INSTITUTO SUPERIOR DE ENGENHARIA DO PORTO
MESTRADO EM ENGENHARIA INFORMÁTICA




Plataforma online para promoção da literacia fílmica entre público socialmente excluído

EDUARDA FILIPA RODRIGUES FERNANDES
Junho de 2021

POLITÉCNICO
DO PORTO

Instituto Superior de Engenharia do Porto

Online platform to promote film literacy among socially excluded audiences

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Dissertation to obtain the Master Degree in Informatics Engineering, Area of Expertise in Software Engineering

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Porto, June 2021

"I want to thank me for believing in me, I want to thank me for doing all this hard work. I want to thank me for having no days off. I want to thank me for never quitting. I want to thank me for always being a giver and trying to give more than I receive. I want to thank me for trying to do more right than wrong. I want to thank me for just being me at all times."

Snoop Dog

Abstract

Over the years, the field of education has undergone major changes in the way it handles and manages the learning process. An example of this is the exponential growth of several projects strongly linked to the support of teaching in the most varied scientific areas, including the cinematographic area. There are a lot of subjects, as philosophy, where teachers use movies as support to explain certain topics.

It is in this context that this project arises. Although there is a wide range of platforms that use cinema to support the educational process, this project wants to revolutionize, innovate, and expand its work to more students, teachers, partners, and include more fragile communities.

Through the improvement of existing features and the development of new technological tools in several formats, this project will allow to each student, or not, to create and share new cinematographic content, as well as, in parallel, share their ideas and perspectives on the most varied topics.

Throughout this document, studies, analyses, and comparisons are carried out, to conclude which tools are most suitable, and how they will have an impact on the educational process of each student. In the end, the results obtained will be analysed in order to verify if the main objective was achieved.

Keywords: Educational Process, European Project, Pedagogical Tools, Socially Excluded Audiences, Usability

Resumo

Ao longo dos anos, a área da educação tem vindo a sofrer grandes mudanças na maneira de como lidar e gerir o processo de aprendizagem. Um exemplo disso, é o crescimento exponencial de vários projetos fortemente ligados ao suporte do ensino nas mais variadas áreas, sejam elas científicas, humanísticas ou de arte. Assim sendo, a área cinematográfica, não é exceção.

É nesse âmbito que surge este projeto. Apesar de existir um vasto leque de plataformas que utiliza o cinema como apoio no processo educacional, este projeto quer revolucionar, inovar e expandir o seu trabalho a mais alunos, professores, parceiros, e incluir comunidades mais fragilizadas.

Através do aprimoramento de funcionalidades existentes e o desenvolvimento de novas ferramentas tecnológicas em vários formatos, este projeto permitirá que cada indivíduo crie e partilhe novo conteúdo cinematográfico, bem como, paralelamente, partilhem as suas ideias e perspetivas sobre os mais variados temas da atualidade.

Ao longo deste documento, são efetuados estudos, análises e comparações, de forma a concluir quais as ferramentas mais adequadas, e de que forma é que estas terão impacto no processo educativo de cada estudante. No final, os resultados obtidos serão analisados com o propósito de verificar se o principal objetivo foi alcançado.

Palavras-chave: Processo Educacional, Projeto Europeu, Ferramentas Pedagógicas, Comunidades Socialmente Excluídas, Usabilidade

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Acronyms e Symbols

ACL	Access Control List
AHP	Analytic Hierarchy Process
API	Application Programming Interface
CCSS	Common Core State Standards
CDA	Content Delivery Application
CLI	Command Line Interface
CMA	Content Management Application
CMS	Content Management System
CRUD	Create Read Update Delete
CSS	Cascading Style Sheets
DOM	Document Object Model
DSR	Design Science Research Methodology
FURPS	Functionality, Usability, Reliability, Performance, Supportability
GUI	Graphical User Interface
HTML	Hypertext Mark-up Language
IDE	Integrated Development Environment
ICO	Independent Cinema Office
JS	JavaScript
JSX	JavaScript XML
MVC	Model-View-Controller
PHP	Hypertext Pre-processor
QFD	Quality Function Deployment
RDBMS	Relational Database Management System
SEO	Search Engine Optimization

STEM	Science, Technology, Engineering, Math
SQL	Structure Query Language
TCO	Total Cost of Ownership
UI	User Interface
UX	User Experience
WYSIWYG	What You See Is What You Get

1 Introduction

From antiquity to the beginning of the 19th century, the predominant school practice was passive and receptive (‘Evolution of Learning’, 2018). Learning was synonymous with memorizing. In this type of learning, there was almost no room for understanding.

The central character in this type of education was the teacher. The teaching procedure at that time was based on the "questions and answers" exercise, where the teacher presented several questions accompanied by its answers, previously prepared (Kosar Altinyelken, 2015).

Despite this type of teaching has been prevalent for a long time, several philosophers and educators began to place more emphasis on understanding than memorization. “Education is a kindling of a flame, not a filling of a vessel” (Socrates, 469-399 B.C).

As the years went by, the student became the center of the learning process, and understanding overrode memorization (Kosar Altinyelken, 2015). The methods applied in the classroom context have become increasingly diversified: reading texts, interactive presentations, lectures, educational games, and video/film viewing are some of the techniques that have been applied. Most of these techniques are possible due to the introduction and evolution of technologies. In fact, nowadays children learn first how to use a mobile device to read.

Despite all this great evolution in education, there is a large part of the world community that does not have great conditions for access, or has no access at all, to education. “An estimated 617 million children and adolescents around the world are unable to reach minimum proficiency levels in reading and mathematics – even though two thirds of them are in school” (UNICEF | for every child, 2019).

The most worrying is that “children with disabilities and from ethnic minorities are also more likely to be left behind” (UNICEF | for every child, 2019).

Realizing that this could be an opportunity for the technological market to focus even more on education, MOG Technologies (*MOG – Digital Media*) joined to a European project in partnership with 10 more European educational partners. This project, described as “CinEd -

European Cinema Education for Youth", aims to provide a set of tools that enable the development of a taste for European cinema, critical judgment and creative sensitivity of young people and contribute to general education through cinema and awareness of Europe's cultural diversity (*CinEd*, 2015).

Thus, this thesis focuses on the development of a young space, containing social inclusion activities, through innovative features specifically designed to help combat this situation by helping to integrate young people who feel socially excluded. The solution to be worked on in this thesis, will be integrated in the European project described above: "CinEd - European Cinema Education for youth". This project was created 5 years ago, defined by a large consortium composed by 10 educational entities, led by Institut Français, where its aim was to facilitate access to European films and expand film education across Europe for young people aged 6 to 18 and teachers.

However, with the exponential growth of competitors in the same market (viewing of films in order to facilitate the educational process), the project saw the possibility of growing, expanding (attracting more pedagogical partners, users, and institutions), and improving its available tools, as well as add new features.

Currently, the project consists of 12 pedagogical partners, led by Cinemateca Portuguesa (*Cinemateca Portuguesa - Museu do Cinema*, 2013) and MOG Technologies (only technological partner).

1.1 Problem Statement

The main problem to be solved by this thesis is the lack of tools and functionalities designed to motivate students for their learning process, encourage their interaction with their teachers, and make the most fragile communities to feel included.

Although the European project "CinEd-European Cinema Education for youth" has its own public website where students and teachers can access information regarding a vast collection of films free of charge, it lacks interactive tools to facilitate the learning process and make students more motivated. Moreover, the materials made available at the current website does not consider the difficulties of the most fragile communities. For example, the website contains a unique space for young people, where what are called "student sheets" are available, in pdf format, for each of the films available. Nevertheless, some of the activities proposed in those documents require the document to be printed, filled out by hand by the student, scanned, and sent by email with whoever wants to share the completed document. This implies the need for equipment, such as a printer that contains a scanning feature. However, most children do not have this type of equipment at home, especially economically disadvantaged families.

Therefore, it urges to develop interactive tools that can, from one hand, improve the learning process and motivate students, and by the other hand, help to integrate the more socially excluded audiences.

This document aims to describe in detail the solution to be integrated with CinEd's project carried out within the scope of the Master Thesis Course in Computer Engineering (TMDEI), in the Master plan in Computer Engineering (MEI), in the field of Software Engineering, at the Instituto Superior de Engenharia do Porto (ISEP), in partnership with MOG Technologies.

1.2 Objectives

As was previously said in section 1.1, the main objective for this project is redesign the CinEd platform and the development of a young space, containing new social inclusion activities, in order to reduce school dropout, through supporting learning process and personal development, within the scope of film literacy.

Therefore is a wide array of different challenges that can be identified and that need to be addressed in order to fulfil the objective defined for the project. Those challenges include:

- Turn all pedagogical materials into interactive materials: For now, all pedagogical materials (known as student sheets, that contain several exercises about the movies) are in PDF format. Thus, it is necessary to turn each exercise contained in those pedagogical sheets into interactive and dynamic exercises, where the child's reasoning ability is stimulated
- Content editing platform: Development of a content editing platform, through the association of several images and sounds provided by the partners. In this space, each student can share their perspective in relation to a certain film, by building a short video, being able to share it with other young people
- New website: Development of an improved website with multi-language support (11 languages), where all tools to be developed (student sheets and the content editor) will be available
- Development of a back-office (content management system): Each partner, must be able to introduce the content on the new website, from news, testimonials, films, subtitles, new pedagogical files, new images and sounds for the editor, and manage emails of potential partners or clients

As a result of all of these objectives, the students should be able to practice their knowledge about a specific or several movies but, above all, express themselves through the developed tools.

1.3 Methodology

This dissertation documents the creation of several features and tools, to support the learning process in an educational environment, to reduce school dropout. In this context, the "Design Science Research Methodology" (DSR) was considered the most suitable for this project. This methodology "creates and evaluates IT artefacts intended to solve identified organizational problems"(Gacenga et al., 2012). In addition, in DSR, mathematical and computational methods are used to evaluate the efficiency and the quality of the artifacts.

Hevner (*Alan R. Hevner | USF Muma College of Business*, 2019) counted 7 guidelines for a design science research:

- Design as an artifact: the solution design, where the designed solution is based on artifacts, such as the representation of diagrams or development techniques
- Problem relevance: the project is contextualized, as well as the definition of its objectives
- Design evaluation: test and validate the solution in order to understand if it meets all the defined objectives, assuming the use of rigorous tests
- Research contributions: it must provide clear and verifiable contributions in the specific areas of the developed artifacts, and present a clear rationale for design fundamentals and/or design methodologies
- Research rigor: value analysis of the project, which allows to perceive the necessity of it, throughout the usage of rigorous methods, such as Analytical hierarchy process (AHP) or SWOT analysis
- Design as a search process: analysis of the state of the art and comparison of existing solutions related to the defined problem, as well as the study of technologies related to the project
- Communication of research: documentation of the work and research results

Despite the guidelines described above follows a numerical logic, the methodology, in most cases, does not follow the normal flow, and this project was not an exception.

Initially, the project was contextualized, and all its objectives were defined (guideline 2).

Followed an analysis of the state of the art, identifying potential competitors and comparing existing solutions related to the defined problem, as well as the study of technologies that may help to solve the problem (guideline 6).

After studying the existing solutions and technologies, was carried out the value analysis of the project, allowing the author to understand the need for it in order to validate its relevance (guideline 5), through the use of rigorous methods.

Then, the solution design was defined, in order to fulfil the objectives outlined in section 1.3, through the representation of diagrams (guideline 1).

This was followed by the implementation and integration of the solution, fulfilling the defined design, as well as its evaluation in order to understand whether it meets all the defined objectives (guideline 3). This phase presupposes the use of rigorous evaluation methods.

Finally, guideline 7, which was developed throughout the development of the solution, consists of the elaboration of this report. Besides that, at 29th Jun it was made a presentation, at Frankfurt, for all partner associated to the project, where all developed features were presented and tested, and all problems encountered until that moment were discusses. Also, there is a chance to submit an article related to this project at Symposium on Computer Engineering (SEI), or other conferences.

1.4 Work Planning

The project was divided in several tasks (Figure 1.1) in order to facilitate the organization of the solution's development:

- Analysis of the project to be developed: presentation and understanding of the thesis project, as well as research of potential competitors
- Gathering of functional and non-functional requirements: phase with more direct interaction with all partners involved. This process was made in several ways, from the design of mock-ups to interviews, focus groups and brainstorming's with partners
- Solution design phase: design of solution architecture
- Implementation phase: phase in which the designed solution is implemented. This phase is divided into 3 categories: back-office, student sheets, and the content editor.
- Testing phase: phase in which the implementation is tested. This phase, like the previous one, is divided into 3 subtopics: back-office, student sheets and content editor
- Integration: after verifying that the 3 categories are working correctly (student sheets, content editor and other general functionalities on the website), it is necessary to integrate them in a single web platform
- Report writing started at the beginning of the project until the end

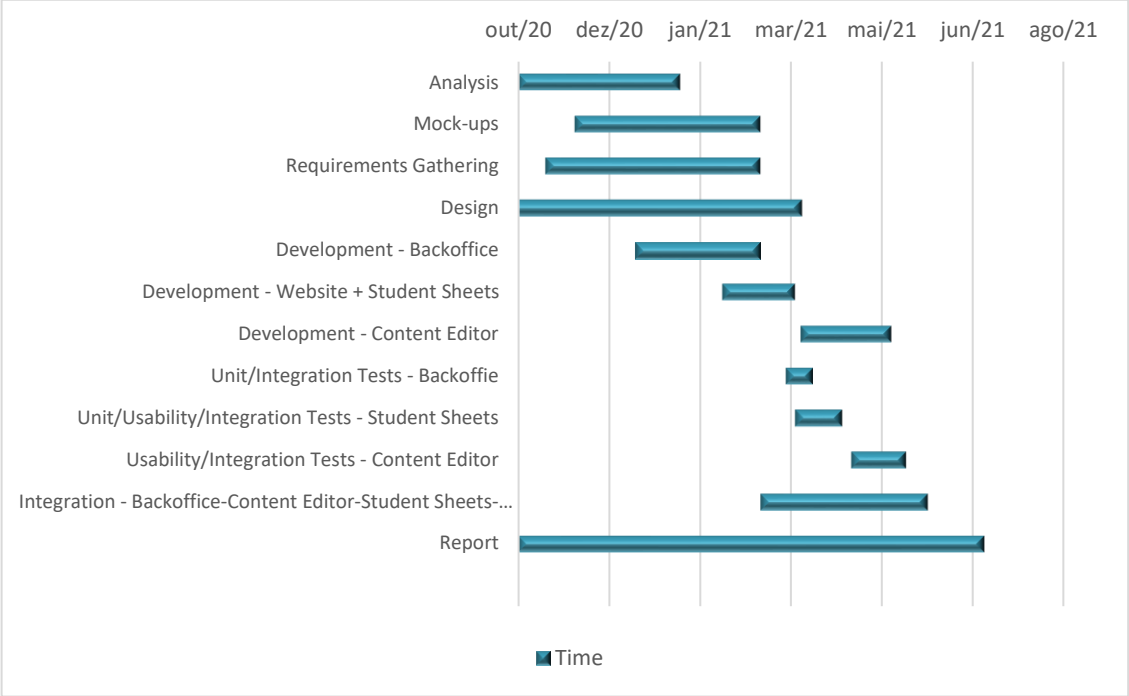

Figure 1.1 - Gantt Diagram

Throughout the entire development of the solution, from the design of the mock-ups to the implementation of the defined requirements and its testing, mentoring meetings were held weekly in order to verify the entire development process.

1.5 Report Structure

This report is divided in 9 chapters:

- Introduction: This chapter begins with a project contextualization. There is a description about what the goals are and how to reach them through "Design Science Research" as well as the expected results at the end of this project. Lastly, it is shown a Gantt Diagram in order to plan all work since the beginning of the project until the end

- State of Art: This chapter, gathers several existing platforms (potential competitors), analysing the strengths and weaknesses of each one, as well as some technologies that can be useful for the development of this project. Besides that, both in the study of competitors and in technologies, it was made a comparative analysis

- Value Analysis: After knowing all the existing competition in today's market, this chapter analyses several solutions that can be implemented to, somehow, choose the best solution for the project and for all the stakeholders involved. For this,

several methods were adopted, such as the Analytic Hierarchy Process (AHP) and the Quality Function Deployment (QFD) methods

- Project Analysis: Here, all stakeholders of the project are identified, as well as the elicitation techniques used in order to gather all the functional and non-functional requirements

- Design: After knowing what requirements the customer wants to have, it is necessary to structure the solution. Here, the patterns to be used in the solution architecture, and in the database architecture are described, presenting several alternatives are discussed and compared. It is also in this chapter that some mock-ups are presented

- Development: In this chapter, are presented all technical details during the process of the solution development designed in the previous chapter

- Experimentation and Evaluation: This chapter, presents the implemented tests in the solution, to guarantee its correct functioning

- Conclusions: This chapter, makes an appreciation of all work made since the beginning until its end, analysing everything that was achieved, as well as the future work to be develop for the continuation of the project

2 State of the art

The movie industry in the educational environment has been growing in the last few years, due to the advantages of it in children's personal development and because it is an easier way to learn some concepts in specific subject, like geography, history, or maths ('Innovating Education and Educating for Innovation', 2016).

Besides that, a lot of websites and platforms have been created to provide this kind of knowledge and possibilities for children. Thus, a research was done to understand how these websites work, their main goals, and functionalities, and how can they help students in their educational process.

In addition, this chapter provides a general idea of the web platforms that already exist in the market and that may be potential competitors for the project to be developed, as well as an approach to the technologies that may be useful for the development of the solution.

2.1 Related Works

From the past and until nowadays, society sees books as the main resource to gain knowledge about several subjects as cultural, educational, and personal development. (Darling-Hammond *et al.*, 2020). However, the adoption of exhibition of movies and documentaries have proven that not only books, but also audio-visual content has contributed a lot to an improvement in children's capabilities at school and in their personal journey. "Students can remember more through videos than just from verbal sessions, as they observed kids remembering dialogue of the movie, they watched a week ago, but nothing from the lecture they attended in the morning" (Literature et al., 2018).

Despite all websites have the same purpose, they can be different in other aspects. Some are focused on specific subjects, a few ones have free content, other ones have pedagogical tools for students, in order to practice their knowledge, and training courses for educators, so they can be prepared and confident to use film effectively in their lessons. "A

historic film can improve your knowledge in history; a sci-fi film can touch you with some knowledge of science and so on. Good comedy movies have the power to make you laugh and can thus enhance your mood. Adventure movies can arise in you a spirit of adventure and motivation" (Literature et al., 2018).

All websites presented from section 2.1.1 to section 2.1.11 have the same goal: widen the scope of knowledge of students and develop an open-mind mentality.

Eleven websites are analysed bellow. This choice was based in some references that partners gave during the process of requirements specification.

After this analysis, the most relevant categories in this area are grouped in Table 2, in order to compare the analysed websites.

2.1.1 Independent Cinema Office

Independent Cinema Office (ICO) works directly with 24 local cinemas in United Kingdom. Their main goal is creating and develop an independent cinematographic sector, in order to everyone can have access to cinema, even though to people who have not social and economic power.

In fact, as they work with local cinemas, they offer several training tools, workshops, and consultancy to them, to make sure they stay economically stable. Additionally, local cinemas have access to various cultural movies.

"Develop an open, challenging and thriving film sector"(*Independent Cinema Office*, 2020) is their motto:

- Open: The cinema is a very strong way of expression because is inclusive and should be accessible to almost everyone. On the other hand, they believe that cinema can build a relationship with who sees it, since they can relate some scenes with their lives and thus, helping them deal with several situations
- Challenging: Cinema can change lives and stimulate progressive thinking
- Thriving: They want that this project be not only sustainable, but also successful

Currently, ICO is developing a new project called "Film Education in your cinema". This project allows certain local cinemas to have schools as partners. The aim is to improve critical thinking and the interest in cultural movies.

Based on "ICO Annual Report 2018-2019" (*Our annual report 2018-2019*, 2020):

- They programmed 902 different films; reached over one million people, generating over 7 million euros
- Offered training tools and workshops to 100 cinematographic professionals from 60 different associations, over 50 different countries

- Released around 38 movies, which were seen by 708 thousand people, generating over 95 thousand euros
- Marketing channels reached over 708 thousand people

2.1.2 Cinema In Education

Cinema in Education (*Cinema-in-Education – PSHE Cinema sessions for schools*, no date) aim is to create moments of discussion about cultural subjects between younger community, such educational themes, and personal situations, and they are open to anyone who wants to book their movies.

Cinema in Education platform has 5 available movies. The subjects covered, by age, are as follows:

- "Facts of Life" for age 7/8: is about divorce and bullying
- "The trouble with Max" for age 8/9: helps young people to examine the varied pressures that they face in their daily lives
- "Love, honour, cherish" for ages up to 9: the difference between love and lust; strategies to resist pressure to engage in sexual activity
- "Babies" and "Truth and lies" for ages up to 10: the moral and emotional implications of pregnancy and abortion, where to seek advice when facing an unexpected pregnancy; highlights the effects of pornography and the sexualized culture on young people

"Ten Ten Productions" and "Ten Ten Theatre" are the partners of Cinema in Education. "Ten Ten Theatre" has the main goal of creating movies and theatre performances of high-quality for children, young people, teachers, and parents. On the other side, "Ten Ten Productions", produce stories about social conscience, civic questions, and faith dimension.

2.1.3 British Film Institute

British Film Institute (*BFI homepage*, 2020) presents and works with an international program about cinema, the "BFI National Archive" - "One of the largest and most important collections of film and television in the world. Its teams of experts ensure that the collection is preserved and developed for future generations and made widely accessible to today's audiences" (*BFI National Archive*, 2020)- and, on the other hand, tries to inspire younger students to be filmmakers in the future. Besides that, BFI works with the government to make United Kingdom one of the most creatively and prosperous places to make films internationally.

BFI and other 25 school institutions (and its professors), created a framework where the main objective was to create a database with several educational movies, in order to promote an easier way of learning. In their own words: "consolidate a body of theory, practices and

principles behind various European film education activities […] inspire and equip people across Europe to be able to enjoy, understand, create, explore and share film in all its forms throughout their lives" (*BFI National Archive*, 2020).

Movies provide children an environment and opportunity to relax during, what can sometimes be, a stressful day. What is more, is that using movies for educational purposes is beneficial, since the process of watching engages the visual memory (an image speaks more than a thousand words), which helps the information to be remembered better. As a result, it will be easier for them to do their final tests (Kosar Altinyelken, 2015).

This framework also offers, a set of resources to help each student interiorize the movie seen. These resources contain a short video (resume), a technical sheet and, as previously said, activity worksheets but, unfortunately, only for premium users.

At the British Film Institute, students can also apply for a training program focused on the production of movies, for ages between 16 and 25, called "Film Academy".

2.1.4 Film Platform

Film Platform connects academic audiences with the most popular and better ranked documentaries from across the world. Each available documentary (more than 350 documentaries) is associated with social, political and/or cultural importance.

"We want to use film to unite students, academics and filmmakers from far-flung corners of the world, allowing them to connect, provoke debate and inspire change" (FILM PLATFORM, 2020). These movies can be seen in streaming or downloaded, and can be used during classes, public screening, or online streaming access.

With streaming, students can access the movies in and out of their university campus. For that, there is a "User guide", which helps every single user to use the platform. This user guide has a lot of information from how to create a login, to accessing films off campus, create a playlist and share films, and how to generate a link to a film/streaming page on the Film Platform. Additionally, has also a video demo in order to help with the connection to the proxy server.

2.1.5 Ro*Co Films

This organization's aim is developing an educational component through documentaries exhibition, bringing these compelling real-life stories to classrooms. On the other hand, they are "committed to generating impact and galvanizing[1] conversation around the most vital issues of our time" (*Ro*Co Films*, 2020). They believe that real testimonials can educate, entertain, and engage younger audiences about different, but important themes.

[1]"shock or excite (someone) into taking action" (*Oxford Languages and Google - English | Oxford Languages*, no date)

As some of the other institutions, Ro*Co Films also provide several resources for students and for educators as:

- Educational DVDs, with different versions – short resume movie or the original
- Each movie is divided by chapter for the use of smaller videos segment during lessons
- Bonus features
- Guide for Educators with activities and discussion questions

Besides these resources mentioned above, Ro*Co Films uses some of the available movies to organize some events and workshops for target universities and schools, so that its teachers can develop their professional skills and adapt their classes.

Also, there is a partnership with Film Platform, as seen at section 2.1.4, which allows seeing movies in streaming too, allowing students and universities stream documentaries at any time, in or off campus.

2.1.6 Films pour Enfants

"Like books, painting and music, films and animated films help children develop their taste" (Films pour enfants, 2020) this is Films pour Enfants' motto. They want to develop an interest in the educational process for children and young people through movies or short films. Also, experience indicates that children learn to develop an opinion about what they watch, saying and arguing about what they liked and what they did not like, cultivate desire by drawing, telling stories, sharing experiences and exchanges opinions with their colleagues.

Secondly, this institution is trying to promote cultural democracy and equal opportunities. There is a big range of students that do not have knowledge or access to the art field and, by seeing movies, they are not only getting in touch with art, but also with educational content. That is why all movies from *Films pour Enfants* are free. Additionally, the fact of having free movies, allows students to watch them out of school, working as an extracurricular activity or informal learning.

Unfortunately, all resources are only available in French. Any other language does not have access to all its contents.

2.1.7 Teaching European History

Unlike the previous organizations, this one focuses only on a subject: Cultural history for high schools' students, with the intention of improving the quality of history's lessons and a deeply knowledge about important historical events. "The project is not based only on the practical skills necessary on the long-term for students, skills that will enable them to grow into active and informed citizens('Teaching European History through Cinema', 2020).

However, Teaching European History through Cinema (TEHC) has several pedagogical materials prepared, to support teachers during classes, for example:

- Film Catalogue: This catalogue is divided into 8 sections, each one related to a historical event. Inside of each section, there is a list of movies that can be seen, accordingly to that theme
- Project guidelines: Tips for teachers that can use during classes or for students' homework, such as good practices and recommendations
- Media Kit: Here, students/teachers, can find a lot of content about diversified topics, for example: multimedia teaching unit; models of film analysis sheet; how to write an essay/video essay

Every year, TEHC organizes a contest to challenge students to make their own video-essay. The intention is to promote team spirit, critical thinking and improve some soft skills like communication, creativity, and active engagement.

2.1.8 Into Film

Into Film, believes that movies are “the heart of every child and young person’s educational, cultural and personal development" (Into Film, 2020). Consequently, this organization works with children between 5 and 19 years old, to inspire and help them in the educational process, to achieve their goals through the film's exhibition. In this way, it is important to provide resources for educators and students that can be used during classes, and after that, at home.

These resources are:

- Training for educators, teachers and youth or community centers - realization of workshops through filmmaking, literacy, and animation. These kinds of training are designed to enrich teaching and learning through film
- Online courses
- Pedagogical tools - free resources with activities, including PowerPoint presentations, embedded clips, informal discussions to facilitate children’s engagement with the film shown: “Into Film puts at the heart of the educational and person’s development of children and young people” (*Into Film | Film in Education | Film Clubs - Into Film*, 2020)

Besides all of these provided resources, Into Film organizes the “Into Film Festival” every year. This festival, enables over 450 000 children to access cinema for free, celebrating filmmaking and learning achievements of educators and pupils from across the UK (United Kingdom). Due to social and economic factors, some children cannot visit the cinema regularly, or cannot visit at all but, with Into Film, that is possible.

With a teacher's testimonial - "Some (students) find certain subjects challenging and watching films gives them an outlet, a different way to express and articulate themselves" (Castell, 2019) – it is possible to understand that Into Film, is doing a good job providing this kind of experiences to young students who do not have economic possibilities.

Accordingly, to "Annual Review 2018/2019" (*Into Film's Annual Review*, 2020):

- 143 736 pedagogical tools were downloaded
- 256 movies were submitted by young people
- 4 184 educators trained
- Over 28 000 subscribers to our get Into Film channel
- 439 154 Into Film festival attendees

2.1.9 Teach with Movies

Teach with movies, founded by two parents, decided that if they "carefully selected feature films, could supplement curriculum and foster social-emotional learning" (James Frieden and Deborah W. Elliott, 2020).

Moreover, they have rich and detailed information about each movie, like:

- Description
- Benefits of the movie
- Possible problems
- Parenting points
- Selected awards & cast
- Using the movie in the classroom
- Discussion questions
- Assignments and projects
- Common core state standards (CCSS) anchor standards
- Bridges to reading
- Building vocabulary
- Links to the internet
- Bibliography

It should be noted that all these contents and movies are free, both for students and teachers. Besides this, there are also lesson plans and worksheets, in order to make classes much more dynamic and interactive. Additionally, to make it easier for teachers to choose a movie, each one has the related subjects, for what range of age is the movie for, and which type of social-emotional and moral-ethical skills the movie approach.

2.1.10 Common Sense Education

Common Sense Education is an organization focused on Science, Technology, Engineering and Math (STEM) subjects. As technology is present in our lives every day, and from a young age, kids use technology both home and schools. As a result, Common Sense decided to create this platform about movies related to STEM.

They have a "For Parents" space, where they explain that "kids are on the front lines of a digital revolution. Devices, social networks, and media are changing childhood in radical ways" (*How Tech Is Changing Childhood | Common Sense*, 2020), and sometimes children do not have a notion that technology can be a bad influence in their lives. For this reason, Common Sense organized some content where parents can resolve some situations that might happen, and how they can avoid some problems, by watching the right movies (or playing the right games) in the right ages.

On the other hand, also teachers have specific content for them that can be used in classes. They have a list with 10 movies that approach a particular topic, for certain ages, lesson plans, quick activities and classroom posters and videos.

2.1.11 CinEd

This project appeared in 2015 and its objective is "to help the greatest possible number of European youths aged 6 to 18 discover European cinema" (*CinEd*, no date)

As for its main features, the following can be highlighted:

- All content is accessed for free, however, it is necessary to register an account to access certain features such as: watching the full movie and having access to the media kit
- Contains specific student sheets (in PDF format) for a certain film, being accessible to all types of users
- There is a section specially designed for teachers, with teaching materials and tips of the classes that can be taught

In order to compare the main features of all of these platforms/websites, the next section (2) focus on that. The main objective of this analysis is to collect as many ideas as possible to be discussed with partners, in order to create new features specially created for the target audience: young students, including the ones with less economic power.

2.2 Related Works Comparison

Through all the analysis made to each of the competitors, it was possible to realize that children can improve their communication, develop a critical thinking, analyse, and interpret what they saw and heard in the movie. On the other hand, they are able to connect with the movie

building an emotional sense, improve their language skills, allows them to imagine and create a different perspective about the film and can keep their attention since the beginning to the end of the movie.

Thus, by researching the works related to the solution to be developed, it was possible**, for the author**, to build Table 1.

Table 1 - Film Sensibility: Skills, Dimensions and Connection to Personal Life

<table>
<tr><th colspan="5">Film Sensibility</th></tr>
<tr><td rowspan="2">Skills Developed</td><td>Communication</td><td>Critical Thinking</td><td>Analytical Skills</td><td>Interpretation</td></tr>
<tr><td>Emotional Understanding</td><td>Improve Language Skills</td><td>Imagination</td><td>Active Engagement</td></tr>
<tr><td>Key Dimension</td><td>Creative</td><td>Critical</td><td>Cultural</td><td>Relationship</td></tr>
<tr><td>Connecting to Personal Life</td><td colspan="2">Personal Development</td><td colspan="2">Civic Responsibility</td></tr>
</table>

In addition to the skills developed and referred to above, movies can be seen as a dimension with 4 categories: imagination (creative), critical thinking (critical), culturalism (cultural) and a social component (relationship). Additionally, movies can as well have an impact on children's daily life through personal development and civic responsibility. Movies can make young people to see actions and analyse moments with a different point a view.

Now having a clearer understanding of the importance of audio-visual content in the learning process, a comparison should be made between the various websites analysed.

Through the meetings held with the partners, it was concluded that the pedagogical materials available, both for students and for teachers, are one of the most important factors that a project of this nature must have. On the other hand, and since this is a European project that aims to reach young people from 6 to 18 years old, also covering a socially excluded public, it is essential to understand the age range and target countries of each website analysed, as well as whether it access is free or not.

Table 2 represents that comparison, analysing which are the target countries, range of ages, pedagogical tools, and its formats, the existing of training courses, if there is any focus on a particular subject, and the type of access to its contents (free or not).

Table 2 - Existing Competitors Comparison

	Target Countries	Range of ages	Pedagogical Tools	Pedagogical Tools Format	Training Courses	Subjects	Is it Free?
CinEd	Global (Preferably Europe)	6 to 18 years old	Technical Sheet; Activity Worksheets; Media Kit	Videos; PDF	No	All subjects	Yes
Independent Cinema Office	United Kingdom (English)	All ages	No	-	Yes	Personal Development	No
Cinema In Education	United Kingdom (English)	7 to 18 years old	No	-	No	Personal Development	No
British Film Institute	Global (English)	6 to 18 years old	Technical Sheet; Activity Worksheets	PDF	No	All subjects	Free and paid content
Film Platform	Global (English)	All ages	Press Kit; Film Poster; Gallery	PDF; Online content	No	Social, Political and Cultural Importance	No
Ro*Co Films	Global (English)	All ages	DVD's (short and original movie); Bonus features; Guide for educators (activities and discussions questions)	Video; PDF	Yes	Social, Political and Cultural Importance	No
Films pour Enfants	Global (English/French)	3 to 15 years old	Technical Sheets; Worksheets; Quiz	PDF; Online content	No	Personal Development	Yes

	Target Countries	Range of ages	Pedagogical Tools	Pedagogical Tools Format	Training Courses	Subjects	Is it Free?
TEHC	Italy, Bulgaria, Romania, Slovenia	up to 10 years old	Film Catalogue; Project Guidelines; Media Kit	Videos (vimeo/YouTube); PDF	No	Cultural History	No
Into Film	United Kingdom (English)	5 to 19 years old	PowerPoint presentations with embedded clips; Technical Sheets; Activity Worksheets	PowerPoint; PDF; Videos	Yes	All subjects	Yes
Teach with Movies	Global (English)	10 to 18 years old	Lesson's plan; Learning guides; Articles on using movies for further education; Worksheets	Word; PDF; Online content	Yes	Health, Science and History	Yes
Common Sense Education	Global (English)	2 to 18 years old	Lesson Plans, Activity Worksheets; Classroom Posters/Videos; Games	Online content; Videos; Posters	Yes	Science, Technology, Engineering and Math	Free and paid content
Science Film Festival	Global (English)	up to 5 years old	Learning games; Projects and hands-on experiments	PDF; Online content	No	Science, Technology, Ecology, Environment, Culture and History, Family Edutainment	Yes

With this comparative table, it is possible to conclude that common features between almost of the analysed websites are:

- Interactive and Online Activity worksheets: no need to print it
- All content should be free: so, they can access to all the information in and out of schools
- Discussion questions: to improve communication and critical thinking skills
- Detailed information about each movie: in order to help the comprehension of it
- Lesson plans: to get classes more dynamical and interesting
- Learning games: funny way to learn about some new concepts
- Posters/ resume schemes

On the other side, it would be interesting to have an image/video editor, to children play with the images, songs and sounds of each film. This can stimulate young people to tell the story in their own perspective, or even make a new one.

