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Investigation on the Effectiveness of Foreign Language Learning using a Browser Extension

by

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ABSTRACT

Multilingualism is a growing phenomenon in modern day society which is studied and learned through various ways. There are a variety of methods that can facilitate users with learning foreign languages, and with an abundance of techniques to choose from, it became a challenging experience to decide which learning approach should be performed.

This work explored the idea of providing users with an educational method that was beneficial for users of all skill levels to learn and improve their knowledge in certain languages using a browser extension. The application allowed users to assist them with extending their language vocabulary while browsing the internet without any distractions. The system was codenamed “Linguify” and has been developed with gamification in mind to ensure that it was a fun and accessible experience for people of all ages and backgrounds.

The following report documents the journey of the project from the start of the research to the testing and evaluation phase, including future works and improvements that would have been made if given additional time and/or performed again.

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I would also like to thank the numerous participants, for their time and effort providing invaluable project feedback throughout. With their help, I was able to improve the usability of the system as well as get a greater idea of the initial system requirements which accelerated my work in a considerable way.

Last but not least, I would like to make a huge thanks to Group CD for supporting me throughout the years of University, keeping me motivated throughout. It has not been unnoticed, and I know that I will look back on these years with great fondness. Thanks guys!

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EP – Equivalence Partitioning

BVA – Boundary Value Analysis

EG – Error Guessing

ET – Exploratory Testing

SDLC – Software Development Lifecycle

SUS – System Usability Scale

1 INTRODUCTION

1.1 OVERVIEW

This project documents the research and development of a Chrome browser extension, created to assist consumers with learning a new foreign language while browsing on the internet. This includes a full investigation on the software quality and usability of the system.

1.2 PROBLEM CONTEXT

Mastering foreign speaking languages is a valuable skill to possess, contributing to a competitive edge in career choices whilst making international travelling a more harmonious experience (Fernandez 2008). With as many as 450 million individuals in the European Union whom have a wide range of diverse ethnic and cultural backgrounds, and has been an increase in demand to learn multiple languages benefiting true intercultural communications (Eurobarometer 2006).

Figure 1 shows gradual yearly increments in the digital language-learning market size with projected values, indicating a consistent growth due to an increase retention for digital applications.

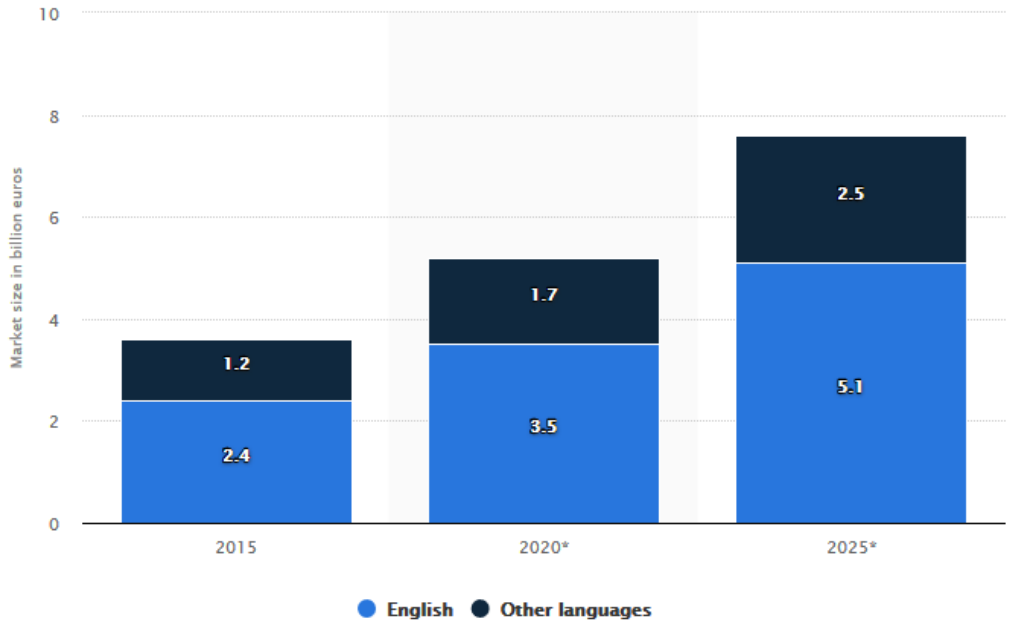


Figure 1: Visual representation of global market size (Statista 2015)

It is statistically shown that the market for digital language-learning products reached $1.8 billion in 2013 (Wu 2016), projecting to surge to over $3.8 billion by 2020 (Seave 2016). Thus, verifying that an already populous industry has the potential to grow continuously.

Language-learning applications have many complications that are amplified in the perspective of new users (Nushi and Eqbali 2018). There is a common issue that users never reach full fluency while utilising digital learning platforms (Ghazali 2006). The lack of user motivation and incentives affect individual performances, which ultimately damages their overall user satisfaction on the product (Lazzeri et al. 2015).

1.3 Problem Definition

The adversity in learning a foreign language can often lead consumers to go with a free mobile platform, with a strong emphasis on simplicity and gamification to engage their users. One such company with this strategy is Duolingo, making the studying of languages significantly more accessible for beginners.

