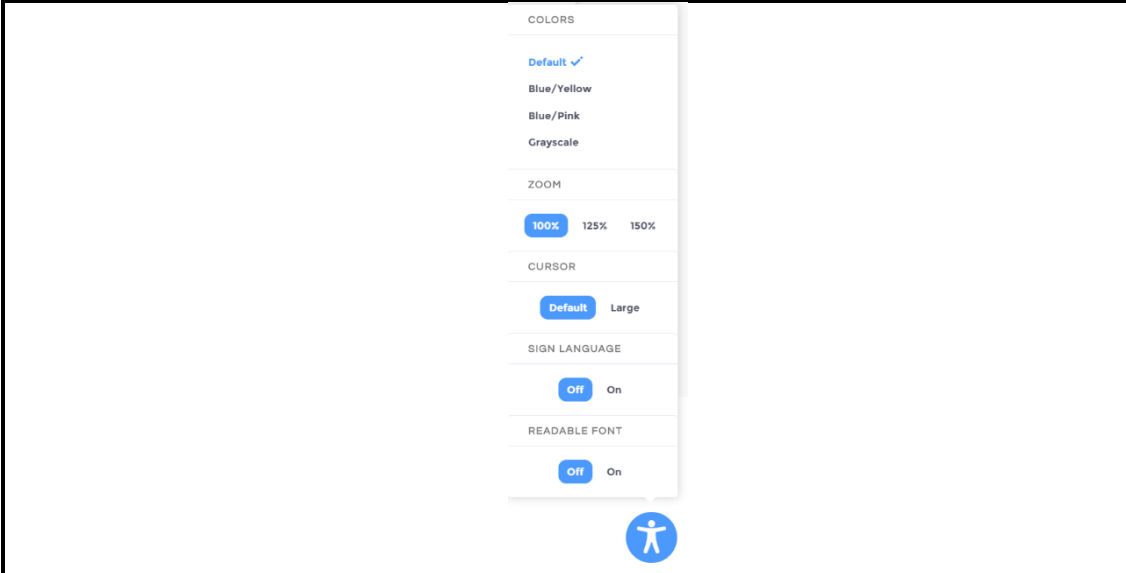
	
Section:	Accessibility.
Description:	The accessibility section contains the options that benefit colour blind, visually impaired and hearing impaired users. The users can change their settings in every page since the button is always available on the right bottom corner of the page.
Interaction:	By mouse hovering the accessibility icon, the user will be presented the following options: <ul style="list-style-type: none"><li>• Colour: The user is able to choose between the available colour palettes, which will change the appearance of the web platform.</li><li>• Zoom: The user is able to enlarge the page between 100%, which is the default, 125% and 150%.</li><li>• Cursor: The user can change the cursor between the default and a larger version of the cursor.</li><li>• Sign Language: This option will turn on/off the Virtual Sign avatar, that will translate the selected text to sign language.</li><li>• Readable font. The user can change the font between the default (off) and a more readable and clearer font (on).</li></ul>

Figure 32 - Accessibility Menu.

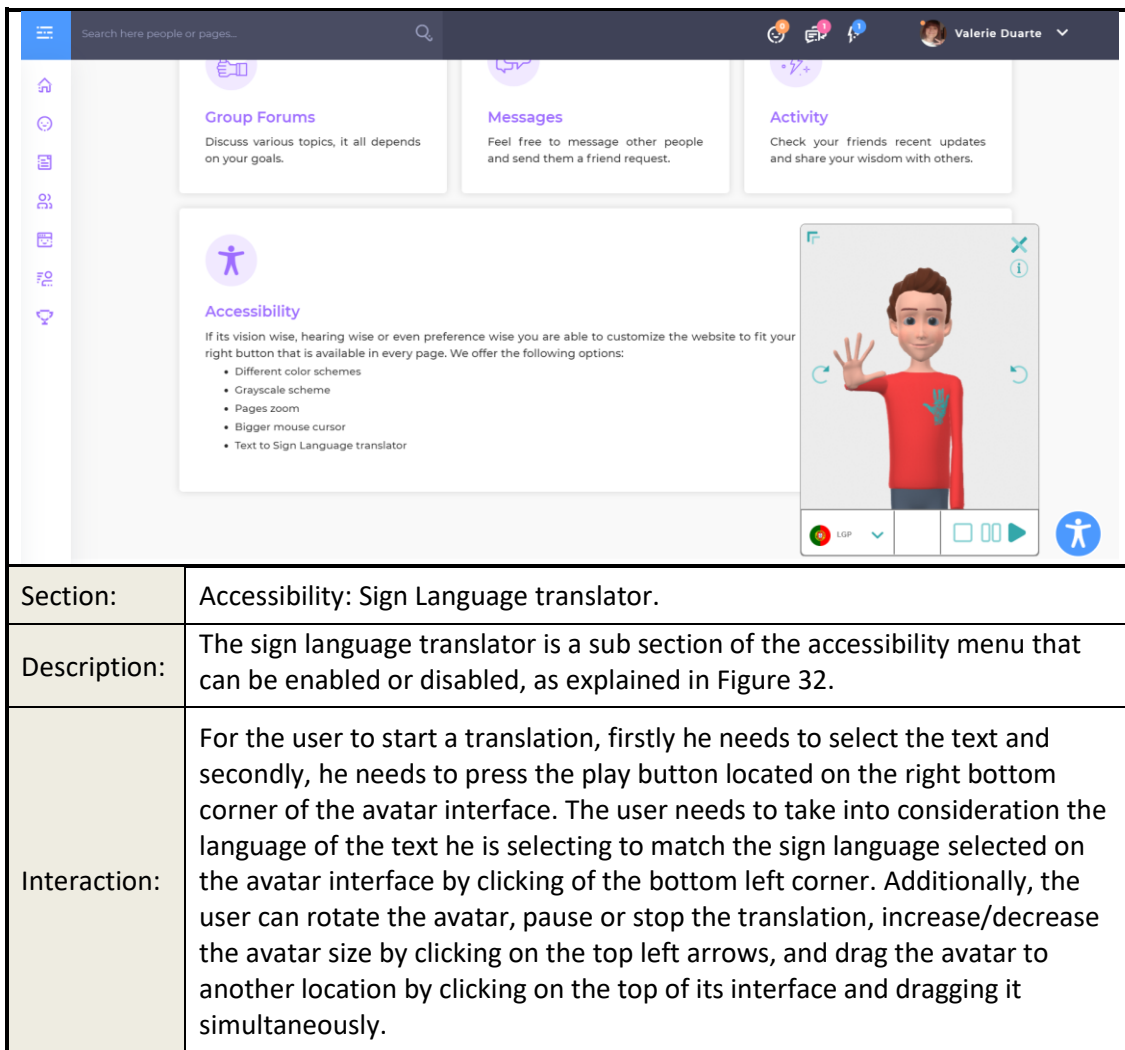


Figure 33 - Accessibility: Sign Language translator (Virtual Sign)

### 5.3.2 Coding

This section will present the technical content regarding the code for multiple functionalities developed for this dissertation.

```

1. function clickColorScheme(scheme, name) {
2.     if (scheme === 'gray') {
3.         grayDocument();
4.         document.body.classList.remove('image-hue');
5.         setCookie("custom-thesis-2020-color", scheme, 30)
6.         return;
7.     }
8.     document.documentElement.style.filter = '';
9.     changeColorScheme(scheme[0], scheme[1], scheme[2], scheme[3]);
10.    document.body.classList.remove('default');
11.    document.body.classList.remove('pink-blue');
12.    document.body.classList.remove('blue-yellow');
13.    document.body.classList.add(name);
14.    if (scheme.toString() === defaultScheme.toString()) {

```

```

15.         document.body.classList.remove('image-hue');
16.     }
17.     else {
18.         document.body.classList.add('image-hue');
19.     }
20.
21.         setCookie("custom-thesis-2020-color", JSON.stringify(scheme), 30);
22.         activeScheme(scheme);
23.         e.preventDefault();
24.     }
25.
26.
27. function changeColorScheme(firstColor, secondColor, thirdColor, iconColor) {
28.     document.documentElement.style.setProperty('--primary-accent-
color', firstColor);
29.     document.documentElement.style.setProperty('--secondary-accent-
color', secondColor);
30.     document.documentElement.style.setProperty('--third-accent-
color', thirdColor);
31.     document.documentElement.style.setProperty('--icon-
color', iconColor);
32.     document.documentElement
33.     var cssFile = document.createElement('style');
34.     createStyle(cssFile, '.message-button .yz-send-message', 'background-
color', firstColor);
35.     document.head.appendChild(cssFile);
36.     e.preventDefault();
37. }

```

Code 1 – Change colour scheme functionality.

The excerpt of Code 1 supports the change of the web platform colour scheme through the primary, secondary, third and icon colour that are global variables on the CSS file. The function *setCookie* saves the colour scheme to a cookie so it can be loaded throughout the web platform pages.

```

1. function signLanguage(toggle) {
2.
3.     if (toggle === 'On') {
4.         document.getElementById('virtualsign').style.visibility = 'visible';
5.         document.getElementById('vsOpen').click();
6.         document.getElementsByClassName('sign-language-
button')[1].classList.add('active');
7.         document.getElementsByClassName('sign-language-
button')[0].classList.remove('active');
8.     }
9.     else {
10.
11.         if (document.getElementById('vsLoading').classList.toString() !== 'vs-
hide') {
12.             document.getElementById('virtualsign').style.visibility = 'hidden'
;
13.         }
14.         else {
15.             document.getElementById('vsClose').click();
16.         }
17.         document.getElementById('virtualsign').style.visibility = 'hidden';
18.         document.getElementsByClassName('sign-language-
button')[0].classList.add('active');

```

```

19.     document.getElementsByClassName('sign-language-
      button')[1].classList.remove('active');
20.     }
21.     e.preventDefault();
22. }

```

Code 2 – Toggle Virtual Sign web plugin.

The excerpt of Code 2 supports the toggle of the sign language avatar, which is an external component based on Unity<sup>3</sup>. The function *signLanguage* has one input named “toggle” which is used for controlling the enable/disable of the Virtual Sign web plugin. If the input toggle is active (“on”) the browser searches the HTML document for Unity component and enables the plugin. If the input toggle is inactive (“off”) the avatar interface is hidden from the HTML document while running on the background.

```

1.  function setCookie(name, value, days) {
2.      var expires = "";
3.
4.      if (days) {
5.          var date = new Date();
6.          date.setTime(date.getTime() + (days * 24 * 60 * 60 * 1000));
7.          expires = "; expires=" + date.toUTCString();
8.      }
9.      document.cookie = name + "=" + (value || "") + expires + "; path=/";
10. }
11.
12. function getCookie(name) {
13.     var nameEQ = name + "=";
14.     var ca = document.cookie.split(';');
15.
16.     for (var i = 0; i < ca.length; i++) {
17.         var c = ca[i];
18.         while (c.charAt(0) == ' ') c = c.substring(1, c.length);
19.         if (c.indexOf(nameEQ) == 0) return c.substring(nameEQ.length, c.length
    );
20.     }
21.     return null;
22. }

```

Code 3 - HTTP cookie management.

Cookies are text files with small pieces of data, for example, the username and password of a user. HTTP cookies are a specific type of cookie that is used to identify specific users and improve their web browsing experience [50]. The data stored in a cookie is created by the server upon the user’s connection. This data is labelled with a unique ID to the user and to his computer.

Regarding the web platform developed withing this dissertation, the cookies are applied to maintain the accessibility features enabled throughout the navigation of web platform. Having a cookie stored within a browser implies that the user does not need to keep enabling/disabling the features even if he closes the browser or page.

---

<sup>3</sup> Unity - <https://unity.com>

The function `setCookie` requires three different inputs (name, value, days). The “name” input is used for retrieving a value by using the function `getCookie`, the “value” input is used for storing a value and finally the “days” input is used to set the expiration date of the cookie.

The function `getCookie` purpose is to retrieve the value stored in the users’ browser.

### 5.3.3 Gamification

Gamification was recently redefined by Gartner as the “*use of game mechanics and experience design to digitally engage and motivate people to achieve their goals*” [51]. The reason we call it Gamification is because the gaming industry was the first to master Human-Focused Design. World leading gamification expert Yu-Kai Chou developed a framework named Octalysis divided in eight core drives which he believes are the key to bringing fun and engagement into almost any task (Figure 34) [52].

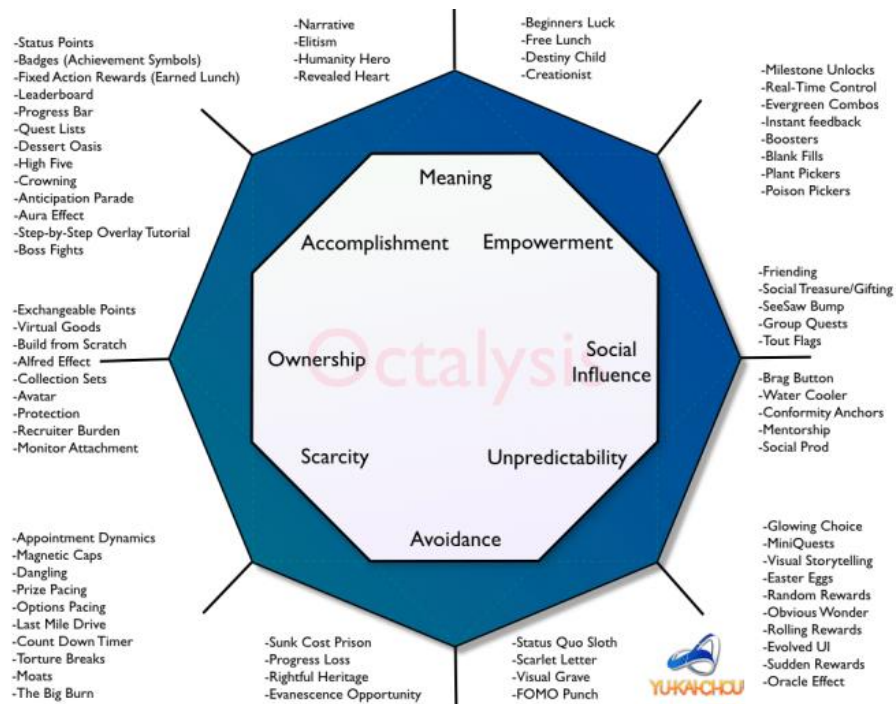


Figure 34 - Yu-kai Chou Octalysis Framework

According to Yu-Kai Chou, the history and effectiveness of elements like points, badges and leaderboards is their ability to use core drivers as an advantage. By taking that into account, we opted to use the following basic game elements:

- **Point System:** To make users feel like they have a meaning, purpose, and sense of progression.
- **Badges:** To tap the need for accomplishment and reward.
- **Leaderboard:** To appeal to the users’ need for social status and influence.

### 5.3.3.1 Points

Each user of the web platform has their own point balance, where they are able to view gained/lost points, as illustrated in Figure 35. Every time a user gains or loses points, the transaction is logged into a central log for accountability, this log is available in the users' profile. We defined actions and attributed points to each one respectively as specified in Table 20.

Table 20 – Points gain/lost by action.

<b>Groups</b>		
<b>Action</b>	<b>Description</b>	<b>Points</b>
Group Creation	Limit 1 per day	50
Group Deletions	Limit 1 per day	-50
New Group Avatar Upload	Limit 2 per day	1
New Group Cover Upload	Limit 1 per day	2
New Forum Topics	Limit 2 per day	10
Editing Forum Topics	Limit 1 per day	1
New Forum Posts	Limit 2 per day	2
Editing Forum Posts	Limit 1 per day	1
Joining Groups	Limit 1 per day	25
New Group Comments	Limit 5 per day	2
Adding Topic to Favourites	Limit 10 per day	2
New Forums	Limit 2 per day	20
Forum Reply	Limit 5 per day	1
<b>Login</b>		
Site daily visit	Limit 5 per day	5
<b>Members</b>		
New Profile Activity	Limit 5 per day	5
New Profile Avatar Upload	Limit 1 per day	20
New Profile Cover Upload	Limit 1 per day	20
New Friendships	Limit 5 per day	5
New Comment	Limit 10 per day	2
New Private Message	Limit 25 per day	1

### 5.3.3.2 Badges

Badges were designed and are awarded automatically when a user completes certain requirements, as illustrated in Figure 35.

Name	Action	Required points	Badge
<i>Social Architect</i>	Logging in 500x Creating a group 50x Creating forum topics 100x Replying to forum topics 300x	N/A	
<i>Chatterbox</i>	Sending private messages.	500	
<i>The Critic</i>	Favorite a topic.	400	
<i>The Regular</i>	Logging in.	500	
<i>Space Invader</i>	Joining a Group.	300	
<i>Pillar of Creation</i>	Creating a group.	500	
<i>The Publisher</i>	Commenting in groups.	500	
<i>Ink Master</i>	Updating your profile.	300	
<i>Connoisseur</i>	Viewing content.	1000	
<i>Social Butterfly</i>	Adding people to your friend list.	300	

Figure 35 - List of badges.

### 5.3.3.3 Leaderboard

The Leaderboard is generated based on the users point history, it presents the competitive placement of the thirty members with most points earned within the web platform, as previously shown in Figure 29.

### 5.3.4 Server

To host the web platform files and data related to this project, we will require a remote machine capable of handling external HTTP requests, process the web platform files and store the data in a database.

Taking this into account, we installed Windows operative system on the machine, XAMPP stack comprised of Apache webserver (to process our webpage files), PHP (to process any php code in the former), MariaDB (data storage) and finally WordPress (our Content Management System).