With the comparison of the related works, an analysis of potential technologies that may be used in the construction and development of the solution is handled.

2.3 Technologies

For this project in concrete, and already knowing what the outcomes of the project should be, this section is divided in the next sub-sections: front-end and back-end technologies, databases, and content management systems (CMS).

The main purpose of this approach is to analyse the existing technologies in each of the areas mentioned above, in order to later, at section 5, make a better choice of what the best technologies to develop this project are. Thus, each tool and technology were investigated to be aware of what are the limitations and what can be done with each one.

2.3.1 Front-end Technologies

In the world of web development, it is expected that the users are familiar with:

- Hypertext Markup Language (HTML), for the structure
- Cascading Style Sheets (CSS), for styling
- JavaScript, for logic

There are a lot of frontend technologies, although it is not possible to study and investigate all of them. For this reason, the choice of frontend technologies is based on the GitHub at Figure 2.1, and on Stack Overflow at Figure 2.2, top three.

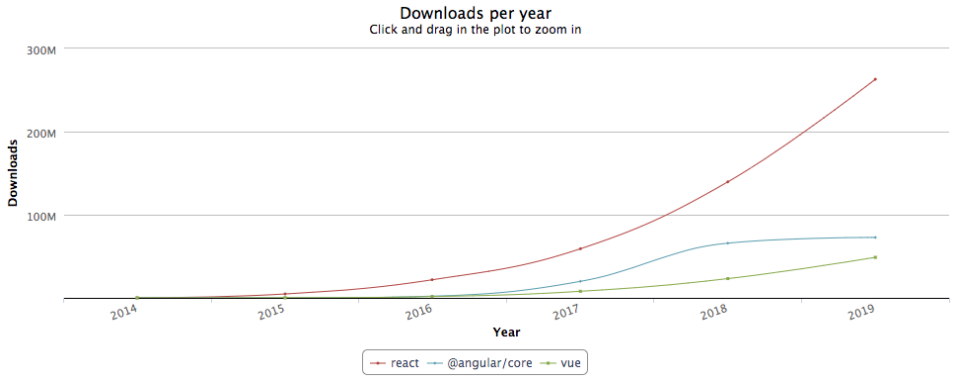

Figure 2.1 - GitHub: Frontend Frameworks Popularity (React, Vue and Angular) (Front-end frameworks popularity (React, Vue and Angular), 2019)

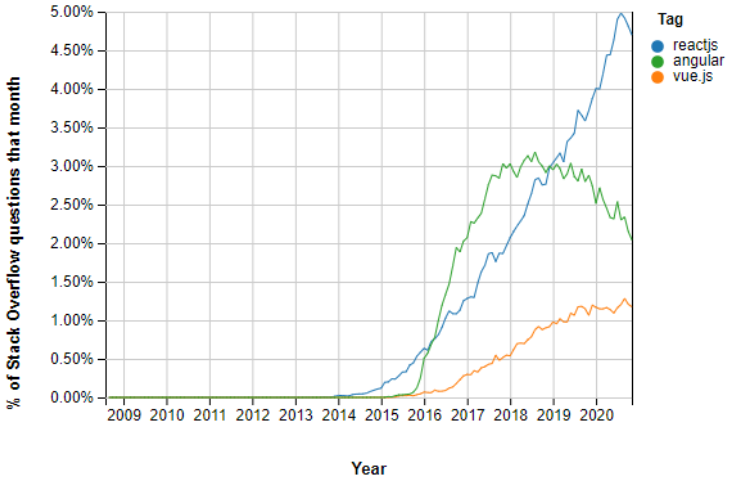

Figure 2.2 - Stack Overflow: The most popular frontend frameworks (*Stack Overflow Trends*, no date)

Both of Figure 2.1 and Figure 2.2 shows, in the same order, that the most used frontend technologies in 2019 were React, Angular and VueJS. Thus, these are the technologies to be studied and analysed in the next sub-chapters.

2.3.1.1 React

"React is used by 0.4% of all websites whose JavaScript library we know. This is 0.3% of all websites" (*Usage Statistics and Market Share of React for Websites, December 2020*).

React is a JavaScript library for building UIs. It uses JSX syntax, a syntax extension of JavaScript (JavaScript and HTML). JSX is built to use elements to make components. Despites that, it divides the view into small components allowing to reuse code (this is possible because the components can refer to other components), to create more complex UIs. "Data can be passed

from parent components to children as props. Props are immutable and cannot be passed upward in a component tree hierarchy" (Saks, 2019).

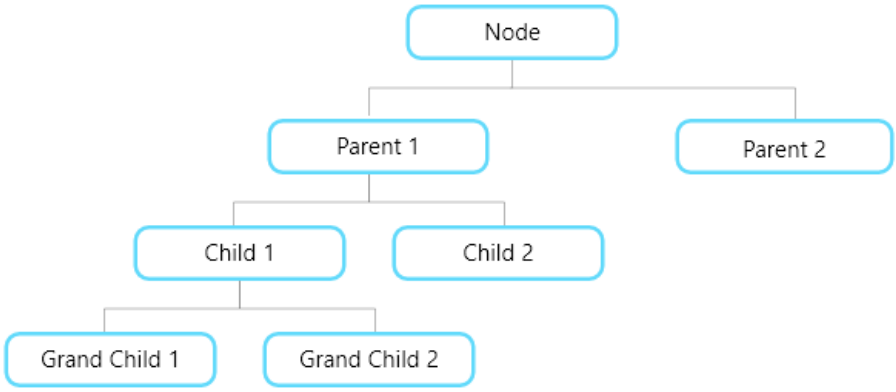

Figure 2.3 - React Structure (based on *File Structure – React*, 2020)

React architecture (Figure 2.3), unlike most technologies, does not follow the Model-View-Control architecture. React, only uses the "View" layer.(*A Detailed Study of React: The React.js Application Architecture*, 2018). The core principles of React are Flexibility, Efficiency and Declarative code. Its flexibility can be seen, for example, with the CSS files. In React it is possible to define a CSS file, containing a general style, and to be used several times just using calls to its "className", and that is a very good advantage. Another advantage of using React is because of Document Object Model (DOM). DOM is, in an easy way of comprehension, what a browser creates when a web page is loaded. In Figure 2.4 it is possible to see its structure.

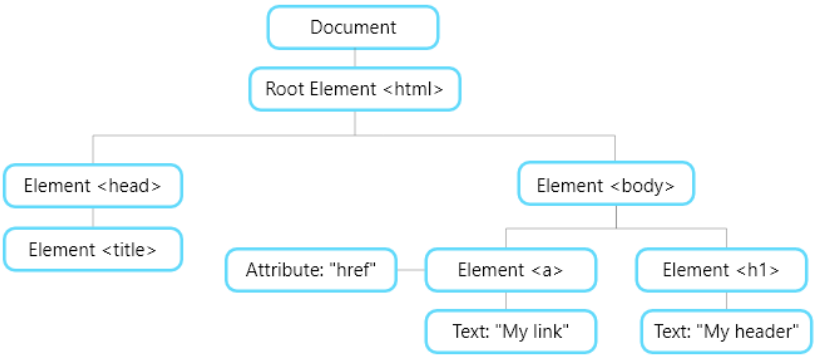

Figure 2.4 - DOM structure (based on *Forwarding Refs – React*, 2020)

But, as DOM manipulation is costly in terms of computing resources, react is designed to perform a virtual DOM. The virtual DOM is a programming concept where the representation of a UI is kept in memory and synced with the "real" DOM by a library such as ReactDOM. "ReactJS works by storing the state of your application internally, and only re-rendering your content into the browser when the state changes" (Chris Dawson, 2014).

React also has a “Get Started” section, where users can try and learn react. In that section, it can be found an extended tutorial with several sub-sections about different subjects, main concepts, testing resources, advanced guides, API references and a builder book, an open-source web app to write and host documentation. Besides that, there are online courses and example projects created by its community.

2.3.1.2 Angular

“Angular is used by 0.5% of all websites whose JavaScript library we know. This is 0.4% of all websites” (*Usage Statistics and Market Share of Angular for Websites, December 2020*, 2020).

Nowadays, Angular is designed for all existing platforms: web, mobile, native mobile, native desktop, and it is written in HTML and TypeScript.

Likely most of frameworks, Angular is component-based, organized hierarchically, as it is possible to see below (Figure 2.5 - Angular Structure (based on *Angular - Introduction to components*, no date).

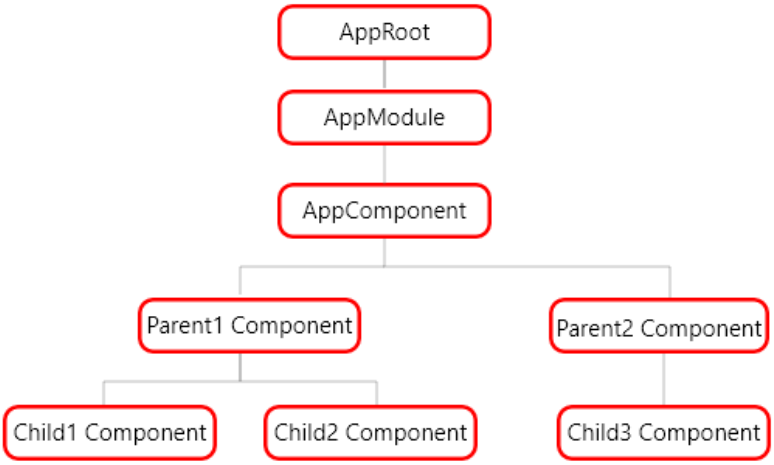

Figure 2.5 - Angular Structure (based on *Angular - Introduction to components*, no date)

The information flows from a parent to child component, from a child to a parent component, or between two related/unrelated components. Components can display information and perform action. These components are in three different files - a HTML file for template, a CSS file for styling and a TypeScript file for logic.

There are also some templates that ca be used by users. These templates can be extended in different languages and the users can add their own components.

About the architecture of Angular, is a MVC based framework. This fact is an advantage because Model-View-Controller (MVC) separates data and different business logic, that means that duplication of code is certainly less, saving time to user. Besides that, the modification in one component does not affect the entire model.

About learning Angular, exists in their website several resources about development, education and community. In development resources exists a lot of support about Integrated Development Environments (IDE), data libraries, tooling, User Interface (UI) components and cross-platform development. In education resources, there are a set of books biography, workshops, and online trainings, which users can use, in a way of support their knowledge process. In the other hand, it is available some community curations and podcasts. With that, users can search for a solution to their problems and difficulties.

2.3.1.3 Vue.JS

"Vue.js is used by 0.5% of all websites whose JavaScript library we know. This is 0.4% of all websites" (*Usage Statistics and Market Share of Vue.js for Websites, December 2020*, 2020).

Vue is HTML based template syntax and is considered as a lightweight JavaScript library. "Vue puts more emphasis on the user experience, making it easy to pick up, if user knows the basics: HTML, JavaScript and CSS" (Saks, 2019). One of Vue's purpose is build a single page application but is considered as one limitation to developers and for commercial usage. Similarly to React, VueJS uses DOM as well. However, Vue can determinate which components need to re-render, and apply the necessary number of DOM manipulations to it. On the other hand, and just like Angular, Vue uses directives in its templates.

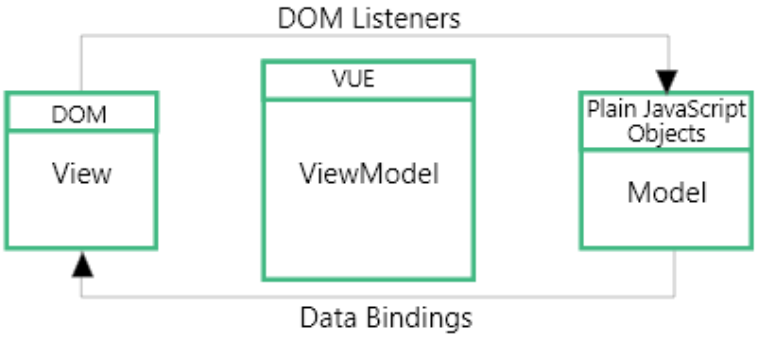

Figure 2.6 - VueJS Structure (based on *Introduction — Vue.js*, no date)

Through Figure 2.6, it is possible to see that Vue is composed by three sections: View, View-Model and Model. In View section, is where the website content is displayed (by DOM), View-Model works as a data interface between View and Model. DOM Listeners, monitors and update the Model section's data and, when this data is updated, DOM Binding will update the content of the website and its appearance.

Similarly Angular and React, VueJS also has a detailed documentation and examples on their homepage for the beginners who want to learn Vue, or to solve some problems. Main concepts are explained too with examples and illustrations.

2.3.1.4 Front-end Technologies Comparison

After the individual analysis made to each of the chosen frontend technologies, it is necessary to create a comparative table, Table 3 – , in order to help in the decision when choosing the most appropriate technology for the project.

This comparison is based on the most relevant factors of the study carried out on each one: structure, architecture, type of writing, and documentation.

In addition, and just as the tools to be developed have to be lightweight (one of the requirements of the customers), through study “JavaScript frameworks: Angular vs React vs Vue” (Saks, 2019), it was also possible to observe the performance of each of the technologies submitted to the same "test", under the same conditions.

Table 3 – React, Angular, and VueJS Comparison (based on ““JavaScript frameworks: Angular vs React vs Vue” (Saks, 2019))

	Structure	Architecture	Written In	Documentation	Performance (Create a table with 10 000 rows)
React	Component based	V	JSX + CSS	Good	2866 milliseconds
Angular	Component based	MVC	HTML + CSS + TS	Good	6361 milliseconds
VueJS	Component based	V - MV - M	JS + HTML + CSS	Good	1447 milliseconds

After analysing the table, it is possible to observe that these 3 technologies have several characteristics in common, with performance being the most differentiating factor. But, probably, that factor will have great weight when deciding on the frontend technology to be used.

Also, accordingly with a study “JavaScript frameworks: Angular vs React vs Vue” (Saks, 2019) was concluded that “For getting a job, React being the most popular one, is probably the best framework to learn. The easiest to learn and the fastest performing is the Vue. Angular is the hardest to learn and the slowest performing framework” (Saks, 2019).

2.3.2 Back-end Technologies

This subsection introduces Node.js and Express.js. The choice of these two technologies is based on the user experience and the top of StateOfJs, regarding the classification of backend. This subsection introduces NodeJs and ExpressJs. The choice of these two technologies is based on the user experience and the top of StateOfJs (*State of JS 2020: Back-end Frameworks*, 2021), regarding the classification of backend frameworks most used in 2020, respectively.

2.3.2.1 Node.js

NodeJS, it is a server-side and event-driven platform based on JavaScript, C and C++ “used for constructing fast and growing network application”, (Chitra and Satapathy, 2017), and it has the possibility of being executed in several environments such macOS, Microsoft, and Linux.

Its goal is to build web applications that are fast and easily scalable, using an event-driver mechanism and non-blocking Input/Output (I/O) operations. On that way, the platform is efficient and lightweight, ideal for applications that run across multiple devices and that contain the need for real-time communication with significant amount of data.

Some of the most important features of node.js, but which may not represent an advantage for the project to be developed, are:

- Contains a single thread, but is highly scalable: Node.js uses a single thread model with event looping and which, through its event mechanism, helps the server to respond in an asynchronous way and makes it highly scalable, unlike traditional servers that create limited threads to respond to incoming requests
- It is a platform aimed at asynchronous events: all APIs that use Node.js are asynchronous, that is, the server does not wait for data to be returned, always proceeding to the next request with the operation of an event and notification mechanism so that all requests made to the API have a response

Due to all these factors, there are many projects and companies that use Node.js in their applications. These include eBay, Microsoft, PayPal, and Uber.

2.3.2.2 Express.js

"Express is a minimal and flexible Node.js web application framework that provides a robust set of features for web and mobile applications" (*Express - Node.js web application framework*, 2017) written in JavaScript. In addition, it is an open-source framework designed to optimize the construction of web applications and API's. Unlike Node.js, "Express.js does not know how to handle async/await"(*Express - Node.js web application framework*, 2017).

One of the most desirable features of express.js is that simplifies building APIs and has a lot of features when comparing with any other back-end technology.

2.3.2.3 Back-end Comparison

Although Express.js is based on node.js, it was possible to see, through the individual analysis done in section 1 and section 2, that there are several differences between them.

Thus, it was possible to create Table 4, to gather the main characteristics to be analysed later in section 5.1, in order to make a better choice when choosing the backend technology for the development of the solution.

Table 4 - Back-end comparison

	Node.js	Express.js
Written in	C, C++, JavaScript	JavaScript
Usage	Used to build server-side and event-driven apps	Used to build web-apps

	Node.js	Express.js
Coding Time	More time	Less time
Author experience	Yes	No

The main differences between these two technologies remain in the purpose of usage of each one, and in time of development. While node.js is used to build more complex apps, supporting event-driven, and consequently taking more time to the developer, express.js can be more useful when the purpose is building a web app, developing it quicker.

Now that both the front-end and back-end technologies have been analysed, an analysis follows of the technologies that concern the content management systems.

2.3.3 Content Management Systems

Here, it is presented a general idea about what is a content management system (CMS) and its main goals. Besides that, some of the most popular content management systems are presented and compared with each other.

With the research about CMS, it was verified that exist two sub-types of CMS: Headless CMS and decoupled CMS.

In the end, a comparison is made (Table 6) between a traditional CMS, headless CMS, and decoupled CMS, to see what their similarities and differences are.

2.3.3.1 Traditional CMS

Content Management Systems (CMS) "supports the creation, management, distribution, publishing, and discovery of corporate information", providing "the ability to manage the structure of the site, the appearance of the published pages, and the navigation provided to the users" (Shaikh and Fegade, 2012), or in other words, manage dynamic content of a website in the easiest way without the need of building or developing a website from scratch.

At a technical level, a CMS can be divided into two components:

- Content Management Application (CMA): content management of website – Create, Read, Update, and Delete functionalities, through *"What You See Is What You Get"* (WYSIWYG[2])
- Content Delivery Application (CDA): it is the backend. This, takes the content from CMA, stores it, and make it visible for the visitors

[2] "editor or program that allows a developer to see what the end result will look like when the interface or document is being created"(*What is WYSIWYG (what you see is what you get)? - Definition from WhatIs.com*, 2011)

With CMS, it is possible build static websites, blogs, eCommerce stores, social networks, portfolios, membership sites and online courses. This is possible because all content has an efficient way of managing data, and usually have a good performance.

About the strengths and weaknesses of using CMS:

- Strengths:
  - Easy to use: a dashboard is included with a simple interface and an editor. The editor, has an automatic render, which allows the user to see all changes that has been made
  - User Friendly: there are a lot of available templates
  - Multi-User: allows different users with different permissions
  - Advanced Settings: functionalities can be added through plugins and extensions
  - Big Community
  - Improves the user experience (UX)
  - Good search engine optimization (SEO): Offer add-ons to help the optimization of the site for search engines
  - WYSIWYG: Content editor with any knowledge of code
- Weaknesses:
  - Webpages oriented frameworks: the content cannot adapt to digital platforms
  - Everything is on the same bucket: impossible to reuse the content (images, html, and CSS)

Considering the number and information of advantages and disadvantages presented above, it is possible to say that "this modern approach offers users with a poor IT background the opportunity to be independent and creative in creating their own website" (Dejan Viduka, Vladimir Kraguljac, and Igor Lavrnic, 2019).

There are about a thousand of CMS. According to W3Techs website (W3Techs, 2020), in Figure 2.7, the most popular CMSs in 2020 were: WordPress, Joomla and Drupal. In the end, is presented a comparison table (Table 5 - CMS Comparison, where the most important aspects are compared between each CMS.

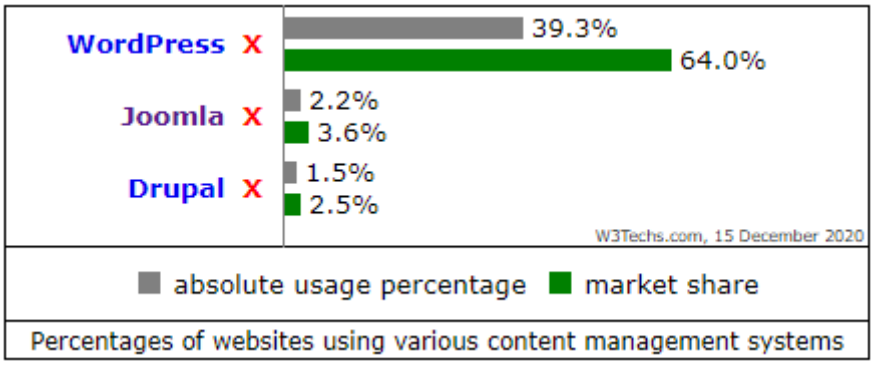

Figure 2.7 - Comparison of the usage statistics of WordPress vs. Joomla vs. Drupal for websites (W3Techs, 2020)

Through Figure 2.7, it can be seen that:

- WordPress is used by 39.3% of all websites, that is a content management system market share of 64.0%
- Joomla is used by 2.2% of all websites, that is a content management system market share of 3.6%
- Drupal is used by 1.5% of all websites, that is a content management system market share of 2.5%

2.3.3.2 WordPress

"WordPress is a software designed for everyone, emphasizing accessibility, performance, security and ease of use" ('Democratize Publishing', 2018). WordPress was designed to respond to the exponential growth of blogs. There are several available templates and plug-ins to add new functionalities, and it is built in PHP and MySQL.

Despite the general features previously referred, WordPress has its own specific features:

- User management: supports users with different roles, giving them access to different permissions as well
- Media management: image editing tools
- Languages: are available more than 70 languages
- Plugin System: it is possible to create new plugins
- Template System: it is possible to create new templates
- Custom Content Types: it is possible custom the platform through coding
- Application framework: to build their own application, WordPress provides translations, users management, http request, databases and it is possible to the user to use their own APIs

However, despite all these features, advantages and its popularity, WordPress has been a target to cyber-attacks, requiring greater vigilance and constant maintenance.

2.3.3.3 Joomla

Used by 2.2% of all websites, "Joomla offers a great opportunity to grow your business building websites and applications" (Decoux, 2020). Just like WordPress, Joomla allows having several users with different roles and different access permissions. Besides that, can be used for corporates websites, intranets, and extranets. It is also built on PHP and MySQL on a model-view-controller web application framework, and has some tools to create articles, banners, and contact forms.

About its specific features:

- Access Control List (ACL): the access for each user role or groups, can be defined
- Templates: possibility to the user to create their own template
- Responsive: uses bootstrap for responsive designs
- Language: are available more than 70 languages
- Categories: it is possible to create categories with nesting and no limits of depth

There are also, features specifically for developers with an extended developer documentation, as:

- Inventory control systems
- Data reporting tools
- Custom product catalogue
- Integrated e-commerce systems
- Communication tools

With a codebase designed to be robust, Joomla has the two-factor authentication and an extensive access control level. There is an experienced team of users and developers that are always tracking new bugs and fixing security issues.

2.3.3.4 Drupal

"Drupal is a powerful framework that has inspired a new generation of digital experiences" (*Drupal for Developers*, 2018), initially developed as a platform to create social networks and nowadays used by 1.5% of all websites.

In contrast to the others CMS, Drupal requires a certain level of knowledge about technical skills, otherwise it is not possible to make the most of its potential. It is also built in PHP but has

more options about the database. It can be used MySQL (just like the others), MariaDB[3], PostgreSQL [4]or phpMyAdmin.

PhpMyAdmin is a free software tool written in PHP and supports a wide range of operations with MySQL and MariaDB and has a large documentation (contributors, no date). About its features, the most relevant is that supports for most SQL features, import data from CSV and SQL, export data to several formats like CSV, SQL, XML and PDF and creates graphics of the database layout in various formats too.

Drupal integrates its system with Symfony. "Symfony is a set of reusable PHP components, and a PHP framework for web projects" (*Symfony, High Performance PHP Framework for Web Development*, no date)

As well as the other technologies, Drupal has available a user guide for developers and has its own features:

- It is multilingual: automated language translation
- Marketing Automation: target the right audience
- Security: is resilient against critical internet vulnerabilities, and so, has strong coding standards and a strict community code review process
- Content as a Service: Decouple the frontend and backend to scale content across silos

2.3.3.5 CMS Comparison

After an individual analysis of each of the traditional CMS alternatives, it makes sense that a comparison is made between them (Table 5). This comparison serves mainly to understand what brings together and separates these CMS in terms of technologies and databases. The choice of these two categories was based on the need to understand whether there would be any additional research to be done at this stage.

In addition, it is also important that the implementation of the back office is secure, thus, security is one of the categories to be compared.

[3] One of the most popular open-source relational databases, made by the original developers of MySQL (*MariaDB Foundation*, no date). The main difference between those two databases is the MariaDB supports many different storage mechanisms and might offer better performance (*Open Source Database (RDBMS) for the Enterprise*, no date).

[4] PostgreSQL is a powerful, open-source object-relational database system, that has earned it a strong reputation for reliability, feature robustness, and performance (Group, 2021).

Table 5 - CMS Comparison

	Technologies	Database	Is it secure?	Open Source	Learning Level
WordPress	PHP	MySQL	No	Yes	Easy
Joomla	PHP	MySQL	Yes	Yes	Easy
Drupal	PHP	MySQL; MariaDB; PostgreSQL; phpMyAdmin	Yes	Yes	Medium

With this table, in short, it is possible to notice that all 3 CMS's use the same technology and have a common database. To decide which one it is the best CMS, it will depend on what the client wants to do, and what's the project's purpose.

2.3.4 Headless CMS

"Although CMS enable nontechnical users to make changes on their website but still require technical skills when adding new features and maintained […]. Furthermore, a little change in the server may cause the entire CMS fail or error" (Hoong and Ameeden, 2015).

As the years passed, websites became more complex, and content was no longer only displayed into a web browser. Information passed from web browsers directly to smart TVs, tablets, phones, and watches. To address this need, headless CMS offerings have gained popularity in the market. By "offerings" means more flexibility and scalability, when compared to the traditional CMS.

Table 6 - Traditional CMS vs Headless CMS

	What provides?	Content Model	Supported Devices	Content Display
Traditional CMS	Repository for the content; UI for editing; theme/app	Built only for a single page	Limited	Ways to display data
Headless CMS	Store content; admin dashboard; No presentation layer	Built for many products	Limitless	An API to the data

Flexibility is possible because the presentation layer is separated from the content repository body. Through an API, the content repository is connected to a separate presentation layer, allowing to send the content without the presentation layer. That permits to choose an appropriated interface to the digital platform, however, does not solves the content structure issue to reuse information between different platforms.

To achieve and solve the issue previously referred, a decouple CMS might be the answer. As Deane Barker said, "a decouple CMS is proactive – it prepares content for presentation and pushes it into a delivery environment. A headless CMS is reactive – it manages content, then just sits and waits for some process to ask for it" (Sam Saltis, 2018).

In addition, a decouple CMS is developed to respond to the needs of each project. Developers and users do not need to be attached to the templates provided by the traditional CMS.

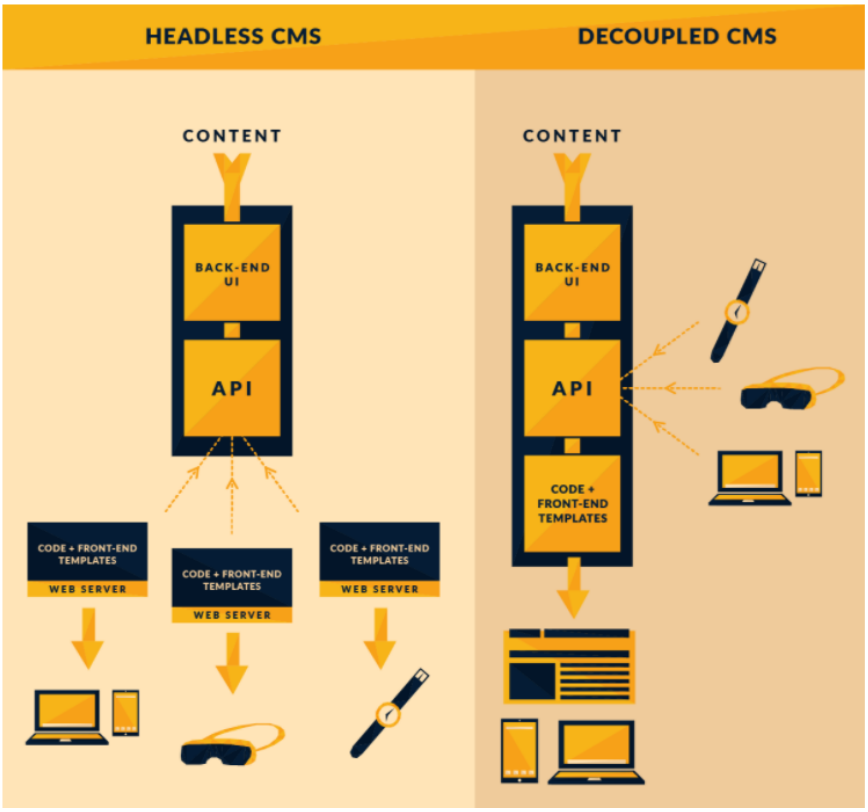

Figure 2.8 - Headless CMS vs Decoupled CMS (Sam Saltis, 2020)

In summary:

- A headless CMS responds to API calls to retrieve the content to each channel. Does not have a frontend system, which means content management tools are integrated via API

- In a decoupled CMS, the frontend and backend communicate to each other through calls to an API. “WordPress and Drupal are examples of traditional CMS that are using a decoupled version of their CMS. They are providing extensions and plugins that decuples them from their frontends” (Contentstack, no date).

The next section (2.3.4.1), presents an example of a headless CMS, as well as its main features, in order to support the analysis previously made about traditional CMS and headless CMS.

2.3.4.1 Strapi

Organizations like NASA uses Strapi as a support base for their website. “Strapi is the leading open-source headless CMS. It’s 100% JavaScript, fully customizable and developer first”(*Strapi - Open source Node.js Headless CMS* 🚀, no date).

It is an automation tool, which aims to speed up the development and backend management, through the construction of robust APIs. It also provides a very advanced administrative management panel, where through a click, an administrator can insert different information on its platform, decide what to make public/private, and manage users who have access to its panel, as well as the levels of permission.

Strapi has huge documentation and tutorials for beginners. In addition, it is possible to integrate Strapi with multiple frameworks, fronted or backend programming languages such as React, Python, Angular, VueJS, Ruby, and others.

2.3.5 Databases

Giving a small and general context about databases, there are two main databases types: relational and non-relational (Chickerur, Goudar and Kinnerkar, 2015).

A relational database has the data organized in tables, and each table can stablish a relationship with other(s) table(s) (Patil *et al.*, 2017a). On the other hand, a non-relational database is less structured, but allows more flexibility and adaptability. Besides that, has all the information stored in a single construct, or document, where the data is listed (Patil *et al.*, 2017a).

Looking again at Table 5 - CMS Comparison, it is possible to see that the common database to all the studied CMSs is MySQL. For that reason, this database will be one of the databases to be studied in this subchapter.

2.3.5.1 MySQL

Accordingly, with EverSQL (Figure 2.9), DB/Engines (Figure 2.10) and C#Corner (Figure 2.11), MySQL is between the first and second place in the most popular databases in 2020.