However, there are limitations in that strategy for users with an intermediate knowledge on a particular language (Powers 2017). This is a result of catering more to the beginners and increasing their overall registered user total instead of providing enough challenges for the more experienced users (Claes 2014).

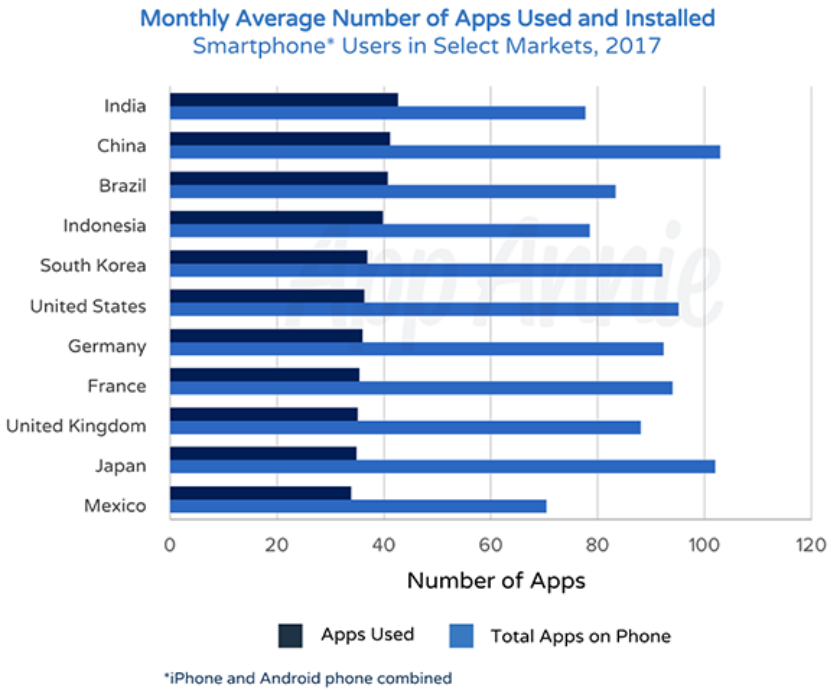


Figure 2: Graph detailing the average smartphone apps used (Perez 2017)

Individuals are using their smartphones more than ever, with an average of over 30 apps used on a monthly basis (Lovejoy 2017).
Figure 2 illustrates the average number of apps installed and regularly used per country, indicating that mobile systems are a competitive market to gain user attention (Perez 2017). Users are required to spend a lot of their time to learn a language (The Linguist 2015), demanding a platform that does not interfere with their everyday activities.

The disparity between what the system can provide the user, and what the user demands the system to accomplish was another large issue that needs to be addressed (Palomo-Duarte et al. 2015). The slow learning progress of Duolingo-like systems potentially causes user frustration (Reardon 2011). This ultimately leads to more users pursuing learning languages elsewhere (Niño 2015).

Learning a new foreign language is a very challenging exercise (Andreou and Segklia 2017). Although major steps have been taken to producing a fun and universally accessible learning experience (Huynh et al. 2017), it can be a massive time sink to begin learning with a lack of incentives to entice users to continue using the system (The Linguist 2015).

1.4 PROPOSED SOLUTION

The proposal was to build a browser extension, allowing users to casually browse the internet while being challenged to translate words on web pages currently in their foreign language vocabulary list. The extension connects to a translation JSON array, featuring respective English and Spanish words. The array was also used to verify whether user inputs have been implemented correctly when adding words to their list vocabulary list.

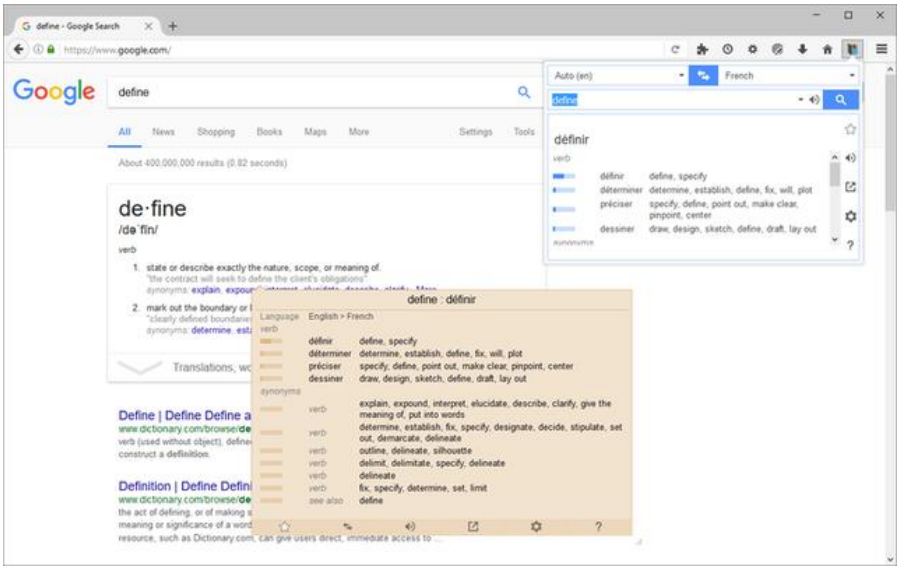


Figure 3: Screenshot of Chrome Translation Browser Extension

The choice of building the system as a browser extension platform enables the product to reach out to as many individuals as possible, being easy to apply and accessible. Providing an affordable service that doesn't interfere with their everyday life was key.