After the installation and configuration of the previous software, the next step was verifying if the machine was listening and responding to HTTP requests send to by accessing its local address (e.g. 192.168.0.12).

Once confirmed, a route was setup, forwarding external HTTP requests through the port:88, which is safer than using the general port:80 for outside access. After the route is completed, the web platform is online and running and anyone with the IP address<sup>4</sup> can now access the web platform.

---

<sup>4</sup> Web platform IP address: <http://62.48.198.114:88/wordpress/>

## 6 Trials and Evaluation

This chapter presents the evaluation methods and hypothesis testing that will complement the final solution. The evaluation is divided into two moments. The first one, regarding the quantitative evaluation, is achieved through the Quantitative Evaluation Framework (QEF), which will assure the quality of the initially established results. The second moment consists in the user satisfaction survey conceived to test the web platform features, usability and accessibility.

### 6.1 Hypothesis

In order to verify whether the established objectives were fulfilled, in other words, if the web platform is able to improve the student's integration in Higher Education, the following hypothesis were considered:

- **Null Hypothesis ( $H_0$ )** – The web platform developed did not improve the integration of students and did not made any appropriate contribution to the problem.
- **Alternative Hypothesis ( $H_1$ )** – The web platform developed only improved the integration of students that do not have accessibility issues and partly contributed to the problem.
- **Alternative Hypothesis ( $H_2$ )** – The web platform developed improved the integration of students and made an appropriate contribution to the problem.

$H_0$  implies that the social inclusion average did not improve with the use of this web platform.

$H_1$  implies that the social inclusion average improved partly with the use of this web platform.

$H_2$  implies that the social inclusion average improved with the use of this web platform.

## 6.2 Criteria

For the purpose of evaluating the final solution, the following dimensions were defined in order to assess the quality of the web platform:

- **Technical** – This dimension assesses the technical aspects of the web platform, in other words the functional requirements. In addition, this dimension assesses how accessibility-friendly the web platform is.
- **Pedagogical** – The pedagogical dimension makes it possible to assess whether the web platform promotes inclusivity and if it is in fact useful for students.
- **Ergonomic** – In addition to assessing the web platform usability this dimension takes into account socio-cultural aspects. Most of this dimension factors evaluate the relation between the users and the platform by revealing if it is according to their expectations, characteristics and necessities.

### 6.2.1 Quantitative Evaluation Framework

In order to validate the quality and the performance of the web platform developed, this project is supported by the use of Quantitative Evaluation Framework (QEF).

QEF is a quantitative assessment method that can measure a solution's quality through a multidimensional foundation that calculates its completion percentage [53].

Moderating the development of this project with QEF assures the quality of the initially established results. QEF enables evaluating the web platform quality in a three-dimensional space, each of which aggregates a set of factors. A factor is a component that represents the system performance from a specific point of view. Factors are divided into requirements; each requirement has been assigned specific weights correspondent to their importance and priority.

In the context of this project, the following dimensions and factors were chosen and specified in Table 21.

Table 21 - Simplified version of QEF's dimensions and factors

Dimension	Factor
Pedagogical	Inclusion
Ergonomic	User Interface
	User Experience
	Sociocultural
Technical	Functionalities
	Accessibility
	Support

The pedagogical dimension includes one factor, which is inclusion. The requirements assessed refer to the viability and the value of the web platform, in other words, they were chosen to uphold the contribute of the web platform regarding social inclusion.

The ergonomic dimension includes three factors: user interface, user experience and sociocultural aspects. The requirements were based on the understanding of the user interaction with the web platform, more specifically, if the user can explore smoothly the web platform.

The technical dimension also includes three factors: functionalities, accessibility, and support. The factors are for the most part functional requirements to understand if the developed functionalities are appropriate given the purpose of the web platform. Additionally, the accessibility factor is crucial to understand if the hearing and visually impaired users can interact with it effectively.

In total, QEF comprises 67 requirements, where the pedagogical dimension is highly based on the results of the first survey, specified in section 6.3.1. Some of the other requirements need to be assessed using the web platform by the target audience. Considering that, a second survey, named "user satisfaction survey" (see Attachment A) was developed in order to support the feedback of those factors.

According to the results of the user satisfaction survey, users had a pleasant experience while exploring the web platform functionalities and they would like to continue using it in the future. Furthermore, the users stated that the web platform would improve the integration of students in Higher Education.

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Finally, regarding QEF’s quota, with all the received feedback from both surveys, we achieved 89% of the total fulfilment percentage, as specific in Table 22.

Table 22 - Quantitative Evaluation Framework (QEF) of this project

q	D	Q <sub>i</sub>	<u>Dimension</u>	Q <sub>j</sub>	W <sub>ij</sub> (Factor Weight j in Dim i) [0,1]	<u>Factor</u>	rw <sub>jk</sub> (requirement weight k in Factor j) {2, 4, 6, 8, 10}	<u>Requirement</u>	wfk % requirement fulfillment k) [0,100]
89 %	0.30	91.07	Pedagogical	91.071	1.000	Inclusion	10	The web platform promotes social interaction	100
							10	The web platform promotes social inclusivity	100
							10	The web platform enables students to find other students for group projects	100
							6	The web platform enables students to find other students with similar interests and other matters	100
							10	The web platform is useful for students	75
							10	The web platform includes functionalities for visually impaired and hearing impaired students	75
		72.31	Ergonomic	100	0.05	User Interface	10	The interface is simple	100
							10	The pages layout is consistent	100
							10	The colors are adequate	100
							10	The interface is attractive	100
							10	The font is adequate	100
			0.57		10	The interface is intuitive	100		

				86.96 4		User Experience	10	The instructions while the user interacts with the platform are clear, precise and consistent	75
							10	The user can easily login and logout	100
							10	The menu navigations are consistent	100
							8	The web platform content does not have grammatical or syntax errors	90
							8	The web platform is compatible for all browsers	75
							10	The user can easily adapt to the web platform	75
							10	The visual feedback is display to the user regarding his actions	75
							8	The server performance is acceptable	100
							10	The user can get familiar with the web platform functionalities quickly	90
							8	The interface contributes for the continuous use of the web platform	90
				10	The interface provides the same experience for users with accessibility problems	75			
				93.75	0.19	Sociocultural	10	Texts are well written and all the sentences make perfect sense	75
							10	Messages are easy to understand and not offensive	100
							10	Messages should not contain racist, xenophobic or anti-Semitic content	100

							10	Content is related to the web platform	100
		94.74	Technical	96	0.78	Functionalities	10	User chooses the type of accessibility	100
							10	User can create an account	100
							10	User can login and logout	100
							10	User can view, edit and delete profile	100
							10	User can create, edit and delete a group	90
							10	User can create a group forum	100
							6	User can choose group type	100
							10	User can invite members to group	100
							10	User can leave groups	100
							10	User can remove members from group	100
							8	User can promote members from group	100
							10	User can approve or deny members	100
							10	User can post content on group	75
							10	User can create, edit, delete group forum topics	100
							10	User can reply to group forum topics	100
							8	User can view, send and delete messages	90
							6	User can view activity	100

						6	User can post content on activity	75
						6	User can edit and delete content on activity	75
						4	User can like content	100
						10	User can add and delete friends	100
						10	User can accept and deny friendship requests	100
						10	User can view other users' profile	100
						8	User can earn points by completing specific actions	75
						8	User can earn badges	100
						6	User can earn ranks	100
						8	User can view leaderboard	100
						6	User can view and delete notifications	75
						10	User can view list of members	100
						10	User can view list of groups	100
						10	User can search for other users, groups, group forums and group forum topics.	100
						89.06 3		
10	The color schemes are adequate for color blind users	100						
10	The font size can be increased	100						
8	The zoom of the page can be increased	75						
6	The cursor can be increased	100						

							10	The keyboard navigation is adequate for visually impaired users	50
							10	The font can be changed to increase the readability	100
				95	0.05	Support	10	User data is protected from unauthorized access	100
							10	The web platform is stable and executes systematically without failures	90

## 6.3 Assessment methodology

In order to validate the hypothesis previously defined, two surveys were held. The first named *“Inclusion & Belonging”* focuses on collecting data regarding the student’s integration. The second is a user satisfaction survey, which focuses on understanding if the web platform functionalities are in fact useful and if the chosen approach was appropriate. This will be done through the pedagogical, ergonomic and technical criteria previously defined.

### 6.3.1 Students Integration: Inclusion & Belonging

This survey aims at gathering the student’s perspective and insights concerning their integration in the higher education institution they are attending. As previously mentioned, the survey was inspired in a Harvard University initiative, which aimed to assess its community’s perceptions in inclusion and belonging [13]. Therewithal, it was based on a study that addresses the issue of school integration and discrimination in Portugal and Romania [54]. The structure of the survey was developed according to the Social Inclusion Assessment Tool (SiAT), previously specified in Section 2.

To assess the participants agreement to a specific question, we chose to use the Likert Scale[55]. This scale is divided between one and five, where one corresponds to “Strongly Disagree”, three corresponds to “Undecided” and five corresponds to “Strongly Agree”. Linkert Scale is commonly used in public health evaluation, where the respondents choose the option that best aligns with their views. It measures latent constructs, that is, characteristics of people, such as attitudes, feelings, and opinions. Thus, considering the main goal of this survey, this scale is the best option.

With the collaboration of the Communication and Image Department at ISEP, the International Relationships Department at the University of Aveiro, and the Erasmus Student Network of Aveiro and Porto, the Inclusion and Belonging Survey got in total 222 respondents, from which 188 are enrolled in ISEP.

#### 6.3.1.1 General Information

The general section is the first section of the survey. In addition to containing the basic questions such age, institution, course and degree, its primary purpose was to identify if there is any type of exclusion towards the gender, ethnicity and if applied, the disability of the participant. The following graphics show the results of the general section of the survey.

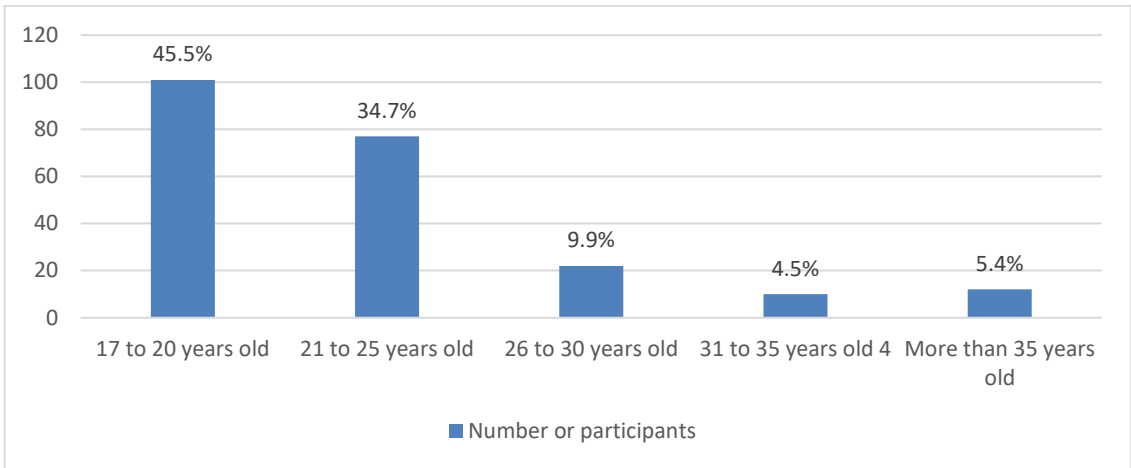


Chart 1 - Age

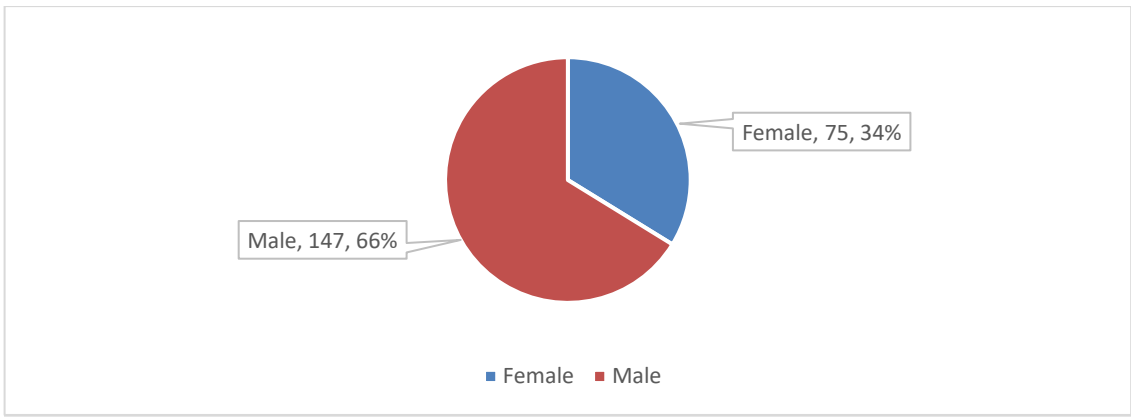


Chart 2 - Gender

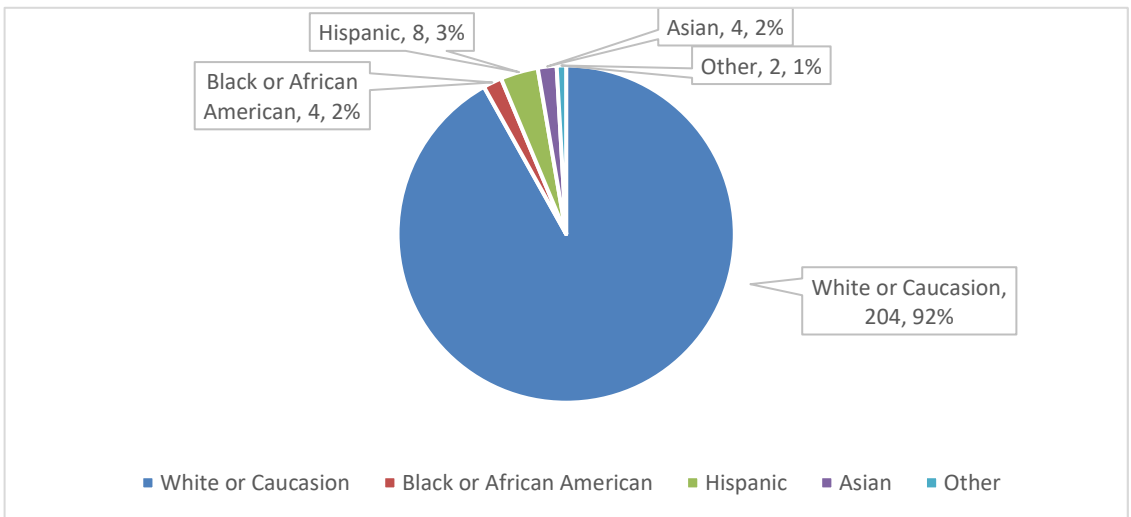


Chart 3 - Ethnicity

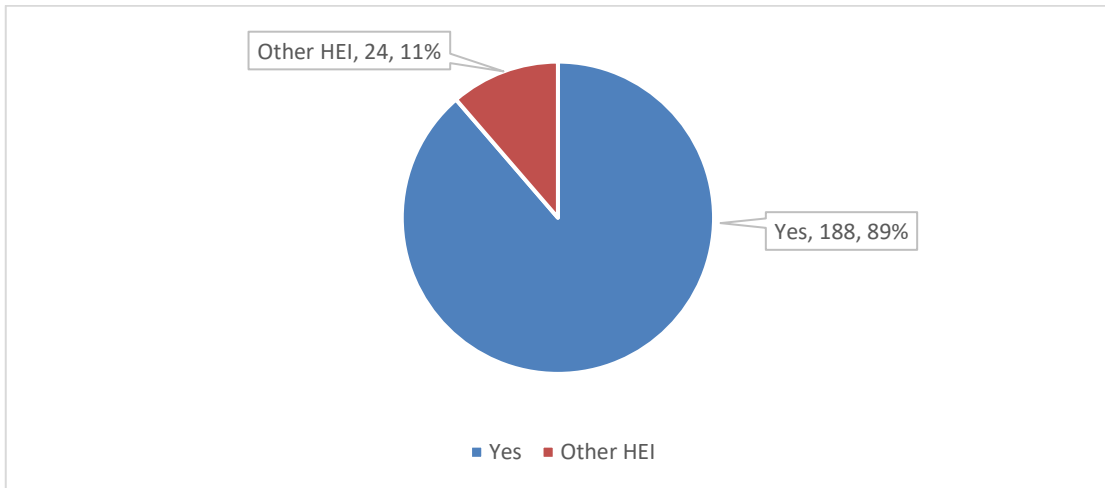


Chart 4 - Are you enrolled in ISEP? If not please specify the institution you are enrolled in.

Table 23 - What course are you enrolled in?