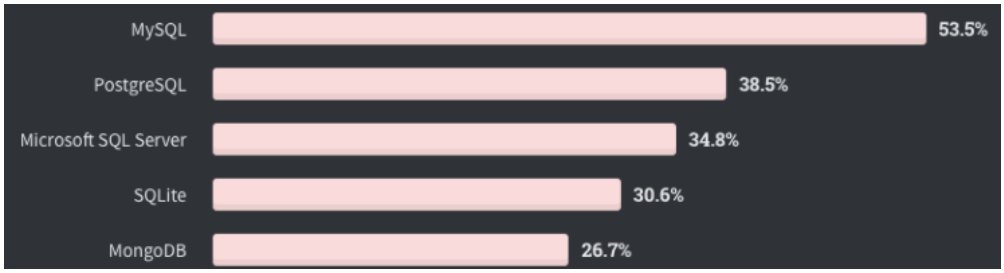

Figure 2.9 - Most popular databases in 2020 (Oded Valin, 2020)

Rank			DBMS
Dec 2020	Nov 2020	Dec 2019	
1.	1.	1.	Oracle
2.	2.	2.	MySQL
3.	3.	3.	Microsoft SQL Server
4.	4.	4.	PostgreSQL
5.	5.	5.	MongoDB

Figure 2.10 - DB-Engines Ranking 2020 (DB-Engines Ranking, 2020)

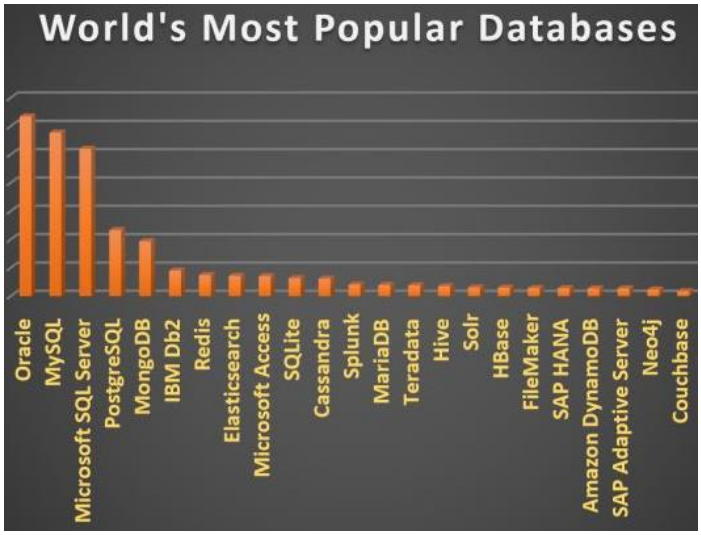

Figure 2.11 - Most popular databases in the world (Mahesh Chand, 2019)

MySQL has some of the largest and fastest-growing organizations as costumers – YouTube, LinkedIn, Facebook, Twitter, Netflix, GitHub and so on. Its main purpose is to create, modify,

extract data and control user access to the database. “In many ways, MySQL offers a best-of-all worlds scenario: It runs on many platforms, enjoys a low TCO, and is stable” (Suehring, 2002).

This RDBMS [5]is also used by many database-driven web applications, like Drupal, Joomla and WordPress already studied in this chapter.

MySQL security has three main areas of concern: the host server, the software itself and user accounts. These categories are equally important because securing all is necessary to protect the database. To keep MySQL secure, there are some aspects that should be done as: the software should be updated, the server should be run as non-privileged user, firewalling the server and the access that each user has should be carefully determinate.

2.3.5.2 MongoDB

MongoDB, is the non-relational database studied in this report because, looking over again to Figure 2.9, Figure 2.10, and Figure 2.11, is the first non-relational database showing up.

“MongoDB is a document database, which mean it stores data in JSON-like documents” (*mongoDB*, 2021). Besides that, has a powerful query language where queries are JSON themselves, helping us to make the filtration of information, easier.

On the other hand, as mongoDB stores the data in a very flexible way, it is possible to change the data structure anytime, and the attribute fields can vary from document to document.

MongoDb considers that its biggest advantages, when comparing to other type of database, are:

- High availability through built-in replication and failover
- Horizontal scalability with native sharding[6]
- Ent-to-end security
- Native document validation and schema exploration with Compass
- Management tooling for automation, monitoring, and backup
- Fully elastic database as a service with built-in best practices

2.3.5.3 Databases Comparison

This comparison was done based on the previous analysis for each one of the databases and in 2 studies, where their main goals was to compare some features of MySQL and MongoDB in order to understand which one is the better one.

In Palanisamy and suvitha Vani (Palanisamy and SuvithaVani, 2020) study, the focus was to compare these two databases analysing several properties, types, differences, limitations, and query processing.

[5] Relational Database Management System

[6] “Sharding is a method for distributing data across multiple machines. MongoDB uses sharding to support deployments with very large data sets and high throughput operation” (*Sharding — MongoDB Manual*, no date)

On the other side, Patil and Hanni ((Patil *et al.*, 2017b) analysed the performance of MongoDB and MySQL in the same conditions, testing the same properties: Windows server 2008 R2, 64bit version, 4GB of RAM, 45GB of space on disk, running on a x64 processor.

In the following table (Table 7 - MySQL vs MongoDB), it was gathered the most relevant conclusions taken in both of studies:

Table 7 - MySQL vs MongoDB

	MySQL	MongoDB
Storage	Static - it is necessary to restructure the entire table or database if any change comes up	Very flexible storage - it is possible to change data structure very easily
Query Processing	Queries are processed simultaneously (in parallel) - sometimes this process can crash	Queries are processed one by one
Performance	0.0511sec to insert 10 records 0.0698sec to insert 50 records	0.005sec to insert 10 records 0.01sec to insert 50 record
Security	Has some concerns in the host server, the software and user accounts	End-to-end security
Main Limitation	Scaling has to be done on incredible servers that are costly and hard to deal with.	Unlike relational databases, do not have any graphical interface tool to communicate with databases

In conclusion it is possible to say that if the data is very structured, then a relational database might be a better option. On the other side, if data does not have a specific structure or night have a potential for rapid growth, then NoSQL will be a better choice.

2.3.6 Summary

In this chapter, several works related to the theme of the thesis were presented and analysed, realizing the main differences and similarities between them. Technologies that could prove useful for the development of the solution were also presented, ending each study with a comparison.

In terms of technology, were studied front-end technologies (addressing angular, react, and vueJs), back-end technologies (node.js and express.js), traditional CMS and headless CMS, comparing them both, and finally, an analysis of databases.

This analysis essentially serves so that the choice of each of the technologies is the right one. All choices made, as well as their explanation, will be presented in chapter 5.

In the next chapter, is made a value analysis of the problem, analysing the opportunity of this project, to find out if it is an asset from the customer's perspective.

3 Value Analysis

Value Analysis, also known as Value Engineering, is “an organized approach to improving the profitability of product applications and it utilizes many different techniques in order to achieve this objective”(Rich and Holweg, 2000) (Figure 3.1 - Value Engineering Process).

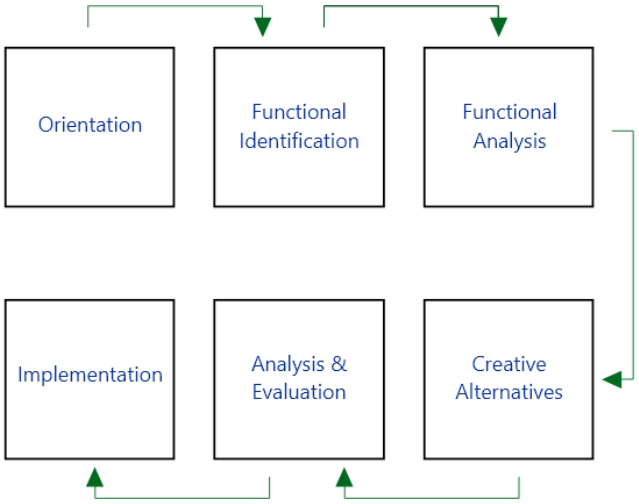

Figure 3.1 - Value Engineering Process

This process begins in the orientation phase, where the product/service to be analysed must be chosen, and a team structured for its development. This chapter will not refer to that phase, once the product/service to be analysed has already been defined for this thesis project as well as the team structure.

Both the identification and the functional analysis, as well as the creation of alternatives and their evaluation, will be analysed under the “New Concept Development” model (section 3.1). External analyses will be made to understand how the market is (studying potential competitors, through a SWOT analysis), as well as internal analyses to know how the current product can be improved. Subsequently, through these analyses, several alternatives are created, where each one will be evaluated (under a decision support method, known as AHP method) to understand if they will be an asset for both the customer and the company.

After evaluating the alternatives, and deciding what will be implemented, it is time to move on to the implementation phase. This phase will only be analysed in chapter 7.

3.1 The New Concept Development Model

Accordingly, with Peter’s Koen “New Concept Development “model (Figure 3.2), it is possible to identify three different sections with different goals, but together, they complete each other.

- The engine – a controllable section that includes the vision, mission, culture and a process of strategies and innovation, representing a business strategy
- The core frontend – includes all the activities that are necessary for the innovation process
- The influencing factors – an uncontrollable section, representing all off external factors like customers, competitor's business, and economic climate

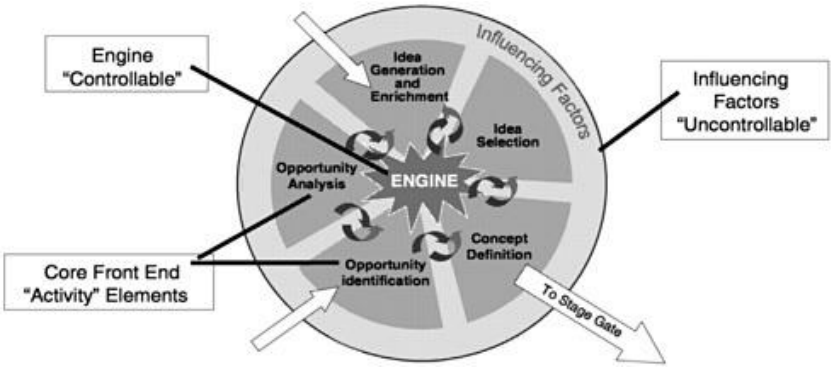

Figure 3.2 - New Concept Development Model (Koen, Bertels and Kleinschmidt, 2014)

The activity elements referred at the core frontend, are composed by 5 fundamental activities in a project lifecycle: opportunity identification, opportunity analysis, idea generation and enrichment, idea selection and the final step, concept definition. Also, that two incoming arrows, means that a project can start at the “opportunity identification” stadium or at the “idea generation and enrichment”.

3.1.1 Opportunity Identification

Opportunities can appear in several ways, for example, the existence of a product can mean an opportunity, as well as the implementation of new features in existing products/services.

For this project, it is possible to say that is started in the “opportunity identification” step. The main idea was already structured, but 5 years later, all stakeholders involved, saw an opportunity to grow and improve the concept of the project, because an exponential growth of websites with the same purpose came up: Implement new features and techniques in the education process through the visualization of cinematographic content, which on the one hand motivates students and, on the other hand, facilitates their learning process.

In section 2.2, an analysis was made of all existing competitors in the same area as this project. At the end of each individual analysis, a comparison table (Table 2) was created to have a better overview of the functionalities of each competitor. At the end of this analyse, two questions came up: “Why are we going to improve this product/service? How can we stand out from the main current competitors?”

UNICEF argues that “lack of trained teachers, inadequate learning materials make learning difficult for many children”(*Education | UNICEF*, no date), what’s more “pupil’s ethnic background is strongly connected to their chances to becoming excluded”(‘Key Learning Exclusion Literature Review’, no date). “Approximately 14% of young people disengaged to some degree in Year 10 when they start to face Key Stage 4 examination demands and for all types of disengaged young people disengagement worsened over time”.(" Young People At-risk of Drop-out from Education: Recognising and Responding to their Needs, by Oxford University", Stamou *et al.*, 2014)

Thus, this project appears with the intention of breaking or reducing the flow of school dropouts in order to motivate all young students (from 6 to 18 years old) to continue their educational process and to integrate or reintegrate students who may feel excluded from the community through the development of new and innovative technological tools. Thus, having knowledge of the competitors' offers, it is possible to create new ideas so that the project stands out from the other competitors.

But an opportunity may not represent any added value to the company or organization and, therefore, it is necessary to carry out an analysis and make some conclusions about it.

3.1.2 Opportunity Analysis

The purpose of analysing the opportunity is to identify the strengths and weaknesses of the opportunity and make conclusions regarding the value it adds to the product.

As the focus of this project is the development of new tools and include fragile communities in society, an analysis was made in order to understand what needs to be improved:

- Website design is not attractive
- All content is left aligned
- Wrong links
- User guide available only in French
- Too long and confusing texts
- Repeated content in several sections
- Teaching materials available in only a few languages
- Images download is not working properly
- Does not exist any type of features that include fragile communities
- Pedagogical Materials for students are only available in PDF format (if the student do not have a printer in home, or do not have access to it, they cannot do the exercises)

But not everything is bad, of course. CinEd, has a very strong unfair advantage when compared with other competitors already in market. “A real unfair advantage is something that cannot be easily copied or bought by your competitors” (Ash Maurya, 2021). In other words, an unfair advantage is something that a product/project has, but none of its competitors have, and cannot have as much as they try. Some of the best examples of unfair advantage are: Insider information, large networks effects or SEO ranking.

In CinEd’s project, the unfair advantage is that the project is supported by several partners across all Europe. In addiction, and since the project has been in market for 5 years, there is already an existing customer community. And, with the concept of “Unfair Advantage”, comes another concept: Value Proposition. In order to be able to create an adequate and correct value proposal, it is necessary to first know what advantages and disadvantages the current project has on the market and analyse how we can improve the project, adapting it to the target audience.

There are several tools that help look over to the analysis of an opportunity, namely the SWOT analysis. This type of analyze, can be divided into four parts:

- Strengths – characteristics that represent an advantage over the competition
- Weaknesses – characteristics that disadvantage the product/service in relation to the competition
- Opportunities – whenever an external factor creates a favorable scenario to the product/service
- Threats – all circumstances that create an unfavorable environment for the product/service (and which the company has no control)

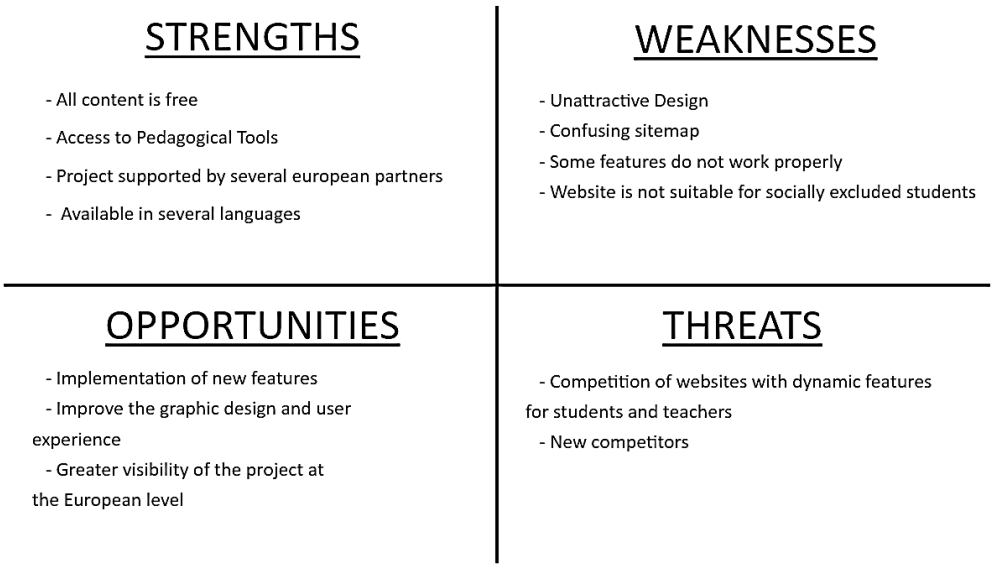

Figure 3.3 - SWOT Analysis

Based on Figure 3.3 - SWOT Analysis, Figure 3.3 and the analysis in section 2.1.112.1, it was noticed that one of CinEd's strengths is having all its free content - from films to teaching materials. However, also in section 2.1.11 , an analysis was made of the current CinEd website, and it was noticed that there is space for improvement at many levels - from graphic design to usability by a user or functionalities with malfunction. The declared opportunities are, in fact, an opportunity for the website to grow at all levels, especially those mentioned in the weaknesses, to prevent possible threats.

3.1.3 Ideas Generation

Through the previous analysis, it was necessary to generate solutions that can solve the identified problems, simplify the functions of all the partners involved and that increase the product's competitiveness in the market.

Thus, a search was made for possible solutions that would fulfil the points identified in the opportunities, such as:

- New design in the current platform
- Turn all the pedagogical materials into interactive materials: For now, all teaching materials are in PDF format. Thus, it is necessary to transform these materials into interactive, online and dynamic materials
- Option to create user accounts so that students can share content with each others
- Implementation of a content editor

3.1.4 Idea Selection

Analytic Hierarch Process (AHP) is one of the Multi Criteria Decision Making (MCDM) methods. "Is an approach to decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion and determining an overall ranking of the alternatives"(Supraja and Kousalya, 2016).

As this project works directly with 10 more partners, with MOG being the only technological partner, it is not up to the company to decide what should be implemented or not. Thus, the AHP method will not be applied in order to decide which solutions should be implemented, but in order to prioritize the functionalities, from the most important to the least important, within the ideas generated in 3.1.3.

3.1.4.1 Phase1: Construction of the hierarchical decision tree

"Since AHP is a hierarchical model, it develops a hierarchical structure between objective, criteria, and alternatives" (Supraja and Kousalya, 2016).

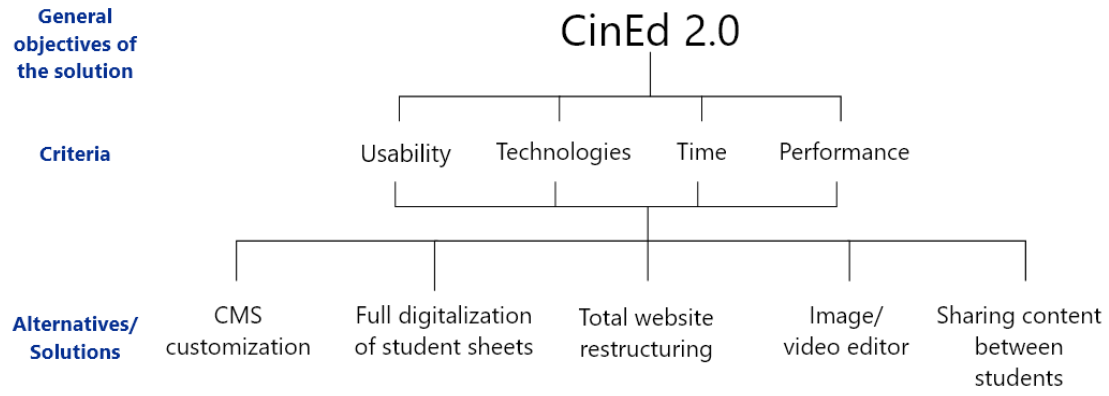

Figure 3.4 - AHP: Analytic hierarchy process, phase 1

In Figure 3.4, the hierarchy tree was built in order to divide the decision problem into hierarchical levels, thus facilitating its understanding and evaluation.

After analysing the problem, it was decided that usability, technologies, time, and performance would be the key criteria in prioritizing the various features requested by the partners.

3.1.4.2 Phase2: Hierarchy elements comparison

At this stage, it is necessary to establish a set of priorities among the various elements at each level, through a comparison matrix (Figure 3.6).

The values to be considered for each criterion are based on the Fundamental Scale (Figure 3.5).

Intensity of importance	Definition	Explanation
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 strong favored and its dominance is demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is need

Figure 3.5 - Fundamental Scale by Saaty (1991)

Based on the values of - Fundamental Scale by Saaty (1991), a comparison matrix (Figure 3.6) was created between the various criteria previously defined.

	Usability	Technologies	Time	Performance
Usability	1	3	2	1
Technologies	1/3	1	1/2	1/3
Time	1/2	2	1	1/3
Performance	1	3	3	1

Figure 3.6 - Comparison matrix

The - Comparison matrix shows that usability and performance are comparable, that is, both criteria have the same importance value at the hierarchical level. Besides that, usability and performance also have the highest importance values, compared to the other criteria.

3.1.4.3 Relative priority

At this stage, the priority vector, or proper vector, is determined. This vector determinates the place that each criterion occupies. This value is calculated in 2 steps:

- Combine the criteria with the same unit - each element of the matrix is divided by the total sum of its respective column
- Calculate the arithmetic average of the values for each row of the normalized matrix

The result was the following:

Usability	6/17	1/3	4/13	3/8	0.3422
Technologies	2/17	1/9	1/13	1/8	0.1077
Time	3/17	2/9	2/13	1/8	0.1694
Performance	6/17	1/3	6/13	3/8	0.3807

Figure 3.7 - Priority vector

Thus, it can be concluded that the criterion "Performance" appears first, followed by "Usability" occupying the second place. This result, from the perspective of the project's objective, makes perfect sense since the website and all its functionalities must have a good performance (since the website can be used by young people with weak connections to the Wi-Fi network) and good usability (since the features will be used mostly by children (6 to 18 years old), from different parts of Europe).

3.1.4.4 Relative priorities consistency

The next step is to calculate the Consistency Ratio (CR), in order to verify if the attributed values to each criterion, were the most suitable.

This step focuses on 4 steps:

- Calculate the weight vector
- Calculate the maximum λ
- Calculate the consistency index (CI)
- Calculate the consistency ratio (CR)

$$\begin{bmatrix} 1 & 3 & 2 & 1 \\ 1/3 & 1 & 1/2 & 1/3 \\ 1/2 & 2 & 1 & 1/3 \\ 1 & 3 & 3 & 1 \end{bmatrix} \begin{bmatrix} 0.34 \\ 0.11 \\ 0.17 \\ 0.38 \end{bmatrix} \approx \begin{bmatrix} 1.39 \\ 0.43 \\ 0.69 \\ 1.56 \end{bmatrix}$$

Figure 3.8 - Weight vector calculation

In Figure 3.8, it is possible to see the result of the weight vector, resulting from the multiplication of the priority comparison matrix with the relative priority vector.

To calculate the λ max, it must be done the average division of the weight vector, with the vector of relative priorities:

$$\lambda \text{ max} = \frac{1.39 + 0.43 + 0.69 + 1.56}{4} = 4.04$$

Figure 3.9 - λmax calculation

λmax, represents the biggest priority value of the priority comparison matrix. Thus, it is necessary to calculate the CI:

$$CI = \frac{\lambda \text{ max} - n}{n - 1} = \frac{4.04 - 4}{4 - 1} = 0.0133$$

Figure 3.10 - CI calculation

Now, to calculate the CR, it is necessary to divide CI by the Random Consistency Index (RI). This Random Consistency Index, is the number of pairwise comparisons made:

Table 8 - Random Consistency Index table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

As 4 comparisons are being made (usability, technologies, time, and performance), the CI is 0.90.

$$CR = \frac{CI}{RI} = \frac{0.0133}{0.90} = 0.01$$

Figure 3.11 - CR calculation

The result of the consistency ratio must always be less than 0.1 (or less than 10%), this means that the adjustment is small compared to the current values attributed to each comparison. The higher its value, the greater is the distance of comparison between criteria.

In this case, the result obtained was 0.01, which means that the values of the relative priorities are consistent.

3.1.4.5 Comparison matrix for each alternative/solution

Following the same thinking as in the previous steps (sections 3.1.4.2 and 3.1.4.3), was calculated the priority vector for each alternative/solution, accordingly to each criteria:

- A: CMS customization
- B: Full digitalization of student sheets

- C: Total website restructuring
- D: Image/video editor
- E: Content sharing between students

Thus, Figure 3.12 represents the comparison matrix between the five alternatives, according to the usability criteria:

	A	B	C	D	E	
A	1	1/3	1/2	1	1/2	0.12
B	3	1	2	1	2	0.30
C	2	1/3	1	1/2	2	0.17
D	1	1	2	1	3	0.27
E	2	1/2	1/2	1/3	1	0.13

Figure 3.12 - Usability comparison matrix

Figure 3.13 represents the comparison matrix in relation to the technology criteria:

	A	B	C	D	E	
A	1	1/2	1/3	1/2	2	0.13
B	2	1	1	1	2	0.24
C	3	1	1	2	2	0.31
D	2	1	1/2	1	2	0.21
E	1/2	1/2	1/2	1/2	1	0.11

Figure 3.13 - Technologies comparison matrix

Figure 3.14 represents the comparison matrix in relation to the time of development criteria:

	A	B	C	D	E	
A	1	1	3	1	4	0.29
B	1	1	2	1	3	0.25
C	1/3	1/2	1	1/2	2	0.13
D	1	1	2	1	3	0.25
E	1/4	1/3	1/2	1/3	1	0.08

Figure 3.14 - Time comparison matrix

Figure 3.15 represents the comparison matrix in relation to the performance criteria:

	A	B	C	D	E	
A	1	1/3	1/3	1/3	1/2	0.08
B	3	1	1	1	2	0.26
C	3	1	1	1	2	0.26
D	3	1	1	1	2	0.26
E	2	1/2	1/2	1/2	1	0.14

Figure 3.15 - Performance comparison matrix

Considering the result of the criteria priority vector, and all other vectors calculated for each individual criterion:

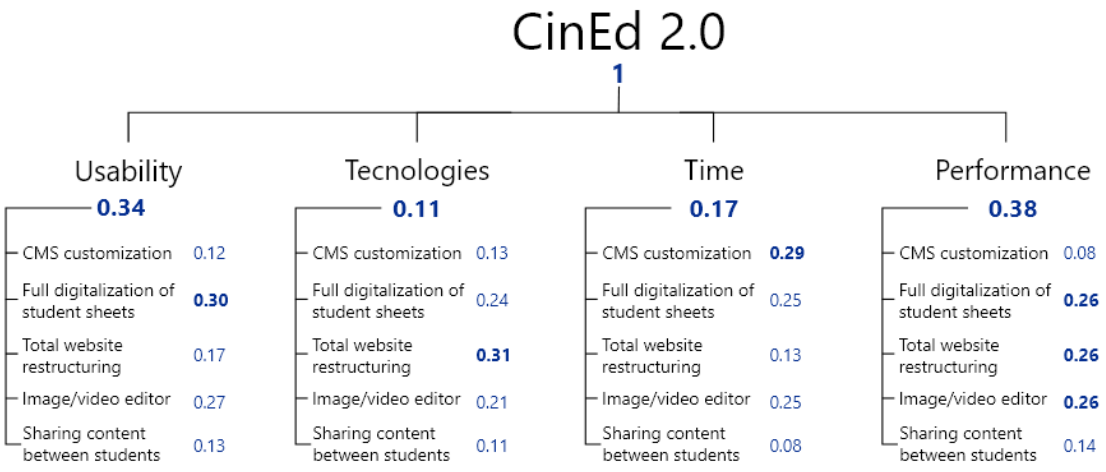

Figure 3.16 - Parity comparison matrix for each criterion

Figure 3.16, shows the relative importance of each of the alternatives/solutions.

In conclusion:

- Full digitalization of student sheets, is considered the most important feature in terms of usability
- The website restructure, has the biggest importance in terms of the technologies used
- In terms of development time, customization of the CMS is what will take the longest
- The digitization of student sheets, as well as the website and the image/video editor, are equally important in terms of performance

3.1.4.6 Composite priority and solution prioritization

In this last stage, the composite priorities are obtained, in order to prioritize solutions according to the criteria.

To do so, simply multiply the values of each priority vector for each criterion (Figure 3.12, Figure 3.13, Figure 3.14, and Figure 3.15), and those of relative priorities, obtained at the beginning of the method.

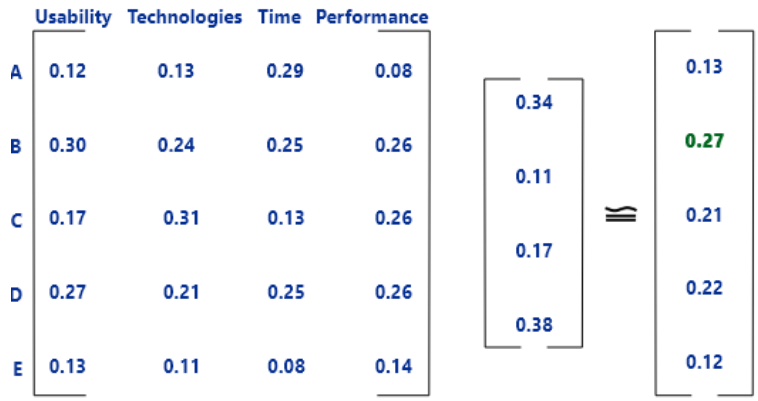

Figure 3.17 - Prioritizing solutions

Thus, it is possible to conclude that the most relevant solution for this project is the digitization of student sheets, presenting a weight of 27%. This is followed by the video/image editor (22%) and the restructuring of the website (21%), with very similar weights.

Finally, the customization of a content management system (13%) as well as the sharing of content between students (12%) have the lowest values.

As stated at the beginning of this chapter, all the solutions presented will have to be implemented, since they were required by the partners, however, the AHP method is an asset to decide the degree of importance and weight that each solution has for this project.

3.2 Value Proposition

The value proposition, “defines the specific strategy to compete for new customers” (Susana Nicola, Eduarda Pinto Ferreira, and J. J. Pinto Ferreira, 2015). In other words, it consists of defining what the product is, who is the target customer and if is unique, and why.

Within the scope of the project, the value proposition consists of a new website with online student sheets and an editor of images/video, and the customization of a content management systems for the partners. This new solution offers more usability to its users compared to other websites analysed on **Error! Reference source not found.**. Besides that, will not only add some n ew functionalities (such as online student sheets), but also the usability with a new editor, allowing the users to create small presentations/videos in a simple and funny way.

For these reasons, a value proposition was made for this project:

- As much of the European youth community still have little access to education, all partners associated with “CinEd - European Cinema Education for youth” project, saw the need to make it more accessible and dynamic. Through the development of a young space, containing social inclusion activities, supporting the learning process and personal development, these new features should stimulate exchange between the various beneficiaries of CinEd (namely students and teachers), as well as film literacy between the younger European public.

For	All European students, and specially those who are unable to access education, or feel socially excluded
Who	Need support in their educational process and personal growth
The	New CinEd website
Is	A socio-cultural and educational support platform
That	Which allow quick and fun access to educational content and a wide collection of films
Unlike	Many other websites
Our	Contains activities of different formats, is totally fee and accessible fom any device and, promotes film literacy among the younger audience

Figure 3.18 - Elevator Pitch

On the other hand, an elevator pitch (Figure 3.18) can be an alternative to the “Product proposition”, and a useful solution to provide an easier way of comprehension of what the service/product can provide.

3.3 Quality Function Deployment Method

“Quality Function Deployment (QFD) is a quality tool that helps to translate the Voice of the Customer (VoC) into new products that truly satisfy their needs” (Jaiswal, 2012).

The QFD process is performed through matrices that follow the needs of customers and the technical requirements related to it. Its result has the shape of a house, known as “House of Quality”. In this process, the customer's requirements (“WHAT the customer want?”)) are converted into engineering quality attributes (“HOW are we going to do it?”).

The construction of the “House of Quality” follows the following steps:

1. Identification of the main customer needs (WHATs). As the list of requirements is quite large, only the general requirements are presented:
    a. Online Student Sheets
    b. Creation of a content editor
    c. An attractive website
    d. Backoffice for partners
    e. Shareable Student Sheets

2. Determination of the importance/weight of each need, in a scale from 1 to 5

3. Elicitation of performance measures or design requirements (HOWs)
    a. User-friendly interface: the entire user interface must be attractive
    b. Good usability: the entire user interface must be simple and intuitive to use
    c. Compatible with multiple browsers: must be accessible to various types of browsers and platforms (tablet, computer)
    d. Audio-visual content processing: image and sound processing, where the result should be a video
    e. Gamification: keeping students motivated while making their tokens, through rewards
    f. Interactivity: the entire interface must have an interactive component
    g. Internationalization: the entire interface must be available in several languages since it is a European project

4. Identification of competitors and carrying out a comparative analysis between them. The choice of these two competitors was based in Table 2 - Existing Competitors Comparison, once they seem to be the most complete websites
    a. Teach with Movies and Into Film

5. Determination of the relationship between HOWs and WHATs, that is, how each performance measure affects a certain need
    ◎ Strongly Related - 9
    ○Medium Related - 3
    △Weakly Related - 1

6. Determination of the relationship between different performance measures
    ◎Strong Positive Relationship
    ○ Positive Relationship
    ×Strong Negative Relationship
    ✳Negative Relationship

7. Calculation of the importance of weighting, of each performance measures

Based on these customer needs and quality characteristics, the House of Quality was built for the proof of concept to be developed in the second phase of this project, shown in Figure 3.19.

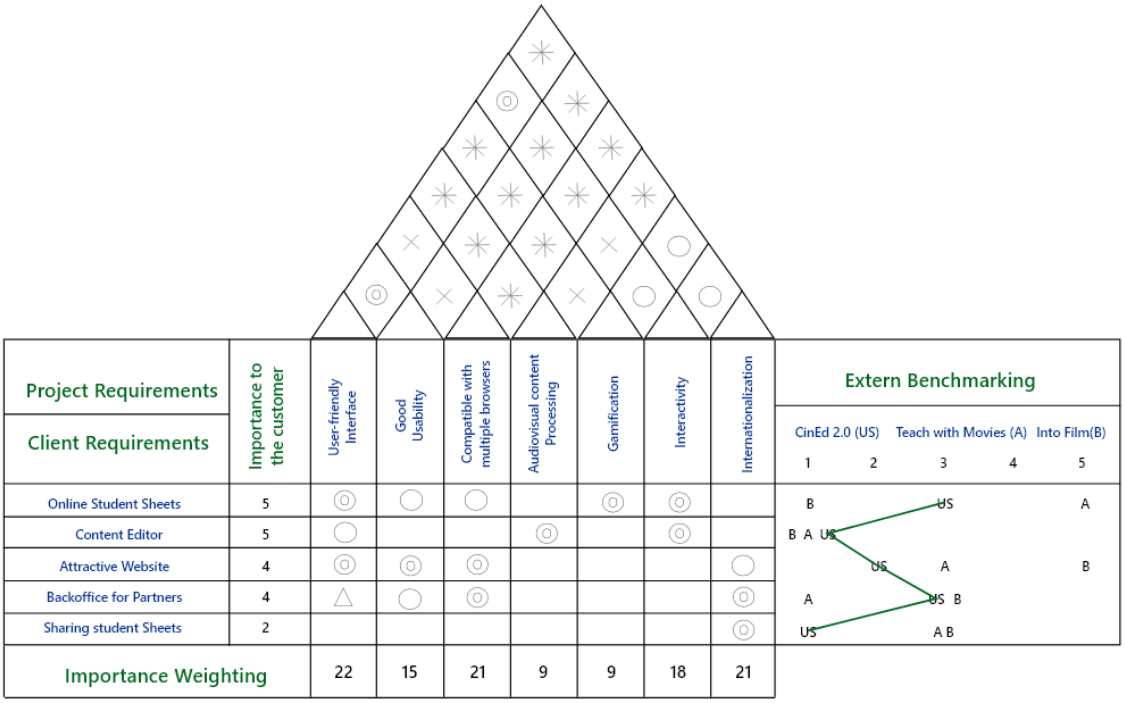

Figure 3.19 – Quality Function Deployment Method

From the analysis of Figure 3.19, it appears that the quality characteristic more directed to the client's requirements is the interface being user-friendly since it is the one that has the greatest relative weight. This is due to the fact that despite all the tools to be developed, from the student sheets to the content editor, as well as the back-office and the entire website in general, they have to be very intuitive and simple to use since it will be used by both students and teachers. It follows compatibility on various web platforms, as well as internationalization, since all the tools to be developed, will be used throughout Europe.