In order to maintain user incentives while using the system, the product contains gamifying features that increases the incentives to use the product every day while browsing on Chrome.

By producing an in-depth usability evaluation on the system, the team identified potential usability issues within the system, as well as developing an understanding of user requirements. All human factor techniques were centred on evaluating the incentives with using the system on a regular basis.
Figure 4 contains a brief Project Timeline that was followed throughout the project.

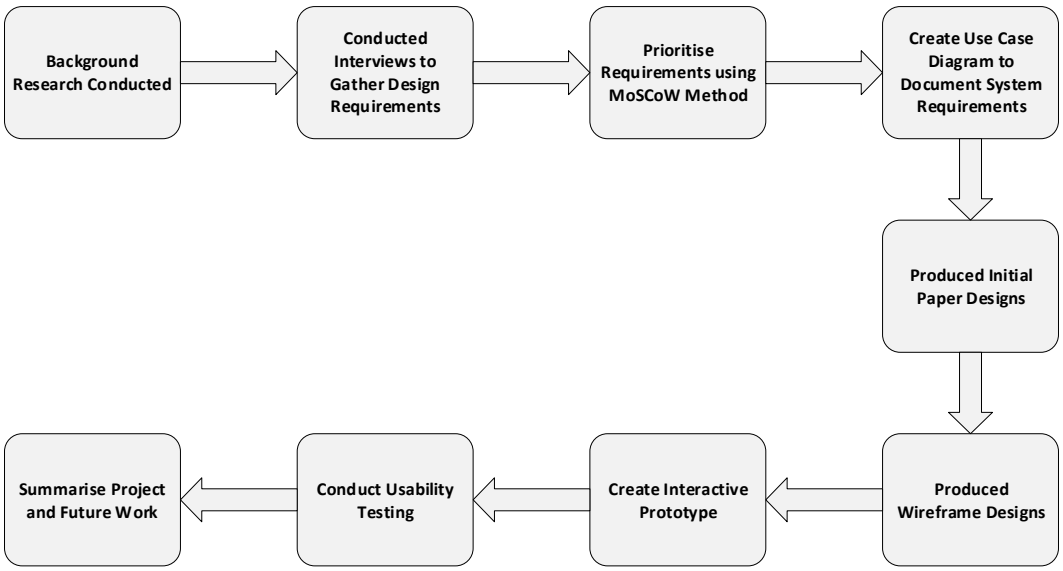


Figure 4: Project Timeline

During the project, various prototype design versions were created including Paper and Wireframe designs, these versions were then evaluated by the developers and users.
A use-case diagram and interviews were also produced to model the functionality and requirements of the artefact, which translated into crucial design choices and development priorities (Klimek and Szwed 2010).

The artefact was created using industry-standard HTML, CSS and JS frameworks, built for developing responsive web-based applications and enables compatibility support.
Finally, the system followed the correct Content Security Policy standards that was required to be followed to prevent code injection attacks, resulting in malicious web page content (West and Medley 2019).

1.5 AIMS AND OBJECTIVES

1.5.1 Aim

Investigate how a browser extension system, emphasising on ease of use and gamification can assist the experience of foreign language learning.

1.5.2 Objectives

This report documents the following objectives, rationales and objective actions:

ID	Objective	Rationale	Objective Action
1	Produce a detailed background study which conducts aspects of the digital learning market including gamification, competitors, and language learning methods and teachings.	Important to provide context to the information discussed throughout the project.	I. Review similar products and procedures. II. Research methods used to translate words on a web page. III. Research the advantages and disadvantages with gamification IV. Research language learning mobile applications and digital app retention. V. Research multiple language learning methods and teachings.
2	Elicit the optimal methodology for this project.	Provides detailed planning on how time will be allocated during the development process	I. Provide detailed time allocations during the entire project in the form of a Gantt chart. II. Decide the correct development methodology for this project. Research included.

3	Develop a browser extension system applying Software Engineering practices, using the knowledge from the background study.	Produce an artefact that will maximise user retention and ease of use while learning a foreign language.	I. Build a solution which enables the translation of words on a web page (JSON). II. Build a solution capable of improving the user retention (Gamification). III. Propose and write evaluation methods.
4	Critically evaluate the system using the appropriate software testing methods, utilising the research from the background study.	Evaluation will utilise the research from the background study, providing an overall consensus on the result of the final artefact.	I. Test the solution using both Functional and Structural Testing techniques, ensuring the accuracy matches the development requirements. II. Evaluate the system to ensure the artefact meets client requirements.
5	Produce a reflective examination of the system as a whole.	Restating the main aim, having a final summary on the project for the readers.	I. Evaluate the project delivery. II. Investigation on future development possibilities and experience learnt.

Table 1: Project Objectives, Rationale and Objective Actions

1.6 SUCCESS CRITERIA

Key points based on the initial aims and objectives to determine when the task was a full success.

ID	Success Criteria
1	Background studying has been thoroughly researched, containing aspects relating to the web-based artefact.
2	Optimal methodology has been selected/applied while considering the project characteristics.
3	Requirements process has been followed correctly, while being integrated seamlessly into the methodology and development of the system
4	Artefact delivers a well-featured system providing the essential requirements as a bare minimum
5	The system has been evaluated and conducted throughout the development process

Table 2: Project Success Criteria

1.7 RISK ANALYSIS

Tables below contains the project risk matrix, demonstrating how risks are being valued to a combination of probability and severity. The risk table produced are adapted from the ISO 31000:2018 international standard (ISO 2019).