What course are you enrolled in?		
Course name	Number	Percentage
Informatics Engineering	102	45.9%
Mechanical Engineering	20	9%
Electrical and Computer Engineering	20	9%
Industrial Management Engineering	10	4.5%
Biomedical Engineering	10	4.5%
Chemical Engineering	10	4.5%
Civil Engineering	7	3.2%
Electrical Engineering – Power Systems	7	3.2%
Other courses	36	17.2%

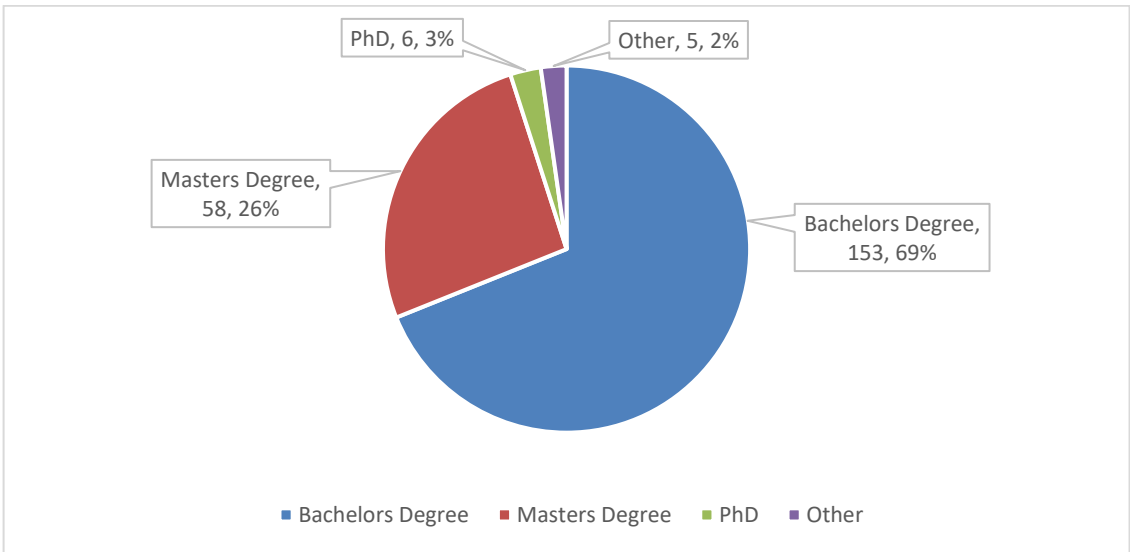


Chart 5 - Which degree are you attending?

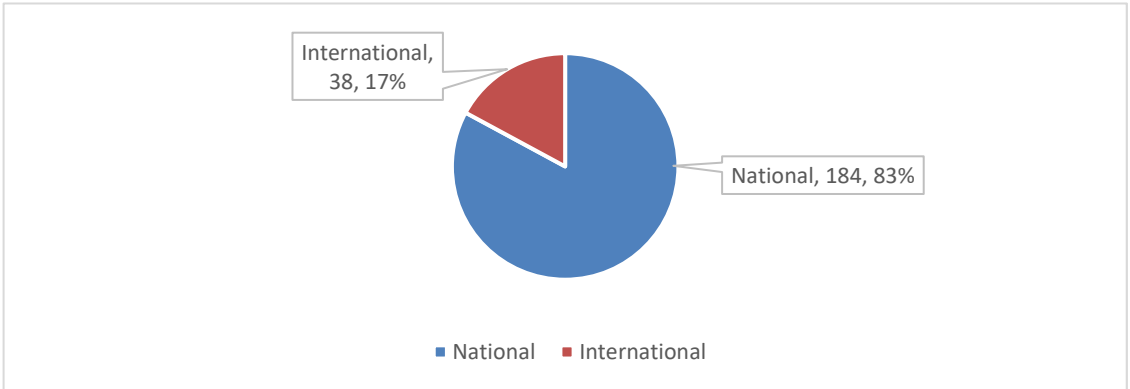


Chart 6 - What type of student are you?

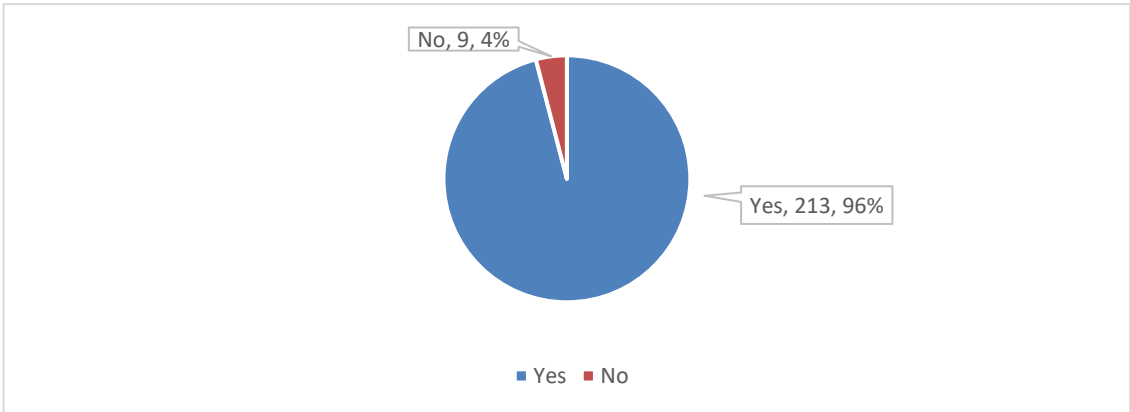


Chart 7 - Do you have any disabilities?

### 6.3.1.2 Accessibility section

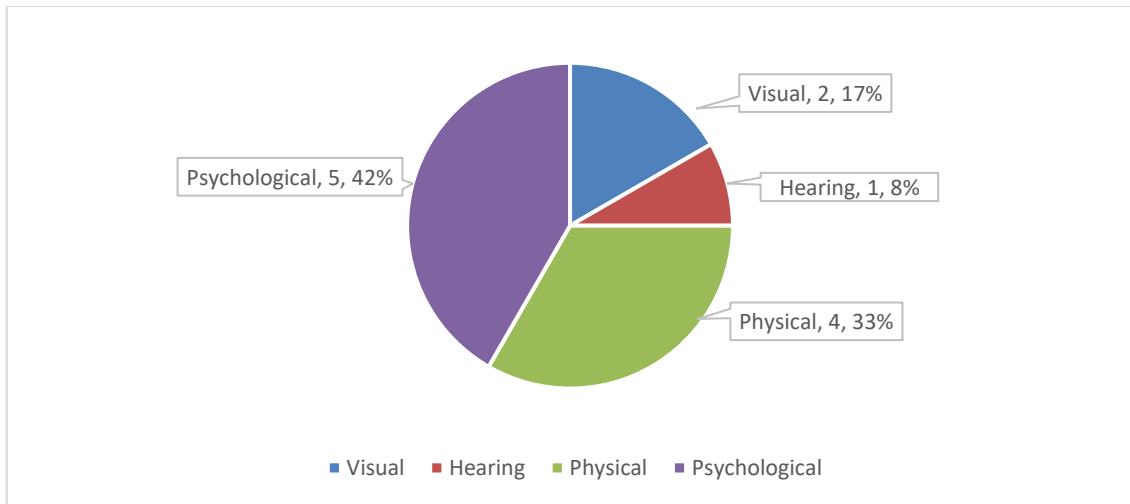


Chart 8 - Please specify your disability

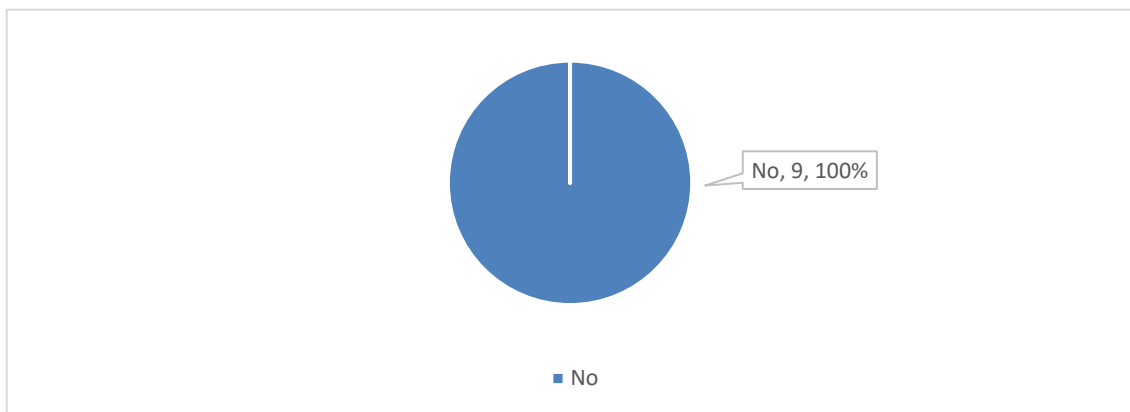


Chart 9 - Did you have problems locating points of interest or simply getting there?

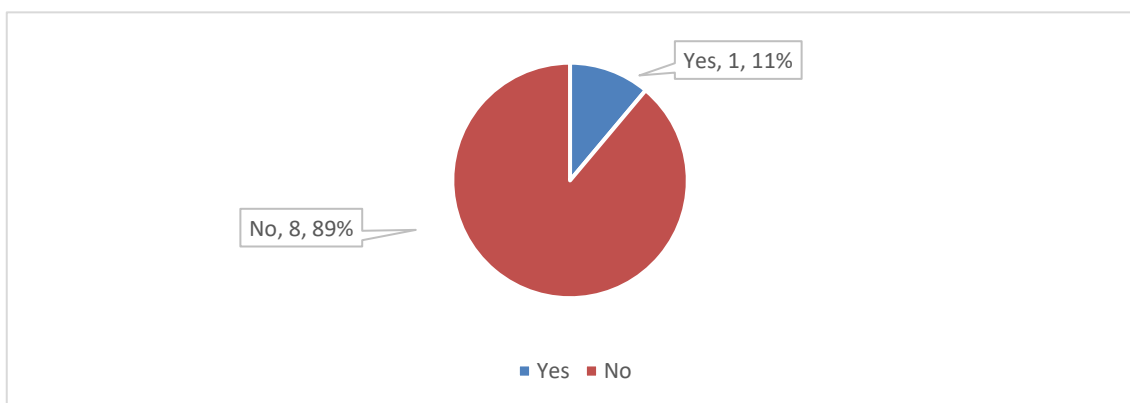


Chart 10 - Were you assigned a guide/tutor in your first days?

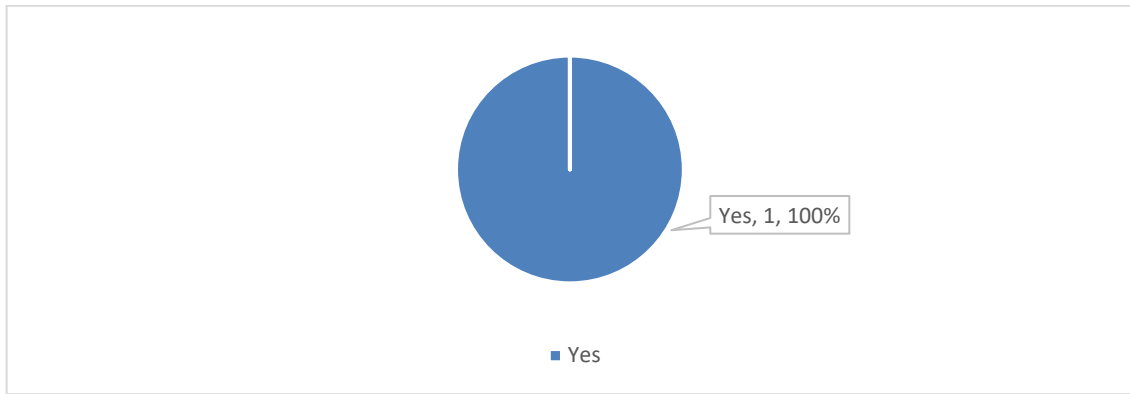


Chart 11 - If you answered yes to the previous question, was your guide provided in a timely manner?

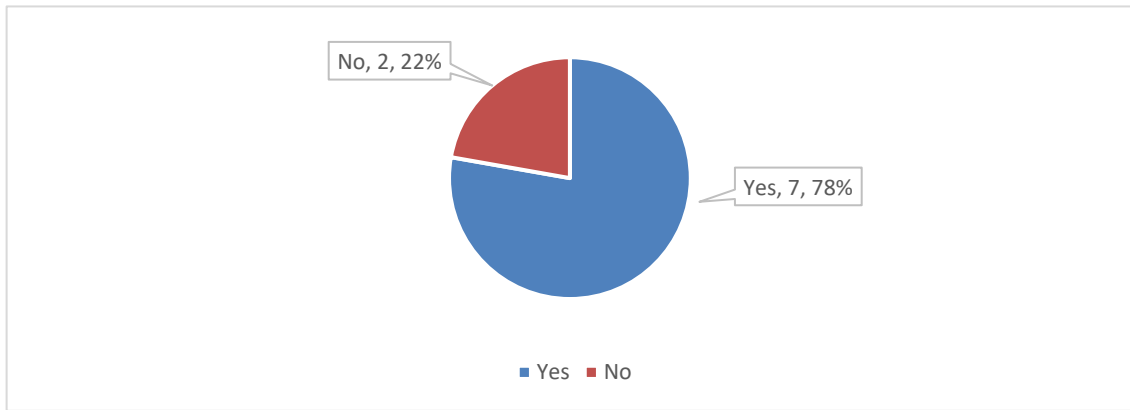


Chart 12 - Were you provided with relevant information that met your needs?

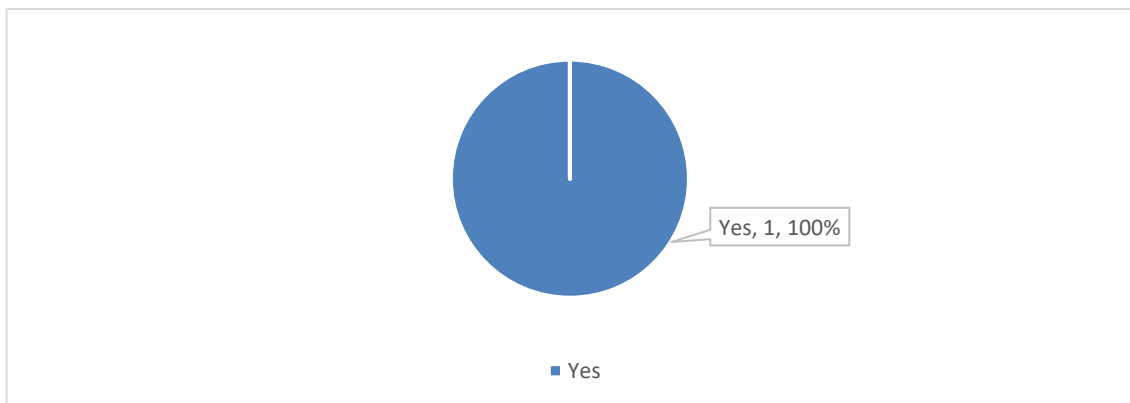


Chart 13 - Does the Institution have accessibility features that meet your needs?

There were no responses to the following questions:

- Did you have difficulty in finding someone that knows sign language?
- Does the institution website have accessibility features that meet your needs?

### 6.3.1.3 International Students and National Students

International Students and National Students are two separated sections. Both sections have, in the most part, identical questions. These sections are separated in order to assess the contrast of Portuguese students' opinions (national students) in comparison to other students' opinions (international students), regarding their feelings of inclusion. In total, from the 222 participants, 184 are national students and 38 are international students. The following graphics show the results of this section.

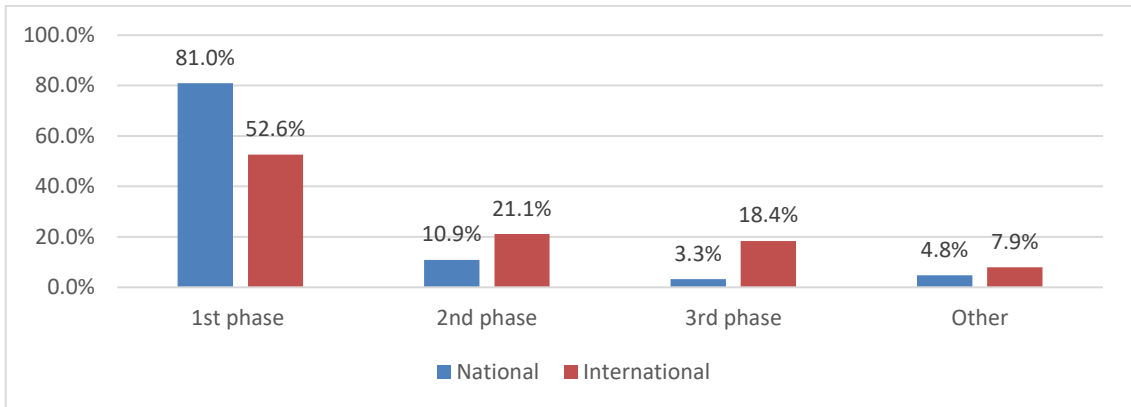


Chart 14 - When did you enrol in the institution you are attending now.

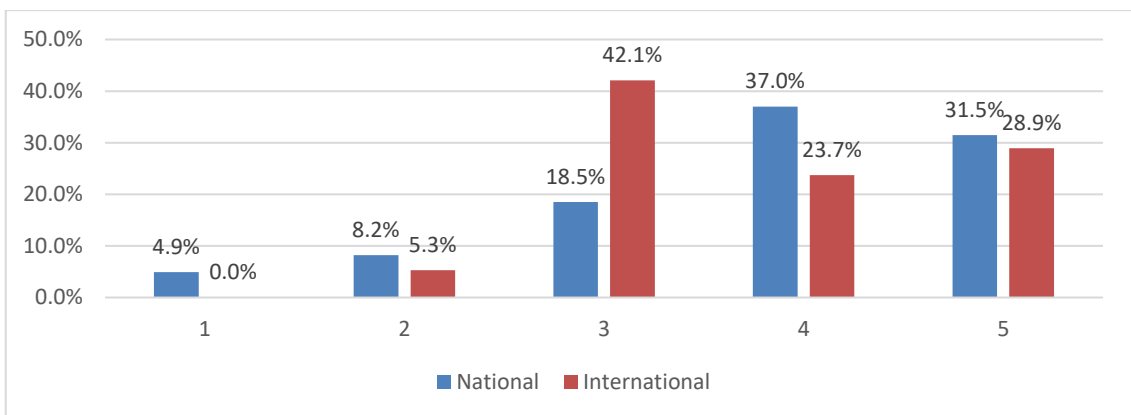


Chart 15 - I feel like I belong at this institution

The results from Chart 15 show that the majority of both types of students share the same sense of belonging regarding their institution. Although, with the highest percentage of 42.1%, the international students chose option three, which can imply that they do not feel comfortable or welcome yet.