3.4 Summary

This chapter describes the entire innovation process, from identifying and analysing the opportunity to the definition of the solution, in order to understand the value that its development can bring to the company and the customer. Ideas were also generated to handle the identified opportunity, and each of them was submitted to the AHP method to verify whether its implementation would make sense. Finally, using a qualitative method, the various features were analysed as to its importance for the project. After concluding that the solution is advantageous to implement, both for the company and for the customer, it is necessary to design a solution that meets all objectives.

4 Analysis

Once the state of the art is done and having an overall of the existing competition, it is necessary to make an analysis of the project functionalities, so afterward start to design the project.

Insofar as the project requires a set of functional and non-functional requirements, this chapter focus on its analysis, as well as on the description of the requirements gathering process. In addition, all stakeholders and actors that are considered relevant to this project are listed and described.

4.1 Stakeholders

"A stakeholder is a person or group of people who can affect or be affected by a given project" (*What is a Stakeholder? How to Identify, Analyze & Manage Project Stakeholders*, no date).

In this project, three stakeholders were identified:

- Coordinator of the Project – Project manager:
    - From Portugal: Cinemateca Portuguesa

- Pedagogical Partners - Responsible for the manual translation of each student sheet, in their mother language as well as the introduction of new pedagogical content:

    - From Portugal: Os Filhos de Lumiére
    - From Spain: A Bao a Qu
    - From France: Cinematheque Français
    - From Italy: Get Cooperativa Sociale
    - From Finland: Ihmefilmi

- From Bulgaria: Arte Urbana Collectif
- From Romania: Sociatatea Culturala Next
- From Czech Republic: Association of Czech Film Clubs
- From Germany: Deutsches Filmimsti
- From Croatia: Asociace Ceskych Filmovyc

- Technological Partner:
  - From Portugal: MOG Technologies

4.2 Elicitation Techniques

The requirements gathering process was based on well-defined approaches to interact with stakeholders. For that, it was used a few elicitation techniques. This, consists in “learning, uncovering, extracting, surfacing, and/or discovering needs of customers, users and other potential stakeholders” (Hickey and Davis, 2003).

The meetings with the stakeholders were conducted in the form of interviews, focus groups, brainstorming, user interface analysis and prototyping.

4.2.1 Interviews, Focus Groups and Brainstorming

Interview-based elicitation methods are probably the most traditional and commonly used method for requirements elicitation. The interview is one of the simplest traditional techniques to use and produces good results in the initial phase of collecting information (Rueda, Panach and Distante, 2020) This is because there is prior preparation of a set of questions and to have direct contact with the customer.

On the other side, a focus group implies a group discussion in order to identify perceptions, thoughts, and impressions of a selected group of people regarding a specific topic of investigation (Milena, Dainora and Stancu, 2018). Here, all users have the chance to voice their thoughts. Also, this technique is very useful for exploring client's attitudes, preferences, and needs.

These two techniques were widely used simultaneously. Initially, in a first meeting with the partners, a focus group was held, where only 1 representative from each of the 4 pedagogical partners was present (in a total of 10 partners), and where the brainstorming led the meeting.

Subsequently, the meetings were conducted through an interview where, sometimes, brainstorming took place once again.

4.2.2 User Interface Analysis

User interface analysis techniques help to "identify gaps in the current user flow to better optimize the user's experience" ('Getting Started With Requirements Elicitation', 2020). Besides that, it is possible to study existing systems to discover functional requirements and to understand how an existing system works.

4.2.3 Prototyping

It helps the stakeholders to develop a strong notion about the application which has not yet been implemented, that through the visualization of it, all partners could verify if what they asked for was done, or if it is necessary to reformulate some aspects.

This technique (Figure 4.1 - Prototyping ProcessFigure 4.1) was widely used during practically the entire development of the project, in order not to implement something that would not be valid under the customer's view, wasting software development time.

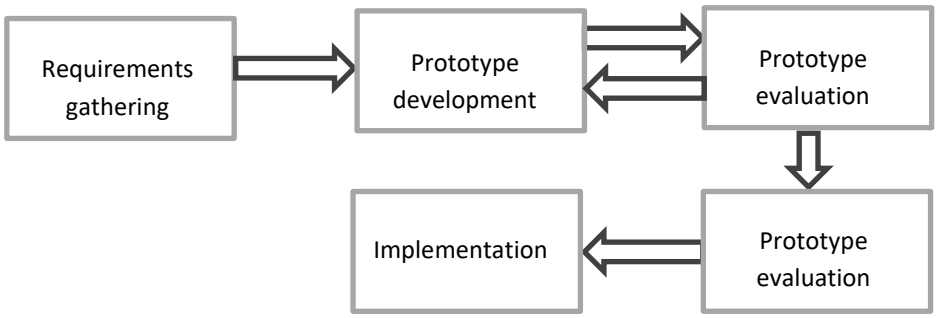

Figure 4.1 - Prototyping Process

The idea is to gather the requirements defined by the stakeholders, create a prototype with several possibilities according to the defined requirements, validate the prototype, make refinements if necessary, and finally, move towards implementation.

4.3 Requirements

In order to have a good overview of the requirements of this project, this section is focus on the technical specifications that the project will have. To make a good analysis of the quality requirements, it is used the FURPS model. This model considers five characteristics that make up its name: functionality, usability, reliability, performance, and supportability.

The FURPS model, "proposed by Robert Grady and Hewlett-Packard Co. decomposes characteristics into two different categories of requirements" (Samadhiya, Su-Hua Wang, and Dengjie Chen, 2010): the functional requirements and the non-functional requirements. In that way, this sub-chapter splits into that 2 main parts.

4.3.1 Functional Requirements

As a matter of organization, this section is divided between the back-office, general features from the website, student sheets and the content editor.

For each of these sections, is analysed a use case package diagram, to have an overview of the users and their permission levels. Besides that, a table of use cases is also presented and studied, to better specify the package diagram.

4.3.1.1 Back-office

The main purpose of the back-office is to introduce new information and content on the website, by all partners, in a quick and simple way. By that, were considered 3 levels of access to the several functionalities, according to what was requested by the consortium of partners.

Thus, the following scheme (Figure 4.2 - Permission Levels to Back-office), represents a hierarchical tree of permissions between the types of users that exists in the back office.

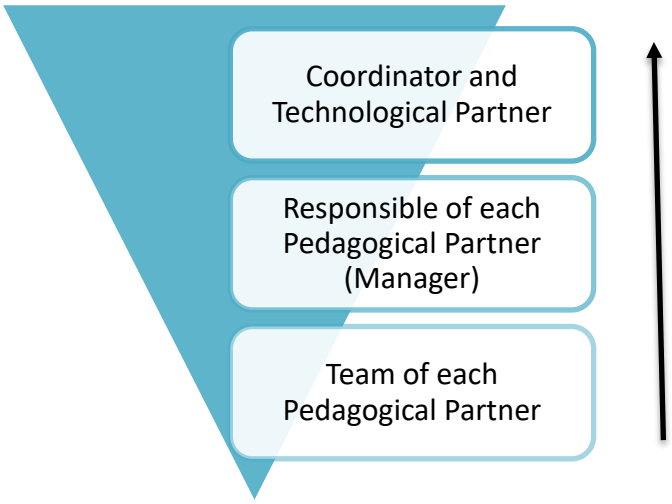

Figure 4.2 - Permission Levels to Back-office

As the level of hierarchy increases, the features accessible to each user accumulate. In other words, all the features accessible by the team of each pedagogical partner, are also accessible to each one of those responsible. However, not all features accessible to a partner's manager are accessible to its team, once belongs to a lower level.

As there are several features in common for all types of users, a use case package diagram (Figure 4.3) sounded like a better choice to represent the functionalities accessible to each one. “Use cases are often a primary requirements artifact in object-oriented development methodologies, this is particularly true of instantiations of the Unified Process, and for larger projects package diagrams are often created to organize the usage requirements” (Scott W. Ambler, no date). The choice of this diagram was also based on the complexity of reading and understanding that a use cases diagram would have.

Figure 4.3 shows that most of the existing functionalities are management functionalities. However, and as mentioned above, not all features within each package are accessible to all users.

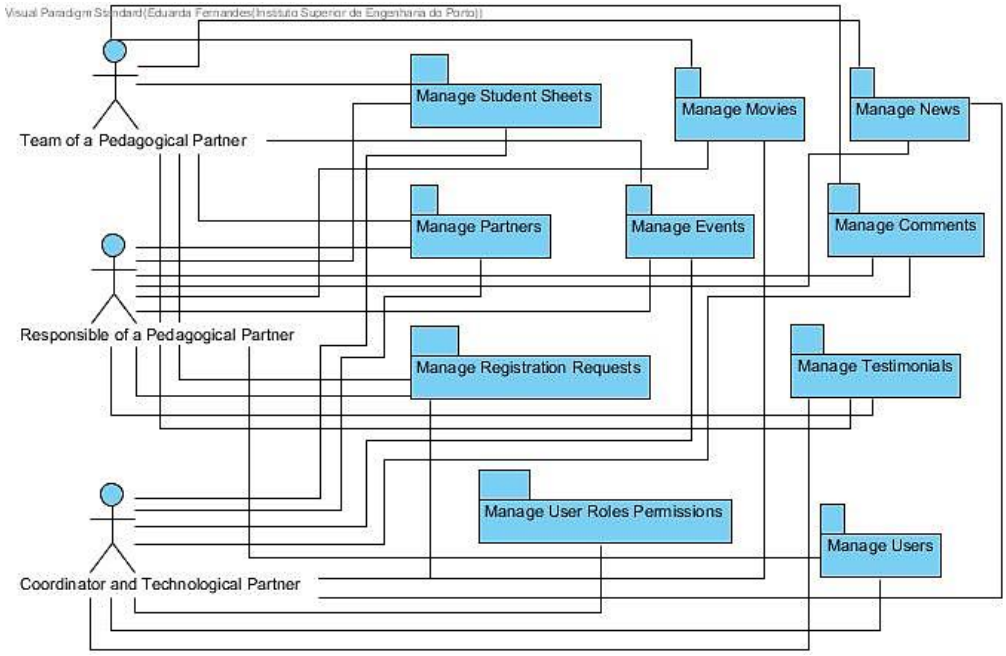

Figure 4.3 - Use Case Package Diagram

Thus, in Table 9, it is possible to see all the use cases found in each package. On the other hand, it is also possible to see which use cases can be accessed by each type of user. This choice was based, once again, on the reading complexity that a use cases diagram would have.

Table 9 - Back-office Functional Requirements

User Type	Package	Use Cases
All Users	Manage Movies	Add, Edit and Consult Movies Hide Published Movies Consult Movies Transactions
	Manage News	Add, Edit and Consult News Hide Published News
	Manage Events	Add, Edit and Consult Events

User Type	Package	Use Cases
		Hide Published Events
	Manage Student Sheets	Add, Edit and Consult Student Sheets Hide Published Student Sheets
	Manage Comments	Publish and Delete Comments
	Manage Partners	Consult Partners List
	Manage Users	Consult Activated Users List
	Manage Registration Requests	Consult Registration Requests
Team of each Pedagogical Partner, Coordinator and Technological Partner	Manage Movies	Delete Movies Publish Movies
	Manage News	Delete News Publish News
	Manage Events	Delete Events Publish Events
	Manage Student Sheets	Delete Student Sheets Publish Student Sheets
	Manage Users	Deactivate an Active User
	Manage Registration Requests	Activate and Delete a Registration Request
Coordinator and Technological Partner	Manage Movies	Add, Edit, remove attributes to Movies
	Manage News	Add, Edit, remove attributes to News
	Manage Events	Add, Edit, remove attributes to Events
	Manage Student Sheets	Add, Edit, remove attributes to Student Sheets
	Manage Testimonials	Add, Edit, remove attributes to Testimonials

User Type	Package	Use Cases
	Manage Comments	Add, Edit, remove attributes to Comments
	Manage User Roles Permissions	Change an User Role

4.3.1.2 General Functionalities

As mentioned in section 4.3.1.1, its main objective is the introduction and management of content in the front-office. In addition, both student sheets and the content editor will also be available on this web platform.

The following diagram (Figure 4.4), is represented all the use cases that are directly linked with access to the pages and features of the website.

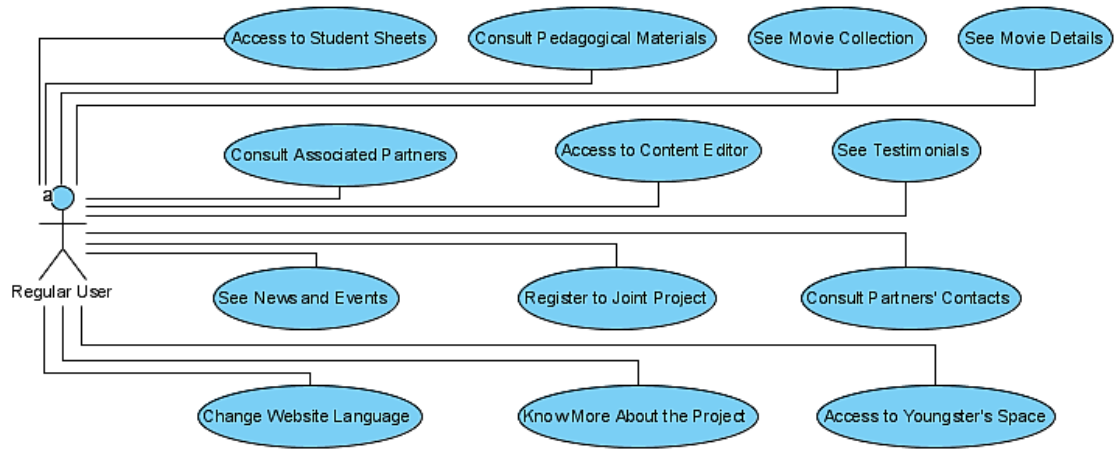

Figure 4.4 – General Features: Use Case Diagram

In the use case diagram of Figure 4.4, it can be seen two use cases which are directly related to the student sheets and the content editor ("Access to the Student Sheets" and "Access to the content Editor", respectively). As these are the two major focuses of this project, they are analysed in more detail in the following sections (4.3.1.3 and 4.3.1.4).

4.3.1.3 Student Sheets

To facilitate the insertion of the existing and new student sheets, in the back-office, it was necessary to create a fixed and common structure that would cover all types of exercises existing in PDF versions.

In Table 10, it is possible to see the structure that each student sheet will follow:

Table 10 – Student Sheets Structure

Section	Topic	Exercise Type
A - The Film	Seen in film	Drag and drop exercise
	Heard in film	Exercise of listening to excerpts from the film
	Said about the film	Reading exercise
B - In Europe and Elsewhere	A film, several titles	Reading exercise
	A film and its era	Reading and images visualization exercise
C - The Film and Me	I learn, and I imagine	Open response exercise
		Letter writing exercise
	Choosing and creating images	Image upload exercise (3 exercises)
		Creating stories/poems exercise
D - To Go Further	-	Reading and images visualization exercise

Each student sheet will obey the defined structure represented, containing a total of 12 exercises. In addition to these exercises, student sheets will also have more functionalities associated. Figure 4.5 represents those functionalities, in a use case diagram form:

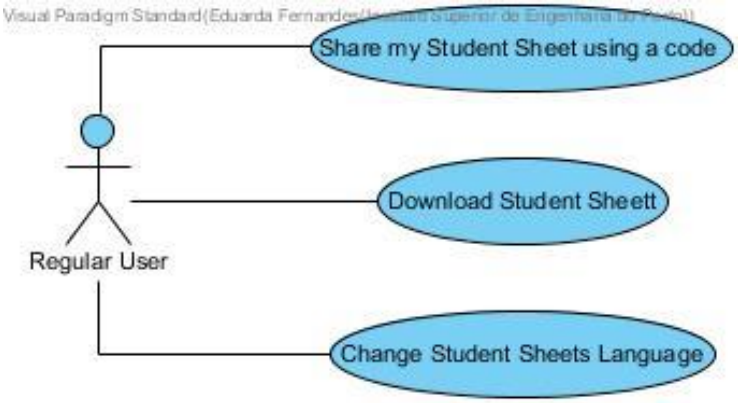

Figure 4.5 – Use Case Diagram: Manage Student Sheets

Furthermore, to the set of exercises referred to in Table 10:

- student sheets must be available in all languages of the partners associated with this European project: Portuguese, Spanish, French, Italian, Finnish, Bulgarian, Romanian, Czech, German, Croatian, and English

- student sheets must have an option to download it in pdf format
- if the user wants to share the student sheet online, a sharing code must be provided

4.3.1.4 Content Editor

The main objective of developing this feature, in addition to being an innovative feature in the field of education, is motivating and integrating the most fragile communities in society. The output result that this feature can have is a slideshow or a pdf with a set of images.

In the following diagram (Figure 4.6 - Content Editor: Use Cases Diagram), it can be seen the use cases associated with this tool.

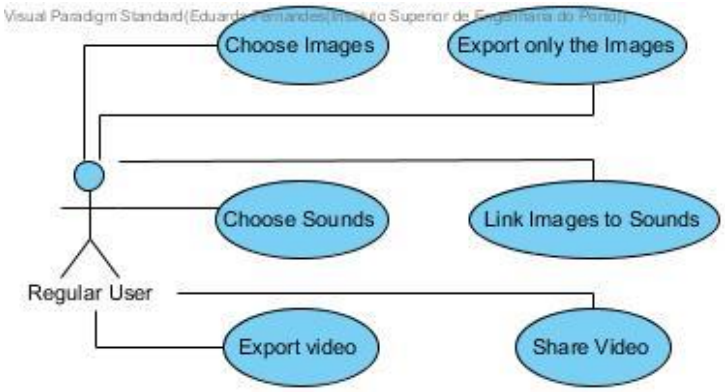

Figure 4.6 - Content Editor: Use Cases Diagram

In order to maintain and improve an existing functionality, this feature can have two different outputs:

- through the association of images and sounds, the output can result in a slideshow
- by choosing images (only), the student can download, in pdf, the chosen images. This option was also made due to certain types of exercises that already existed in old student sheets, such as: "Choose your favourite images from the film and write a poem"

Thus, in order to better understand how to achieve these two types of outputs, the following diagram of activities was designed (Figure 4.7).

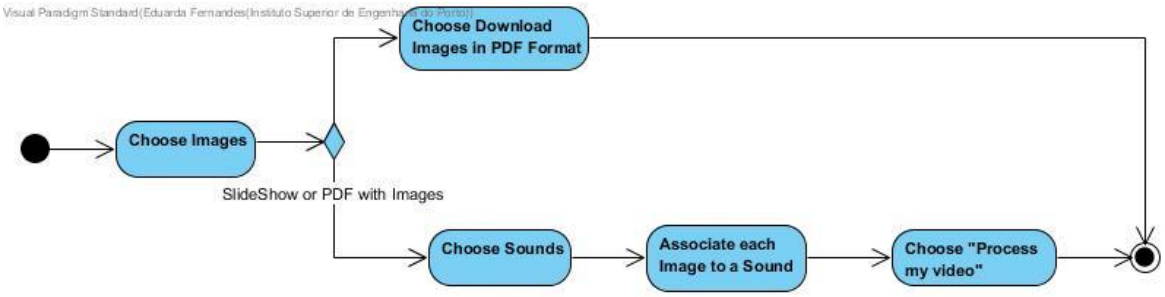

Figure 4.7 - Content Editor: Possible Activity Flow

Therefore, the student starts by choosing the images that like the most. Then, if the student wants to do an exercise of the type “Write a poem”, then he should download the chosen images. Otherwise, and if he wants to make a slide show, the next step is choosing the sounds and associate each one with each image. Once he finishes this step, he can process the video, and turn the images and sounds into a slideshow.

4.3.2 Non-Functional Requirements

As previously mentioned in section 4.3, the analysis of non-functional requirements will be based on the FURPS model. “FURPS stand for functionality, usability, reliability, performance and supportability” (Singh and Kassie, 2018). Once the functionalities of both the back-office and the website have been analysed, it is time to study their quality attributes.

4.3.2.1 Usability

“Acquiring the understanding of domain and user is essential for defining the characteristics for software and even for effective user interface” (Umar and Naeem Ahmed Khan, 2011).

As the main target audience of the website is young people (between 6 to 18 years old), the entire visual interface must be easy to interpret - from the most informative pages to the virtual student sheets as well as the content editor.

Also, the back-office should be very intuitive, so that each partner does not have any difficulty in doing certain tasks, such as introducing new information about a film, in their mother language.

4.3.2.2 Reliability

Reliability is “frequency/severity of failure, recoverability, predictability, accuracy, mean time to failure” (Chung *et al.*, 2012). Thus, there must be consistency in the transmission of data between the back office and the website, and back, to avoid the existence of failures on both sides. The reliability coefficients have values between 0 (lot amount of errors) and 1 (no errors at all). For that reason, reliability, should have values between 0.6 and 1.

4.3.2.3 Performance

Performance is all about “time/space bounds, such as workloads, response time, throughout and available storage space” (Chung *et al.*, 2012)

As for performance, there should be a normal response time and a maximum response time. The values stipulated for this project are:

- Normal response time: 1 - 2 seconds

- Maximum response time: 4 seconds

4.3.2.4 Supportability

Supportability, consists in “testability, extensibility, adaptability, maintainability, compatibility, configurability, serviceability, installability, localizability and portability” (Chung *et al.*, 2012)

Both website and back-office must support multilingual. The languages to be available must be the official language of each of the partners, as well as English, being the main language of communication between people from different countries.

On the other hand, both platforms must be accessible in several web browsers (chrome, Firefox, edge, among others), as well as in several mobile devices (namely computer and tablet), thus compelling a responsive design.

4.3.3 Summary

In this chapter, all those involved in the project were identified, as well as the different elicitation techniques that were used in the meetings with customers.

This chapter also contains all the functional and non-functional requirements and the permission levels of the project. Now that there is a clearer idea of what is needed for the project, it is essential to design the solution in order to correspond to the objectives set.

5 Design

For a product or functionality to be implemented, it is necessary to plan. The planning objective is to define how the solution will be developed based on the identified problems and the state of the art, through the gathered requirement in order to achieve a the main objective, already defined at section 1.2. As mentioned in section 1.3, the design of a solution must generate artifacts, made with rigorous and tested methods. In this chapter, is made the selection of technologies that will be used in the development of the solution, as well as the architectural design that the solution might have.

To conclude the chapter, some mock-ups made, presented, and approved by the partners are shown, making a comparison with the visual entity that the European "CinEd" project currently has.

5.1 Choice of Technologies

At this stage of the solution design process, the decision about technologies that will be used to build and implement the solution is made. Decision making will be based on the study previously done in the state-of-the-art chapter.

5.1.1 Front-end

In section 2.3.1, 3 front-end technologies were studied: Angular, React, and VueJS. According to one of the requirements specified by the project partners and considering that the solution can be used in places with poor internet access, it is necessary that the solution is not heavy, or in other words, should have a good performance. Following this logic and looking again at Table 3 of section 2.3.1.4, the author could immediately exclude Angular, since it presents very high-performance values. Also, through that table, it is possible to see that VueJS is the technology

with the lowest values, so the author could consider it as the most suitable technology for this project.

For professional reasons, it was advised, by author's supervisors, that React was the technology of choice over VueJS. Once React is the technology with more use in the company where the internship took place, the technology chosen for the frontend is React.

5.1.2 CMS

The first decision to make about the back-office would be to choose between a traditional CMS or a headless CMS. Returning to section 2.3.3, in Table 6, there is a comparison between these two types of CMS.

This project needs a back-office that manages several contents, to be presented on a web platform. As this platform would have to be done in detail and accordingly with the requirements of the partners (maximum customization in terms of graphic design), it was decided to use headless CMS, since it does not have a presentation layer, or requires any type of template for the graphical interface. In addition, these types of CMSs have APIs that are built automatically as content types are built, that is, their integration with React will be simple, facilitating the implementation work.

5.1.3 Database

The choice of the database was based on the type of data to be stored, but mainly on the comparison table of section 2.3.5.3. According to the comparative table, made after analysing each one of the databases (MySQL and MongoDB), realized that perhaps MongoDB could be the best option for the following aspects:

- MongoDB has a very flexible way of storing information when compared to MySQL. The fact that partners changed their minds and ideas happened a lot. As this database allows changing the data structure in a simple way, facilitated this process a lot
- Data persistence is faster compared to MySQL, as it was possible to verify in Table 7 of section 2.3.5.3

On the other hand, and as will be seen in section 5.2, the data are not very close to each other, so it would make no sense to adopt a relational database. Therefore, MongoDB will be the database chosen for this project.

5.2 Database Model

To better illustrate the domain of the project, a database model was made, to demonstrate the attributes and relationships between documents, as it is possible to see in diagram of Figure 5.1 - Database Model.

This diagram is the mirror of the scope of the functional requirements specified in section 4.3.1.

The partners (represented by the document "Partner") are the center of the model since they are responsible for all content management: testimonials, news, events, films, student sheets, and the content that the editor will have available to users who visit the platform.

Analysing the diagram in more detail:

- The document "Collection" represents the section where all the films are concentrated, hence the connection "1 to many"
- Each film has a student sheet associated with it (1 to 1 connection)
- Both student sheets and content editor are available in the "Youngster's Space" section. Similarly to the collection, the youngster's space has several student sheets available, but only one editor (1 to many connections, and 1 to 1 connection, respectively)

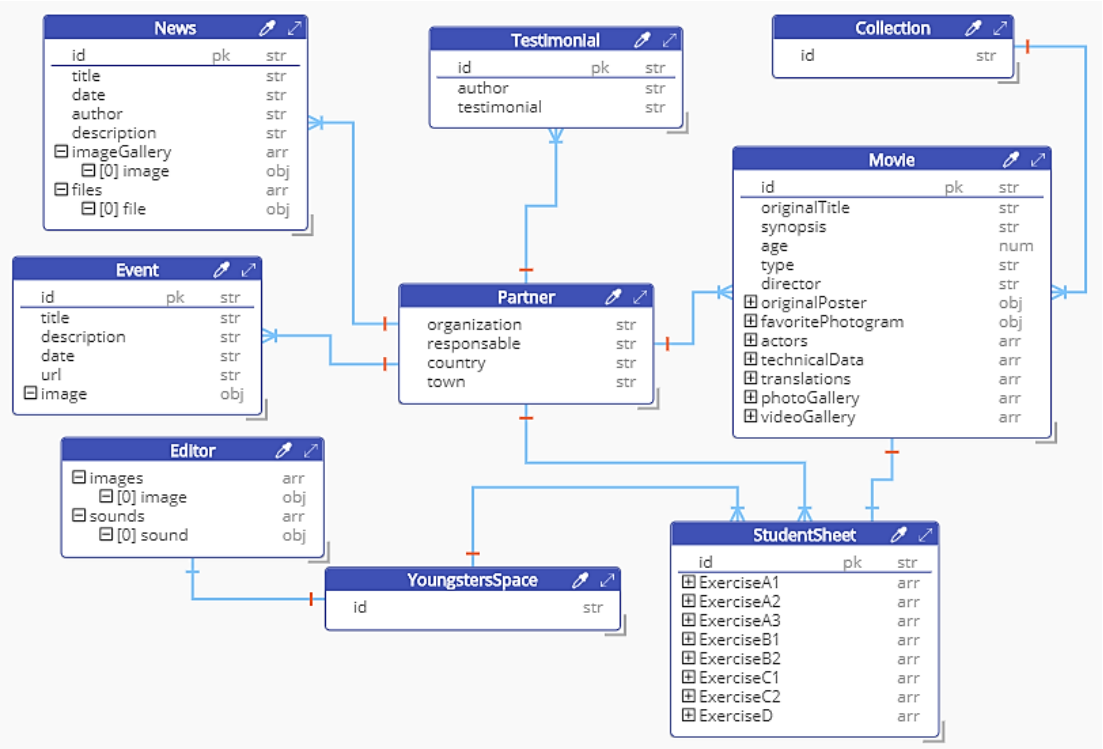

Figure 5.1 - Database Model

5.3 Architecture

In this subsection, two possible architectures will be analysed. Component diagrams will be used for each of these two alternatives, however, the notation may differ slightly from the official notation, because it served as a basis for demonstrating and explaining better to customers how the solution will be organized. The purpose of these diagrams is to demonstrate the relationship that exists between components in a system, always considering how they are related.

5.3.1 Alternative 1

In Figure 5.2, it is possible to understand the components that exist in the thought solution. In this alternative, there are 4 main components:

- UI - where is the application's graphical interface, containing the pedagogical materials and tools, and with which the user will interact
- Business Logic - the place where four components can be found: the rendering engine, the business logic of the content editor, of the student sheets, and of another website features
    - Rendering - modifies the graphical interface that will be shown in the browser, always passing the information that comes from the other components
    - BusinessLogic_CE - it is the component where the business rules of the content editor are listed and managed, that is, it is in this component that it is decided what information should be passed towards the database and in the opposite direction
    - BusinessLogic_SS - like the BL_CE component, it is in this component that the business rules of the student sheets are listed and managed
    - BusinessLogic_Web - this component contains the business rules of the rest of the website
- Backoffice - component where all content management is found, from insertion, editing, or removal of content
- DB_Backoffice - component where the data is stored

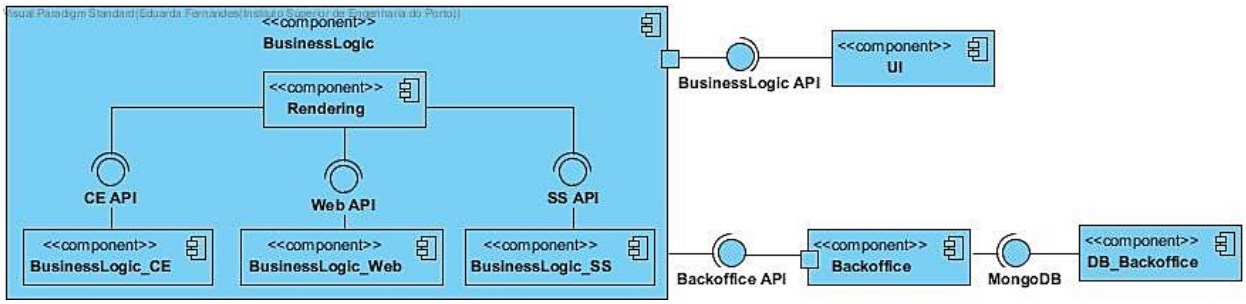

Figure 5.2 - Component Diagram: Alternative1

In this alternative, all the components of the business logic consume APIs coming from the back-office, and there is only one database, which will be responsible for the persistence of all information coming from the components.

5.3.2 Alternative 2

A possible alternative, represented by Figure 5.3, demonstrates how the application can be structured if the low coupling is a priority. This alternative also allows several developers to be working simultaneously without compromising the correct functioning of the remaining components. In addition, changing or inserting new features, for example in the content editor, does not require changes to be made to the student sheets component.

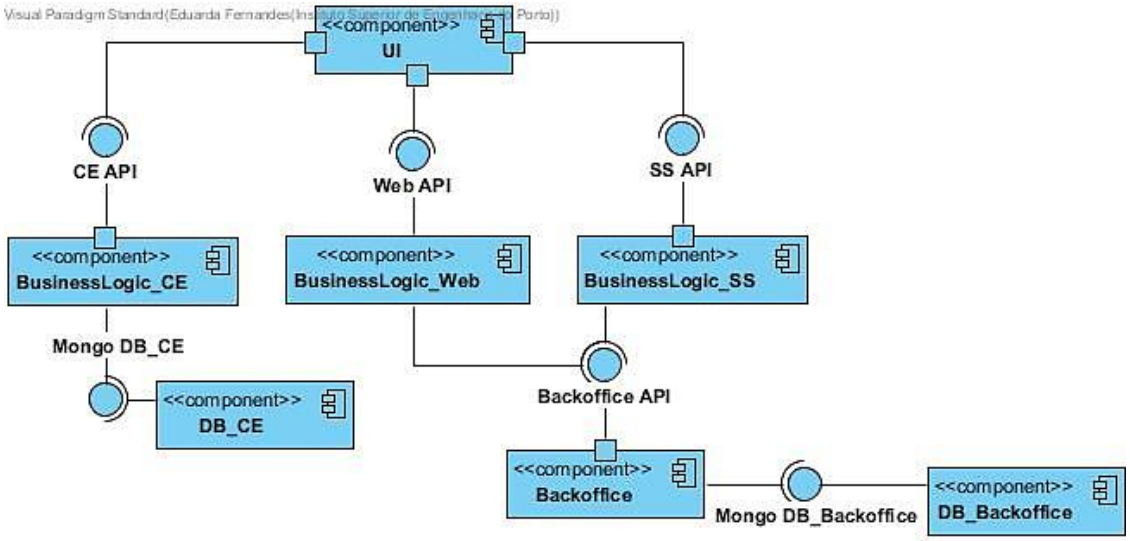

Figure 5.3 - Component Diagram: Alternative 2

This alternative, unlike alternative 1, contains two databases: one for the content editor, containing images and sounds that will be available in the user interface, and another database for the content management of student sheets and other functionalities of the website, which is directly linked to the back-office.