1.7.1 Risk Matrix

A risk matrix was produced which defines the levels of risk by considering the probability/likelihood against the severity of the risk. This simple mechanism increases the visibility of major risks and assists the team decisions making during the design and implementation phases.

Severity Category	Definition
1 (Negligible)	An event that would have no effect on the program as a whole.
2 (Minor)	A minor event that would cause a small cost or scheduling increase. Requirements would still potentially be achieved.
3 (Moderate)	An event that would cause a moderate cost or scheduling increases. Example would be a desirable requirement not being met.

4 (Major)	Serious event that would cause major cost or scheduling increases. Example would be a non-essential requirement not being fulfilled.
5 (Critical)	Critical event that would cause major system failure. (Unable to achieve minimum accepted system requirements)

Table 3: Risk Matrix Ranges

Probability Range	Interpretation
1	Very unlikely to occur
2	Unlikely to occur
3	Occurs on average half of the time
4	Likely to occur
5	Very likely to occur

Table 4: Risk Probability Ranges

1.7.2 Risk Table

Risk	Probability (1-5)	Severity (1-5)	Risk Value	Effect on Project	Mitigation	Action Type
Translation to not function properly	3	4	4	Product inaccuracy and unreliable learning material.	Use the correct methodology continually integrating to find errors as early as possible.	Mitigation
Obtaining the incorrect methods to translate words on the webpage.	2	4	3	Lack of tools to translate the words, resulting in a poor concept.	Begin research early, gaining understanding on the tools required to translate the words effectively. Manual approaches potential alternative for prototype purposes.	Contingency

UX of the system to interfere with user productively	2	3	3	Bad UX will cause users to not continue using the system. Reduction in user base.	Research similar browser extension systems and create usability evaluations to discover what users approve prior to the development of the system	Avoidable
Development proving to take longer than expected.	3	3	3	Risk potential to push back other important tasks including documentation and the testing phase. This ultimately leads to some tasks lacking quality or being incomplete.	Producing a detailed Gantt chart prior to the development of the artefact to manage time more effectively.	Acceptance

Hard drive failures	1	5	5	Loss of documentation and deliverables	All project work to be saved onto an external cloud storage service as well as a portable USB.	Prevention
Lack of tester commitment to the Project	2	3	2	Wrong testing mindset as well as having an unrealistic testing expectation.	Early agreement with more testers than expecting just in case. All testers will be found prior to the development.	Mitigation
JSON file errors	2	4	4	Translation JSON files doesn't work as intended, causing large changes in the development process.	Early research and development on the JSON files to find potential errors as early as possible.	Prevention

Artefact not fully compatible with Google Chrome	2	2	2	Due to many websites being built differently. There may have incompatibility issues with certain sites. Particularly ones that don't contain text.	Functional testing with the waterfall methodology will find all the discrepancies in the early stages of development.	Mitigation
Shortage of test participants	2	4	3	Evaluation will suffer, impacting the quality of the product whilst increasing the cost.	Gathering and notifying participants significantly in advance of the testing phase.	Mitigation

Testing finds severe issues late in the development process	3	5	4	Increasing the time and stress pressures at the critical stages in the project, leading to reducing artefact quality.	Tests will be made, which is often to identify and address flaws early.	Mitigation
Primary development computer faults	1	5	4	Loss of documentation and deliverables and main method to complete the project.	Multiple backups of the project including using cloud services. Alternative computers to use.	Mitigation/ Acceptance

Developer illness	1	5	4	Potential slippage due to a reduced time to complete tasks. Cause the developer to prioritise on important objectives only.	Risk unlikely to happen.	Acceptance
Supervisor absence	1	4	3	Lack of supervisor reviews held which may lead to delays of requirements and objectives.	Communication via email is used throughout the project.	Acceptance
System features are too complex for the developer to construct	3	2	2	Features will be missing in the final product if too complex to produce before the specified deadlines put in place.	Research will begin early in the development stage as well as prioritising features in the artefact using MoSCoW.	Acceptance

Table 5: Risk Analysis

1.8 OVERVIEW OF DISSERTATION

This documentation consists of 6 additional chapters, the implementation and contents are described as follows:

Chapter 2 – Providing the background study and research throughout the project, gathering details required to fully understand the overall project. This section will inform readers with what was required to solve the issue.

Chapter 3 – Eliciting the Requirements and Analysis decisions in a detailed and concise manner, breaking down the issue to more manageable specifications. Contains further stating on how all work was evaluated.

Chapter 4 – Contains a discussion on the overall project planning and methodology techniques being used, including descriptions on the constraints and complexity of the project. This section shows readers why each methodology was chosen.

Chapter 5 – Concerning the overview of the artefact design implementation using high level technical descriptions. Large breakdown of how each mechanic was implemented. This chapter includes the software testing, using multiple testing techniques justifications for the selection.

Chapter 6 – Evaluation reflecting on the project performance which includes the software quality and usability testing results.

Chapter 7 – Final conclusion containing project positives, and future development improvements that would have been made if the project was performed again.