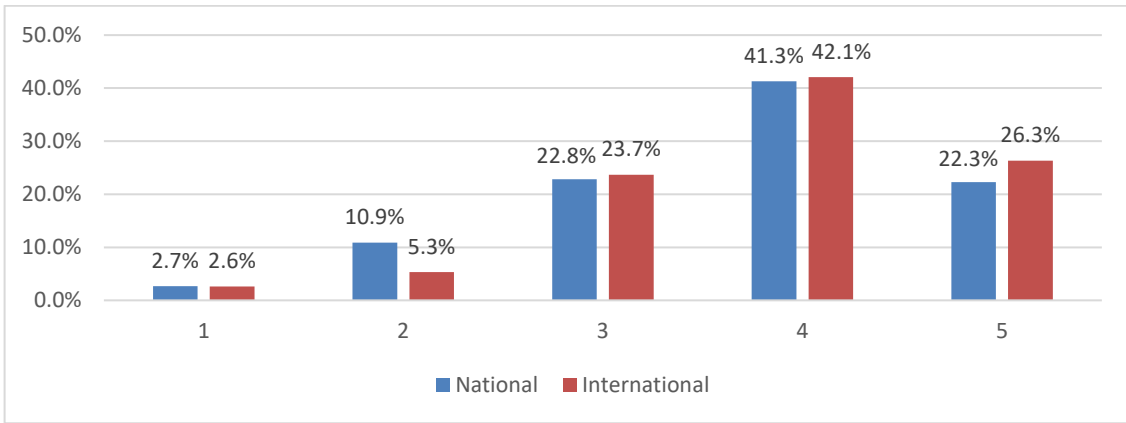


Chart 16 - My relationships at my institution are as satisfying as I would want them to be.

The results from Chart 16 are mostly positive. Approximately 63% of the national students' state that they are satisfied with this indicator, nevertheless 37% find themselves undecided or unsatisfied. Regarding the international students, the values are almost identical, 70% state that they feel satisfied as much as they would like to in regard to their institutional relationship network.

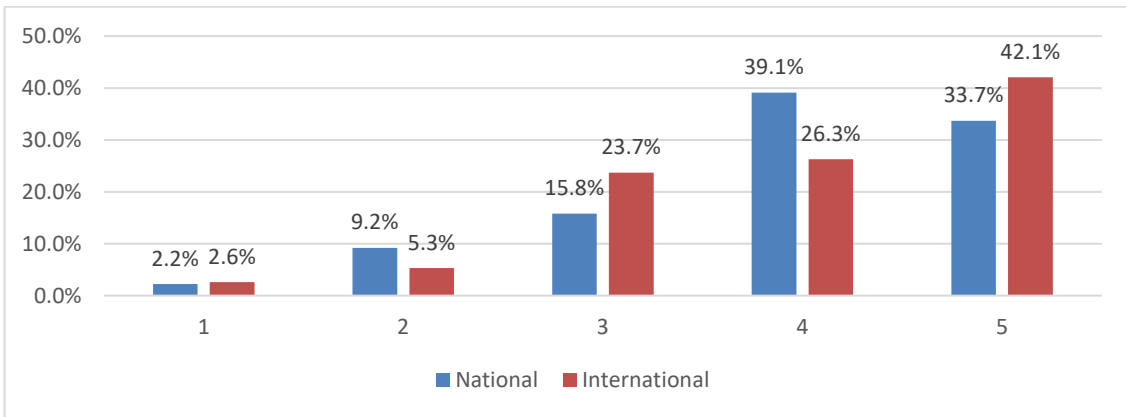


Chart 17 - I feel like I can be my authentic self at my institution

The results of Chart 17 show that the majority of the students' state that they can be their authentic self on the academic environment. Strictly speaking, 72% of the national students and 68.4% of the international students do not feel oppressed by their peers.

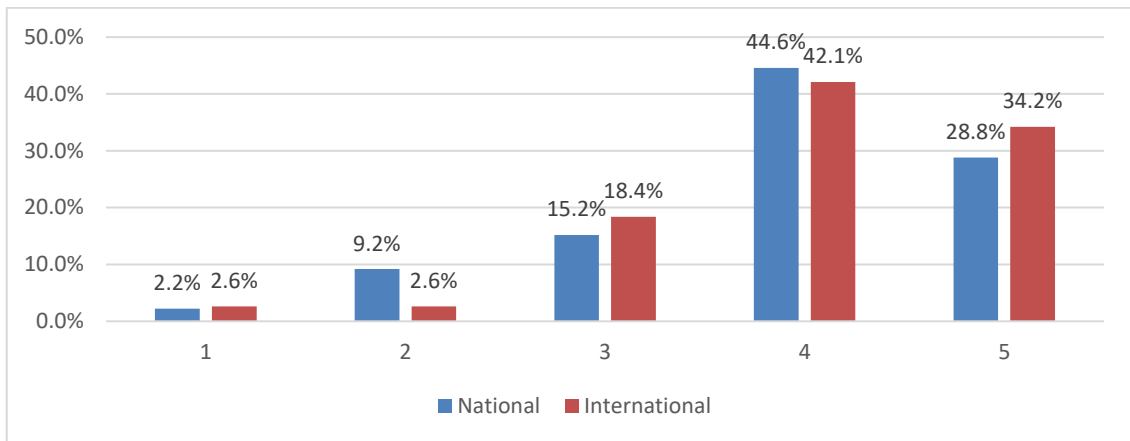


Chart 18 - I feel comfortable expressing my opinions to other peers at my institution.

The results of Chart 18 show that the majority of students' feel comfortable in expressing their opinions, therefore they feel at ease when discussing topics with their peers.

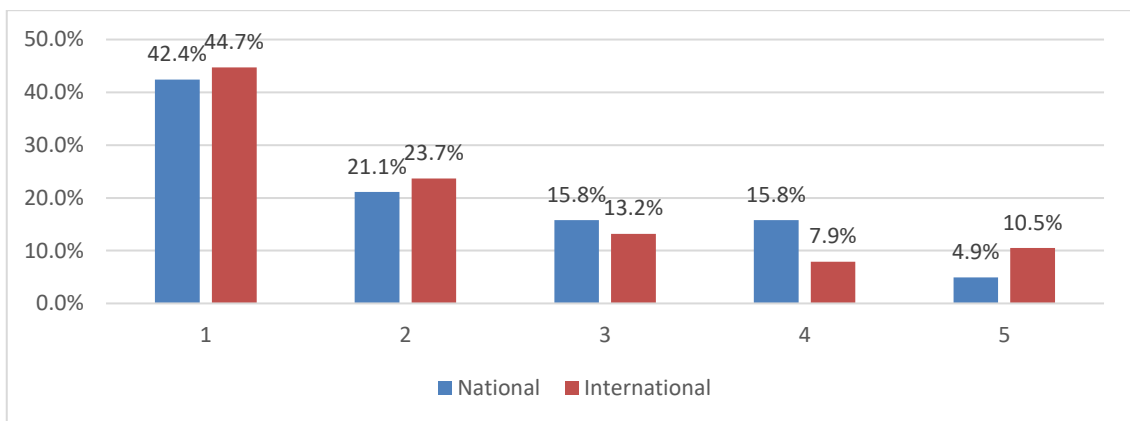


Chart 19 - I have felt some students look down on me because of how I am.

Regarding the feeling of contempt, even though more than 40% of the students, both national and international, affirm that they have not felt look down upon due to how they are, approximately 60% are divided throughout the chart. By this, we can acknowledge that a high number of students has felt some degree of contempt from their peers, where approximately 20% of both student types confirmed that they strongly agree with the statement.

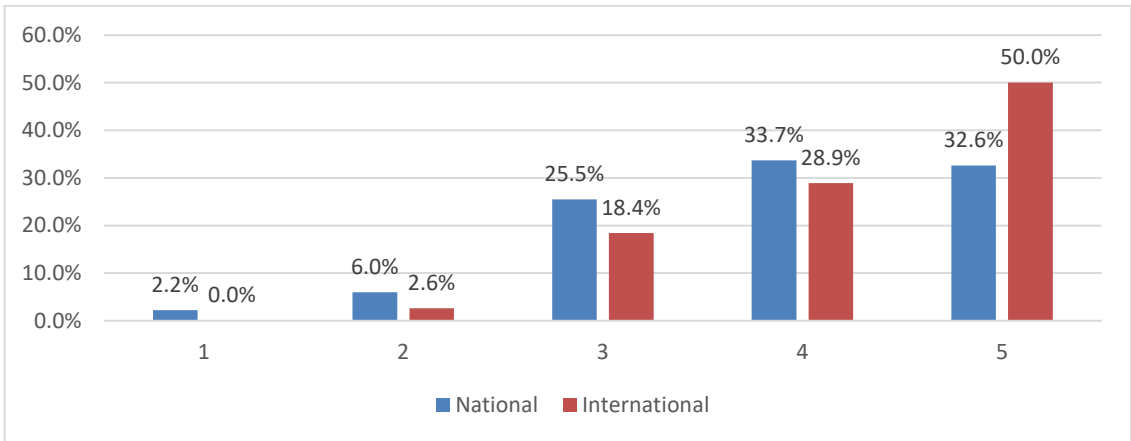


Chart 20 - I feel respected.

The results of Chart 20 are mostly positive, which implies that the majority of the students feels respected during their academic life. In average, 20% of both students' types have not either felt respected or disrespected.

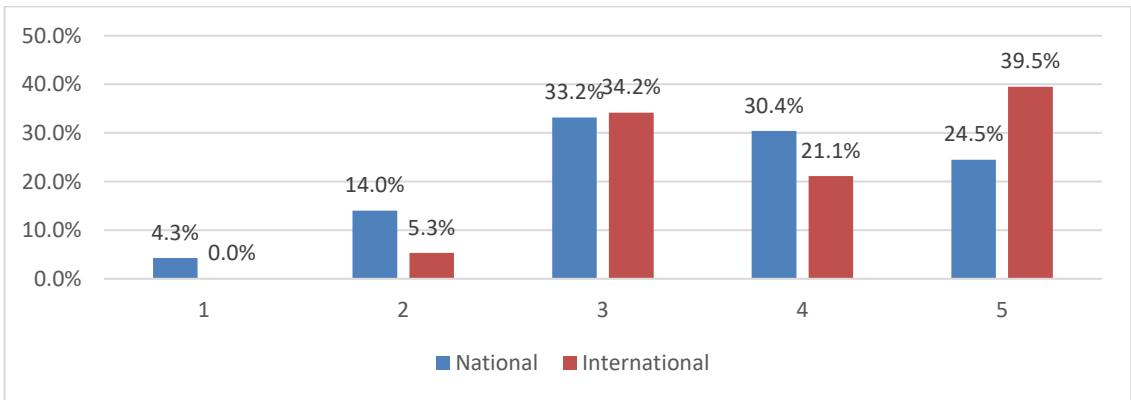


Chart 21 - The social groups are diverse.

Regarding social diversity, approximately 35% of both student types chose option three, with this, we can acknowledge that the social groups are somewhat diverse.

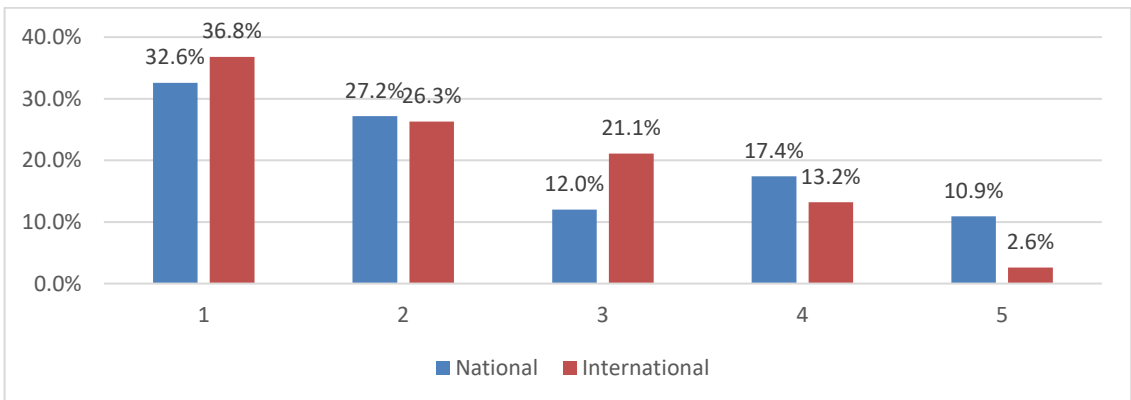


Chart 22 - I have felt alone or isolated.

The results shown on Chart 22 can be alarming for both types of students, since approximately 30% of national students and 15% of international students confirmed that they in fact felt alone or isolated. In addition, around 17% of students have felt somewhat lonely during their academic life.

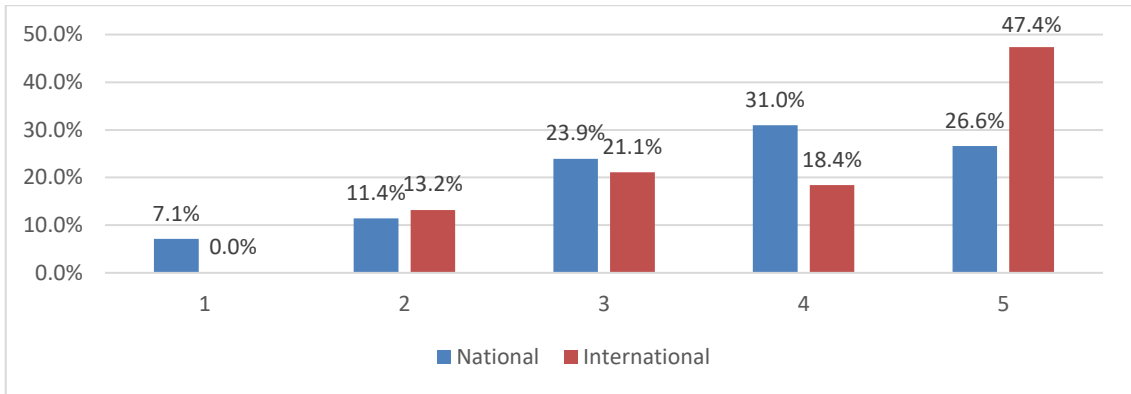


Chart 23 - It was easy to make friends.

The results from Chart 23 show that more than half of the international students find it easy to establish friendships among their peers. In contrast, approximately 19% national students find it difficult to connect with other students. Moreover, we can knowledge that there is some degree of resistance towards establishing friendships, since around 20% of both student types choose option three.

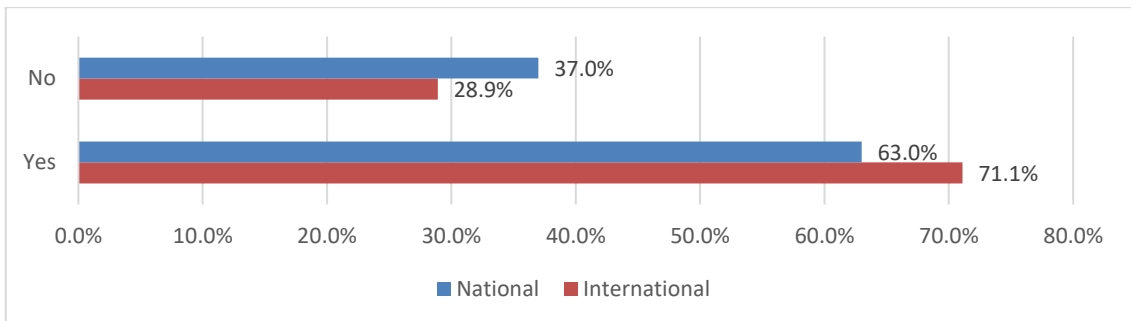


Chart 24 - I have been out socially with my institution peers.

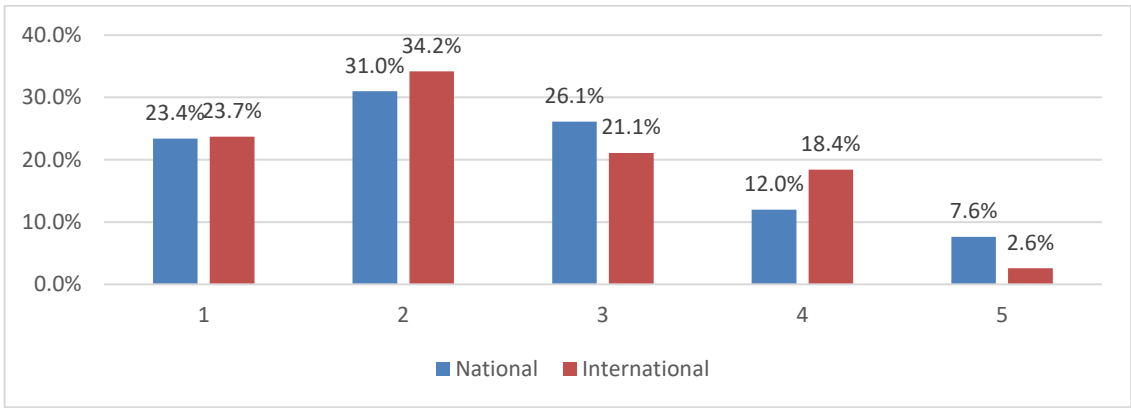


Chart 25 - It is hard to find other students for group projects.