5.3.3 Best Alternative

The biggest indecision, at the beginning of the solution design process, would be for the content editor to have its own database or, its information would come from the back-office just like with student sheets and the rest of the website. It was decided, then, that the partners should be able to customize the application to the maximum. In this way, they are able to choose what content to show to the client-side and, therefore, choose which images and sounds should be available in the editor.

Thus, the most suitable alternative for the solution of this project is Alternative 1.

5.3.4 Deployment Diagram

"A typical UML deployment diagram models the actual deployment of software components into hardware nodes. It illustrates the configuration of the hardware components (nodes) as well as how software components and artifacts are mapped onto those nodes" (Jebraeil *et al.*, 2017).

Having already decided which architecture to use in the solution for this project, the deployment diagram was built and presented in Figure 5.4.

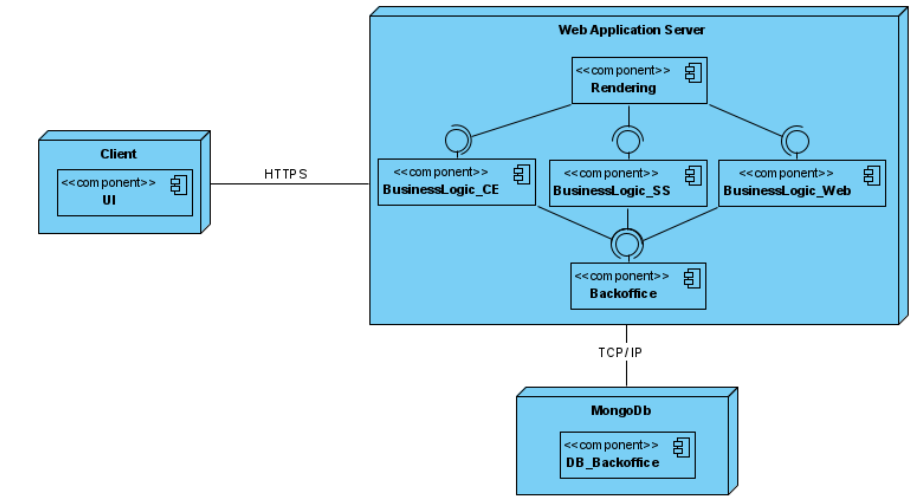

Figure 5.4 – Deployment

Communications between the UI node and web application server node, are of the Hypertext transfer protocol secure type, also known as HTTPS communications. "is a security protocol that is commonly used to secure web or internet transactions" (Wibowo, Nuha and Wibowo, 2020). The HTTPS client (UI) initiates an HTTPS request and after a request is made, the client waits for the response. The server (web application server) processes the request and sends a response back.

On the other hand, communications between the web application server, and the database, are of the TCP/IP type. TCP/IP provides "reliable data transmission in the IP environment, full-duplex operation (data in two directions simultaneously transfer)", and is connection-oriented used to transfer a large amount of data with high-reliability requirements (Zhang, Xia and Han, 2015).

5.4 Mock-ups Design

As mentioned in section 4.2.3, the use of prototypes was one of the techniques used in meeting with partners, to gather most of the requirements.

Thus, in this section, some mock-ups are presented, in order to make a comparison between the old design and the new one. The homepage of the new website, the space dedicated to students, the content editor, and an example of a student sheets exercise are presented in the next subsections.

5.4.1 Psychology of Colors

"Colors play an important role in how your brand is perceived" (Ferreira, 2019). The first step in the design process of the mock-ups was to study which colors would be most suitable for this type of project. "Color psychology is the study of colors in relation to human behaviour" and, in marketing, "plays an essential role in the art of persuasion with the goal of eliciting action from consumer"(Dodds, 2020).

Since the beginning of this process of choosing colors, the partners wanted to keep the logo, in order to preserve the essence of the project. However, after several attempts to use the tones associated with the logo (dark orange and purple), it was decided that these were not the best colors, because they are very heavy. In addition, and after analysing the symbology associated with these two colors, it was obtained (*Color Psychology Meaning - Symbolism & Personality*, no date):

- Dark orange – Associated with hubris/over confidence, pride, and aggression
- Dark purple – Sadness, uninspiring, traditional, intuition, spiritual and suppression of emotions

One of the great challenges was to select new colors to renew the existing features and for the new ones. After the generation of several palettes that matched with the logo and that transmitted good feelings, the following colors, represented in the palette of Figure 5.5, were chosen (*Color Psychology Meaning - Symbolism & Personality*, no date).

Figure 5.5 - Palette

- Cultured or light gray – Associated with calming, wisdom, and enlightenment
- Gold metallic – Wealth, success, generous, confident, and knowledge
- Dark cyan - encourages objective, analytical, and deep thinking

5.4.2 Homepage

One of the major problems mentioned by the partners was the user interface (use of bold colors and repeated information on several pages) and the user usability (unattractive layout with a confusing road map) that the website provided to all who visited it.

Figure 5.6 represents part of the current home page.

Figure 5.6 - CinEd website homepage (old version)

As it is possible to see, the only colors used are purple and orange. According to the partners, these would not be the most correct colors to use on a website of this nature. It was thus defined, from the beginning of the project, that the entire existing website would be changed. The goal would be to bring a new visual identity, make it more technological in order to attract potential customers, partners, and institutions. And therefore, several changes have been made. The home page to be used as soon as the solution is ready, and to be launched on the market is represented by Figure 5.7.

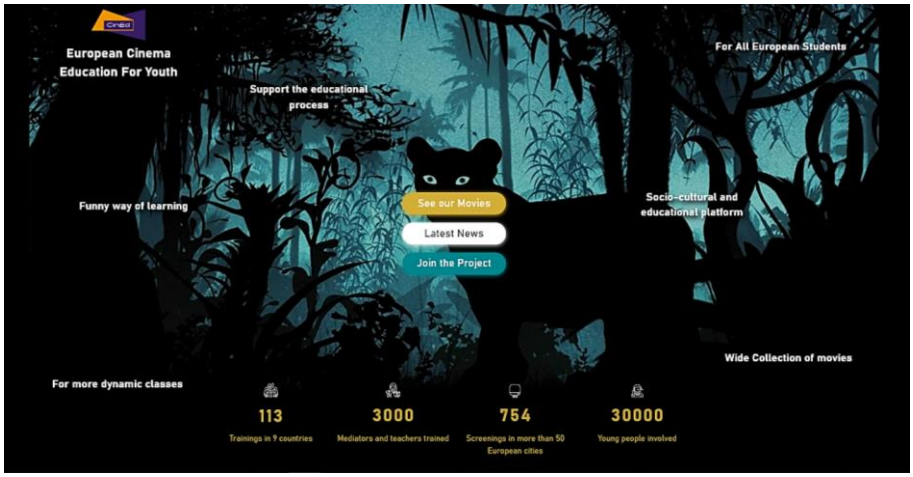

Figure 5.7 - CinEd Website Homepage (new version)

On this homepage version, some of the most important information about the project is presented in a more subtle way. When a new user enters the website, can immediately get a sense of what the project is about, what it is the target audience and its objective. In addition, all sentences have fade animations to make the site more dynamic and “fun”.

5.4.3 Youngster’s Space

This page is entirely dedicated to students. Here, it is possible to find various tools such as: interactive maps, content editors, and student sheets for each film. This section was specifically designed for young people. In Figure 5.8, it is possible to have a vision of how it is now. The great criticism that this section had by the partners, is that it is very similar to the section "The Collection". The only difference is that here, it is possible to access the student sheets, and to an image selection tool.

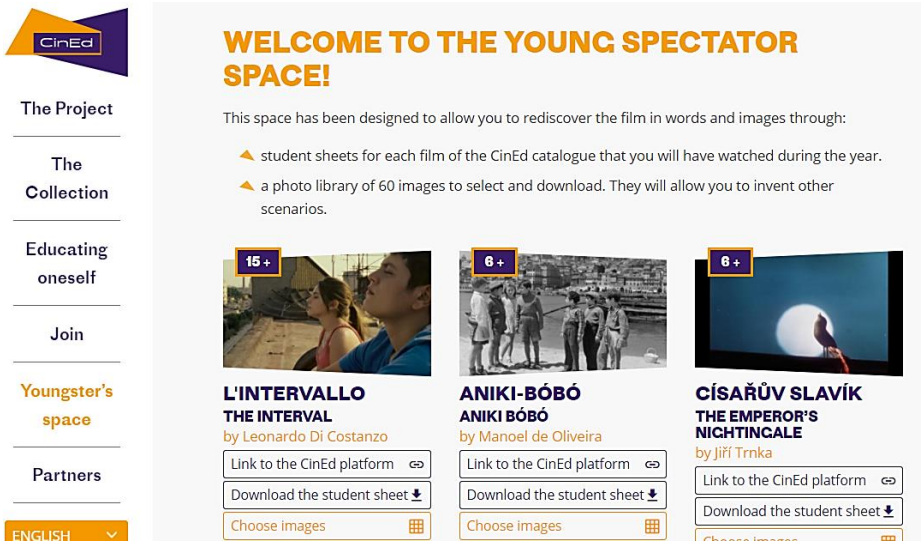

Figure 5.8 - CinEd website "Youngster's Space" (old version)

Figure 5.9 depicts the future section of Youngster's space. Upon entering this space, young people immediately have a clear sense of the features and options they can choose to do: play with the content editor, explore through the interactive map, or make the student sheets that are available.

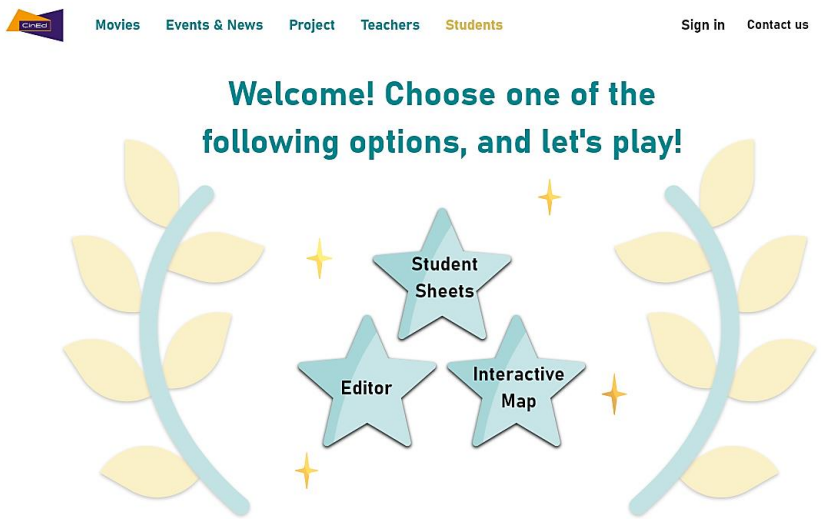

Figure 5.9 - CinEd website "Students Space" (new version)

The fact that the design is simple, and has bright colours, makes it interesting in the eyes of children. Through the presentation of several alternatives and the feedback received from stakeholders, it was decided that this is the ideal mock-up for the main page of the students' space.

5.4.4 Content Editor

This feature has the purpose of reach all young people who may feel socially excluded. For this, and as it was said in section 4.2.1, through a brainstorming meeting, the idea of developing a content editor came up (Figure 5.10). In this space, young people, through the combination of several images and sounds, have the opportunity to create a "new film", a new perspective on a certain theme, and, in a way, have a voice in society.

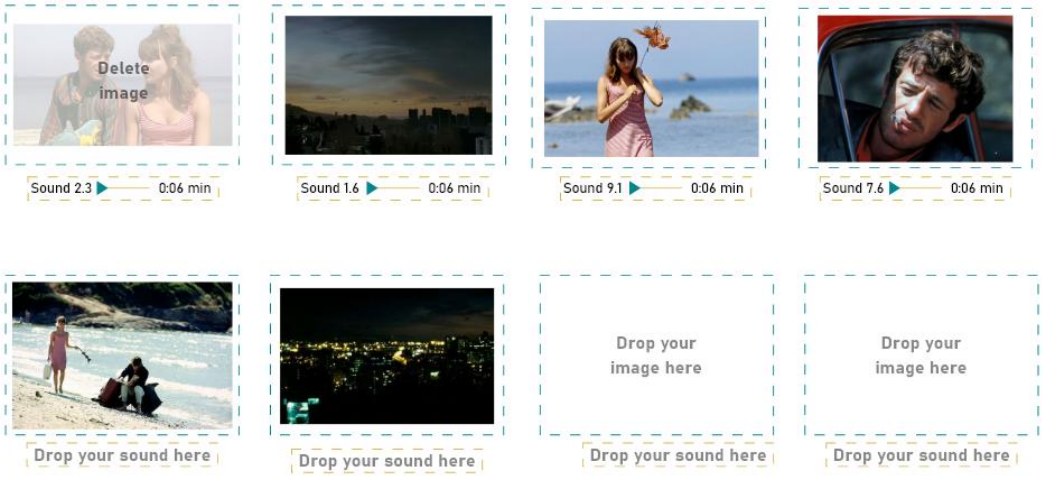

Figure 5.10 - Content Editor

With a simplistic design and a short description of what they can do and how they can do it, young people will be able to create new creative content, converting it into a slideshow or simply downloading several images, in order to maintain the existing functionality.

5.4.5 Exercise of a Student Sheet

As described throughout this document, and according to the result obtained in section 3.1.4.6, using the AHP method, the digitization of student sheets is one of the main features and a large part of the project's core. The main focus has been on how to make student sheets attractive, fun, that motivate and encourage students to want to do them. In Figure 5.11, there is an example of an exercise of a student sheet.

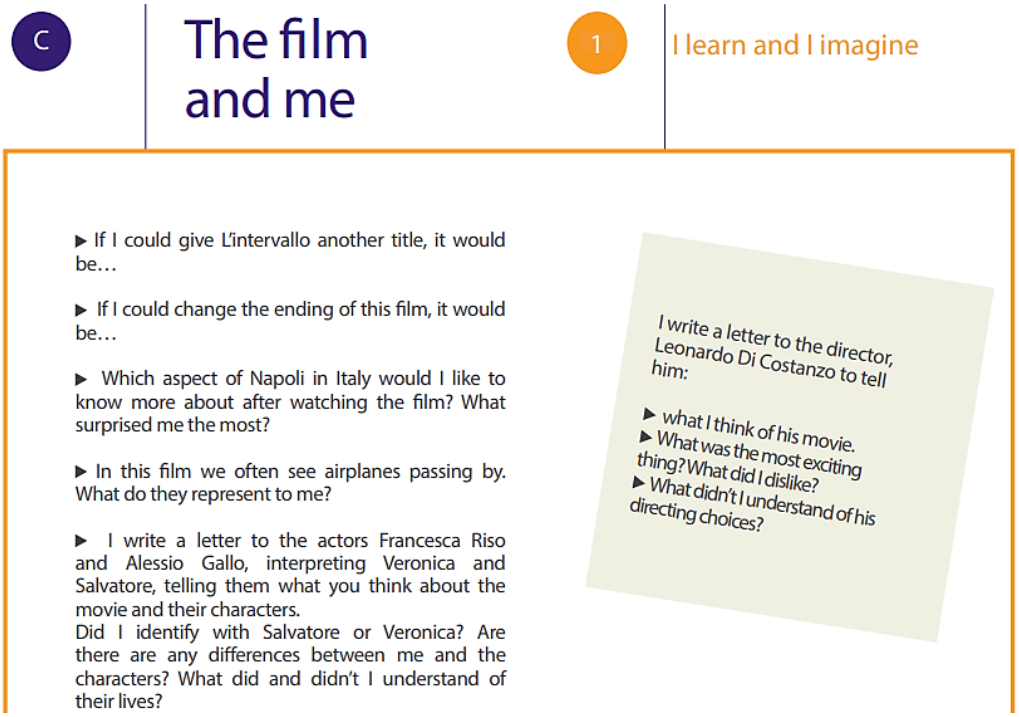

Figure 5.11 - Student sheet: letter exercise (old version)

Here, students would only have the opportunity to write the letter with a notebook and a pencil. In this way, Figure 5.12 reflects the same exercise, but in digital mode.

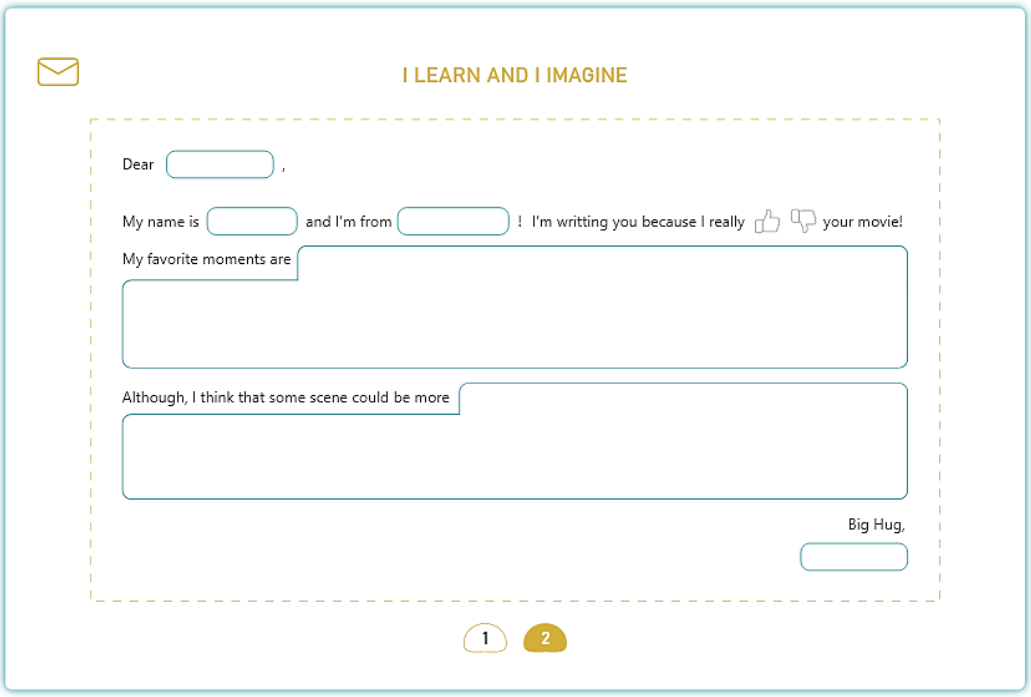

Figure 5.12 - Student sheet: letter exercise (new version)

The entire design was changed, maintaining the structure of the exercise, but making it interactive, dynamic, and, above all, fun. Through sounds and animations, young people gain a certain motivation to discover what comes next, until the end of the student sheet.

5.5 Summary

In this chapter, the solution design was presented, both technical and graphical, which solves the identified problems. The entire technical aspect of the system was presented (system architecture, domain modelling, and system implementation). The designed solution presupposes the resolution of the problems identified in section 2.1.11, in order to meet the requirements in section 4.3, also fulfilling the analysis made in Value Analysis chapter. The previously presented mock-ups were also designed over the different meetings that were held with customers and later accepted for implementation by them.

Following is the implementation of the system, based on all the planning carried out in this chapter, where the technical details will be explained.

6 Development

All planning and analysis of a system culminate in its implementation, followed by continuous analysis of the system and its maintenance.

Once the project is quite extensive in terms of functionalities, as seen in 4.3, this chapter will be divided into the development of the back-office, the interactive student sheets, the content editor, how user management is going to work and how multilanguage support is handled.

In each of these sections, it will be explained how the development process took place, as well as demonstrating how certain features were implemented, associated with several images for better understanding, in order to demonstrate, in chapter 7, that the objectives initially proposed were achieved.

6.1 Backoffice

As explained in this document, namely in chapter 4.3.1.1, BackOffice's main objective is to manage all information related to the content that is available on the front-office (web platform). For this, and through the survey of requirements and technical specifications, throughout the design process and development of the project with customers, the development of Backoffice started by creating all generic models for each of the content necessary for their management (the content types).

As it can be seen in Figure 6.1 - Strapi: Content Types, each partner will have access to the main content management menu, where they will find all the information regarding each of the models, as well as all the available features.

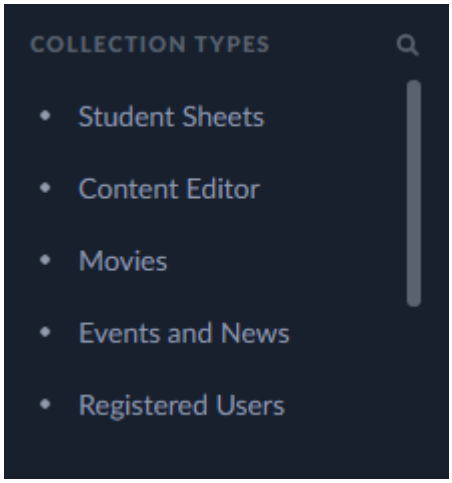

Figure 6.1 - Strapi: Content Types

Each of these submenus contains all the information that may be available on the web platform, indicating the contents that are published, or that are still in draft mode.

The functionalities available in each of the content types are to create, delete, publish, or hide content. Thus, and since the functionalities are very similar from content-type to content-type, the implementation of the back office at a structural level was quite simple.

On the other hand, and since the web platform must be available in 12 different languages (language belonging to each of the associated partners and English, being considered as a common global language), the management of the various languages was one of the most complex features. Once Strapi does not yet have any plugins connected to the internationalization of content, several components associated with each of the content types were created to perform this same management.

In Figure 6.2, it is possible to see the structural model of the content-type “News / Events”, consisting of a component “Translations”, where the partners will carry out the translations of the necessary contents.

For each of the remaining existing content types, there is a component of the type "translations" to carry out the respective translations in each of the available languages.

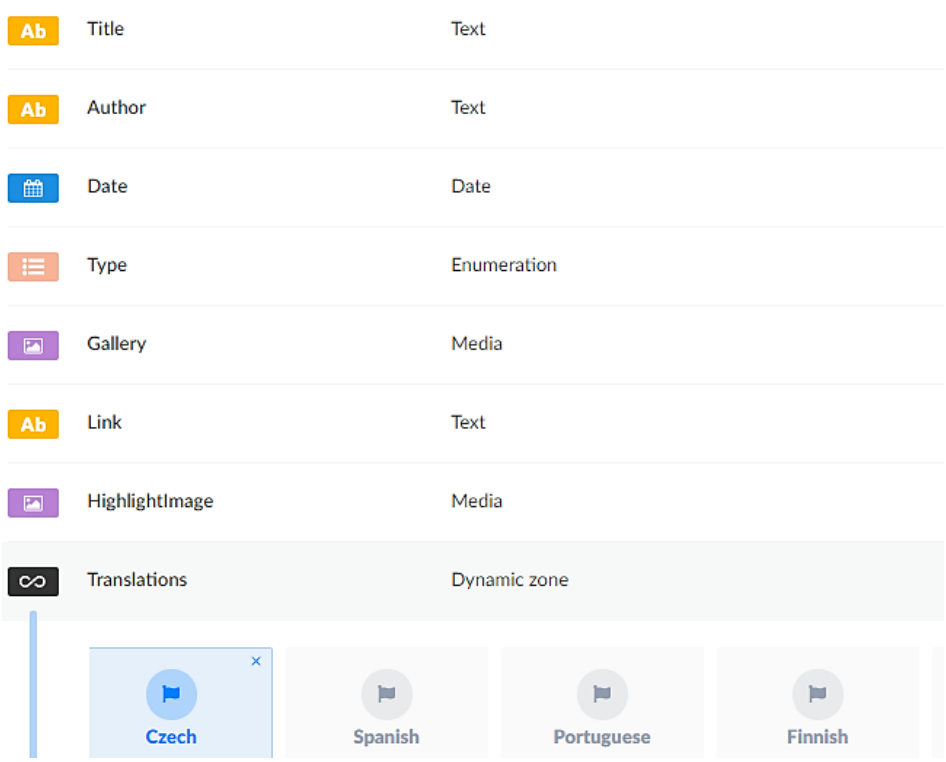

Figure 6.2 - Strapi: Content Type of “Events and News”

In order to have consistency on the web platform, and once all content will be manually translated by the partners, the default language is English. That means that, if any partner wants to introduce some new content, that content must be in English.

In addition to managing content to be published on the platform, all partners will also be able to control who will have access to exclusive content such as student sheets, content editor, films, and teaching materials.

Although all the content is free, the partners want to have a greater guarantee that users who have access to this type of content, use it for educational purposes. To this end, a section was created, in the back office, responsible for this management (Figure 6.3), which will be documented in section 6.2.

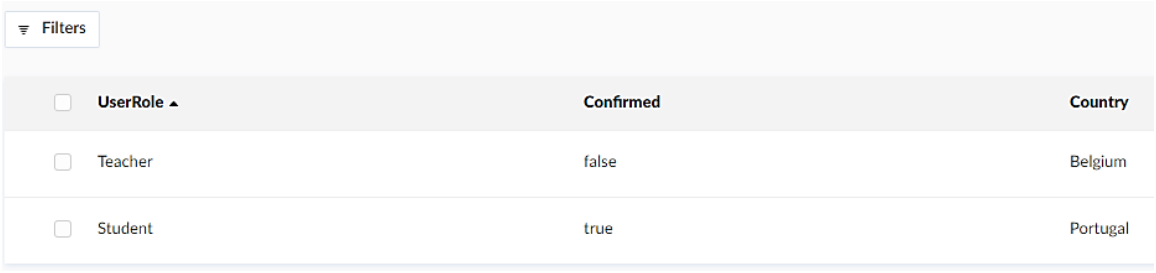

Figure 6.3 – Strapi: Registered Users Management

6.2 User Management

On the platform, there are 2 types of possible user registration: student or teacher/institution and therefore, 2 different account validation treatments.

After a student has successfully registered, their account will be validated automatically, without going through any validation process. However, “student” accounts will only have exclusive access to student sheets and the content editor.

Also, if any of the partners want that any account to be suspended, they just need to go to the user management page and suspend the account (Figure 6.4, “Confirmed: off / on”), having the possibility to reactivate it again.

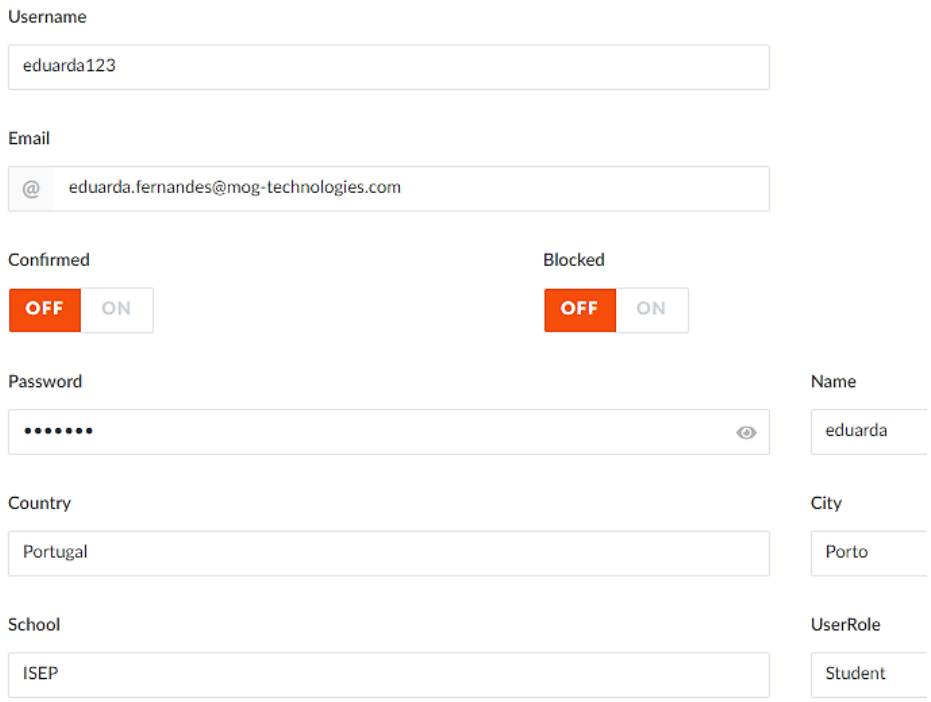

Figure 6.4 – Strapi: User Details

One aspect that is worth highlighting when registering student accounts is the fact that the system allows the use of the same email for several registrations. This allows, for example, a teacher to be able to create multiple accounts for several students in the same class, with a single email. In these cases, the username is the unique identifier in the database, and the differentiating attribute in the existing accounts (Figure 6.5).

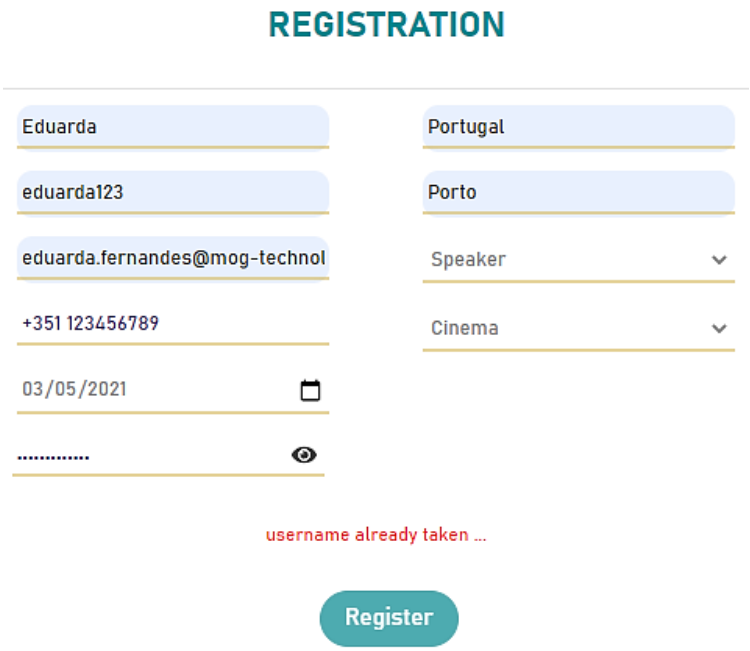

Figure 6.5 – FrontOffice: User Registration

In case of teachers/institutions, all registered accounts go through a validation process by the partners. Figure 6.6, represents these two processes: validation of users with role “Student”, and users with “Teacher/Institution” role.

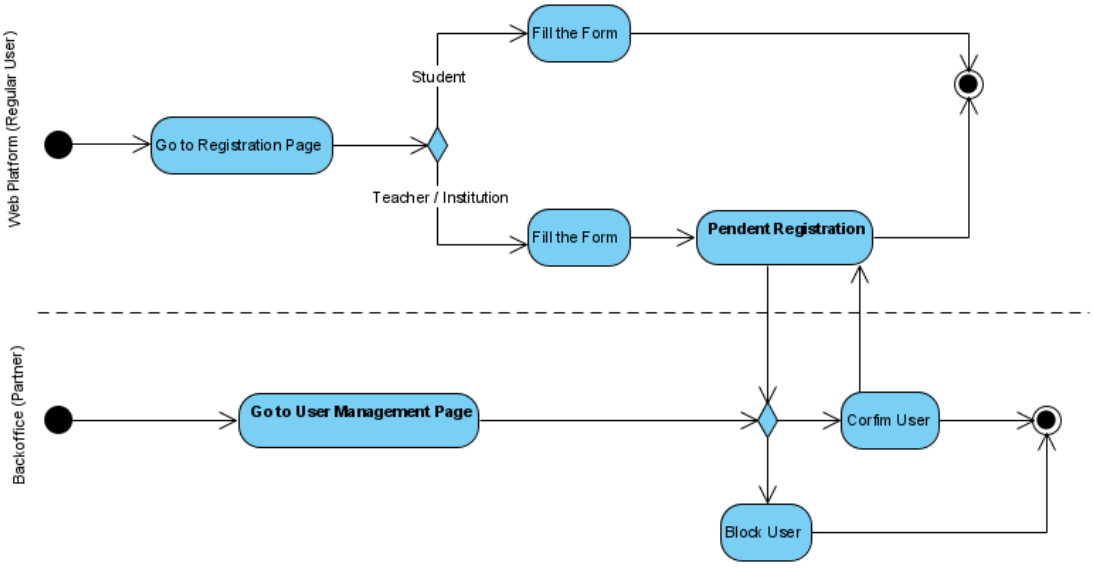

Figure 6.6 - User Management: Activity Flow

After filling in the mandatory registration form and if the user type is “teacher/institution”, he/she is informed that only after his/her profile has been validated by a partner, he/she will be able to access the exclusive available content. This content refers to student sheets and

content editor (as it happens to those who have a “student” account), as well as films and teaching materials (content that is not accessible to a “student” account).

After a partner activates a profile, the user in question will be notified, by e-mail, that his account is already active, being able to log in and access all available content.

6.3 Interactive Student Sheets

For this project, student sheets can be considered the most important part. The entire project management revolved around student sheets. The degree of importance attributed to this feature is based on the existence of student sheets, but only in PDF format. In this second phase of the CinEd project, it was decided to make this feature available in two formats: PDF, and interactive content, where young people will be able to develop their file on a specific film directly on the computer.

This new way of presenting content allows young people who do not have resources, such as printers, to carry out their work online, saving it at a certain time, and can continue to develop it whenever they want. In addition, it allows them to share all their work with whoever they want from a simple code, without having to download it or share it via e-mail, as many students aged between 6 and 10 years old, do not have an email address.

The development of this functionality, started with the creation of the content type on Strapi so that partners can introduce the necessary content such as exercise descriptions, guidelines, images, sounds, and others.

In Figure 6.7, the model that represents Exercise A1 is shown, where several images of a given film are made available as well as the description of the exercise.