2 BACKGROUND STUDY

2.1 OVERVIEW

Prior to the management of the technical system, further consideration to the present mechanics and development must be researched. This was to aid the necessary progression of the software development process.

This chapter documents a few important topics centred around how individuals interact with the language learning systems, describing possible limitations that they may encounter.

2.2 LANGUAGE LEARNING TEACHINGS

Foreign language learning teachings have evolved over the last hundred years (Smith 2014), all derived from socially/economic circumstances and intuition. All teachings represented a combination of language teaching beliefs.
The teachings discussed in this report include Grammar-Translation and Direct Methods which will both be discussed in great detail.

2.2.1 Grammar-Translation

Grammar-Translation emphasises the teachings of second language grammar (Conti 2016). In practice when using this particular method of teaching, the reading and writing skills are the major focus, with little to no attention put to the speaking and listening area of language learning (Conti 2016).

This approach has faced many criticisms for its effectiveness, with some criticising that it often constructs user frustration, with the tedious experience of memorising unusable grammar rules and vocabulary (Natsir 2014).

This frustration comes from the feeling of not making as much progress as the user expects with the work (Makassar 2018). Referring to the proposed solution, this particular method may not be beneficial as it does not pay much attention to the user communicative competence (Natsir 2014).

In spite of these criticisms, Grammar-Translation was a well-practiced technique as it was easy to apply and creates demands on teachers. It was able to take out the guessing game for users when learning a language as it directs on the rules, eliminating the trial-and-error strategy.

2.2.2 Direct Method

Direct Method was a major change from the Grammar-Translation method of teaching previously discussed, by using the appropriate foreign languages as a means of producing instructions and communications in a class (Dowie 2016). This modern technique included using illustrations of images and spoken narrative practices through visual activities (Mart 2013). Examples of a direct method of teaching was through the use of pantomiming and real-life objects.

It was the first large attempt to make language learning a successful way of teaching, releasing students from the inhibitions all too often associated with learning a language (Rivers 1968).

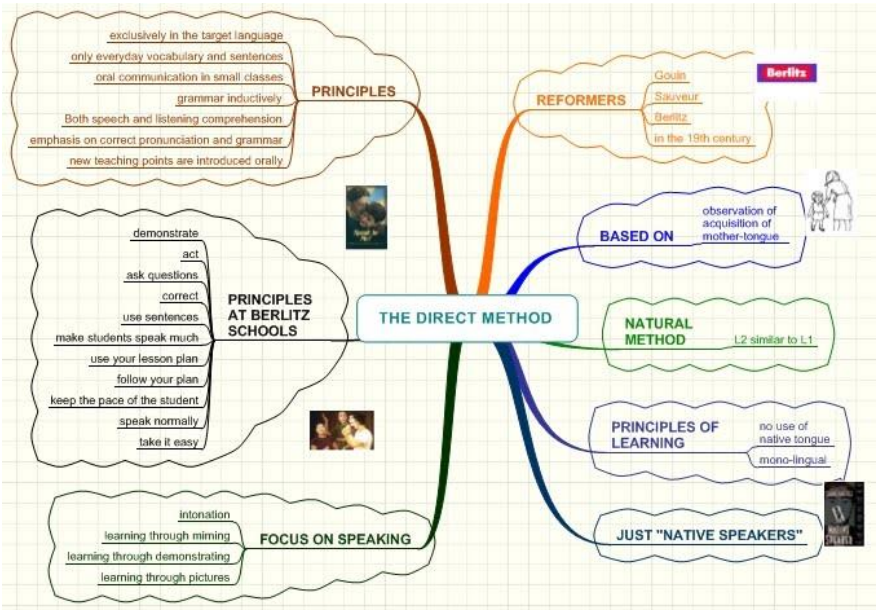


Figure 5: Direct Method Flowchart (Bejo 2017)

This teaching requires specialists who are native speakers, which can be a difficult requirement to achieve (Dowie 2016). Referring to this project, making the art of learning a language to be a more visual experience was at high priority, replacing words on webpages and testing the user's memory to achieve the goal of learning a language fluently (Batool et al. 2017).

2.3 GAMIFICATION

The method of gamification combines two sets of existing worlds: work and play; allowing for a playful interaction whilst simultaneously working to produce a quality result (Alsawaier 2017). It is a young and rapidly developing area with the intention of modifying user behaviour, increasing fidelity and motivating users (DuVernet et al. 2019).

Researching gamification to make sure that the processes is done correctly was very important in this project, so analysing the science behind the method with examples of successful and unsuccessful cases were discussed to the detail.

2.3.1 Science behind Gamification

Gaining an understanding of the user was an important ingredient to producing an effective gamified process (Kiryakova et al. 2013). It was key to discovering how to gather user emotion and desires (Woodcock and Johnson 2017). Knowing this, businesses can then create an understanding of what pushes people to interact with game-like systems (McKenzie 2011).

Gamification was one of the biggest reasons for the gaming industry booming success recently, with countless studies on human behaviour being applied to video games (Wolery 2019). Thus, gaining an understanding of the psychology of what was engaging to humans (Morschheuser et al. 2017). This knowledge combined with game theory resulted in a high awareness on the underlying gamifying mechanics (Kiryakova et al. 2013).