The results from Chart 25 show that approximately 50% of students find it significantly difficult to assemble groups for projects. Although the other half of the students does not have any sort of difficulties on creating or joining a group.

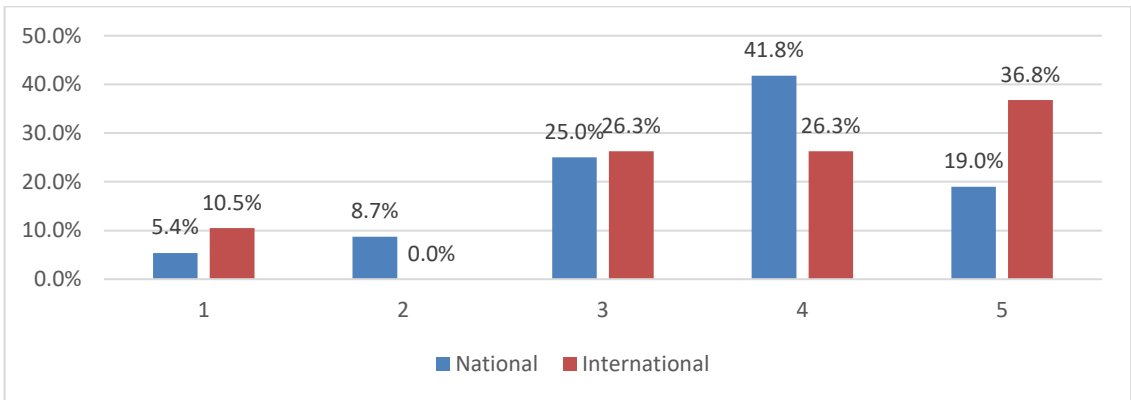


Chart 26 - Were you satisfied with the institution services provided when you first enrolled?

According the results from Chart 26, around 35% of both student types are discontent and partially discontent with the institutional services. Nevertheless, approximately 65% had a positive experience and were well-informed when they first enrolled.

Table 24 - If you were unsatisfied, which were the services you needed that were not provided?

If you were unsatisfied, which were the services you needed that were not provided?		
Matter	National Students (Number, Percentage)	International Students (Number, Percentage)
Getting my class schedule.	8 (8.4%)	9 (52.9%)
Getting assigned to a class.	13 (13.7%)	5 (29.4%)
Introduction to the Moodle.	16 (16.8%)	6 (35.3%)
Knowing the location of points of interest on campus.	41 (43.2%)	5 (29.4%)
How to apply to student housing.	14 (14.7%)	3 (17.6%)
Information on Scholarships.	25 (26.3%)	1 (5.9%)
Getting the course material.	17 (17.9%)	3 (17.6%)
Getting timely responses.	42 (44.2%)	3 (17.6%)
Getting in touch with someone for help.	40 (42.1%)	5 (29.4%)
Other matters.	4 (4.5%)	1 (5.9%)
<b>Total</b>	<b>95</b>	<b>17</b>

Although this question was not mandatory, approximately half of students stated that they in fact had inconveniences during their enrolment. Regarding the international students' respondents, around 50% had difficulty getting the class schedule and around 30% also had difficulty in getting assigned to a class, getting in touch with someone for help, locating points of interest on campus and the introduction to Moodle. On the other hand, approximately 45% of national students did not get timely responses from the institutional services. Additionally, they share the same difficulties in regard to locating points of interest and getting in touch with someone for help.

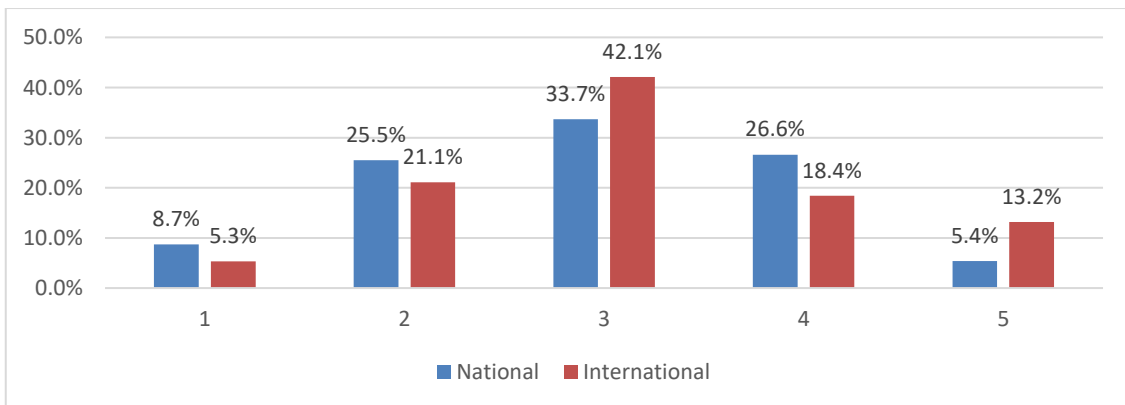


Chart 27 - How hard is it to approach already formed social groups in your class?

The results from Chart 27 show that, since most of the students chose option three, students have somewhat difficulty in approaching already defined social groups in their class. Consequently, the other 60% of the students are divided throughout the other values of the chart. Hence, 30% of the students find it hard to connect with already existing social groups and the other 30%, in contrast, find it easier.

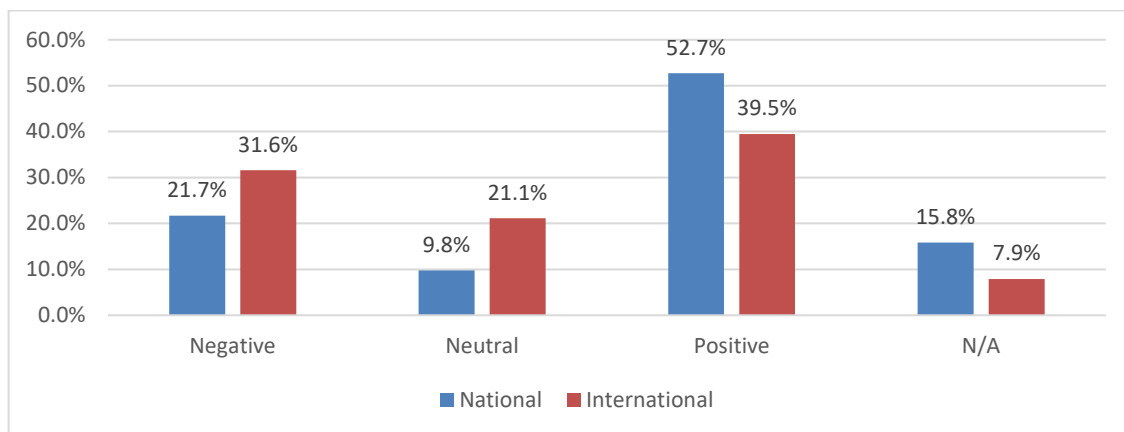


Chart 28 - Regarding social inclusion, what's your opinion towards your peers?

Chart 28 is the representation of the student’s opinions analysis, which was an open-answer question. When questioned about their opinion towards their peers, even though the higher percentage for both student types are positive, there are significant negative aspects. An alarming 32% of international students and 22% of national students have a negative opinion towards their peers. Subsequently, a lesser percentage of students chose to stay neutral.

#### 6.3.1.4 International Students – Specific Questions

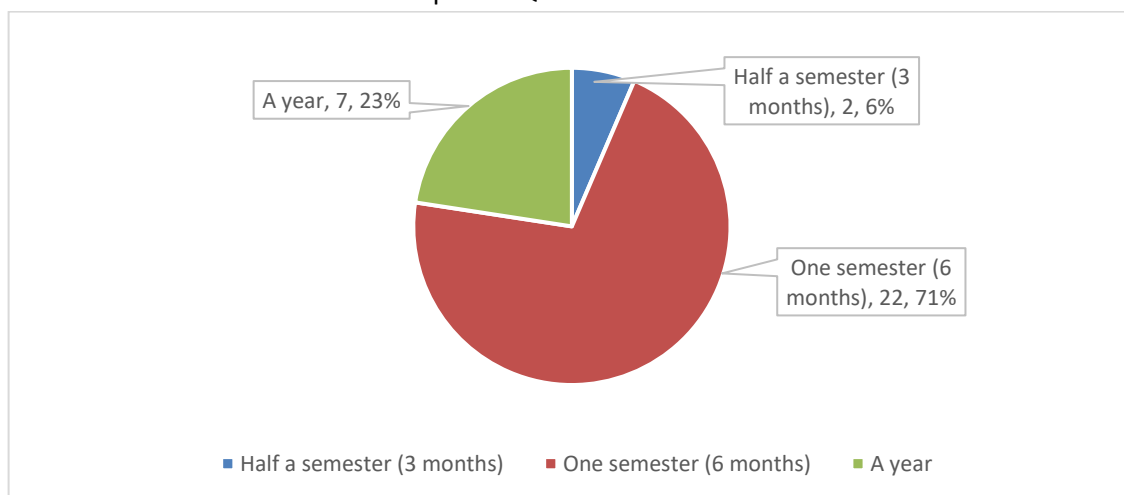


Chart 29 - If you are in the Erasmus+ Program, which duration have you chosen?

As specified in Chart 29, the majority of the international students opted to participate on the Erasmus+ Program for one semester (6 months), and approximately a quarter chose the duration of one year.

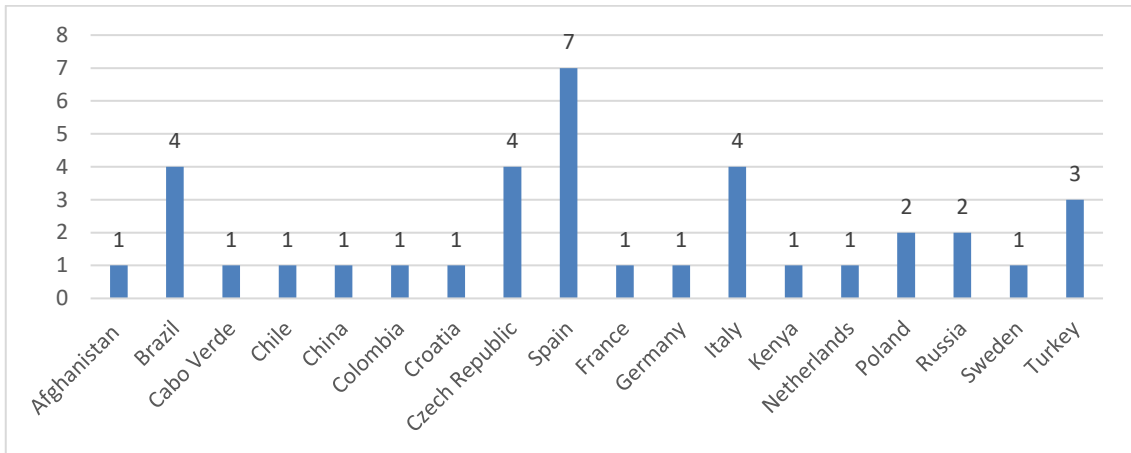


Chart 30 - Nationality

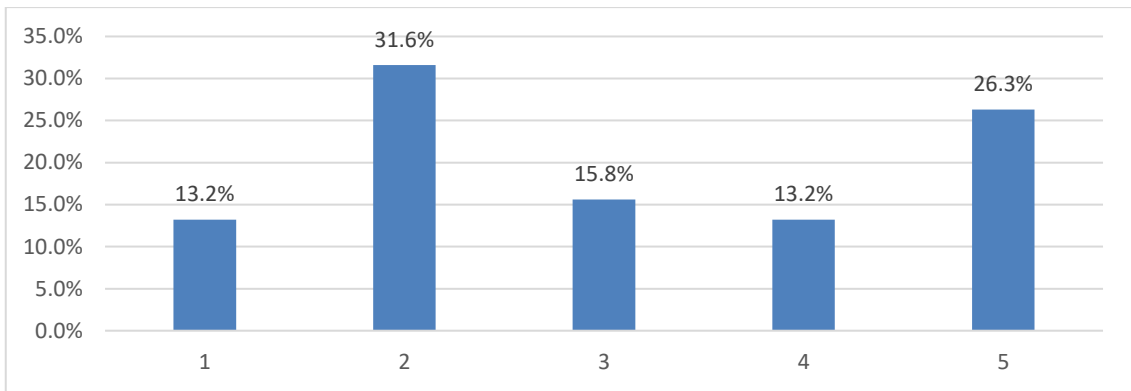


Chart 31 - How well do you understand Portuguese?

Chart 31 shows that most of the international students, around 45%, have difficulties understanding Portuguese. On the other hand, the other 55%, have the minimal understanding of the language.

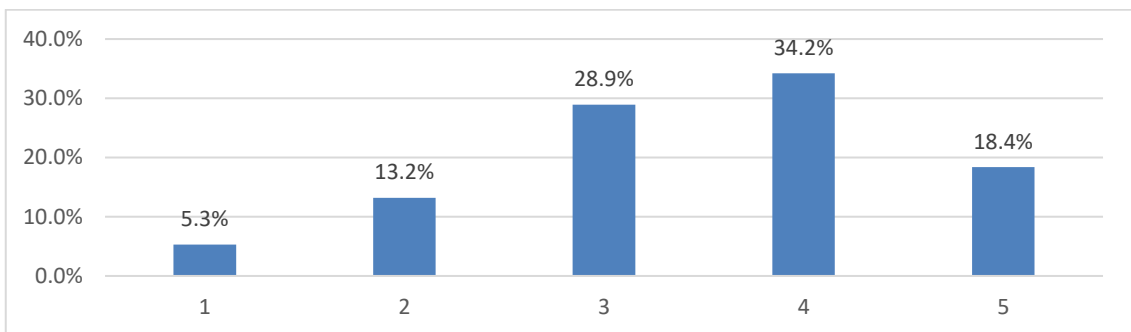


Chart 32 - How hard is it to approach Portuguese students?

In accordance with the positive opinions regarding the approachability of Portuguese students, international students mostly consider that they are friendly towards foreign people.

6.3.1.5 National Students – Specific Questions

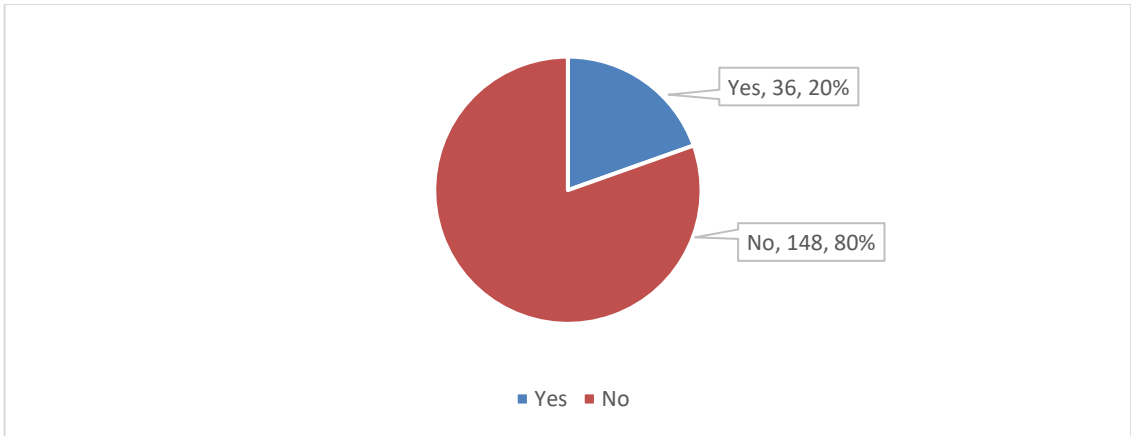


Chart 33 - Did you have to relocate to attend institution?

6.3.1.6 Participation section

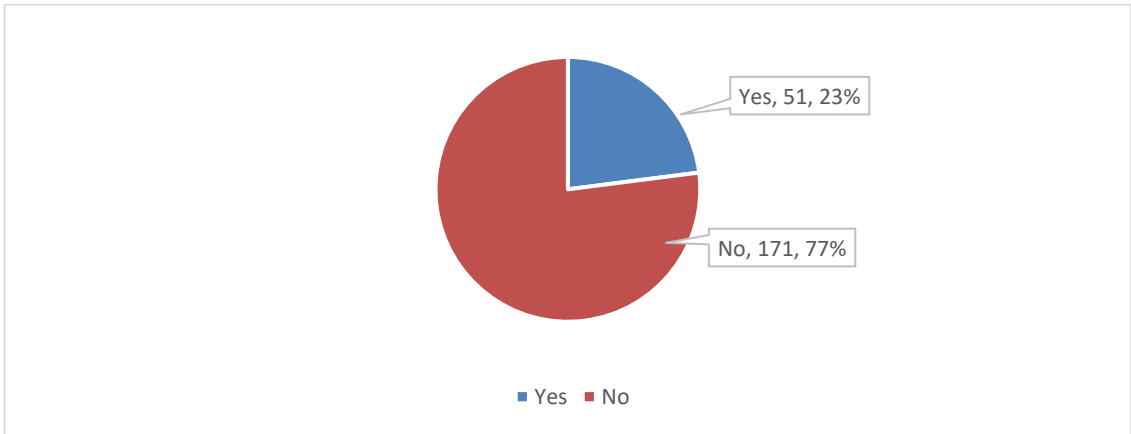


Chart 34 - Would you use a website where you can find other students that can help you with your needs?