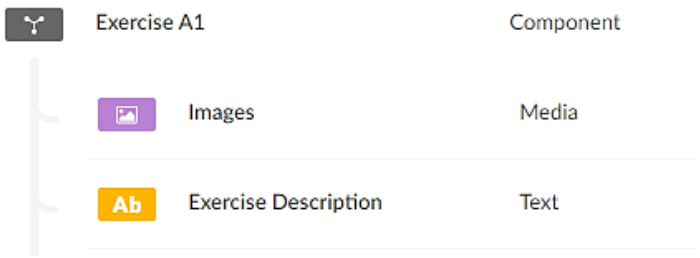

Figure 6.7 – Strapi: Content Type of Exercise A1

On the front Office side, the result of this exercise is represented by Figure 6.8. The student begins by choosing the images he likes most and describing the feeling they convey to him.

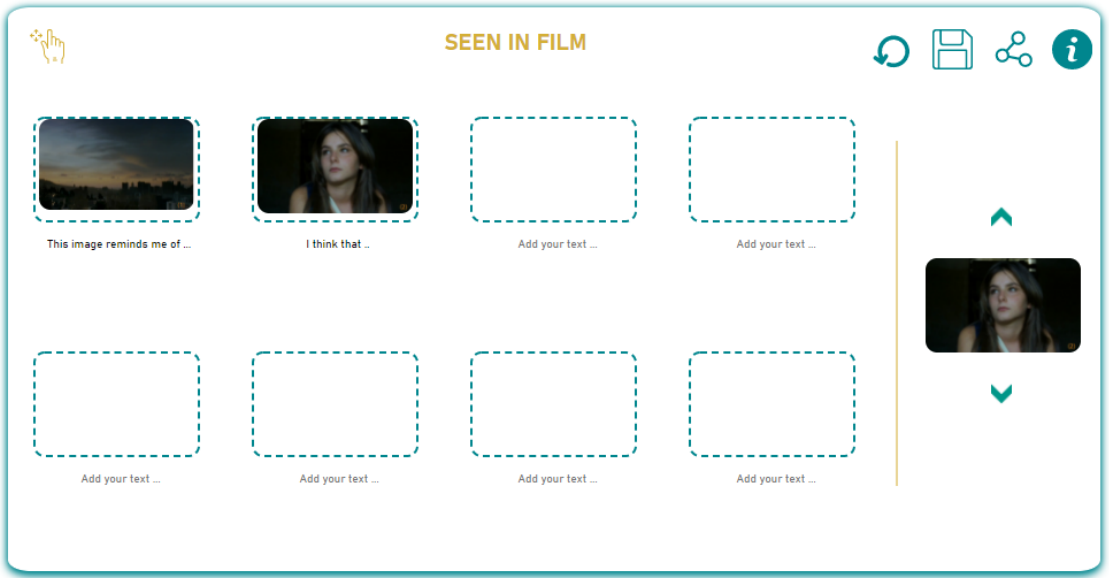

Figure 6.8 - FrontOffice: Exercise A1

Also, in Figure 6.8, it is possible to see 4 icons in the upper right corner. Each of them represents a different functionality (from left to right):

- **Clear exercise**: the exercise is completely deleted so that the student can start over again from scratch
- **Save exercise**: when the student completes an exercise, he must save it, before moving on to the next exercise. The "save" of the exercise is not done automatically, because first, all the information that the student enters, must be saved in Strapi, and only later in the database. An example of this, is the upload of images. In exercises that consist of uploading images (Figure 6.9), the image has to be uploaded to Strapi's media library (a plugin from Strapi), and only afterwards is saved in the database in the corresponding field (Figure 6.10)

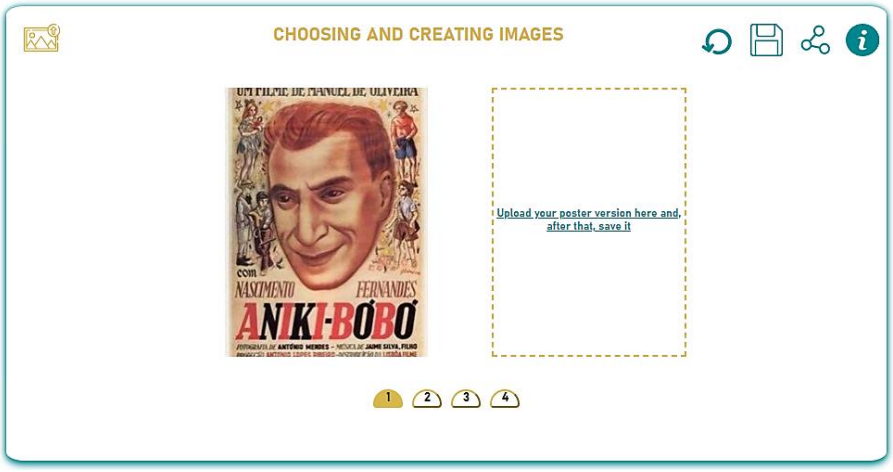

Figure 6.9 - FrontOffice: Exercise C2.1

In Figure 6.9, the student starts by selecting the image that he wants to upload. After that, he/she must save it by clicking on the “Save” icon. Figure 6.10 demonstrates the process of uploading and saving the image to the media library and database.

On lines 135/136 of Figure 6.10, a FormData is built. The FormData “provides a way to easily construct a set of key/value pairs representing form fields and their values”, where the “files” is the key, and the “image” is the content (is this case the uploaded image by the student) (*FormData - Web APIs | MDN*, 2020). After the formData is built, the content is uploaded to the Strapi’s media library (line 270), placing the image in the corresponding field for the content type, and saving it in the database (lines 281-282).

```
254     onSubmit = e => {
255         e.preventDefault();
256 
257         if (!this.state.NewPoster || this.state.NewPoster.length === 0) {
258             alert('Image not selected!');
259             return;
260         }
261 
262         this.setState({ loader: false });
263 
264         const studentSheetId = localStorage.getItem('studentSheetId');
265         const formData = new FormData();
266 
267         Array.from(this.state.NewPoster).forEach(image => {
268             formData.append('files', image);
269         });
270         axios
271             .post(`${BASE_URL}/upload`, formData, {
272                 headers: { 'Content-Type': 'multipart/form-data' },
273             }).then(res => {
274                 console.log('res: ', res);
275                 console.log('nome foto: ', res.data[0].name);
276                 //this.state.photoId = res.data[0].id;
277                 this.setState({ photoId: res.data[0].id });
278                 console.log('photoId: ', this.state.photoId);
279                 console.log('newPoster: ', this.state.NewPoster);
280                 console.log('noImage', this.state.noImage);
281                 axios.put(`${BASE_URL}/student-sheets-answers/${studentSheetId}`, {
282                     ExerciseC2_1_NewPoster: this.state.photoId
283                 }).then(response => {
284                     console.log(response)
285                     this.setState({ loader: true })
286                 })
287             })
288             .catch(err => {
289                 console.log(err);
290             })
```

Figure 6.10 - Images Upload Process

- Share student sheet: by clicking on this icon, the student will be redirected to a page where a code will be made available to him, which he can share with anyone he wants. Anyone who has a valid code will be able to view an already completed student sheet, where all fields will be “disable” so that there is no possibility to change the data entered by the author of the shared student sheet. This feature will be explored in more detail in section 6.4
- Info: this icon contains a brief description of the purpose of the exercise

All information communications between Strapi and the web application are done through APIs.

Once student sheets are available only to authenticated users, all calls to the content of student sheets on Strapi are made through the passing of a Bearer Token[7] of the authenticated user.

```
axios
    .get(`${BASE_URL}/student-sheet-englishes`, {
        headers: {
            Accept: "application/json",
            "Content-Type": "application/json",
            Authorization: `Bearer ${token}`,
        },
```

Figure 6.11 - Get API through Bearer token

If the call returns a failure, then the user is automatically redirected to a page where they are asked to register or to authenticate.

6.4 Share Student Sheets

After several brainstorming meetings to discuss what would be the best way to share student sheets, it was concluded that the generation of a unique code would be the best option. Thus, throughout the student sheet, the share icon is always available, so that the student can share its student sheet at any time. This sharing is done through a unique code, consisting of 15 characters (Figure 6.12 - FrontOffice: Sharing code).

Figure 6.12 - FrontOffice: Sharing code

[7] "The bearer token is a cryptic string, usually generated by the server in response to a login request. The client must send this token in the Authorization header when making requests to protected resources" (*Bearer Authentication*, no date)

Anyone who has access to a valid code, just enter it in the code reading field (Figure 6.13 - FrontOffice: NavBar with code box. Otherwise, an error message will be shown, indicating that the inserted code does not exist.

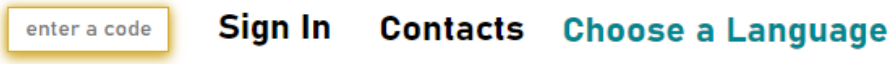

Figure 6.13 - FrontOffice: NavBar with code box

If the code is valid, then the user will be redirected to a page, containing a student worksheet, but with all fields in disabled format. Figure 6.14, represents the same exercise as Figure 6.9, but without upload options, remove or change the image.

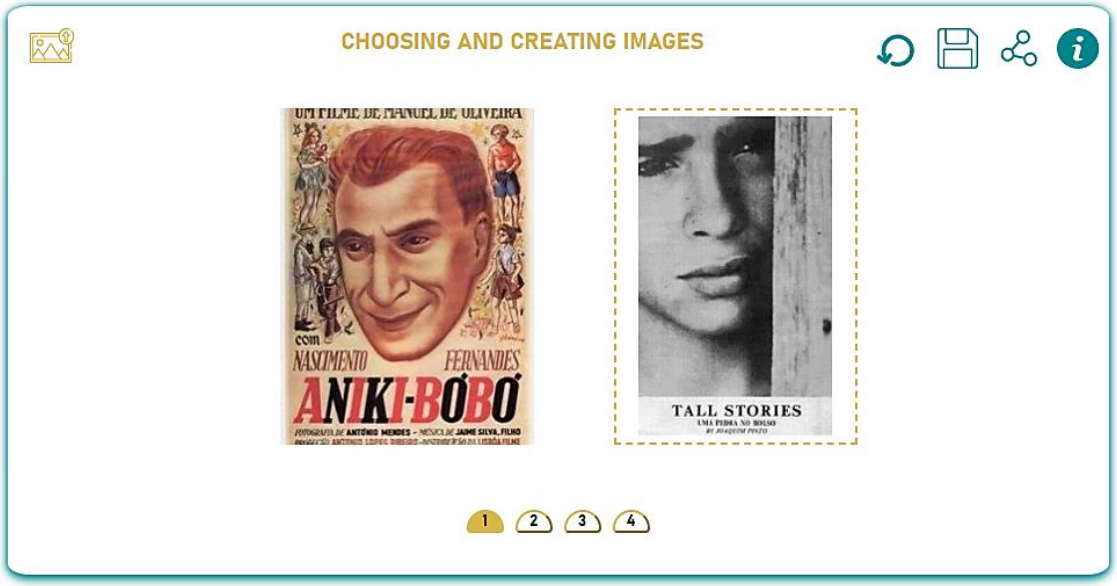

Figure 6.14 - FrontOffice: Visualization of a shred Student sheet

Once the description of the entire implementation process of the features related to the student sheets has been completed, the next section the implementation related to the content editor.

6.5 Content Editor

As was said in chapter4.3, both this feature and the interactive student sheets are the focus of innovation in this project. In this space, any student will have access to a wide range of images and sounds, which through their combination, will result in a slideshow. This feature will provide young people with an open and creative space where they can express themselves in any way they want.

However, and highlighting that the project is constituted by a consortium composed of 12 partner entities, communication, and decision-making by the partners, was not the best. Given that this is a very complex feature of the platform, there is a need for a joint and democratic decision by the partners, the implementation that was made could still suffer some future changes according to an evolution in the definition of the requirements.

Despite this, the entire research work was carried out, both at the design level (how the editor will be at a visual level, working also on the User Interface and User Experience part) and at a technical level (how it will be the architecture and structure of the publisher's implementation, what will be the best way of development). In this subsection, the analysis and study made of the design and how everything will be processed are presented.

This functionality, like the others, started with the analysis of the technical requirements imposed by the partners, in order to map them into mock-ups.

As also mentioned in section 4.3.1.4, this feature will have 2 types of output: a pdf containing image sequences, or a slideshow.

The user will have 2 menus at his disposal, containing the available images and sounds (Figure 6.15), as well as the main section, where the various elements will be associated (Figure 6.16).

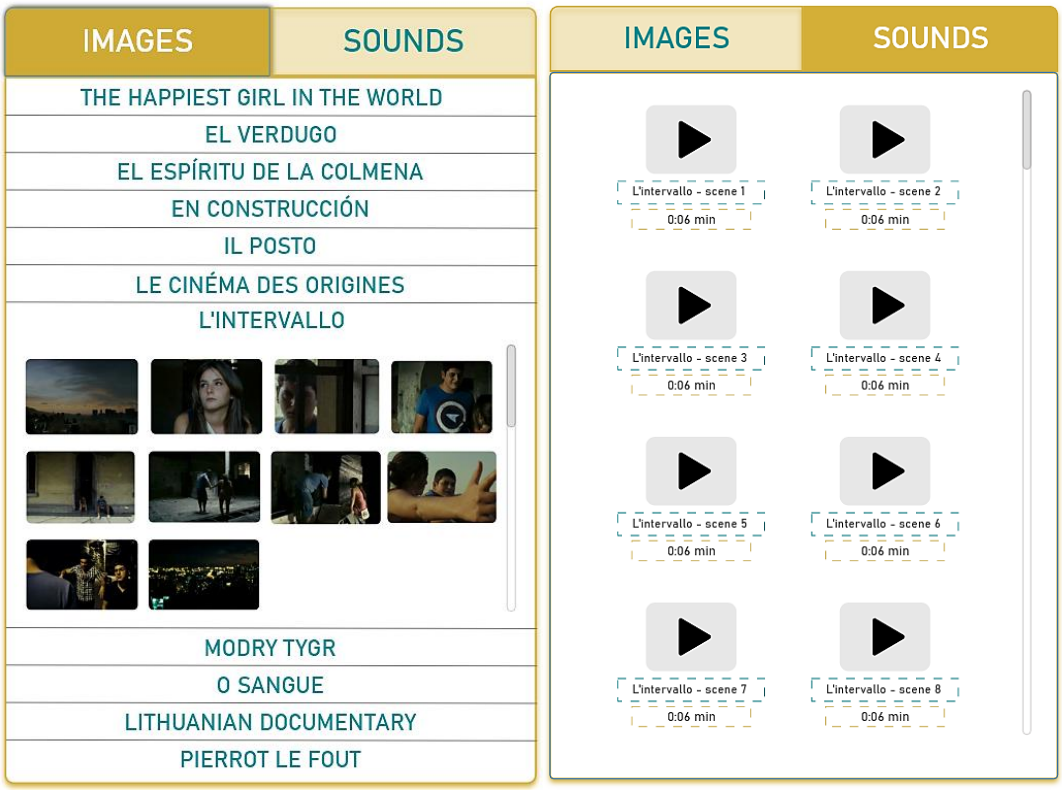

Figure 6.15 – Image and Sound Menus (respectively)

In the image's menu (on the left), they are categorized into sub-menus, corresponding to the different films, to facilitate their organization. In addition, it will be easier to search for images,

if the student is looking for an image that represents a specific moment in a certain film. The same goes for the sound's menu. Here, the user will find sounds from some scenes, songs, dialogues, and more general sounds (e.g., wind, rain, birds singing, etc). The choice of each of these elements (images/sounds) is done by drag and drop to the main section (Figure 6.16). This was done to maintain consistency and similarity with certain exercises in the student sheets.

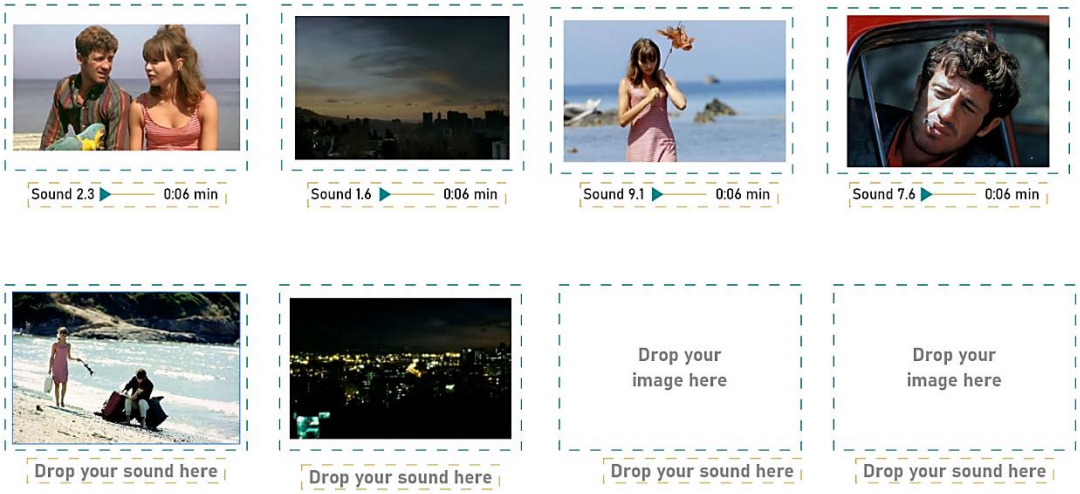

Figure 6.16 - Main Section of the Editor

When the student finishes his choices of images and, optionally, some sounds, he/she will be able to obtain, as a result, a slideshow, as illustrated in the figure below (Figure 6.17).

Figure 6.17 – Slideshow

This slideshow can be presented in 2 ways:

- each image is presented with exactly the same duration as the sound that is associated with it
- or, there is only one sound, which acts as a background for the set of chosen images. In this case, the duration of each image in the slideshow is fixed and equals the duration of the sound divided by the total number of images of the sequence

As others in the platform, this feature is designed and implemented in a very simple way so that it can be used by very small children, aged from 6 years old onwards, and who do not have much experience with computers or other types of digital technologies experience However, for older children, some features could be added, as will be seen in chapter 8.3.

If the student selects for the option of only downloading the chosen images, then the result will be a PDF, as shown in Figure 6.18.

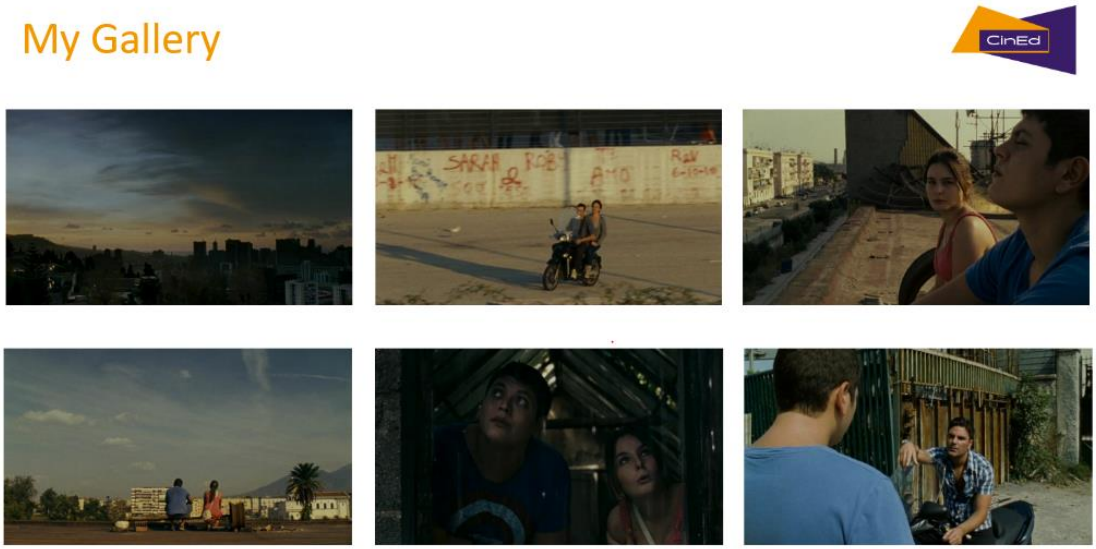

Figure 6.18 - Images PDF

6.6 Multilanguage Support

In order to make the platform accessible in several European countries, and given that not all children understand English, it was decided that it would be available in 12 languages: Belgian, Czech, Deutsch, Finnish, French, Croatian, Italian, Lithuanian, Portuguese, Romanian, Spanish and English.

There are 2 types of translations made on the platform: the translation of static content, and the translation of dynamic content.

6.6.1 Translation of static content

Static content is all content that is not introduced into Strapi by partners since it is permanent information. Examples of static content can be found on the homepage, about the project, teachers, and contacts.

To deal with this type of translation, the “i18next” framework was integrated. “I18next is an internationalization-framework written in and for JavaScript” (*i18next*, 2021). This framework has a wide range of plugins available, which facilitates the integration and management of the loading of the various languages. In addition, it also contains an automatic language detector, with no need, on the part of the author, to have to detect the user's language manually.

Initially, a file was created with the general configuration of i18next (Figure 6.19). This configuration allows automatic loading of the files with the various translations, detecting the user's language and, in case of not being able to detect it, use English as a fallback (language defined by default).

```
i18n
  // load translation using http
  .use(Backend)
  // detect user language
  .use(LanguageDetector)
  // pass the i18n instance to react-i18next.
  .use(initReactI18next)
  // init i18next
  .init({
    fallbackLng: 'US',
    debug: true,
```

Figure 6.19 - i18next.JS Configuration

Then, the various files were created with the translations collected from partners, to proceed with their implementation in the components of React.

For this, and in order to not to have to change the implementation made until that moment, the “withTranslation HOC” (higher-order component) was used. “The withTranslation is a classic HOC and gets the t function and i18n instance inside your component via props” (*withTranslation (HOC)*, 2019) (Figure 6.20).

```
const NavBarComponent = withTranslation(['translation'])(NavBarClass);
```

Figure 6.20 - withTranslation HOC usage

The translation process for the various components is very similar. However, it is in the “NavBar” component, that the various translations are loaded (Figure 6.21).

```
<div className="dropdown">
    <div className="changeLanguageWrapper">
        <button className="dropbtn"><b>{this.state.chooseLanguage}</b></button>
        <img src={dropDown} className="dropbtn" alt="dropDown"></img>
    </div>
    <div className="dropdown-content">
        <li value="bg" onClick={() => this.handleClick('BG')}>BG</li>
        <li value="cz" onClick={() => this.handleClick('CZ')}>CZ</li>
        <li value="de" onClick={() => this.handleClick('DE')}>DE</li>
        <li value="fi" onClick={() => this.handleClick('FI')}>FI</li>
        <li value="fr" onClick={() => this.handleClick('FR')}>FR</li>
        <li value="hr" onClick={() => this.handleClick('HR')}>HR</li>
        <li value="it" onClick={() => this.handleClick('IT')}>IT</li>
        <li value="lt" onClick={() => this.handleClick('LT')}>LT</li>
        <li value="pt" onClick={() => this.handleClick('PT')}>PT</li>
        <li value="ro" onClick={() => this.handleClick('RO')}>RO</li>
        <li value="sp" onClick={() => this.handleClick('SP')}>SP</li>
        <li value="en" onClick={() => this.handleClick('US')}>EN</li>
    </div>
</div>
```

Figure 6.21 - Navbar Component

If the platform starts in English, and the user wants to change the language, the function "handleClick(language)" is called. This function (Figure 6.22), maps the received parameter, in the list with the various translated files, and loads the correct file.

```
handleClick(lang) {
    i18next.changeLanguage(lang)
}
```

Figure 6.22 - NavBar Component: handleClick function

A concrete example can be explained through Figure 6.23 and Figure 6.24. If the user wants to browse the French platform, the file "FR/translation" is loaded, and therefore all the values "{t ('NavBar.xxxx')}" represented in Figure 6.23 will be replaced by the values in Figure 6.24.

```
<nav className="navbar">
    <div className="container-fluid">
        <ul className="nav navbar-nav">
            <div className="leftLinks">
                <li><a href="/"><img src={logo} className="logoNav" alt="logoNav"></img></a></li>
                <li><a id="movies" className="link" href="/collection" onClick={this.goMovies}>{t('NavBar.Movies')}</a></li>
                <li><a id="eventsNews" className="link" href="/newsEvents" onClick={this.goEventsNews}>{t('NavBar.EventsNews')}</a></li>
                <li><a id="project" className="link" href="/about-project" onClick={this.goProject}>{t('NavBar.Project')}</a></li>
                <li><a id="teachers" className="link" href="/teachers" onClick={this.goTeachers}>{t('NavBar.Teachers')}</a></li>
            </div>
        </ul>
```

Figure 6.23 – "t" function usage

```
"NavBar":{
  "Movies": "Films",
  "EventsNews": "Evénements/Actualités",
  "Project": "Projet",
  "Teachers": "Enseignants",
  "Students": "Élèves",
  "SignIn": "S'identifier",
  "Contacts": "Contacts",
  "Language": "tradução"
}
```

Figure 6.24 - French Translations File

6.6.2 Translation of dynamic content

As mentioned in 6.1, Strapi does not yet have a language management mechanism, so several fields dedicated to the translation of dynamic content have been built. This dynamic content is all the content that will be introduced by the partners, and that can be changed with some frequency, or are constantly introducing new content on the platform. Examples of dynamic content are student sheets, news/events, and all information related to the films.

The translation process for the details of a film takes place as follows:

- A partner starts by introducing all the information about the film in English (mandatory, as it is the language chosen as the fallback), and optionally, in his mother tongue, as shown in Figure 6.25.

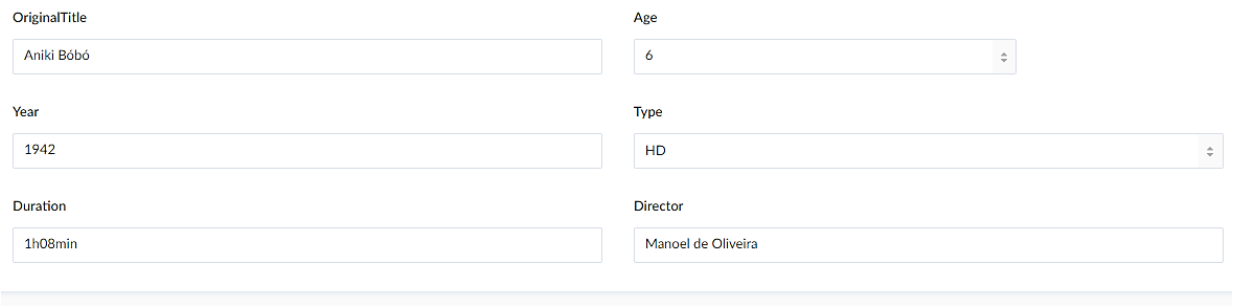

Figure 6.25 - Strapi: Movie Details, part I

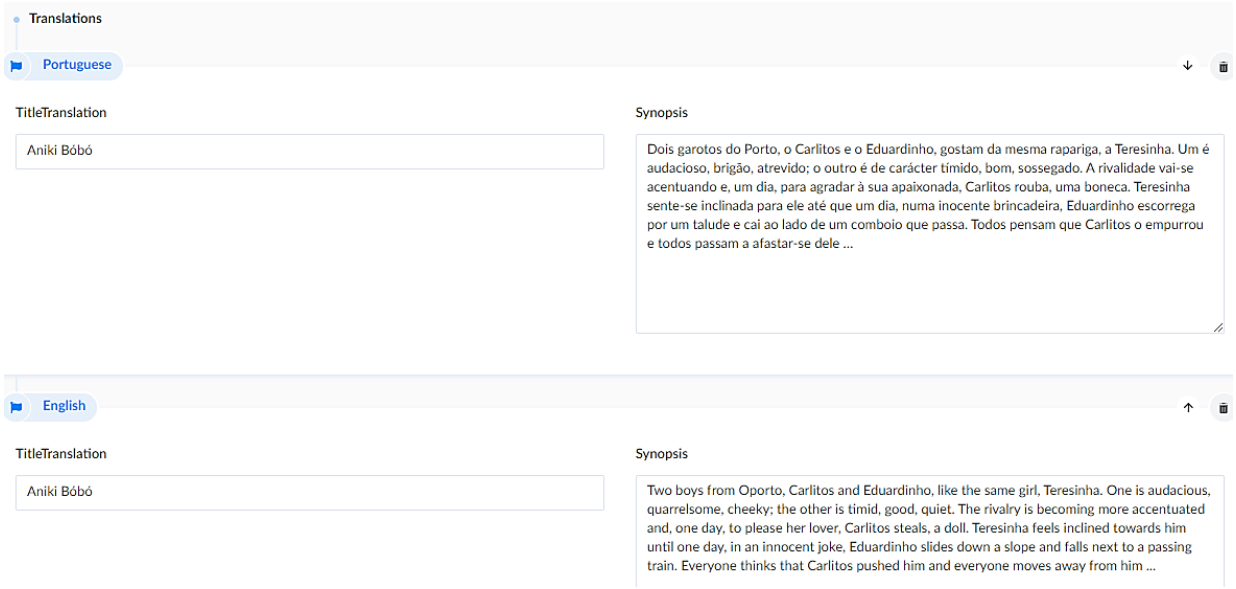

Figure 6.26 - Strapi: Movie Details, part II

- When all the necessary information is complete and the partner publishes the new information on the platform, react will map the languages. In this case, as the information about that specific film is only available in English and Portuguese, any other language that is chosen by the user, will be presented in English. Figure 6.27 represents that same mapping: it verifies which language to be used by the user at that moment (i18next.language), and if the return value is not available, it returns the English translations.

```
if (i18next.language === "PT" && (components.filter(t => t === "translations.portuguese").toString())) {
    this.setState({ language: "translations.portuguese" });
} else if (i18next.language === "SP" && (components.filter(t => t === "translations.spanish").toString())) {
    this.setState({ language: "translations.spanish" });
} else if (i18next.language === "CZ" && (components.filter(t => t === "translations.czech").toString())) {
    this.setState({ language: "translations.czech" });
} else if (i18next.language === "FI" && (components.filter(t => t === "translations.finnish").toString())) {
    this.setState({ language: "translations.finnish" });
} else if (i18next.language === "RO" && (components.filter(t => t === "translations.romanian").toString())) {
    this.setState({ language: "translations.romanian" });
} else if (i18next.language === "FR" && (components.filter(t => t === "translations.french").toString())) {
    this.setState({ language: "translations.french" });
} else if (i18next.language === "BG" && (components.filter(t => t === "translations.bulgarian").toString())) {
    this.setState({ language: "translations.bulgarian" });
} else if (i18next.language === "IT" && (components.filter(t => t === "translations.italian").toString())) {
    this.setState({ language: "translations.italian" });
```

Figure 6.27 - Language Mapping

The expected result are as follows:

- Figure 6.28, if: i18next.language == “PT”

Figure 6.28 - FrontOffice: Portuguese Version

- Figure 6.29 if: i18next.language == “US”, or in any other language not available at Strapi

Figure 6.29 - FrontOffice: English Version

6.7 Summary

In this chapter, was explained how the implementation process for each feature and functionality was made, from the back-office structure to the management of different users.

As it was possible to see, and although almost features were implemented, the content editor was not completely finished since the lack of communication with partners decreased in these last 2 months. Also, some problems with the actual technical company responsible for the maintenance of their platform appeared, contributing for the delay of several details for some features.

Now, that the development is concluded, it is necessary to evaluate and test to make sure the quality of the system is good as well as the features are correctly implemented. In the next chapter, all tests, methods, and experiences are executed and analysed.

7 Experiments and Evaluation

"Software testing plays a vital role in the affirmation of the software quality and reliability"(Brar and Kaur, 2015). After developing any product, it is necessary to evaluate it to see if the problems identified have been mitigated as well as if the solution produced is of sufficient quality.

It is expected that there will be evaluations throughout the development process but there are some quantities that can only be evaluated when the product is developed.

This chapter aims to evaluate the solution developed both at a technical level and at the level of usability and performance by defining experiences, tests, questionnaires and analysing their results.

7.1 Hypothesis

Based on the problem and the objectives that are intended to be achieved with this project, the hypothesis that is defined for this thesis is redesigning the CinEd platform and the development of a young space, containing new social inclusion activities will contribute to support the learning achievements and the personal development of youngsters within the scope literacy.

7.2 Evaluation Measures

From the beginning, quantities were identified that would have to be considered during the entire process of project development, as in the choice of technologies and approaches, so that the fine solution was the best possible.

To correctly assess whether the objectives set were achieved, the amounts to be evaluated are divided into:

- Degree of usability difficulty
- Response time of certain functionalities, as mentioned in section 4.3.2.3
- General quality of the system

These values will be calculated and analysed in the next sections (from 7.3.1 to 7.3.3).

7.3 Evaluation Methodology

Evaluation methods are an integral part of a project's evaluation process. This process consists of a set of activities that, according to the indicators to be defined, will allow the assessment of the formulated hypothesis to proceed.

In this context, methods, tests, and questionnaires were applied.

The evaluation of the solution occurred in several phases so that each feature was evaluated and analysed correctly. For this, all the tasks to be performed in this module were distributed by three milestones, as can be seen in Table 11.

Table 11 - Evaluation milestones

Milestone	Deadline
Quality Evaluation Framework	2021/06/13
Performance Testing	2021/06/20
Usability Testing	2021/06/20

As shown in Table 11, three processes were carried out to evaluate the system as a whole, in order to verify if the defined hypothesis, mentioned in 7.1, was achieved.

The technical quality of this project is measured through software testing, such as performance testing as well as the usage of a quality evaluation framework. These two processes are very straight, that means that there is no need of any statistical study, to analyse the outcome values.

The degree of usability difficulty testing is the most difficult value to measure once the concept of “usability” is based on the personal experience of each person. However, it is possible to run some methods and processes in order to evaluate that user experience and turn that experience into a measure value, as it will be seen at section 7.3.3.