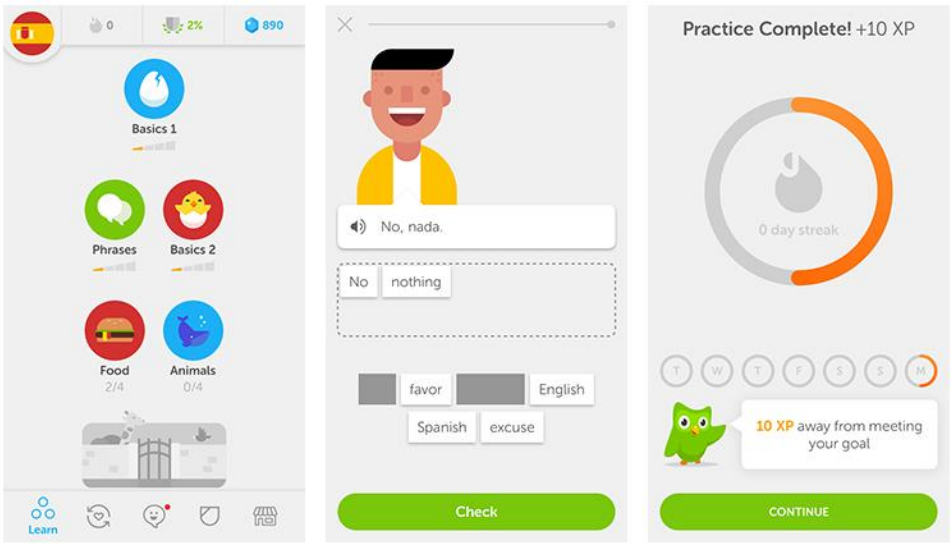


Figure 6: Duolingo App Screenshots with Gamification (mLevel 2017)

Gamification can use a plethora of gaming elements and mechanics with the latest computing technologies, but what makes it most effective was incorporating real world understandings to what engages individuals (Wolery 2019).

Producing a game that does not interact with the most basic user desires will ultimately cause the user to not be enticed to continue playing (Tenfold 2018). Gamification experts believe that in a gamified system, the ratio was “75% to 25%, psychology to technology” (Zichermann and Cunningham 2011).

The following subsections will explore two types of psychology and game activity cycles with the aim of exploring theories relevant to gamification and will aid in the design of the artefact.

2.3.1.1 Four-Drive Model

The four-drive model was developed by Lawrence and Nohria (Lawrence and Nohria 2002) and was based on evolutionary biology. This model states that motivators that drive human behaviour can be categorised into four main drives: acquire, bond, defend and learn. Acquire was the gaining of anything from immaterial objects which include status power and influences (Kaufman 2019).

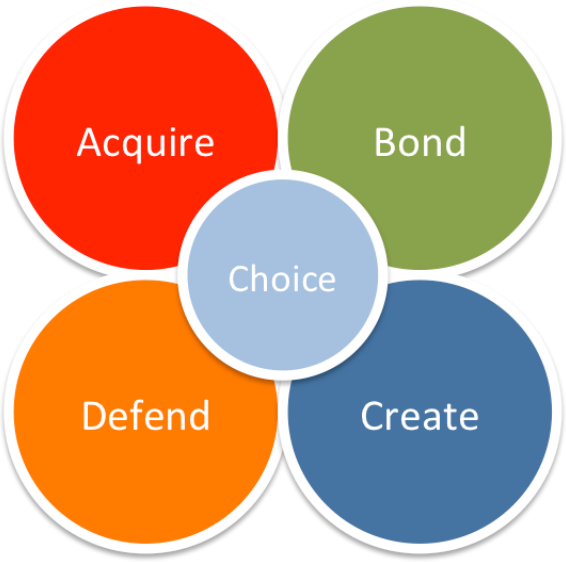


Figure 7: Four-Drive Theory Drives

Bond describes the development of relationships and communications between other individuals. Defend was describing the protection of physical/emotional properties. Finally, Learn was about the acquiring of new knowledge and skills through the curiosity of life (Kaufman 2019).

This model was generally used in organisations for employee and customer motivation (Zoey 2016), demonstrating that it can be freely applied to systems including loyalty programs and gamification (Wolery 2019). The more drives that gamification manages to invoke, the greater the possibility of appealing to users and increasing the use base.

2.3.1.2 Fogg's Behaviour Model

Fogg proposed a behaviour model theorising that in order for a behaviour to occur, the user must have the motivation, the ability and a successful trigger to perform said behaviour [52]. **Figure 8** contains a simplified adaptation of Fogg's graph (Groenewegen 2018), stating that all three components must occur concurrently for the target behaviour to take place successfully. This means that an event must be motivating and achievable in order to trigger the targeted behaviour (Kaufman 2019).

In regard to gamification, the gaming elements/mechanics can influence the users over the activation threshold and perform the expected behaviour (Wu 2011). A successfully gamified system must cause all three elements of the behaviour model to occur at once.