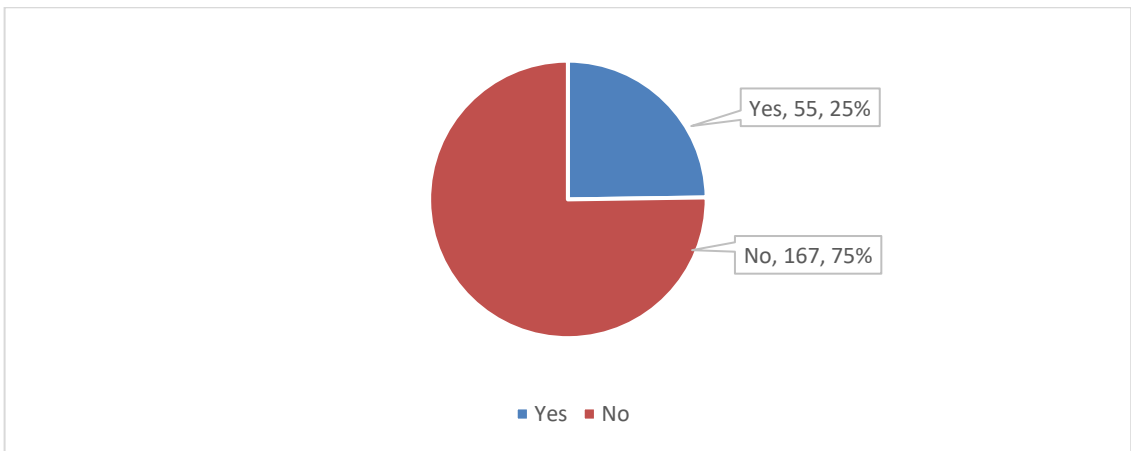


Chart 35 - Would you like to collaborate with the design process of this web platform?

Regarding the collaboration of the design process, 38 participants provided their email for further contact.

### 6.3.2 User Satisfaction Survey

In order to validate the previous defined hypothesis, a user satisfaction survey was conceived to measure the quality of the web platform. Even though 38 participants provided their contact and 222 students participated on the Inclusion and Belonging Survey (see section 6.3.1), only 16 decided to explore the web platform. The user satisfaction survey is available in Attachment A.

To begin with, on the personal information section we gathered the age, gender, ethnicity, nationality, and the type of participant (proficient or inexperienced regarding the use of technology). There were 11 male and 5 female participants, they were all white or Caucasian and the majority was proficiency in the use of technology.

The second section is based on the educational information of the participant, it was asked in which Institution did the respondent studied, what course did was he enrolled in, the type of student (national or international), and the class schedule (day time or evening time). The majority of respondents are national students that did not study in ISEP and have daytime classes, 75% are enrolled in a bachelor's degree.

In regard to the accessibility we also asked the participants if they had any disabilities and to specify them, if applied. Four of the respondents stated that they have a disability, in each 2 have a hearing disability and the other 2 have a visual disability.

As the previous survey, the following sections were also measured by using the Linkert Scale, where one corresponds to "Strongly Disagree", three corresponds to "Undecided" and five corresponds to "Strongly Agree".

The third section focuses on the QEF Technical Dimension by presenting the participants with functionality related questions. Half of the participants spent between 30 minutes to 2 hours exploring the web platform where the overall feedback was positive. The functionalities that the respondents found less useful are the increase of the cursor size and changing the text font.

The fourth section focuses on the QEF Ergonomic Dimension by presenting the participants with usability related questions. The overall feedback was positive, although 3 respondents found technical errors.

Finally, the fifth section focuses on the QEF Pedagogical Dimension by presenting the participants with inclusion and experience related questions. Every respondent state that they would like to continue using the web platform and that it will improve the integration of students in Higher Education.

## 6.4 Result Analysis

In order to properly evaluate the analysis of each survey, this sub-chapter is divided respectively. Each QEF dimension will be discussed and evaluated according to the obtained answers. The first sub chapter corresponds to the first survey that assesses the students inclusion in HE, and the final sub chapter corresponds to the second survey that assesses the user feedback regarding the web platform.

### 6.4.1 Students Integration: Inclusion & Belonging

After a more in-depth analysis, we concluded that most students feel comfortable with the institution they are enrolled, however, that feeling does not translate to the relationship with their peers.

A significant percentage of international and national students, 32% and 22% respectively, have negative opinions towards their peers. Consequently, students tend to have difficulties in connecting with other students and posteriorly, establishing friendships.

Additionally, most of the students that have negative opinions complain that their peers are too conservative, this can be related to, according to Chart 25, that students tend to hesitate on assembling groups for projects and that can lead to a decreased social groups diversity (Chart 21).

Regarding the age factor, students that are older than 26 years, tend to feel more isolated since they are more excluded from social groups.

Students with disabilities have some extremely negative opinions towards their peers regarding their social interactions, such as:

- *"..I don't like how they portray themselves as. I feel like everyone around me thinks too highly of themselves."*
- *"..most interactions feel superficial."*

In comparison to Portuguese students, international students' social behaviour is less complicated, they tend to feel more at ease regarding the interactions with other students, therefore, according to Chart 22, they tend to feel less lonely. Since international students come to a new country and are introduced to a new culture, they tend to create social groups within themselves as it was expressed on some of their affirmations. Additionally, all the Czech students expressed that Portuguese students tend to avoid foreigners.

Half of the students that participated on the survey encountered inconveniences during their enrolment in Higher Education. Around 50% of International students had difficulty getting the class schedule and around 30% also had difficulty in getting assigned to a class, getting in touch with someone for help, locating points of interest on campus and the introduction to Moodle. On the other hand, approximately 45% of national students did not get timely responses from

the institutional services. Additionally, they share the same difficulties about locating points of interest and getting in touch with someone for help.

Considering the enrolment phase, students who were admitted on the 2<sup>nd</sup> and 3<sup>rd</sup> phase were more unsatisfied with the institutional services and felt out of place within the institution.

In accordance with SiAT we concluded the following:

**1<sup>st</sup> Identification: Who is excluded?**

- Students with disabilities.
- Students older than 26 years.
- Students that are admitted on the 2<sup>nd</sup> and 3<sup>rd</sup> phase.

**2<sup>nd</sup> Analysis: How are they likely to be excluded?**

- Not included in social groups.
- Experience some degree of contempt.
- Tend to be avoided.

**3<sup>rd</sup> Actions: Why are they likely to be excluded?**

- Students that are admitted on the 2<sup>nd</sup> and 3<sup>rd</sup> phase experience more difficulty in interacting and joining social groups because they are already strongly formed.
- There is some degree of prejudice towards students with disabilities, which leads to their exclusion.
- Different ages usually entail different life perspectives and different levels of maturity, therefore, older students struggle to connect with younger students and vice versa.

**4<sup>th</sup> Monitoring: What can be done towards greater social inclusion?**

- Regarding its services, the institution should better monitor and guide students that enrol on the 2<sup>nd</sup> and 3<sup>rd</sup> phase in regards of integration.
- Create programs that mix up both students' types, international and locals, to eliminate prejudice and increase social diversity.

The web platform developed within this dissertation, will provide tools that will give students the possibility of creating and joining groups which facilitates social interaction and in consequence, improves social inclusion. Students can create/join groups for personal reasons such as wanting to meet other students with the same interests and goals, or to simply find peers for a subject group project. Since the web platform will provide hearing and visual accessibility tools, students that have any of those disabilities will be still be able to enjoy the web platform equally.

## 6.4.2 User Satisfaction Survey

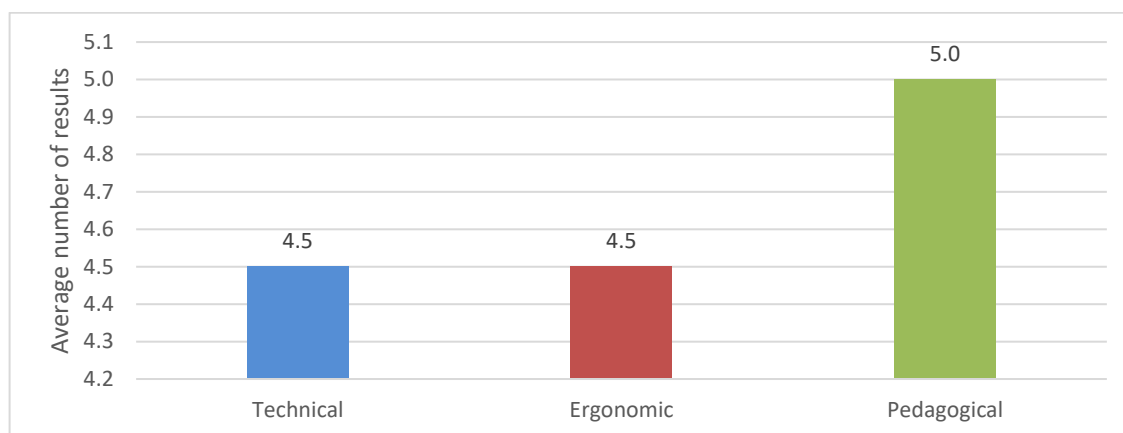


Chart 36 - Average of the responses given by the participants according to the QEF Dimensions.

Chart 36 is the result of the calculated average per dimension. As illustrated above, the Pedagogical dimension was the most enjoyed by the respondents. With this, taking into consideration that this dimension is composed by social integration questions, we can assert that the target audience fully accepted this solution as an improvement of the integration of students in HE.

The following sub-sections include a more in-depth analysis regarding each dimension. This analysis will consist in the most and least favourable question according to the respondents. Additionally, we will analyse the responses from the open-answer questions.

Overall, the participants feedback was very positive as shown in the complete results specified in Attachment - A.

### 6.4.2.1 Pedagogical Dimension

As previously mentioned, the Pedagogical dimension consists of questions regarding social inclusion. The obtained feedback supported QEF where we achieved a fulfilment rate of 91.07%

Participants were asked two mandatory questions, the first, is if they would like to continue using the web platform in the future so they could find people that can help with their needs. The second is, if they think of the web platform as a means to improve the integration of students in HE.

Considering that the focus of this dissertation was to provide a web platform that would improve the social integration of students, by having an approval rate of 100%, we can conclude that the previously defined hypothesis (see section 6.1) was successfully accepted.

Furthermore, 15 out of the 16 participants stated that they have a favourite feature of the web platform. The most praised feature was the point system, where the respondents mentioned that it stimulates them to continue using the web platform and gives it an extra appeal, thus supporting its success. The second favourite feature was the accessibility, more specifically the sign language avatar and the colour schemes options.

#### 6.4.2.2 Technical Dimension

The Technical dimension was based in questions about the web platform functionalities. The obtained feedback supported QEF where we achieved a fulfilment rate of 94.74%.

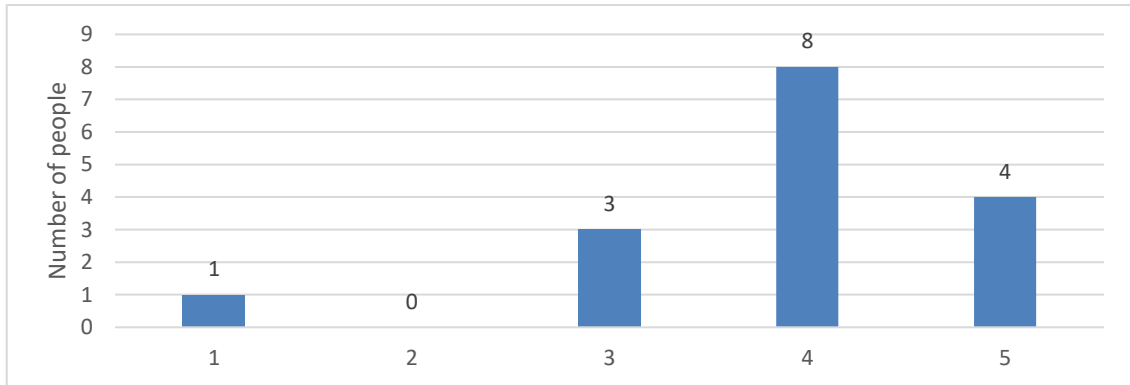


Chart 37 - How useful do you think it is to increase the cursor size?

This feature is part of the accessibility menu meant specifically for visually impaired users. Compared to other questions, as shown in Chart 37, the responses are more distributed throughout the chart scale. We concluded that this might have happened due to the design choice and size of the cursor.

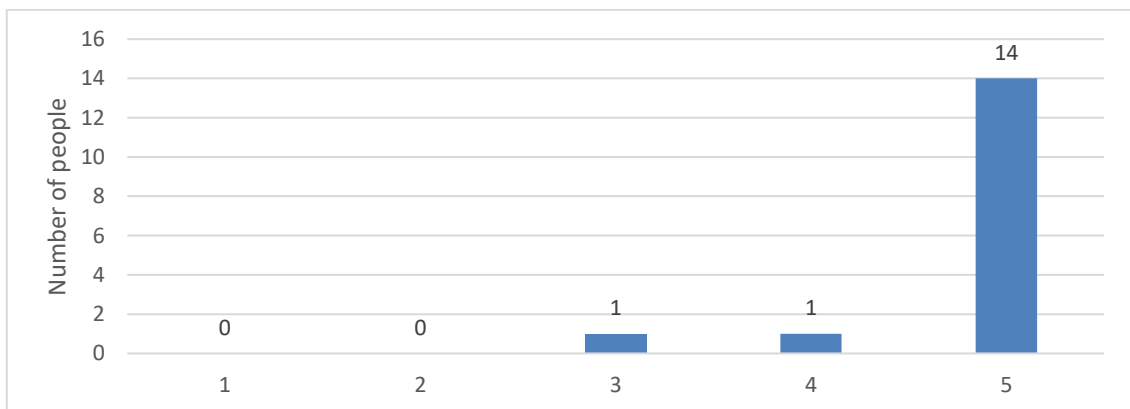


Chart 38 - In general, how difficult was it to interact with the accessibility functionality?

Making the accessibility feature optional was one of the first decisions before the development of the web platform. Therefore, the interaction should be easy and intuitive (see Section 5.3.1.1) as confirmed by the respondents on Chart 38, where 14 of the 16 users stated that the interaction was very easy.

The feature section of the survey also included two open-answer questions. The first one was what functionalities would the respondent like to add and the second one was what functionalities did the respondent find unnecessary, if any.

Most of the respondents stated that they preferred a module that would offer real time communication (online chat) instead of the existing messaging system, and an option to change

between the default theme and a darker theme. Regarding the unnecessary functionalities, the respondents stated that they did not find the activity feed relevant.

#### 6.4.2.3 Ergonomic Dimension

The Ergonomic dimension was based in usability questions. The obtained feedback supported QEF where we achieved a fulfilment rate of 72.31%, which was the lowest of the three dimensions. This dimension was the most complex to evaluate since it includes the user experience factor which is highly dependent of the user's personal preferences.

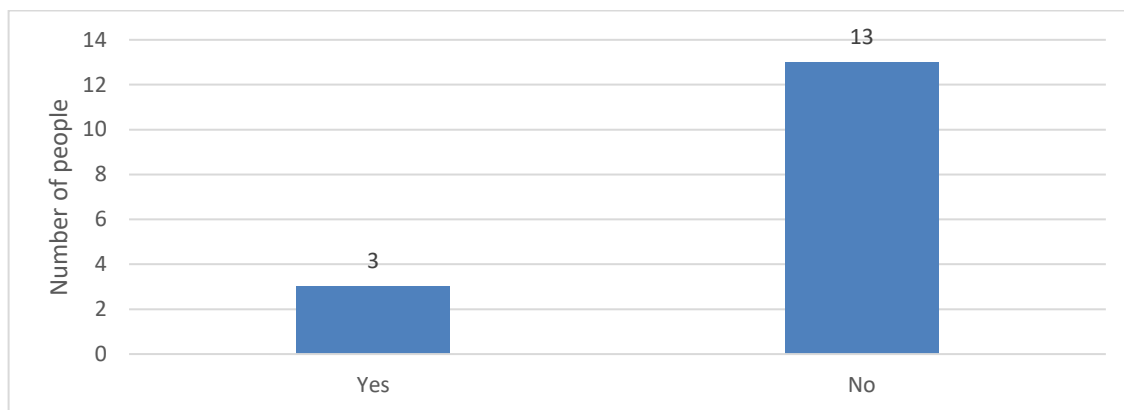


Chart 39 - Did you find any technical errors during the use of the website?

Technical errors are highly important, since they directly affect the overall user experience in a very negative fashion. The respondents stated that the zoom functionality was not compatible with the browser Firefox and that the warning/error messages should be clearer and user friendly.