7.3.1 Quality Evaluation Framework

The diversity of educational technological solutions opens new perspectives in improving the quality of education systems (Escudeiro and Bidarra, 2008). It is in this context that the Quantitative Evaluation Framework model, known as QEF, appears capable of validating and guaranteeing the quality of systems.

This model (represented from **Error! Reference source not found.** to **Error! Reference source not found.**) assesses the content of the system in 3 dimensions. Each dimension has a set of factors, and each factor has a set of requirements and indicators to be evaluated quantitatively, "measured in percentage relatively to a hypothetical ideal system, whose total quality is assumed to be 100%"(Escudeiro and Bidarra, 2008).

Table 12 shows the dimensions and the respective factors of a particular standard that can be the basis to create quality scenarios for specific software products. Once this project is inserted in an educational environment (including very young children), all the factors aggregated in each of the dimensions, have the purpose of evaluating the solution according to the best possible expectations. All of them are focused on content evaluation, pedagogical components, and usability.

Table 12 - Dimensions and its factors on QEF

Functionality	Functional
	User Experience
	Content Quality
Adaptability	Versatility
	Motivational Aspects
	Pedagogical Aspects
	Maintenance
Efficiency	Audio-visual Quality
	Technical Elements
	Navigation

In particular, for CinEd, the QEF quality scenario considers the following factors per dimension:

- Functionality dimension:
  - Functional aspects: Declare all functional requirements for each of the main features of the project, namely the back-office, student sheets, and content editor

    - User experience aspects: All indicators related to the experience of the user when utilizing the resources to be developed. These requirements go from navigation experiences, system performance, and layout
    - Content quality aspects: This factor is directly linked to the quality of the content that will be presented to the user. All content must be simple to interpret
- Adaptability dimension
    - Versatility aspects: Here, it specifies the versatility that the system should present, both to search browsers and devices
    - Motivational aspects: Based on the concept of gamification. Pedagogical materials and tools should stimulate students' motivation throughout the development of their work
    - Pedagogical aspects: Indicators on the pedagogical content to be available
    - Maintenance aspects: This factor refers to the maintenance of the entire system to be developed in this thesis, such as, for example, the updating and insertion of new content
- Efficiency dimension
    - Audio-visual quality aspects: The quality of audio-visual content, as it will be used in the tools to be developed, and used by young people must have a good quality
    - Technical elements aspects: Requirements related also to performance, but this time, between the back-office platform, with the front-office
    - Navigation aspects: Requirements related to the level of control that the user may have during the navigation of the existing functionalities

After identifying the dimensions and their associated factors, the criteria/requirements were defined, indicating the needs/characteristics that the system must have to meet the initially proposed objectives (from Table 13 to Table 17, in Annex A).

After defining all the requirements comprised, in each factor, the quality scenario specification requires to classify each requirement according to its degree of importance. The importance of a requirement to a factor, is between 2 and 10 (2 being the lowest and 10 the highest importance).

In addition, three levels were defined to reduce the ambiguity when assessing each requirement as to its degree of fulfilment (Figure 7.1, and from Table 18 to Table 22, in Annex B).

Wfk - Fullfilment (%)		
0	**50**	**100**
0-1 positive questionnaires	2-3 positive questionnaires	4-6 positive questionnaires
Low similarity	Only half of the categories present a similar design	High similarity
No	-	Yes
Contents are not appropriated to the users	Contents are appropriated to one or two of the users.	Contents are appropriated to all of users
One or more functionalities available to type of users without that permission	-	Functionalities only available to certain types of users
>3 actions	-	<= 3 actions
No navbar presented	Only half of the screens present a navbar	Navbar presented in all screens
0-1 positive questionnaires	2-3 positive questionnaires	4-6 positive questionnaires
No menu presented	Only half of exercises present a menu	Menu presented in all screens
0-1 positive questionnaires	2-3 positive questionnaires	4-6 positive questionnaires
No menu presented	-	Menu presented in all screens

Figure 7.1 - Fulfilment of a metric evaluation

Now that the QEF quality scenario is completely specified, it is time to analyse the results. All results were obtained through automatic calculus from an existing excel sheet, and from that, is it possible to analyse 3 important values: system performance by factor, by dimension, and the general system quality.

- System performance, by factor (represented by Figure 7.2)

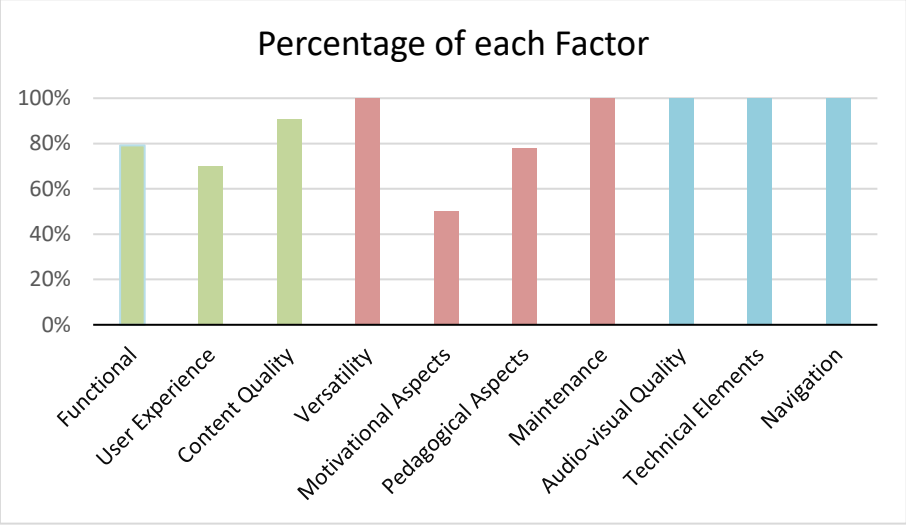

Figure 7.2 - QEF: Percentage of each Factor

  - Analysing the chart, it is possible to notice that most of the factors, have a quality rate above 70%. The only factor that has a percentage value below 70, and as for coincidence, has the lower value, is the “Motivational Aspects” factor.

However, this value can be explained when the requirement associated to that factor is seen: "**Content Editor and Student Sheets are designed in a way which motivates and stimulates users to interact with the available tools: through animations, sounds and interaction**". Also, and accordingly to its metric, the value of 50% was attributed, since this requirement is present in the student sheets, but not in the editor

- System performance, by dimension (represented by Figure 7.3)

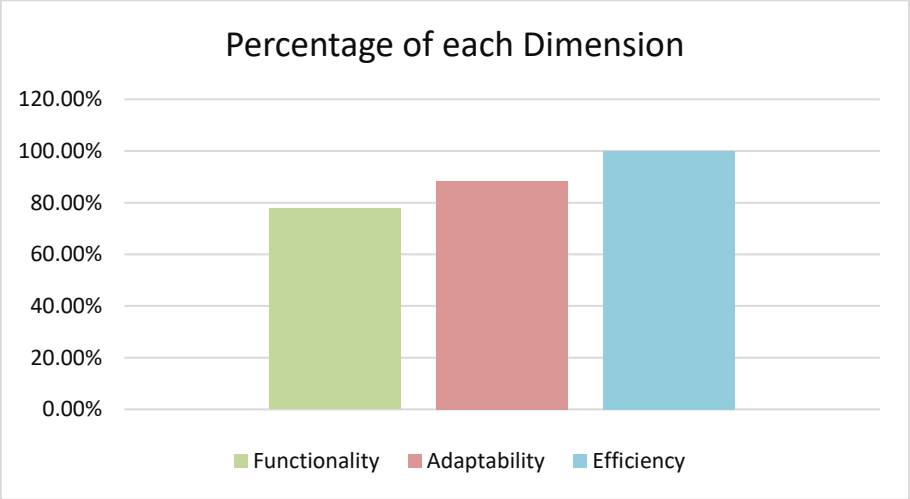

Figure 7.3 - QEF: Percentage of each Dimension

  - This char, presenting the general quality of each dimension, is based on the previous values of Figure 7.2, as each factor belongs to a dimension. For example, as all factors of "Efficiency" dimension had the maximum value of quality then, also this dimension presents the maximum value for its quality (100%). As it is possible to see at Annex A, Table 17, this dimension aggregates all requirements about navigation system, response time (all values will be analysed in the next section), and the quality of audio-visual elements
- System performance as a whole

The value for the overall system performance were 91%. This value shows that, in general, the system has a good performance.

7.3.2 Performance Testing

Throughout this document, the word "performance" has appeared many times. This is because there is a high probability that the solution will be used in places with weak access to the wi-fi network, and therefore, it must have good values of performance.

Thus, it is necessary to carry out some tests about the performance of the software. Performance tests, "involves the evaluation of the software product on multi-dimensional aspects including Speed, Load, Traffic, Stress, Susceptibilities and many others" (Pradeep and Sharma, 2019). Performance will be tested in both test phases as response times are likely to differ from the development environment to the production environment.

To execute performance tests, google chrome dev tools were used, in this case, the Lighthouse. "Lighthouse is an open-source, automated tool for improving the quality of web pages […] it runs a series of audits against the page, and then it generates a report on how well the page did" (*Lighthouse | Tools for Web Developers*, 2021). Before moving on to the analysis of the results of the performance tests, it is necessary to explain which metrics are evaluated by the Lighthouse.

- First Contentful Paint marks the time at which the first text or image is painted
- Time to interactive is the amount of time it takes for the page to become fully interactive
- Speed Index shows how quickly the contents of a page are visibly populated
- Sum of all time periods between FCP and Time to Interactive, when task length exceeded 50ms, expressed in milliseconds
- Largest Contentful Paint marks the time at which the largest text or image is painted.
- Cumulative Layout Shift measures the movement of visible elements within the viewport

In addition to the metrics, Lighthouse provides a set of suggestions that can help improve the performance of the pages being tested.

The pages to be tested at the performance level will be the collection page, containing all the available movies and pedagogical videos, and an exercise of a student sheet. This is because they are the pages that receive more information from the back-office, and therefore, can be the pages with the worst performance values, when compared to other ones (page about the project, news, events, among others).

At the end of this section, the performance values of these two pages will be compared when tested in a development and production environment, in order to verify the existence of very large value ranges.

7.3.2.1 Development Environment

The first page being analysed, it is the collection page, containing all movies and pedagogical videos. At Figure 7.4, the number in a circle at the top right indicates the overall performance score on a scale of 1–100. This page has currently a 62, which indicates that there is a chance for improvement along with the suggestions provided to increase the score and performance.

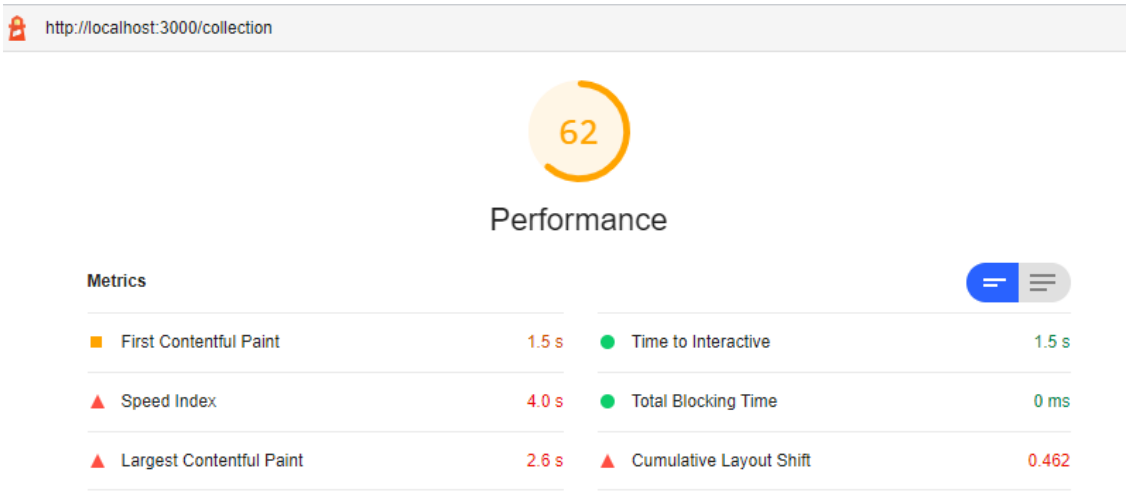

Figure 7.4 – Development Environment: Performance of collection page

In the following image (Figure 7.5), there are suggestions for improvement that can be made in order to refine its performance.

Figure 7.5 – Development Environment: Suggestions for collection page

The same goes for one of the student sheets exercises pages. However, its performance is way better than the collection's page. One of the reasons could be that the collection page must load all the information related to the existing movies and pedagogical videos, while in this case, only the information related to a single exercise is loaded.

Figure 7.6 shows the overall performance and its respective metrics regarding page loading.

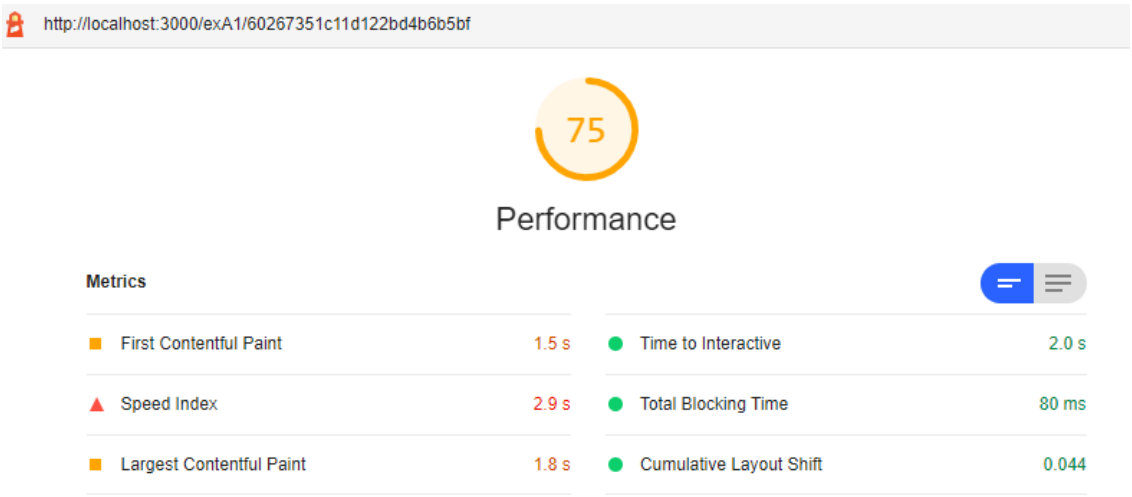

Figure 7.6 - Development Environment: Performance of an exercise

Despite presenting a relatively good performance, suggestions for improvement are presented at Figure 7.7.

Figure 7.7 - Development Environment: Suggestions for the exercise

With the performance values analysed in the development environment, it is time to analyse the values in the production environment, to see if they will differ a lot.

7.3.2.2 Production Environment

Now that all performance values were analysed at the development environment, it is time to verify if those values, for the same pages, can be higher in the production environment, once that is the environment that users will work on it.

As it happened in 7.3.2.1, the first page to test is the collection page. In the next figure (Figure 7.8), there are the values obtained in the report, after the tests are executed. At first sight, it is possible to notice that the general performance value is 76, considerably higher than in the development environment and, consequently, better.

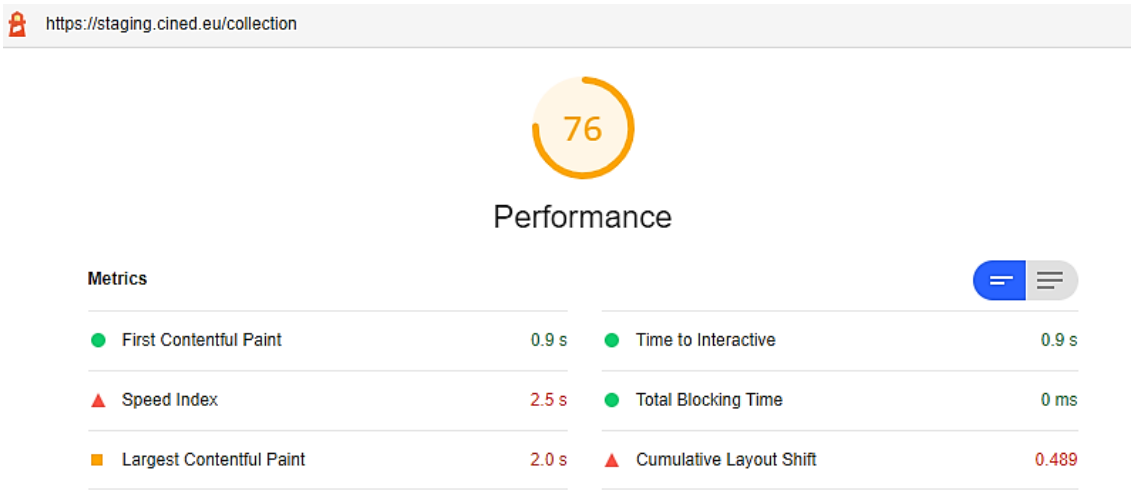

Figure 7.8 -. Production Environment: Performance of collection page

Despite of being a considerably good value, there are improvements that can be done, in order to make the performance even better (Figure 7.9).

Figure 7.9 - Production Environment: Suggestions for collection page

As can be seen in almost of all suggestions that the report gave, in these testing, are about the size of images. It should be made a study in order to understand the causes, and figure it out a solution.

To conclude these types of tests, follows the testing of the same exercise tested in the development environment, so that the values can be trustful in order to make a good comparison between all values obtained.

Figure 7.10 shows the result of the executed test. As it happened in the development environment, the values of the exercise are higher than the values of the collection page.

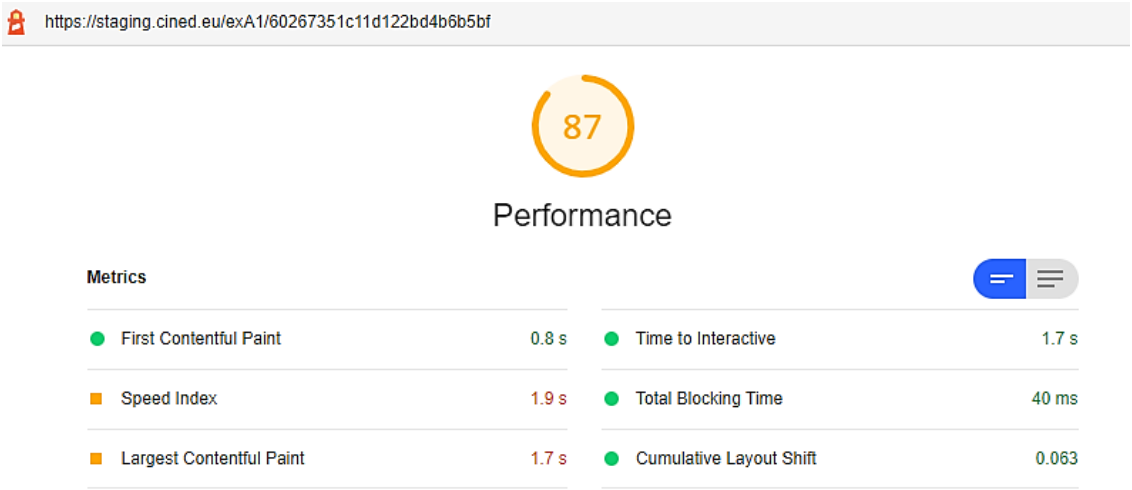

Figure 7.10 - Production Environment: Performance of an exercise

Now that all values were calculated, both in development and production environment, the next section has the objective of making a comparison and take some conclusions.

7.3.2.3 Comparison of performance values between development and production environment

After knowing all the relevant performance values and suggestions for improvement, so that each of the associated values could improve, it makes perfect sense to make a quantitative comparison between the several results.

Starting with the response time, in chapter 4.3.2, referring to the non-functional requirements, and regarding the performance characteristic, it was mentioned that the response time of the system should be between 1 and 2 seconds, with the maximum value being considered as 4 seconds. If the performance value exceeds these 4s, its implementation would have to be checked in order to re-implement certain details to increase and improve the performance of the system.

The chart on Figure 7.11, represents the response time values for each of the pages tested in the development and production environments.

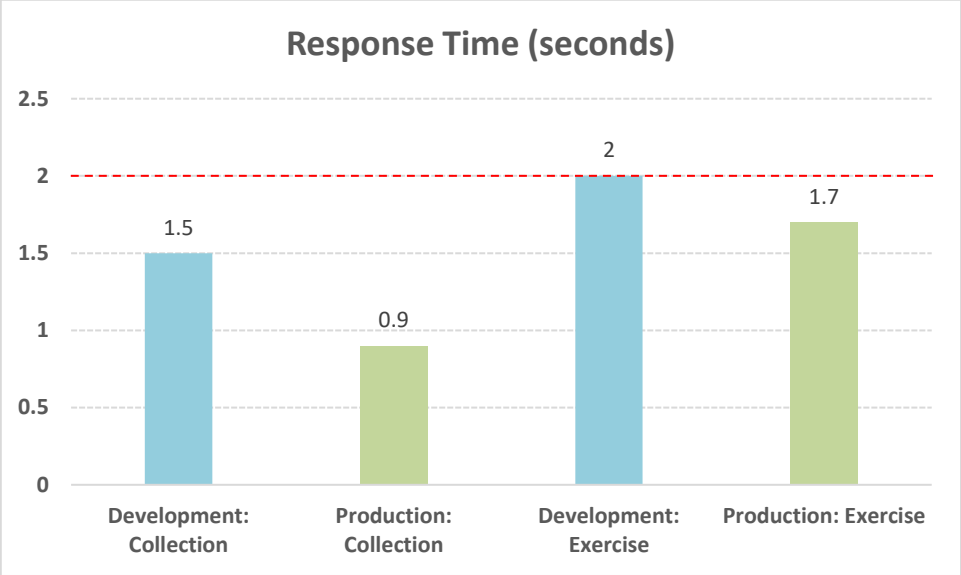

Figure 7.11 - Response time in development and production environment

Accordingly, to the value presented in the chart, it is possible to say that values in production environment are considerably lower, as expected. It can be also seen that these values are bellow of the “red line”, the limit of the response time stablished at the non-functional requirements.

About the general system performance of the testes pages, its comparison is made at chart of Figure 7.12.

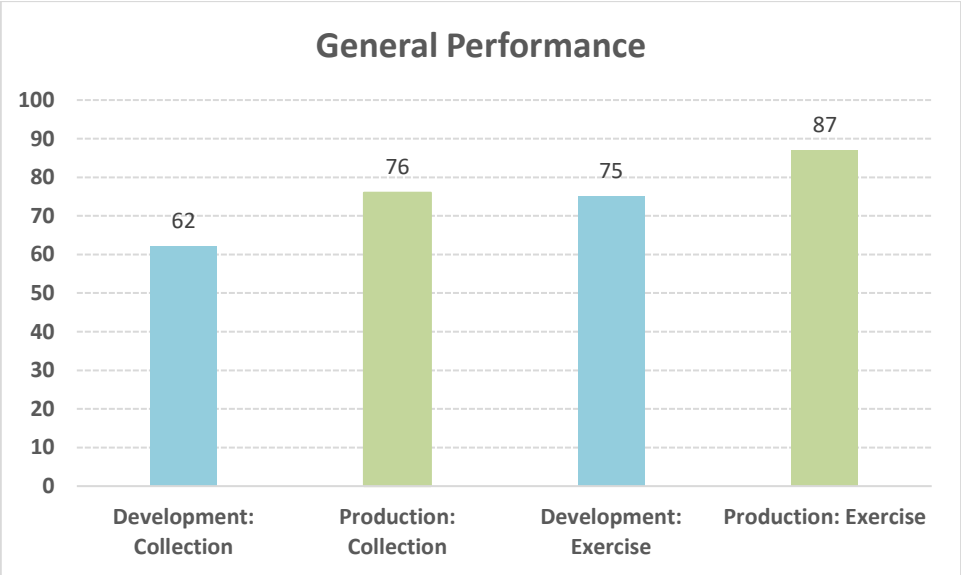

Figure 7.12 - General performance in development and production environment

After analysing the chart, all performance values related to the pages tested in the production environment, are way better than the values obtained in the development context. However, some improvements can be done in the collection page, once its value is below 80. On the other hand, the exercise of the student sheet has a value close to 90, so can be concluded that presents a really good performance.

In the next chapter, a study about usability and user experience will be carried out. Some details that will be analyse in the next section, had impact in some values previous presented, namely the "User Experience" factor, belonging to "Functionality" dimension.

7.3.3 Usability Testing

"Usability testing is a challenge because, most of the times, it cannot be accomplished without the presence of real users, which is complex and requires a lot of effort" (Dias and Paiva, 2017).

According to Dias and Paiva (Dias and Paiva, 2017), there are some platforms and tools that support usability testing. These platforms, like m-pathy[8], EyeTracking[9] or Optimizely[10], involve an analysis of user actions, like mouse speed or clicks. On the other hand, Sasmito, Zulfiqar and Nishom (Sasmito, Zulfiqar and Nishom, 2019), present "System Usability Scale" method (SUS method), founded by John Brooke on 1986. "SUS is the questionnaire to measure the utilizing perception" (Sasmito, Zulfiqar and Nishom, 2019).

Despite this previous study of methods and platforms to test the usability of the various tools developed, these were not used. The entire process foreseen to make usability tests with partners, professors, and students, was not achieved. Since the project coordination (Cinemateca Portuguesa), having had huge problems with the technical company responsible for the maintenance of the current platform, it meant that the dissemination of this new platform/tools was postponed, which made it impossible to distribute the previously prepared questionnaires.

However, and in order to get some feedback on the work, a session was held with 4 elements who had no contact with the current platform, nor with my developed project. During this session, they were asked to explore all the features they had access to, so as not to in any way influence the process of "discovering" the features. In the end, some conclusions were reached:

- Some icons were not completely intuitive, namely, the set of icons present on the student sheets responsible for the reset, save, share, and description of the exercise
- The regex when creating a username was not correctly configured
- The "share student sheet" feature was not working correctly
- Certain animations were not supported on Linux/Mac, or on different browsers

[8] https://www.m-pathy.com/cms
[9] https://www.eyetracking.com/what-is-eye-tracking/
[10] https://www.optimizely.com/optimization-glossary/ab-testing/

In this way, this session served to make some refinements at the UI/UX level, as well as to make small corrections in certain functionalities, namely in the share of the student sheets. Furthermore, when partners, teachers, and students test the platform, they will no longer face the difficulties these 4 people were subjected to.

However, in the Annex C, it is possible to find the questionnaires that will be submitted to the various users in the near future, as soon as the problems of Cinemateca Portuguesa with the technological company are resolved.

7.4 Summary

In this chapter, all forms of project evaluation are presented to prove that it solves the identified problems. Through this evaluation, it is possible to perceive the results of the work carried out as well as make some conclusions and define future work.

To this end, performance and quality tests were carried out using the QEF method, and a session to test its general usability. The evidence gathered through this assessment methodology allow us to conclude that, in general, the project was successfully completed, but that there is room for improvement.

Once the solution has been validated, it is important to make some conclusions from it as well as define future work in order to improve or/and continue the project. The following chapter presents the main conclusions of the project, the main limitations that were felt throughout its development, and presents the lines for future work.

8 Conclusions

As presented in chapter 1, a methodology for the design based on the article "Design Science Research Methodology" was followed. The methodology proposed for the project contains several stages from planning, with the definition of objectives based on identified problems, as well as the development and implementation of a solution that achieved the objectives, until the definition and implementation of tests that validate the solution. Through the various tests performed and analysed in the previous chapter, it is possible to see if the project was successful if it meets the defined requirements and if it solves the identified problems.

8.1 Objectives Achieved

In the initial phase of the project, a set of objectives were identified and defined, and it is necessary, now in the final phase, to assess whether these were achieved.

The objectives defined within the scope of this project are found in section 1.4 and are as follows:

- Turn all pedagogical materials into interactive materials
    - This objective was fully achieved, as it is possible to fill, save and share a specific student sheet, without the need for any other extra equipment than a computer and internet (such as notebooks, pencils, pens, erasers, or printers)
- Content editing platform: Development of a content editing platform, through the association of several images and sounds
    - As seen in 7.3.1, the overall quality value of the system could be higher if the content editor were fully finished and functional. This was since the partners did not give enough feedback regarding certain particularities, preventing its completion. Thus, it can be concluded that this objective was not fully achieved.
- New website: Development of an improved website with multi-language support

    - This objective was also successfully achieved, despite the delay in the response from partners regarding static platform translations. It is available in a set of 12 languages, each one corresponding to the mother tongue of each partner plus English, being the most used world language.
- Development of a back-office (content management system)
    - This objective was successfully achieved, as it is possible to insert all types of content requested by partners in the back office and be presented in a fully formatted and responsive way in the front office.
      Also, through the usability session, as presented in the previous chapter, it was seen that the back-office is working correctly and that it has good usability.

In general, it can be concluded that the project was carried out and completed successfully, despite the feature related to the content editor not being fully complete. In the next subchapter, the greatest difficulties experienced throughout the development of the project will be listed.

8.2 Limitations

Although all the work developed over these 8 months was very productive, some difficulties were felt since its beginning.

The difficulty that was felt most throughout the project, but that prepared the author for the future and professional career was the communication and management of ideas with partners. This was essentially due to two major facts:

- Partners without any kind of technical background
    - Something that happened several times, was the partners wanting a feature or a specific detail in a feature, without having any idea of the technical implications that such decision could have in the work already developed, or in future work
- Feedback time delay
    - The delay in feedback, or delay in making some decisions, was also felt a lot since the beginning of the project, but especially now in its final phase. This delay in feedback or the delay in making decisions, sometimes made the development of the work difficult, as happened with the content editor

To conclude, the next section will mention the work that will be carried out in the coming months, as well as ideas that could also be implemented in the near future.

8.3 Future Work

Despite the overall success of the project and its implementation, there are tasks to be performed in order to definitively complete the project.

As already mentioned, it is necessary that mainly the student sheets and content editor are tested by children of various ages, in order to understand if there is a user experience compatible with the project's end-user.

On the other hand, there are features that have not been fully implemented. An example of this is content editor. In addition to this feature, there are others that may be implemented in the future, such as:

- Creating more complex features in the content editor
    - Editing the chosen images, with filters, text insertion, or option to choose the passage time of each image in the slideshow
- Creation of student sheets according to the children's ages
    - Student sheets could be more complex and challenging for older children, or simpler for younger children
- Creation of a back-office from scratch
    - Although Strapi is an excellent CMS in terms of features and user experience, the ideal would be to create a back-office from scratch, for this type of project, which needs a very high level of content management. As such, Strapi had some limitations in terms of content management, such as: it is not possible to manage multilingual content, content types can, sometimes, be very extensive, and the fact that it is necessary to upload all images and files to the media library (Strapi plugin), without an organization by files or content (like: a section for pdf files, a section for audio files or the ordering of images following a criterion)

Lastly, the system will need ongoing maintenance whether it is to fix bugs or to increase some functionalities.

Additionally, it is expected the promulgate this work in the form of a scientific article and its presentation at meetings and conferences related to the topic.

References

A Detailed Study of React: The React.js Application Architecture (2018) *dzone.com*. Available at: https://dzone.com/articles/a-detailed-study-of-flux-the-reactjs-application-a (Accessed: 18 February 2021).

Alan R. Hevner | USF Muma College of Business (2019). Available at: https://www.usf.edu/business/about/bios/hevner-alan.aspx (Accessed: 15 December 2020).

Angular - Introduction to components (no date). Available at: https://angular.io/guide/architecture-components (Accessed: 15 December 2020).

Ash Maurya (2021) *What is an Unfair Advantage?* Available at: http://ask.leanstack.com/en/articles/904720-what-is-an-unfair-advantage (Accessed: 13 January 2021).

Bearer Authentication (no date). Available at: https://swagger.io/docs/specification/authentication/bearer-authentication/ (Accessed: 24 May 2021).

BFI homepage (2020) *BFI*. Available at: /watch-discover (Accessed: 27 November 2020).

BFI National Archive (2020) *BFI*. Available at: /bfi-national-archive (Accessed: 26 November 2020).

Brar, H. K. and Kaur, P. J. (2015) 'Differentiating Integration Testing and unit testing', in *2015 2nd International Conference on Computing for Sustainable Global Development (INDIACom)*. *2015 2nd International Conference on Computing for Sustainable Global Development (INDIACom)*, pp. 796–798.

Castell, Y. B. (2019) 'Film has become the cornerstone of our school's literacy curriculum. Whether we're focusing on English, PSHE or humanities, film works brilliantly for each and every student. We've succeeded in taking away one of the key barriers to their learning; it means everyone can get involved and no one feels left out.', p. 23.

Chickerur, S., Goudar, A. and Kinnerkar, A. (2015) 'Comparison of Relational Database with Document-Oriented Database (MongoDB) for Big Data Applications', in *2015 8th International Conference on Advanced Software Engineering Its Applications (ASEA)*. *2015 8th International Conference on Advanced Software Engineering Its Applications (ASEA)*, pp. 41–47. doi: 10.1109/ASEA.2015.19.

Chitra, L. P. and Satapathy, R. (2017) 'Performance comparison and evaluation of Node.js and traditional web server (IIS)', in *2017 International Conference on Algorithms, Methodology, Models and Applications in Emerging Technologies (ICAMMAET)*. *2017 International Conference on Algorithms, Methodology, Models and Applications in Emerging Technologies (ICAMMAET)*, pp. 1–4. doi: 10.1109/ICAMMAET.2017.8186633.

Chris Dawson (2014) 'JavaScript's History and How it Led To ReactJS', *The New Stack*, 25 July. Available at: https://thenewstack.io/javascripts-history-and-how-it-led-to-reactjs/ (Accessed: 4 December 2020).

Chung, L. *et al.* (2012) *Non-functional requirements in software engineering*. Springer Science & Business Media.

CinEd (no date). Available at: https://www.cined.eu/en (Accessed: 7 December 2020).