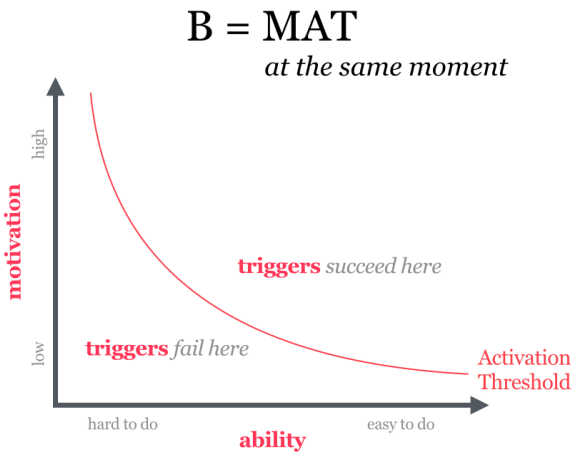


Figure 8: Visual depiction of Fogg's Behaviour Model (Groenewegen 2018)

2.3.1.3 Game Activity Cycles

A gamified system must include an activity cycle to continue the stream of user motivation (Slibar et al. 2018). All games are performed to engage users and push them to progress throughout the game using a sequence of “loops and branch trees” (Werbach and Hunter 2012).

All games are designed with these cycles in mind, since they are the essence of the game (Werbach and Hunter 2012). The actions performed by users will cause events to occur and consequently incites new user behaviours.

There are two different cycles that should be incorporated in a gamified design: engagement loops and progression stairs (Werbach and Hunter 2012 p.95). Engagement loops illustrate what the user interacts with, why they made the interaction and what the system replies in response (Werbach and Hunter 2012 p.94).

Figure 9 depicts the engagement loop and its components (Morales 2014). It starts off with a user building up motivation, causing them to perform a behaviour/action. This action incites a response from the system which includes rewarding points/badges.

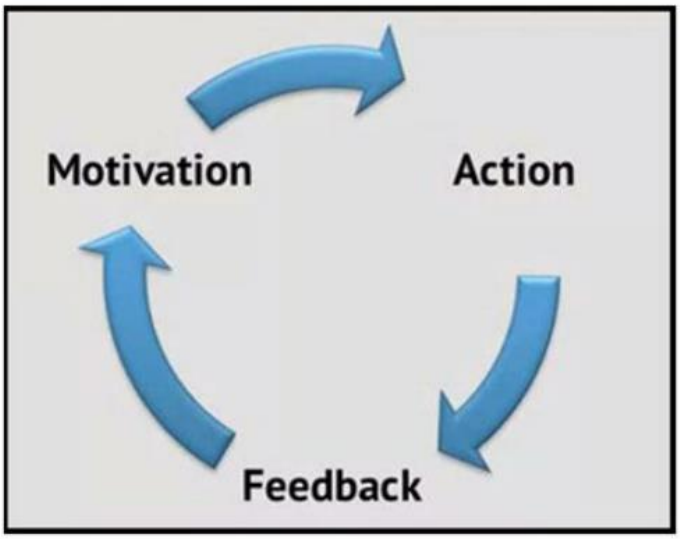


Figure 9: Engagement Cycle (Morales 2014)

2.3.2 Applications of Gamification

Gamification has the potential to help individuals in areas of education where engagement was lacking. Furthermore, it was suggested by researchers to be a sufficient tool for teaching as it will not only motivate users, but also make learning more satisfying in the process (McKenzie 2011).

Students tend to prefer to play educational games as oppose to the traditional classroom learning environment after discovering that schools and universities faced an extreme motivational and engagement issues. Researchers have suggested to include gaming elements into classrooms as a possible solution to the problem (Hirsh-Pasek et al. 2015), since this would engage students into paying more attention about their education, thus ultimately improving their learning.

From an educational perspective, e-learning faces a considerable challenge: the lack of emotional/motivational communication from teacher to student due to the digital format and lack of face-to-face teaching (Vincenti et al. 2017). The lack of student-teacher interactions has to be recouped by alternative techniques that improve the educational approach, motivating students to learn more.

It was implied that a gamified approach would be an effective solution (Vincenti et al. 2017). However, if the design of the gamification does not fit the purpose, it would become less of an incentive to continue using the product (Vincenti et al. 2017).

2.3.3 Failed Gamification Cases

There are a few cases of failed gamification implementations including the possible reasons for their demise. Examples like Zappos and Marriott boosted the gamification knowledge of the development team, which showed to effectively use gamification for this project.

2.3.3.1 Zappos

An online retailer, known for selling clothing and regarded for its marketing and its social media (Kleinberg 2012) has implemented gamifying elements to their product. The aim was to produce a rewards programme for their VIP customers, allowing consumers to obtain badges/points/levels as a reward for their purchasing activity on the website (Kleinberg 2012).

The gaming mechanics made by Zappos were deemed aimless as consumers were unsure what the badges and points signified and what value they had (Graham 2013). Ultimately, the badges and points provided no exciting benefits to users (Kleinberg 2012).

Figure 10: Snapshot of Zappos' Consumer Public Profile (Kleinberg 2012)

Figure 10 shows an image of what a general public profile would look like on their site. You can see that there was no noticeable information which describes what behaviours the company was rewarding.

The lesson to learn from this particular case was to clearly show to users what the rewards are when adding gamification to the system instead of leading consumers confused and frustrated.

2.3.3.2 Marriott

The international hospitality company decided to develop a game called “My Marriott Hotel” on the Facebook platform. Their aim was to take on users as employees for their recent management program (Robson et al. 2015).

This game was inevitably a failure because they build a product that no one wanted to play (Kleinberg 2012) and was deemed a poor business investment. Marriott felt that they needed to gamify their platform because all of their competitors are doing it as well (Joy 2017). **Figure 10** shows a quick snapshot of the Facebook game in question.