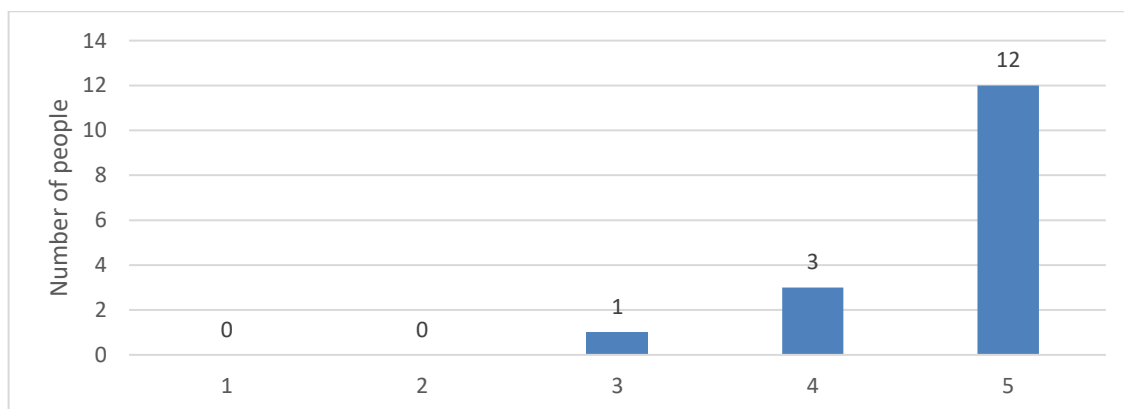


Chart 40 - How do you rate the web platform design?

As shown in Chart 40 most of the users stated that the web platform design choices were pleasing. The web platform was designed by keeping in mind the target audience, which are the students that are enrolled in HE. It is important because it impacts how the users perceive the solution. The first impression can either get them to remain on the page and learn about it or leave and turn to another alternative.

## **6.5 Paper**

During the development of this dissertation, adviser Paula Escudeiro and co-adviser Ana Barata proposed the writing of a paper based on students' inclusion on Higher Education (see Attachment - B). The conference to which the paper was submitted was the CISTI 2019 - 14<sup>th</sup> Iberian Conference on Information Systems and Technologies. CISTI is a technical and scientific event, whose purpose is to present and discuss knowledge, new perspectives, experiences and innovations in the Information Systems and Technologies field.



## 7 Conclusion

Nowadays, web content is still not prepared for users with hearing or visual disabilities, being this the case of most Higher Education Institutions websites, including the website of Instituto Superior de Engenharia do Porto (ISEP). Most importantly, these websites should make information in a way that it can be accessed equally by all students.

Individuals and groups are excluded or included based on their identify. Through the Inclusion and Belonging survey we identified that the most common exclusion factors are the disability status and ethnicity. Identities are complex and can change overtime depending on the context. The students can be members of different groups at the same time and may be excluded given one of their identities but not the other. We also identified that a significant percentage of students tend to feel alone or isolated, which can be a cause of social anxiety or social exclusion.

The research phase consisted in gathering information regarding inclusion, more specifically social inclusion in Higher Education towards the students, as well as analysing websites according to Inclusive Design guidelines. During this phase, we identified that the majority of websites are not accessibility-friendly as they tend to not have any accessibility feature or have multiple accessibility features simultaneously enabled which makes the website not user friendly.

During the design phase, due to external circumstances previously explained, the collaborative methodology initially planned was proved challenging. High fidelity prototypes were developed according to the accessibility principles and sent to the target audience for feedback. The solution was developed using proper engineering practices and QEF was applied to evaluate the quality and evolution of the solution, where 89% of its fulfilment rate was accomplished.

The solution was tested and assessed by 16 students both national and international. Given the obtained results we can conclude that the initial goal was accomplished by making available for students with or without a visual/hearing disability a web platform where they can feel more included to come together as community.

In conclusion, this project proved that using accessibility tools as an optional feature that can be enabled or disabled is the appropriate approach instead of integrating all the accessibility features simultaneously. Taking into account that newly enrolled students have difficulty getting integrated in Higher Education, the web platform resulting from this dissertation is an asset that will help students get settled in their new academic life by providing them with a community already predisposed to help.



# References

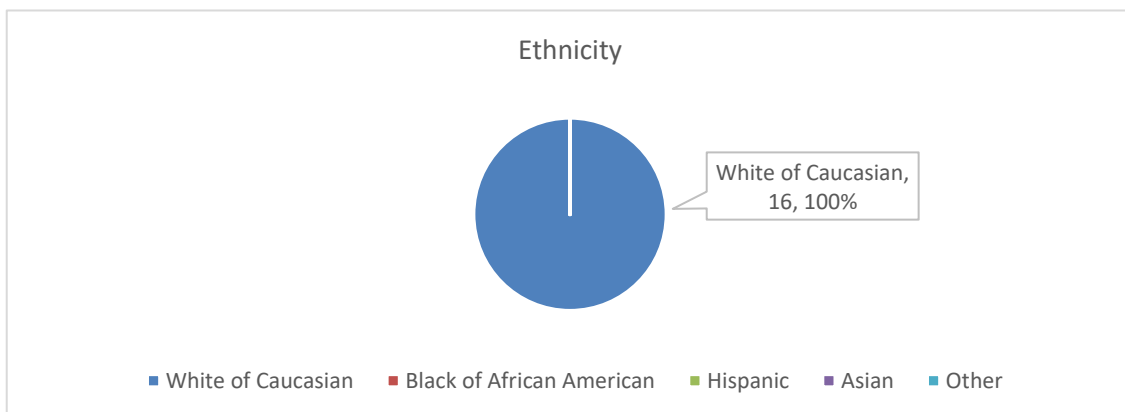
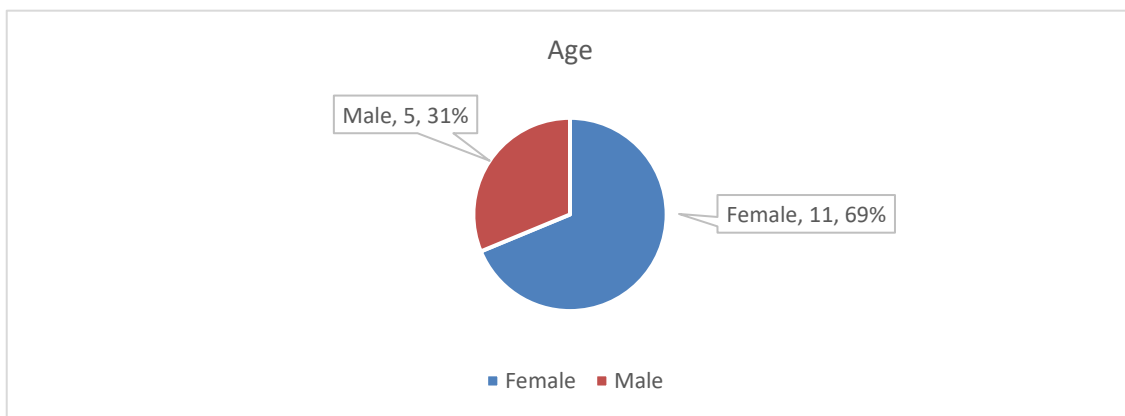
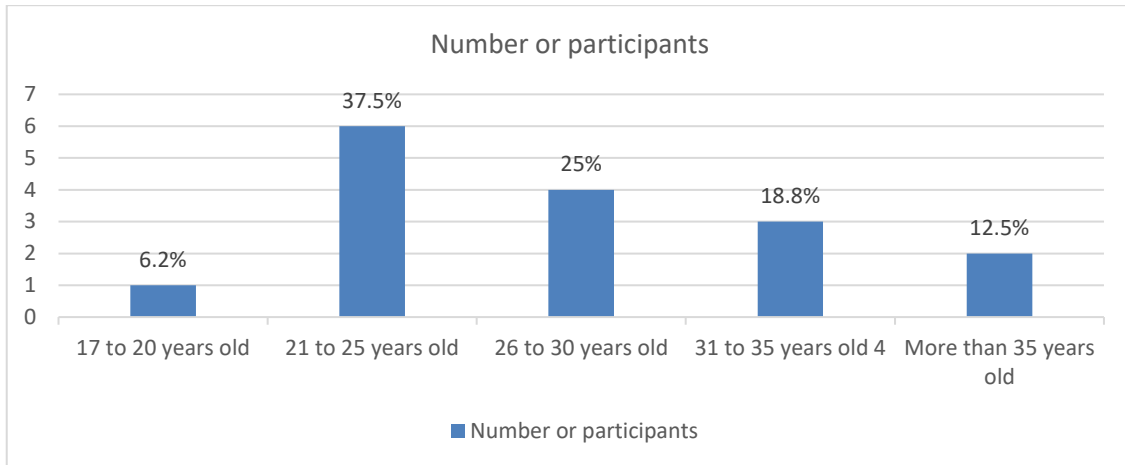
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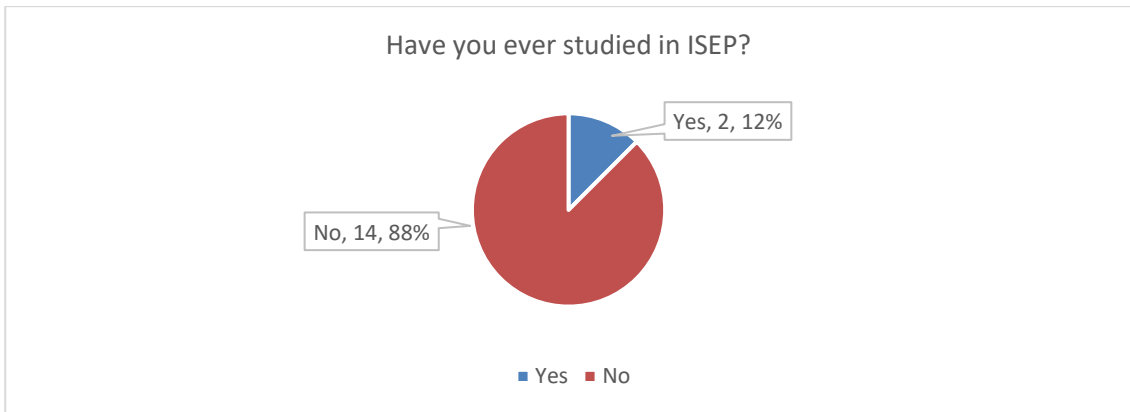
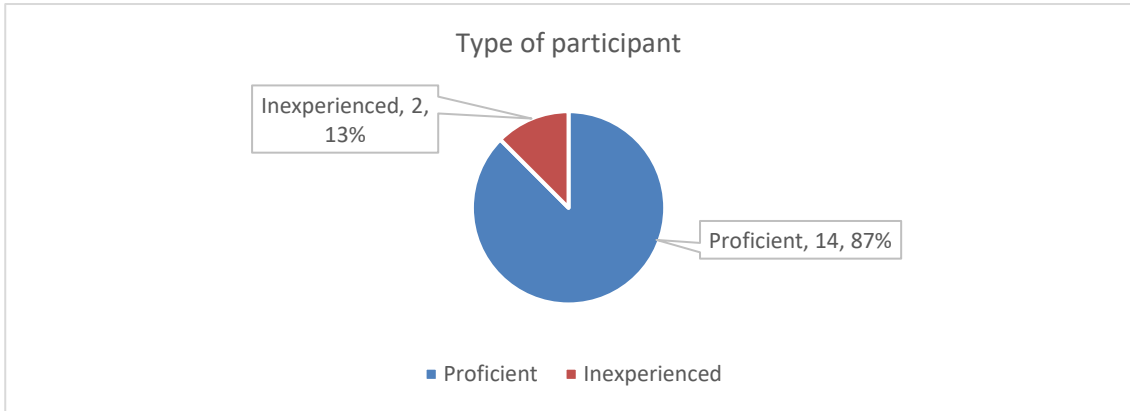
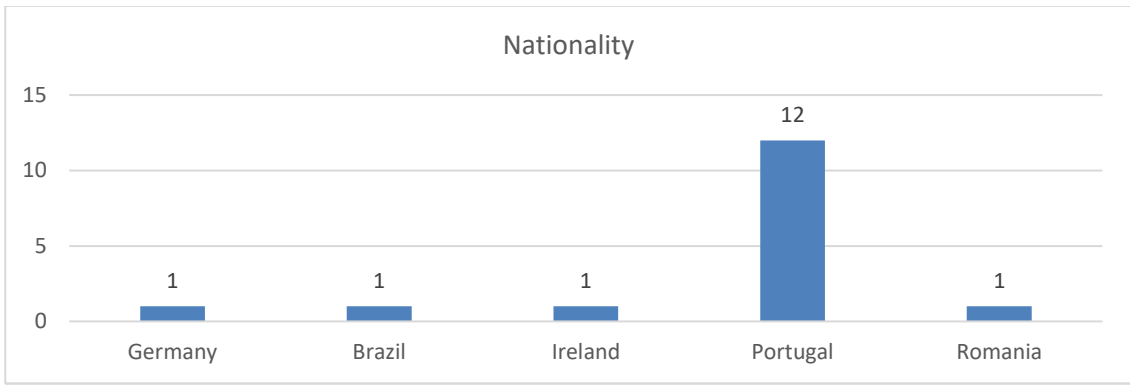
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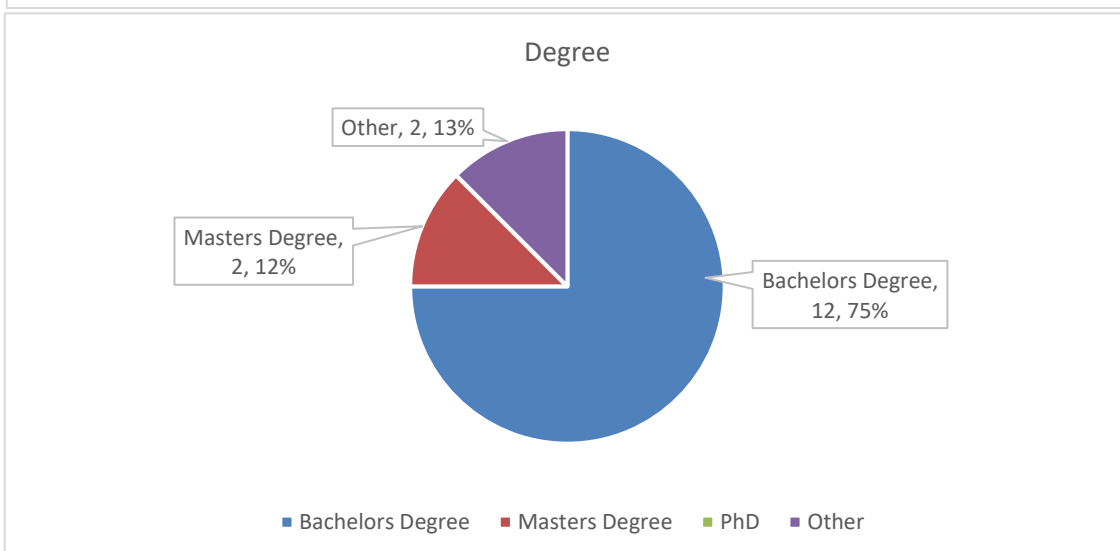
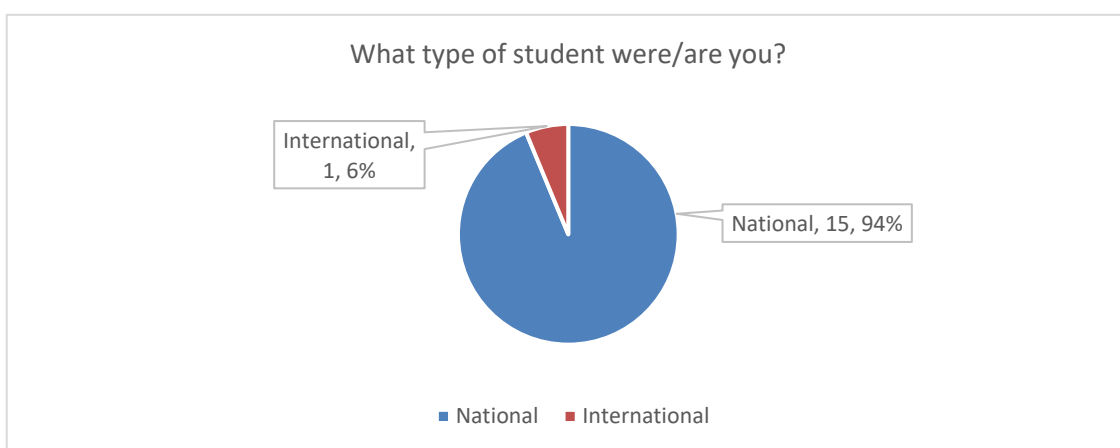
# Attachment A – User Satisfaction Survey

## Survey results

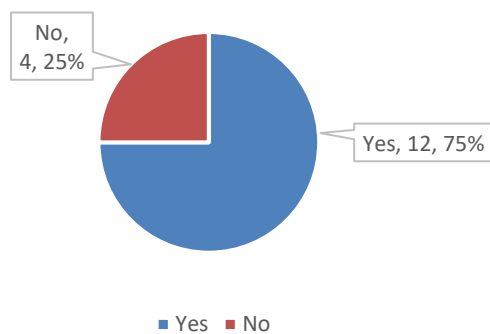




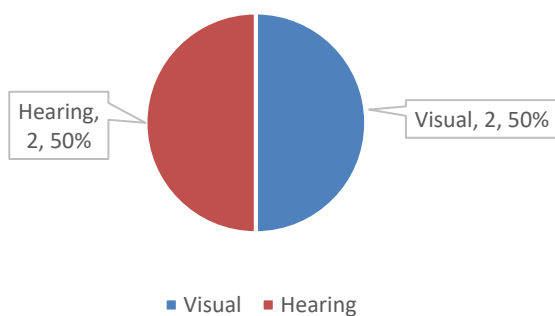
If you answered NO to the previous question, which Institution were/are you enrolled in?	
Institution	Students number
Design, Technology and Communication Institute (IADE)	1
Polytechnic Institute of Viana do Castelo (IPVC)	4
Instituto Superior Técnico (IST)	1
Lisbon University Institute (ISCTE)	1
Instituto Universitário da Maia (ISMAI)	1
Polytechnic Institute of Setúbal (IPS)	1
Pharmacy College – University of Lisbon	1
Cork Institute of Technology	1
Others	3



Do you have any disabilities?