Cinema-in-Education – PSHE Cinema sessions for schools (no date). Available at: https://cinema-in-education.co.uk/ (Accessed: 18 February 2021).

Cinemateca Portuguesa - Museu do Cinema (2013). Available at: https://www.cinemateca.pt/ (Accessed: 18 February 2021).

Color Psychology Meaning - Symbolism & Personality (no date) *Color Psychology Meaning*. Available at: https://colorpsychologymeaning.com/ (Accessed: 19 February 2021).

Contentstack (no date) *Decoupled CMS | Content Management Systems | Contentstack*, *contentstack.com*. Available at: https://www.contentstack.com/cms-guides/decoupled-cms (Accessed: 29 January 2021).

contributors, phpMyAdmin (no date) *phpMyAdmin*, *phpMyAdmin*. Available at: https://www.phpmyadmin.net/ (Accessed: 7 March 2021).

Darling-Hammond, L. *et al.* (2020) 'Implications for educational practice of the science of learning and development', *Applied Developmental Science*, 24(2), pp. 97–140. doi: 10.1080/10888691.2018.1537791.

Decoux, S. (2020) *Joomla! Benefits & Core Features: multilingual, well supported...*, *Joomla!* Available at: https://www.joomla.org/core-features.html (Accessed: 26 November 2020).

Dejan Viduka, Vladimir Kraguljac, and Igor Lavrnic (2019) *Security Challenges Behind the Development and Increased Use of Open Source Web Content Management Systems*. Available at: https://web.b.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=18463312&AN=144575271&h=gwkIVNRbNL%2fkloEZ0bTeY4RC5Y7FB9r5OPN2PglIsDVg3i8gu4uwjtawSrEMR2ixWSPgsJ872zgnVyZfNQEfBA%3d%3d&crl=c

&resultNs=AdminWebAuth&resultLocal=ErrCrlNotAuth&crlhashurl=login.aspx%3fdirect%3dtrue%26profile%3dehost%26scope%3dsite%26authtype%3dcrawler%26jrnl%3d18463312%26AN%3d144575271.

'Democratize Publishing' (2018) *WordPress.org*, 28 March. Available at: https://wordpress.org/about/ (Accessed: 26 November 2020).

Dias, F. and Paiva, A. C. R. (2017) 'Pattern-Based Usability Testing', in *2017 IEEE International Conference on Software Testing, Verification and Validation Workshops (ICSTW)*. *2017 IEEE International Conference on Software Testing, Verification and Validation Workshops (ICSTW)*, pp. 366–371. doi: 10.1109/ICSTW.2017.65.

Dodds, D. (2020) *Color Meaning and Color Psychology in Marketing and Design*, *Atlanta Web Design Company & Digital Marketing Agency*. Available at: https://m16marketing.com/digital-marketing-blog/color-psychology-in-marketing-the-meaning-of-color-in-design/ (Accessed: 19 February 2021).

Drupal for Developers (2018) *Drupal.org*. Available at: https://www.drupal.org/developers (Accessed: 26 November 2020).

'E0362735.pdf' (no date). Available at: https://www.iosrjournals.org/iosr-jmce/papers/vol3-issue6/E0362735.pdf?id=2549 (Accessed: 19 January 2021).

Education | UNICEF (no date). Available at: https://www.unicef.org/education (Accessed: 29 January 2021).

Escudeiro, P. and Bidarra, J. (2008) 'Quantitative Evaluation Framework (QEF)', *Conselho Editorial/Consejo Editorial*, p. 16.

'Evolution of Learning' (2018) *The Progressive Teacher*, 6 June. Available at: http://www.progressiveteacher.in/evolution-of-learning/ (Accessed: 16 February 2021).

Express - Node.js web application framework (2017). Available at: https://expressjs.com/ (Accessed: 22 February 2021).

Ferreira, N. (2019) *Color Psychology: How Color Your Brand*. Available at: https://www.oberlo.com/blog/color-psychology-color-meanings (Accessed: 19 February 2021).

File Structure – React (2020). Available at: https://reactjs.org/docs/faq-structure.html (Accessed: 15 December 2020).

FILM PLATFORM (2020) *FILM PLARFORM*, *FILM PLATFORM - Educational Rights and Screening Licenses*. Available at: https://www.filmplatform.net/about-fp/our-mission/ (Accessed: 26 November 2020).

Films pour enfants (2020) *Films pour enfants*, *Films for Children*. Available at: https://www.films-pour-enfants.com/en (Accessed: 26 November 2020).

FormData - Web APIs | MDN (2020). Available at: https://developer.mozilla.org/en-US/docs/Web/API/FormData (Accessed: 24 May 2021).

Forwarding Refs – React (2020). Available at: https://reactjs.org/docs/forwarding-refs.html (Accessed: 15 December 2020).

Gacenga, F. *et al.* (2012) 'A Proposal and Evaluation of a Design Method in Design Science Research', 10(2), p. 12.

Garg, N., Agarwal, P. and Khan, S. (2015) 'Recent advancements in requirement elicitation and prioritization techniques', in *2015 International Conference on Advances in Computer Engineering and Applications*. *2015 International Conference on Advances in Computer Engineering and Applications*, pp. 237–240. doi: 10.1109/ICACEA.2015.7164702.

'Getting Started With Requirements Elicitation' (2020) *CSpring*, 19 March. Available at: https://cspring1.wpengine.com/getting-started-with-requirements-elicitation/ (Accessed: 5 January 2021).

Glinz, M. (2007) 'On Non-Functional Requirements', in *15th IEEE International Requirements Engineering Conference (RE 2007)*. *15th IEEE International Requirements Engineering Conference (RE 2007)*, pp. 21–26. doi: 10.1109/RE.2007.45.

Group, P. G. D. (2021) *PostgreSQL*, *PostgreSQL*. Available at: https://www.postgresql.org/ (Accessed: 7 March 2021).

Hickey, A. M. and Davis, A. M. (2003) 'Requirements elicitation and elicitation technique selection: model for two knowledge-intensive software development processes', in *36th Annual Hawaii International Conference on System Sciences, 2003. Proceedings of the*. *36th Annual Hawaii International Conference on System Sciences, 2003. Proceedings of the*, p. 10 pp.-. doi: 10.1109/HICSS.2003.1174229.

Hoong, C. C. and Ameeden, M. A. (2015) 'Intuitive Content Management System', in *2015 International Conference on Computer, Communications, and Control Technology (I4CT)*. *2015 International Conference on Computer, Communications, and Control Technology (I4CT)*, pp. 541–543. doi: 10.1109/I4CT.2015.7219637.

How Tech Is Changing Childhood | Common Sense (2020). Available at: https://www.commonsense.org/our-impact/ (Accessed: 26 November 2020).

i18next (2021). Available at: https://www.i18next.com/ (Accessed: 24 May 2021).

Independent Cinema Office (2020) *Independent Cinema Office*. Available at: https://www.independentcinemaoffice.org.uk/about-us/what-we-do/ (Accessed: 26 November 2020).

‘Inovating Education and Educating for Innovation’ (no date). Available at: http://www.oecd.org/education/ceri/GEIS2016-Background-document.pdf (Accessed: 29 January 2021).

Into Film (2020) *About Into Film - Into Film*. Available at: https://www.intofilm.org/about#resources (Accessed: 26 November 2020).

Into Film | Film in Education | Film Clubs - Into Film (2020). Available at: https://www.intofilm.org/ (Accessed: 26 November 2020).

Into Film’s Annual Review (2020). Available at: https://www.intofilm.org/news-and-views/articles/annual-review (Accessed: 18 February 2021).

Introduction — Vue.js (no date). Available at: https://vuejs.org/v2/guide/ (Accessed: 15 December 2020).

Jaiswal, E. S. (2012) ‘A Case Study on Quality Function Deployment (QFD)’, *IOSR Journal of Mechanical and Civil Engineering*, 3(6), pp. 27–35. doi: 10.9790/1684-0362735.

James Frieden and Deborah W. Elliott (2020) ‘Teach With Movies’, *Teach with Movies*, 26 November. Available at: http://teachwithmovies.org/who-we-are/ (Accessed: 26 November 2020).

Jebraeil, N. *et al.* (2017) ‘gUML: Reasoning about Energy at Design Time by Extending UML Deployment Diagrams with Data Centre Contextual Information’, in *2017 IEEE World Congress on Services (SERVICES)*. *2017 IEEE World Congress on Services (SERVICES)*, pp. 59–66. doi: 10.1109/SERVICES.2017.19.

‘Key Learning Exclusion Literature Review’ (no date). Available at: http://decisionmaking.westberks.gov.uk/documents/s50261/9d.%20Appendix%203b%20Exclusion%20Literature%20review.pdf (Accessed: 29 January 2021).

Koen, P. A., Bertels, H. M. J. and Kleinschmidt, E. (2014) ‘Managing the Front End of Innovation’, *Research-Technology Management*, 57(2), pp. 34–43. doi: 10.5437/08956308X5702145.

Kosar Altinyelken, H. (2015) *Evolution of Curriculum Systems to Improve Learning Outcomes and Reduce Disparities in School Achievement*. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000232420/PDF/232420eng.pdf.multi (Accessed: 16 February 2021).

Lighthouse | Tools for Web Developers (2021) *Google Developers*. Available at: https://developers.google.com/web/tools/lighthouse (Accessed: 15 June 2021).

Literature, A. T. A. S. S. S. is one of those who is lucky to have turned her passion into her profession A. post graduate in E. *et al.* (2018) ‘Long and Short Essay on Impact of

Cinema in Life for in English Children and Students', *IndiaCelebrating.com*, 22 June. Available at: https://www.indiacelebrating.com/essay/impact-of-cinema-in-life-essay/ (Accessed: 26 November 2020).

MariaDB Foundation (no date) *MariaDB.org*. Available at: https://mariadb.org/ (Accessed: 7 March 2021).

Milena, Z., Dainora, G. and Stancu, A. (2018) 'QUALITATIVE RESEARCH METHODS: A COMPARISON BETWEEN FOCUS-GROUP AND IN-DEPTH INTERVIEW', *Annals of Faculty of Economics*, 4, pp. 1279–1283.

MOG – Digital Media (no date). Available at: https://www.mog-technologies.com/pt/ (Accessed: 16 February 2021).

mongoDB (2021) *MongoDB*. Available at: https://www.mongodb.com/1 (Accessed: 13 January 2021).

Musa, K. and Alkhateeb, J. (2013) 'Quality Model Based on Cots Quality Attributes', *International Journal of Software Engineering & Applications*, 4(1), pp. 1–8. doi: 10.5121/ijsea.2013.4101.

Ongo, G. and Kusuma, G. P. (2018) 'Hybrid Database System of MySQL and MongoDB in Web Application Development', in *2018 International Conference on Information Management and Technology (ICIMTech)*. *2018 International Conference on Information Management and Technology (ICIMTech)*, pp. 256–260. doi: 10.1109/ICIMTech.2018.8528120.

Open Source Database (RDBMS) for the Enterprise (no date) *MariaDB*. Available at: https://mariadb.com/ (Accessed: 7 March 2021).

Our annual report 2018-2019 (2020) *Independent Cinema Office*. Available at: https://www.independentcinemaoffice.org.uk/our-annual-report-2018-2019/ (Accessed: 18 February 2021).

Oxford Languages and Google - English | Oxford Languages (no date). Available at: https://languages.oup.com/google-dictionary-en/ (Accessed: 13 January 2021).

Palanisamy, S. and SuvithaVani, P. (2020) 'A survey on RDBMS and NoSQL Databases MySQL vs MongoDB', in *2020 International Conference on Computer Communication and Informatics (ICCCI)*. *2020 International Conference on Computer Communication and Informatics (ICCCI)*, pp. 1–7. doi: 10.1109/ICCCI48352.2020.9104047.

Patil, M. M. *et al.* (2017a) 'A qualitative analysis of the performance of MongoDB vs MySQL database based on insertion and retriewal operations using a web/android application to explore load balancing — Sharding in MongoDB and its advantages', in *2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)*

(I-SMAC). *2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, pp. 325–330. doi: 10.1109/I-SMAC.2017.8058365.

Patil, M. M. *et al.* (2017b) 'A qualitative analysis of the performance of MongoDB vs MySQL database based on insertion and retriewal operations using a web/android application to explore load balancing — Sharding in MongoDB and its advantages', in *2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*. *2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, pp. 325–330. doi: 10.1109/I-SMAC.2017.8058365.

Patil, M. M. *et al.* (2017c) 'A qualitative analysis of the performance of MongoDB vs MySQL database based on insertion and retriewal operations using a web/android application to explore load balancing — Sharding in MongoDB and its advantages', in *2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*. *2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, pp. 325–330. doi: 10.1109/I-SMAC.2017.8058365.

Porto, S. D. and Marchitelli, A. (2006) 'The Functionality and Flexibility of Traditional Classification Schemes Applied to a Content Management System (CMS)':, p. 10.

Pradeep, S. and Sharma, Y. K. (2019) 'A Pragmatic Evaluation of Stress and Performance Testing Technologies for Web Based Applications', in *2019 Amity International Conference on Artificial Intelligence (AICAI)*. *2019 Amity International Conference on Artificial Intelligence (AICAI)*, pp. 399–403. doi: 10.1109/AICAI.2019.8701327.

Rich, N. and Holweg, M. (2000) 'Value Analysis/Value Engineering', *VALUE ENGINEERING*, p. 32.

*Ro*Co Films* (2020) *RoCo Films Educational*. Available at: http://www.rocoeducational.com/participant_media (Accessed: 26 November 2020).

Rueda, S., Panach, J. I. and Distante, D. (2020) 'Requirements elicitation methods based on interviews', p. 20. doi: 10.1016/j.infsof.2020.106361.

Saks, E. (2019) 'JavaScript frameworks: Angular vs React vs Vue', p. 47.

Sam Saltis (2018) *Headless CMS Vs Decoupled CMS: Explained In 5 Minutes*. Available at: https://www.linkedin.com/pulse/headless-cms-vs-decoupled-explained-5-minutes-sam-saltis (Accessed: 4 December 2020).

Sam Saltis (2020) *Headless CMS vs Decoupled CMS: The Ultimate Guide*, *Core dna*. Available at: https://www.coredna.com/blogs/headless-vs-decoupled-cms (Accessed: 15 December 2020).

Samadhiya, D., Su-Hua Wang, and Dengjie Chen (2010) 'Quality models: Role and value in software engineering', in *2010 2nd International Conference on Software*

Technology and Engineering. *2010 2nd International Conference on Software Technology and Engineering*, pp. V1-320-V1-324. doi: 10.1109/ICSTE.2010.5608852.

Sasmito, G. W., Zulfiqar, L. O. M. and Nishom, M. (2019) 'Usability Testing based on System Usability Scale and Net Promoter Score', in *2019 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI)*. *2019 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI)*, pp. 540–545. doi: 10.1109/ISRITI48646.2019.9034666.

Scott W. Ambler (no date) *UML 2 Package Diagramming Guidelines*, *Agile Modeling*. Available at: http://agilemodeling.com/style/packageDiagram.htm (Accessed: 8 January 2021).

Serna, M. E. (2012) 'Analysis and selection to requirements elicitation techniques', in *2012 7th Colombian Computing Congress (CCC)*. *2012 7th Colombian Computing Congress (CCC)*, pp. 1–7. doi: 10.1109/ColombianCC.2012.6398001.

Shaikh, M. S. and Fegade, V. (2012) *Modeling Essentials of Content Management System (CMS) for Web-Based MIS Application*. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.412.638&rep=rep1&type=pdf.

Sharding — MongoDB Manual (no date) *https://github.com/mongodb/docs/blob/master/source/sharding.txt*. Available at: https://docs.mongodb.com/manual/sharding (Accessed: 13 January 2021).

Singh, J. and Kassie, N. B. (2018) 'User's Perspective of Software Quality', in *2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA)*. *2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, pp. 1958–1963. doi: 10.1109/ICECA.2018.8474755.

Stack Overflow Trends (no date). Available at: https://insights.stackoverflow.com/trends?tags=reactjs%2Cvue.js%2Cangular%2Cangularjs (Accessed: 4 December 2020).

Stamou, E. *et al.* (2014) 'Young People At-risk of Drop-out from Education: Recognising and Responding to their Needs, by Oxford University', p. 20.

State of JS 2020: Back-end Frameworks (2020). Available at: https://2020.stateofjs.com/en-US/technologies/back-end-frameworks/ (Accessed: 22 February 2021).

Strapi - Open source Node.js Headless CMS 🚀 (no date). Available at: https://strapi.io/ (Accessed: 29 January 2021).

Suehring, S. (2002) *MySQL bible*. New York, NY: Wiley Pub.

Supraja, S. and Kousalya, P. (2016) ‘A comparative study by AHP and TOPSIS for the selection of all round excellence award’, in *2016 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT)*. *2016 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT)*, pp. 314–319. doi: 10.1109/ICEEOT.2016.7755271.

Susana Nicola, Eduarda Pinto Ferreira, and J. J. Pinto Ferreira (2015) ‘ASSETS MANAGEMENT - A CONCEPTUAL MODEL DECOMPOSING VALUE FOR THE CUSTOMER AND A QUANTITATIVE MODEL’, *2015*, p. 18.

Symfony, High Performance PHP Framework for Web Development (no date). Available at: https://symfony.com/ (Accessed: 26 November 2020).

‘Teaching European History through Cinema’ (2020). Available at: http://tehcproject.com/ (Accessed: 26 November 2020).

Umar, M. and Naeem Ahmed Khan (2011) ‘Analyzing Non-Functional Requirements (NFRs) for software development’, in *2011 IEEE 2nd International Conference on Software Engineering and Service Science*. *2011 IEEE 2nd International Conference on Software Engineering and Service Science*, pp. 675–678. doi: 10.1109/ICSESS.2011.5982328.

UNICEF | for every child (2019) *UNICEF | for every child*. Available at: https://www.unicef.org/education (Accessed: 29 January 2021).

Usage Statistics and Market Share of Angular for Websites, December 2020 (2020). Available at: https://w3techs.com/technologies/details/js-angularjs (Accessed: 4 December 2020).

Usage Statistics and Market Share of React for Websites, December 2020 (2020). Available at: https://w3techs.com/technologies/details/js-react (Accessed: 4 December 2020).

Usage Statistics and Market Share of Vue.js for Websites, December 2020 (2020). Available at: https://w3techs.com/technologies/details/js-vuejs (Accessed: 4 December 2020).

W3Techs (2020) *WordPress vs. Joomla vs. Drupal usage statistics, December 2020*. Available at: https://w3techs.com/technologies/comparison/cm-drupal,cm-joomla,cm-wordpress (Accessed: 15 December 2020).

What is a Stakeholder? How to Identify, Analyze & Manage Project Stakeholders (no date) *Project Management Docs*. Available at: https://www.projectmanagementdocs.com/blog/what-is-a-stakeholder-how-to-identify-analyze-and-manage-project-stakeholders/#axzz6hwIHZlh0 (Accessed: 5 January 2021).

What is WYSIWYG (what you see is what you get)? - Definition from WhatIs.com (2011) *WhatIs.com*. Available at: https://whatis.techtarget.com/definition/WYSIWYG-what-you-see-is-what-you-get (Accessed: 4 December 2020).

Wibowo, F., Nuha, H. H. and Wibowo, S. (2020) 'Network Security Analysis Using HTTPS with SSL On General Election Quick Count Website', in *2020 IEEE International Conference on Communication, Networks and Satellite (Comnetsat)*. *2020 IEEE International Conference on Communication, Networks and Satellite (Comnetsat)*, pp. 204–207. doi: 10.1109/Comnetsat50391.2020.9328940.

withTranslation (HOC) (2019). Available at: https://react.i18next.com/latest/withtranslation-hoc (Accessed: 24 May 2021).

WordPress (no date) *WordPress*. Available at: https://wordpress.org/ (Accessed: 4 December 2020).

Zhang, B., Xia, Q. and Han, F. (2015) 'Multi-Point-to-Point Image Transmission System Based on TCP/IP Protocol', in *2015 Fifth International Conference on Instrumentation and Measurement, Computer, Communication and Control (IMCCC)*. *2015 Fifth International Conference on Instrumentation and Measurement, Computer, Communication and Control (IMCCC)*, pp. 1621–1624. doi: 10.1109/IMCCC.2015.344.

Annex A – Quality Evaluation Framework: Requirements

Table 13 - Functionality Dimension: Functional Factor

Functional (Refering Use Cases)	10	FF01 - Backoffice: manage movies (add/edit/consut/delete/publish/hide)	100
	8	FF02 - Backoffice: manage events and news (add/edit/consut/delete/publish/hide)	100
	6	FF03 - Backoffice: manage testimonials (add/edit/consut/delete/publish/hide)	100
	10	FF04 - Backoffice: manage student sheets (add/edit/consut/delete/publish/hide)	100
	2	FF05 - Backoffice: manage comments (hide/pubish)	100
	4	FF06 - Backoffice: consult movies transactions	0
	4	FF07 - Backoffice: consult activated users	100
	8	FF08 - Backoffice: manage users validation requests (accept/reject)	100
	10	FF9 - Student Sheets: change the language between the 12 available languages	100
	10	FF10 -Student Sheets: Complete all exercises or only a few ones	100
	8	FF11 - Student Sheets: share a student sheet through a code	100
	8	FF12 - Content Editor: choose images and download it as a PDF	0
	8	FF13 - Content Editor: choose images and sounds, associate each image to a sound and generate a slideshow	0

Table 14 - Functionality Dimension: User Experience Factor

User Experience	10	FUI01 - Backoffice management is intuitive	50
	8	FUI02 - Both backoffice and developed tools present the same design experience, in their different sections	100
	8	FUI03 - Both backoffice and developed tools present the same navigation experience	100
	6	FUI04 - Backoffice functionalites are organized by type of user	100
	8	FUI05 - Permissions and user type specific options are guaranteed	100
	10	FUI06 - Website have quick access to main functionalities (editor and student sheets), 2sec	100
	6	FUI07 - Website have a navegation bar, to control what the user wants to do	100
	8	FUI08 - Student Sheets exercise have a very intuitive design specially designed for students of all ages (6 to 18), for example: description of each exercise	50
	8	FUI09 - Student Sheets have a navegation menu, so the user can control which exercise wants to do	100
	10	FUI10 - Content Editor have a intuitive design specially design for students of all ages (6 to 18), for example: description of each available functionality	0
	8	FUI11- Content Editor has a navegation menu, so the user can choose the option he/she wants	0

Table 15 - Functionality Dimension: Content Quality Factor

Content Quality	8	FCQ01 - All product information is well structured and organized: a section for partners, a section for general information about the project, a section for news/events, a section to join the project, a section where the movies are stored, a section for teachers, a section for students where the editor and student sheets are available, and an independet platform for all content management	100
	8	FCQ02 - The texts are well written and all the setences make perfect sense	50
	8	FCQ03 - All content is related with the problem statement	100
	10	FCQ04 - All developed tools are related to/solve the problem statement	100
	10	FCQ05 - Internationalization of developed tools, website, and backoffice is correctly handled	100

Table 16 - Adaptability Dimension

Versatility	8	AV01 - Both backoffice and all developed tools in website, are compatible with multiple browsers	100
	8	AV02 - Both backoffice and all developed tools in website, are compatible with multiple devices	100
	6	AV03 - Backoffice allows the configuration of some attributes	100
Motivational aspects/ Stimulates the Initiative	10	AMA01 - Content Editor and Student Sheets are designed in a way which motivates and stimulates users to interact with the available tools: through animations, sounds, and interaction	50
Pedagogical aspects (multi-language)	8	APA01 - Developed tools are easily recognized	50
	10	APA02 - Developed tools, with different type of activities keep curiosity of students, and provide efficient guidelines for trainers/teachers	100
Maintenance	10	AM01 - Backoffice allows the insertion of new pedagogical materials	100
	4	AM02 - All informative content on website can be easily updated	100

Table 17 - Efficiency Dimension

Audiovisual quality	8	EAQ01 - Developed tools must have a consistent audio and video experience	100
	4	EAQ02 - There is no excess of information	100
Technical Elements	8	ETE01 - There is no significant delays between the user interaction and the website responses (2sec)	100
	8	ETE02 - All scenarious have a rigorous design which includes titles,descriptions, menus, videos, sounds, photos and color rules	100
Navigation	10	EN01 - Product has a good structure and allows users to access contents in a intuitive way to the main functions	100
	10	EN02 - login (backoffice) and access security (to backoffice, developed tools and website), ensuring the users privacy	100
	8	EN03 - Navigation system puts users in control (navbars and menus)	100

Annex B – Quality Evaluation Framework: Metrics Evaluation

Table 18 - Metrics Evaluation: Functional Factor

	Wfk - Fullfilment (%)		
Metric Evaluation	**0**	**50**	**100**
Partners can create/delete, publish/hide or edit the details of a certain movie	No access to functionality	Partial access to the functionality	Full access to the functionality
Partners can create/delete, publish/hide or edit the details of a certain event/new	No access to functionality	Partial access to the functionality	Full access to the functionality
Partners can create/delete, publish/hide or edit the details of a testimonial	No access to functionality	Partial access to the functionality	Full access to the functionality
Partners can create/delete, publish/hide or edit the details of a certain student sheet	No access to functionality	Partial access to the functionality	Full access to the functionality
Partners can publish/hide comments made by users	No access to functionality	-	Access to the functionality
Partners can consult all transactions made of a certain movie	No access to functionality	-	Access to the functionality
Partners can consult all active users (and some of their information) in the platform	No access to functionality	-	Access to the functionality
Partners can validate or reject a registration request made by an unauthenticated user	No access to functionality	-	Access to the functionality
Regular users can change the language of the platform to one of the 12 available languages	No access to functionality	-	Access to the functionality
An authenticated user, can complete ou partially complete a specific student sheet	No access to functionality	-	Access to the functionality
An authenticated user, can share his/her student sheet with anyone he/she wants, through a 15 alfanumeric code	No access to functionality	-	Access to the functionality
An authenticated user, can download all choosen images in a PDF format	No access to functionality	-	Access to the functionality
An authenticated user, can create a slideshow throught the association of images and sounds	No access to functionality	Partial access to the functionality	Access to the functionality

Table 19 - Metrics Evaluation: User Experience Factor

	Wfk - Fullfilment (%)		
Metric Evaluation	**0**	**50**	**100**
Interaction questionnaire to two type of users. The first user is a experienced user that already read the manual, the other is a unexperienced user that never read the manual, in a total of 6 questionnaires.	0-1 positive questionnaires	2-3 positive questionnaires	4-6 positive questionnaires
The design experience must be similar. Backgrounds, colors, design of buttons, font types, logos, icons and animations must be similar.	Low similarity	Only half of the categories present a similar design	High similarity
The navigation between screens present the same experience. A navbar, menu and intuitive buttons for the different functionalities, in the same place.	No	-	Yes
Funcionalities must be presented ir order with the relevance for the user.	Contents are not appropriated to the users	Contents are appropriated to one or two of the users.	Contents are appropriated to all of users
Functionalities must be available only to apropriated users.	One or more functionalities available to type of users without that permission	-	Functionalities only available to certain types of users
Executing a functionality musn't take more than 3 actions (clicks, selections,...).	>3 actions	-	<= 3 actions
All sections must present a navbar.	No navbar presented	Only half of the screens present a navbar	Navbar presented in all screens
Interaction questionnaire to two type of users. The first user is a experienced user that already read the manual, the other is a unexperienced user that never read the manual, in a total of 6 questionnaires.	0-1 positive questionnaires	2-3 positive questionnaires	4-6 positive questionnaires
All exercises of student sheets must present a menu.	No menu presented	Only half of exercises present a menu	Menu presented in all screens
Interaction questionnaire to two type of users. The first user is a experienced user that already read the manual, the other is a unexperienced user that never read the manual, in a total of 6 questionnaires.	0-1 positive questionnaires	2-3 positive questionnaires	4-6 positive questionnaires
Content editor must present a menu.	No menu presented	-	Menu presented in all screens

Table 20 - Metrics Evaluation: Content Quality Factor

	Wfk - Fullfilment (%)		
Metric Evaluation	**0**	**50**	**100**
All product information must be divided in functional areas.	No	-	Yes
The sentences are short and fullfill elementary grammar principles.	No	Partial	Yes
All the contents must be extrictly related to the product and doesn't present dummy or irrelevant data.	No	-	Yes
All the developed tools must be extrictly related to the product and doesn't present dummy or irrelevant data.	No	-	Yes
Available translations, must be correctly handled	No	-	Yes

Table 21 - Metrics Evaluation: Adaptability Dimension

	Wfk - Fullfilment (%)		
Metric Evaluation	**0**	**50**	**100**
Backoffice and platform must be supported by chrome, firefox and edge browsers.	No	-	Yes
backoffice and platform must be compatible my computers of different screen sizes, tablets and cell phones.	No	-	Yes
Backoffice present some configuration options like add/edit/delete some attributes of a content-type.	No	-	Yes
Content Editor and Student sheets must have appealing colors, sounds, images and interactive content.	No	Partial	Yes
Content Editor and Student sheets must be easily founded (no more than 3 clicks).	No	Partial	Yes
Content Editor and Student sheets must have appealing colors, sounds, images and interactive content.	No	-	Yes
Insertion of new information on backoffice, mas take between 1-15 minutes (accordingly with the content to insert, e.g: testimonials (1min), student sheet (15min)		-	
Update content on the platform, must not take more than 5 minutes	No	-	Yes

Table 22 - Metrics Evaluation: Efficiency dimension

	Wfk - Fullfilment (%)		
Metric Evaluation	**0**	**50**	**100**
All the applications must apply the same patterns refering audio and video	No	-	Yes
All the contents must be extrictly related to the product and doesn't present dummy or irrelevant data.	No	-	Yes
Functionalities that can take more than 1 sec must present a progress loading icon to inform user that the content is being loaded.	No	-	Yes
Each application must have a main menu and/or a navbar, titles, and descriptions	No	Only sonme sections have a main menu/navbar	Yes
Each application must have a main menu and/or a navbar.	No	Only sonme sections have a main menu/navbar	Yes
Login exceptions (unknown username/password) must present user a message indicating the cause of unperformed login. Only registered users can make login.	No	-	Yes
All of the actions must be made by user interaction. Automatic actions musn't exist.	No	-	Yes

Annex C – Usability Testing

Tasks – Backoffice

1. Create and save the "Modry Tygr" movie with all the necessary details and information.
2. Publish the movie. Did you make it?
   a. Yes
   b. No
   c. If no, why? _____
3. In the movies list, hide the "Aniki-Bobó" movie. Did you make it?
   a. Yes
   b. No
   c. If no, why? _____
4. Create and save the "Modry Tygr" student sheet with all needed information.
5. Publish the student sheet. Did you make it?
   a. Yes
   b. No
   c. If no, why? _____
6. Go back to "Modry Tygr" movie details. Associate the student sheet previously made to the movie. Now, try to publish the movie again. Did you make it?
   a. Yes
   b. No
   c. If no, why? _____
7. Go to the editor section. Upload some imagens and sounds in the right fields. Did you make it?
   a. Yes
   b. No
   c. If no, why? _____
8. Go to the user's section. Deactivate a user with username "teacher123". Did you make it?
   a. Yes
   b. No
   c. If no, why? _____

Tasks – Platform

1. Go to collection page. Did I find it easily?
2. Select the movie "Modry Tygr" and start the interactive student sheet. Complete the student sheet the way you want (you can complete all exercises, or only a few ones). I easily understood the way that student sheets work.
    a. Yes
    b. No
    c. If no, why? _____
3. I easily found the code to share my student sheet.
    a. Yes
    b. No
    c. If no, why? _____
4. I easily found the description of the exercises.
    a. Yes
    b. No
    c. If no, why? _____
5. I easily understood how to save an exercise.
    a. Yes
    b. No
    c. If no, why? _____
6. I easily understood how to reset an exercise.
    a. Yes
    b. No
    c. If no, why? _____
7. I change the language of the website. It was easy?
    a. Yes
    b. No
    c. If no, why? _____
8. Go to the contact's page. Find the contact of the responsible partner of your country. It was easy?
    a. Yes
    b. No
    c. If no, why? _____
9. I put "**luf1EDLCOdL5**" code, on the code box to see a shared student sheet. Was it easy to find the box?
    a. Yes
    b. No
    c. If no, why? _____

Final Appreciation– Backoffice

1. I consider the Backoffice simple to use.

1 2 3 4 5
○ ○ ○ ○ ○

2. I need of a user guide as support to understand as the Backoffice works.

1 2 3 4 5
○ ○ ○ ○ ○

3. I consider the Backoffice confuse.

1 2 3 4 5
○ ○ ○ ○ ○

4. I executed all tasks relatively to the Backoffice very easily.

1 2 3 4 5
○ ○ ○ ○ ○

5. I felt that when I could not make something, the system gave me the right feedback, to help me.

1 2 3 4 5
○ ○ ○ ○ ○

6. I think the design is minimalist and appealing.

1 2 3 4 5
○ ○ ○ ○ ○

7. I think that all partners will adapt easily to the new Backoffice.

1 2 3 4 5
○ ○ ○ ○ ○

Final Comments/ Suggestions about the Backoffice

_____

_____

_____

Final Appreciation– Platform

1. I consider the platform simple to user.

1 2 3 4 5
○ ○ ○ ○ ○

2. I consider the platform confuse.

1 2 3 4 5
○ ○ ○ ○ ○

3. I executed all tasks relatively to the platform very easily.

1 2 3 4 5
○ ○ ○ ○ ○

4. I felt that when I could not make something, the system gave me the right feedback, to help me.

1 2 3 4 5
○ ○ ○ ○ ○

5. I think the design is minimalist and appealing.

1 2 3 4 5
○ ○ ○ ○ ○

6. I think that major users will adapt easily to the new platform.

1 2 3 4 5
○ ○ ○ ○ ○

Final Comments/ Suggestions about the Platform

_____

_____

_____