What type of student were/are you?



What course were/are you enrolled in?	
Institution	Students number
Software Development	1
Nursing	1
Biology	1
Computer an Electronic Engineering	1
Computer Graphics and Multimedia Engineering	3
Computer Science Engineering	2
Management of Information systems	1
Multimedia	1
Data Science	1
Publicity and Marketing	1
Pharmaceuticals	1
Nutritional Science	1
Others	1

Dimension: Pedagogical		
Question	Scale	
	Yes	No
Would you like to continue using JoinMe in the future so you can find other people that can help you with your needs?	16	0
Do you think JoinMe will improve the integration of students in Higher Education?	16	0

Dimension: Ergonomic					
Question	Scale				
	1	2	3	4	5
Do you find JoinMe interface intuitive?	0	0	1	5	10
How do you rate the web platform design?	0	0	1	3	12
Overall, how do you rate your experience using JoinMe?	0	0	1	4	11
	Scale				
	Yes		No		
Did you find any technical errors during the use of the website?	3		13		

Dimension: Technical					
Question	Scale				
	1	2	3	4	5
In general, how difficult it was to interact with the accessibility functionality?	0	0	1	1	14
How do you rate the experience of changing the colour schemes?	0	0	2	4	10
How useful do you think it is to be able to zoom the pages?	0	1	2	3	10
How useful do you think it is to increase the cursor size?	1	0	3	8	4
How useful do you think it is to make the text more readable?	0	1	2	4	9
How useful do you think it is to have a hearing impaired avatar translator?	1	1	0	1	13
How difficult was it to create/join a group?	0	0	2	4	10
How difficult was it to create/join a group forum discussion?	0	1	1	4	10
How difficult was it to customize your profile?	0	1	1	2	12
How difficult was it to message other people?	0	0	4	3	9
How difficult was it to search for people and add them as a friend?	0	0	1	5	10
How difficult was it to check your points and rank?	0	0	1	2	13
	Scale				
	Yes		No		
Do you consider the hearing impaired aid feature interface intuitive?	3		13		

# Attachment - B

## Turning Higher Education Students' Inclusion Real: A Web Platform proposal

Authors Name/s per 1st Affiliation (Author)

line 1 (of Affiliation): dept. name of organization  
line 2: name of organization, acronyms acceptable  
line 3: City, Country  
line 4: e-mail address if desired

Authors Name/s per 2nd Affiliation (Author)

line 1 (of Affiliation): dept. name of organization  
line 2: name of organization, acronyms acceptable  
line 3: City, Country  
line 4: e-mail address if desired

Information greatly impacts the citizens' life; therefore, access barriers can limit future opportunities. This paper introduces a proposal to minimize those barriers and promote equity. Nowadays, web content is still not prepared for users with hearing or visual disabilities, being this also the case of Higher Education Institutions websites, such as the website of Instituto Superior de Engenharia do Porto (ISEP). These institutional websites should make the information available in such way that it can be accessed equally by all students. Every Higher Education Institution has at least one office dedicated to support students' integration, and to better answer their needs, however, the help or information required is not usually delivered timely. The focus of this paper is to present a proposal to improve the integration of students in Higher Education through a web platform that promotes equity. The web platform will be designed to provide accessibility-friendly content for hearing and visual impaired students.

**Keywords – Higher Education Institutions; Social Inclusion; Web Accessibility; Inclusive Design; Students.**

### I. INTRODUCTION

This paper presents a proposal of an innovative web platform which is dedicated to continuously improve the integration of students in Higher Education. The web platform gives the students simpler means to find other students eager to help as well as functionalities to form subject groups, study groups, specific institutional related groups, and more. The web platform will contribute to solve integration and anxiety issues that students face, by providing them with means to easily communicate with other students already predisposed to help, and, in some cases, with a set of characteristics that matches their needs. This way, students won't need to wait for formal institutional orientation at the beginning of the school year, which is not usually delivered timely. Additionally, both hearing and visually impaired individuals' accessibility needs are being considered in the platform design.

### II. INCLUSION

“Inclusion” in Latin means *to shut in*, on the other hand, “exclusion” means *to shut out*. Perceiving inclusion as a circle where inside of it everything is included, exclusion, as its antonym, keeps everything out of that circle. Hence, people usually, tend to promote inclusion because they believe in the possibility of a large circle in which almost all lives.

One of the newest and most controversial terms in today's education contexts is “inclusion” [1]. Simply defined, it means including disabled students with non-disabled students in every

aspect of education from the same classroom to the same social activities and support groups.

Implementing inclusion has never been easily achieved [1]. Disagreements frequently occur between education professionals, parents, students and the law. Many believe that inclusion should be geared towards everyone with a disability, while others believe it should be specific for each person depending on needs and circumstances. Disagreements also arise about how much extra attention should be given to an inclusive student [1].

#### A. Social Inclusion

The World Bank defines social inclusion in two ways. The first is a broad sweep to guide policy makers. It states that social inclusion is the process of improving the terms for individuals and groups to take part in society. The second definition takes into account how the terms of social inclusion can be improved and for whom. It articulates social inclusion as the process of “improving people's ability, opportunity, and dignity of those disadvantaged based on their identity” [2]. Social inclusion is also not the same as equality. The term can add to the idea of equality, but much more importantly, it can explain why some inequalities exist or why some are particularly durable [3].

Individuals and groups are excluded or included based on their identity. Among the most common factors are gender, ethnicity, sexual orientation, and disability status [3], represented in the diagram in Figure 1. These identities are complex, overlapping and they can change over time and vary by context. These individuals can be members of different groups at the same time and may be excluded given one of their identities but not another. The notion of “intersectionality” is based on the understanding that people are simultaneously situated in multiple social structures and realms.

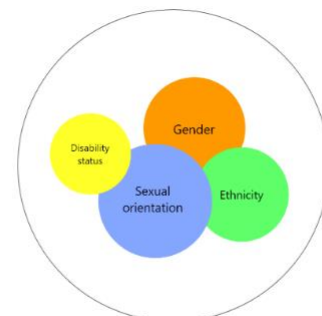


Figure 1. Types of identities (adapted from [3]).

In the circular diagram (Figure 1) each circle size denotes the importance of an identity, which can vary across individuals, groups, and even within the same individual over time. However, when they intersect, identities can produce a multiplication of advantage. For instance, the intersection of sexual orientation and disability status can have significantly worst effects than the effects of disability status alone.

### B. Social Anxiety

The Social Anxiety Association defines social anxiety as the fear of social situations that involve interaction with other people. Everyone has moments of fear over their performance on situations like university exams and projects, or they worry whether they will please their teachers or colleagues. For those who suffer from social anxiety, however, concerns like these may not only impact on their ability to learn, they may also lead them to make education or career choices different from what they would actually prefer [4].

For someone with social anxiety, the new world of being a higher education student is not so friendly. Instead, all they can see is an endless list of potential situations in which they will have to fight hard to block their physical anxiety symptoms and battle to manage their anxious thoughts [5].

The message system proposed in the *Functionalities Section* aims to lessen the pressure and anxiety of face-to-face communication. For those students who suffer from social anxiety or are mostly on the introversion end of the spectrum, the to be proposed system will be of great help since these students have difficulty in vocalizing their thoughts.

### C. Inclusion in Higher Education: Student Support Offices

Higher Education Institutions are the locus of knowledge, being within its capability, the scientific production and articulation with different knowledge areas. What is more, they should be the locus of plurality, diversity and respect towards differences.

Every Higher Education Institution has at least one physical office dedicated to support students' integration free of charge. These offices offer myriad types of services, such as psychological and disability support, skills development, employability and career management training and workshops.

However, due to the increasing flow of students in the last 5 years [6], the Higher Education Institutions, specifically their Student Support Offices, have been dealing with multiple new challenges. Essentially, attending to the very specific needs of international students and students with disabilities, and ensuring equality between them, along with the overall integration of so many students in a timely manner.

Having this context as background, our project stands out as a contribution to minimize integration and anxiety issues, by providing students with means to easily communicate with other students already predisposed to help, and, in some cases, with a set of characteristics that matches their needs, for example, knowing Sign Language. The web platform can be perceived as a complement to the existing Student Support Offices and to the institution's website.

## III. WEBSITES: RELATED WORK

In order to make a website more accessible and user-friendly for the visually impaired, the World Wide Web Consortium (W3C) has developed the Web Content Accessibility Guidelines (WCAG) [7]. These guidelines explain how to structure web content to be more accessible to people with disabilities.

The Paciello Group (TPG) [8] is a world-class accessibility consultancy with a reputation of excellence. They help clients achieve end-to-end accessibility in their digital assets, as well as assist in embedding accessibility into their processes and procedures. TPG is a member of the W3C, together they have defined some of the WCAG 2.0 principles.

### A. The Portuguese Association for the Blind and Low Vision People (ACAPO)

A good example to see some of these guidelines in practice is the Portuguese Association for the Blind and Low Vision People (ACAPO) website [9]. Not all visually impaired people are fully blind, hence various degrees of visual disabilities need to be considered.

The first characteristics evident on ACAPO's website are the choices of large fonts and strong contrasting colors; these increase legibility for those who can still rely on their eyesight.

The used color palette emphasizes on the blue and yellow part of the color spectrum. About 99% of color-blind people have Protanopia, or Deuteranopia, also known as red and green weakness respectively [10]. Both conditions affect the opposite sides of the blue and yellow color spectrum, allowing the person to see these colors almost exactly as they are intended. A very small percentage of people suffer from Tritanopia, also known as blue and yellow color blindness, but unlike the two previously mentioned conditions, these individuals are still able to see the blue color, although with shifted shades. Therefore, blue is a very good color to use in your palette.

The lack of images and animations is another important aspect. Although it is commonly stated that "a single image is worth a thousand words", these "words" are nevertheless meaningless if the image cannot be understood. Be that as it may, the use of images is not forbidden, howbeit their placement should be strategic, and always accompanied by the necessary alternative text to aid the user. Complex animations, on the other hand, should be avoided as they can obscure content, or make certain parts of the user's experience unpleasant if they are unable to comprehend what is on the screen, or have issues with perceiving motion.

An important feature of ACAPO's website is the fact of being optimized to be navigated through simple button presses. The entire website can be navigated with only two buttons, allowing the user to go over the content by repeatedly pressing a specific button, followed by another button which is pressed to confirm and access links (for example, Tab and Enter, respectively).

### B. The Royal National Institute of Blind People (RNIB)

The Royal National Institute of Blind People (RNIB) webpage displays large fonts that make it easier to read, while all buttons and links have stout and colorful contrasting highlights [11].

Whilst the website is optimized for people with low vision, it does not consider color blindness. The color palette includes pink, blue, yellow and green. From this selection, both pink and that specific shade of blue are visible only by people with Tritanopia. Conversely, the yellow is visible only to those with Protanopia and Deuteranopia. The worst, however, is the green, since neither of them will be able to perceive it.

Another aspect to note is the use of pictures on the website. Most of them are correctly accompanied by the alternative text, which helps describe what is being portrayed. Unfortunately, the images that also work as links do not include an alternative text, therefore some users will have no context to follow.

Regarding interactability, it is easy to navigate with the keyboard, although some issues with scalability and responsiveness were identified when using wide displays (more than 1280). The benefit of the large font is lost, for instance, as there seems to be a cap to the font scaling, and the images stretch beyond their boundaries to the point where they are no longer identifiable. These issues have an impact on navigation and interactability, depending on the user's disabilities.

Both ACAPO and RNIB websites comply with some of the WCAG guidelines. Nevertheless, both have also crucial flaws. ACAPO, by focusing all its attention on making the website accessible for users with visual disabilities, ignores the visual attractiveness for sighted users. RNIB, on the other hand, intending to keep the website visually attractive, bears images and uses appealing colors, but fails to consider color blindness users. Additionally, RNIB's website is not responsive and the images alt text is not consistent.

#### IV. DEVELOPMENT

This section specifies the accessibility principles on which the design and development of the web platform will be based, describes the functionalities, the architecture, and also presents planned future work.

##### A. Design Approach

The platform interface design will be based on inclusive design, considering its users feedback. This implies including blind and deaf users in all the phases of the design process, following a collaborative user-centred design methodology [12]. The project will, thus, evolve considering the users' perspectives.

Regarding accessibility, after analyzing various websites, we reached the conclusion that developing a web platform that befits all types of users at the same type is not the best approach. Instead, we plan to incorporate a variety of optional features suited to individual needs and preferences. These features will be drawn upon the following seven accessibility principles defined by TPG [8].

1. Provide comparable experience: Whether out of circumstance, choice, or context people are diverse. As people use different approaches and tools to read and operate interfaces, what the interface offers each user should be comparable in value, quality, and efficiency. Every image of our web platform will have a correspondent alt text, navigable through simple button presses and translated into sign language.

2. Consider the situation: For users who already find interaction challenging, such as those with disabilities, this impact may make usage particularly difficult. Having options to change the web platform contrast and different color schemes make the interface content clearer for color blind users.
3. Be consistent: Familiar interfaces borrow well-established patterns. Universal navigation patterns for the various types of accessibility are crucial for those users. We will be using consistent page architecture across templates to help users navigate key content.
4. Give control: The web platform will not suppress or disable the ability to change standard browser and platform settings such as orientation, font size, zoom, and contrast.
5. Offer choice: There is often more than one way to complete a task. One cannot assume what someone's preferred way might be. The web platform will provide layout alternatives such as grids, lists, graphics or tables, offering the users choices that suit their circumstances.
6. Prioritize content: Interfaces can be difficult to understand when core features are not clearly exposed and prioritized. Thus, the content and features will be progressively revealed allowing users to focus on one thing at a time.
7. Add value: Features should add value to the user experience by providing efficient and diverse ways to find and interact with content. Such as, the integration of the Virtual Sign avatar [13] which translates written text to sign language and content optimization so it can be translated properly by external text-to-speech software.

##### B. Functionalities

In the context of this project, the defined functionality groups are: Account management system, where each user will be offered a set of options to customize the profile, for example, knowing sign language; Notification System, where users will be able to interact through a message system with pre-defined subjects; Request System, where registered users are able to create or apply to a request when looking for help; Application System, where registered users are able to freely apply to requests.

Figure 2 illustrates the web platform functionalities and the respective dependencies.

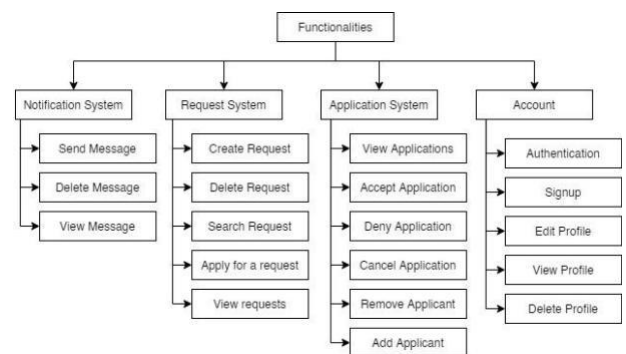


Figure 2. Web Platform Functionalities.

### C. Architecture

The architecture of the project consists in two major components, the frontend and the backend. In the frontend, users will be able to interact with the web platform through its interface, including having access to the accessibility components, such as the sign language translator. The registered users, on the other hand, will be able to access most of the web platform functionalities. The backend contains all the stored data and can be managed by users with admin or moderator status. The figure 3 illustrates the designated architecture.

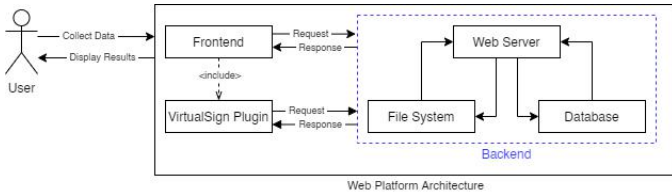


Figure 3. Web Platform Architecture

### D. Future Work

This project will be initially implemented, assessed and tested at ISEP. Subsequently, it may be expanded to other Higher Education Institutions, and possibly adapted to High schools, which will imply the development of additional functionalities and features.

## V. EVALUATION

The evaluation regarding this project is divided into two moments. The first one, regarding the quantitative evaluation, is achieved through the Quantitative Evaluation Framework (QEF), which will assure the quality of the initially established results [14]. The second moment consists in the user satisfaction surveys conceived to test usability and accessibility.

### A. Quantitative Evaluation Method (QEF)

QEF is a quantitative assessment method that measures the quality of a solution through a multidimensional foundation by calculating its completion percentage [14].

This method enables the evaluation of the web platform quality in a three-dimensional space, each of which aggregating a set of factors that represents the system performance from a specific point of view.

In the context of this project, the following three dimensions were chosen:

- *Functionality*, which assesses the technical aspects of the project, i.e., the functional requirements.
- *Adaptability*, which assesses how accessibility-friendly the project is.
- *Usability*, which, besides assessing the projects usability, considers socio-cultural aspects. Most factors in this dimension evaluate the relation between the users and the platform by revealing if it is according to their expectations, characteristics and needs.

## VI. CONCLUSIONS

The inclusive web platform proposal will foster communication, engagement, and interaction between the various types of students. This paper derives from the authors' experience and interest in working with assistive technology and interaction projects. To build a consistent and robust environment direct collaboration with the blind and deaf communities has already started.

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