Figure 11: Snapshot of Marriott Facebook Game (Meritocracy 2017)

The lesson the team learnt from this case was to not create a gamified system in a knee-jerk reaction when you notice the competitors implementing gamification to their services. For this project, the development team spent their valuable resources developing a system that was appealing to the intended audience as oppose to joining the gamification bandwagon because everyone else was as well.

2.3.4 Risks of Gamification

New technologies cause certain risks and dangers that have a chance of affecting user experience (Jiang 2011). Knowing about risks of gamification first-hand was useful in preventing them from happening and figuring out how to mitigate the issues as much as possible. Bad initial gamification design was the culprit for the majority of problems, with estimations that 80% of gamification projects fail due to bad design (Fogel 2015).

Many issues in project with gamification arising due to bad game design includes using game mechanics incorrectly and not understanding their intended users, which leads to user behaviour pitfalls (Algashami et al. 2018). Such issues that could potentially occur includes unintended user consequences and the risk of the user getting disinterested with the poor gaming design (Dymek and Zackariasson n.d.).

2.4 Mobile App Difficulties

Using mobile applications as a learning and teaching platform is currently an effective and common practice in Higher Education (Pechenkina 2017), with development teams gaining interest with investing in digital educational platforms (Hirsh-Pasek et al. 2015).

Mobile app engagement and mobile app retention are two important metrics for companies. With only 40% of customers continuing to use particular mobile applications they downloaded a month ago (Apptentive. 2019), it proves to be a genuine insight into both the success and hardships when building a mobile system.

Churn rate is a term used to describe the rate of attrition. It calculates the number of users who either uninstalling the application (hard-churn), or no longer using the app on their device during a defined period (soft-churn) (VOZIQ Team 2017).

Figure 12: Retention Rate for Non-Messaged Users (Urban Airship 2017)

Figure 3 shows a detailed graph containing the retention rate for users on an application (Urban Airship 2017), thus emphasising that the mobile market is a very difficult area to maintain user attention (Appel et al. 2017). Low app engagement and retention is a recipe for a failed product and so needs to be taken into critical consideration (Armour 2018).

Judging by these negative effects that companies receive when building a mobile system in such an overly-saturated market (Taylor et al. 2018), the decision to produce a desktop application was made fully which has the ability to provide fewer distractions to the user (Appel et al. 2017).

2.5 CRITICAL SUMMARY

As a result of the background study, there was a greater awareness of the techniques and practices used to produce such a system.
Language-learning teachings were discussed to gain a clearer indication on how people worldwide are teaching their students in effective ways. Basing the project more to Direct Method was the beneficial approach for this project.
For users to fully learn a foreign language, time and commitment is required to succeed. The research the team made on gamification proved that it has the potential to boost user incentives on systems. This would be ideal for this project.
Finally, the research on mobile systems and their issues including oversaturation and digital app retention showed the development team that it wasn't the ideal platform for this project.

3 METHODOLOGY

3.1 OVERVIEW

In order to implement the technologies that were previously discussed, an effective development methodology needed to be selected that reflects the nature of the project successfully. This chapter analysed the requirements of the system and how they were elicited and prioritised. Justification with the methodology decisions were made as well.

3.2 DEVELOPMENT METHODOLOGIES

As software has become a critical aspect in every organisation, the set of structured activities made to produce software is now an important topic to developers (Zima 2015). Each methodology is best suited for specific types of project based on stakeholder and project requirements. For this project, a system with the intent to bring full control and order into the development process was a required area (Zhang et al. 2010).
Thus, developing the system using a rigid life cycle model became a clear decision for this project.

Figure 13 shows the Software Development Life Cycle stages in a concise illustration, showing all seven phases of development.

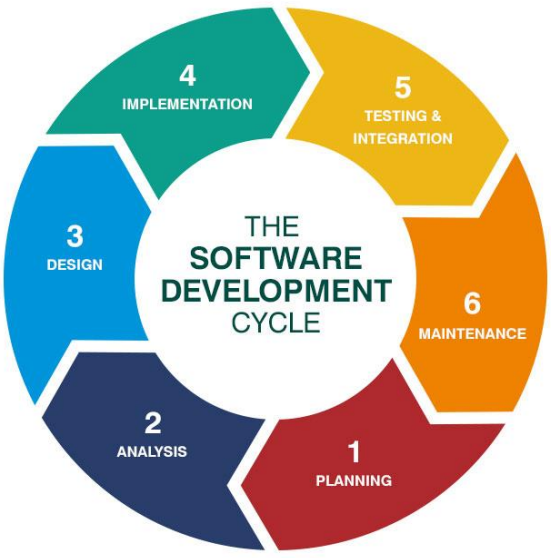


Figure 13: Software Development Life Cycle 7 Phases (Hussung 2019)

3.3 WATERFALL

The Waterfall SDLC method is a sequential development process where progress is determined by a flow through a list of 5 structured phases that must be executed in order to successfully build the system (Bassil 2019). Originally proposed by Winston W. Royce in the 1970s to describe a potential engineering practice (Royce 1970), this method consists of several phases that must be completed before moving to the following phase (Bassil 2019).

Figure 14 depicts the phases of the Waterfall Model; the Requirements, Design, Implementation, Verification and Maintenance (Hussung 2019).

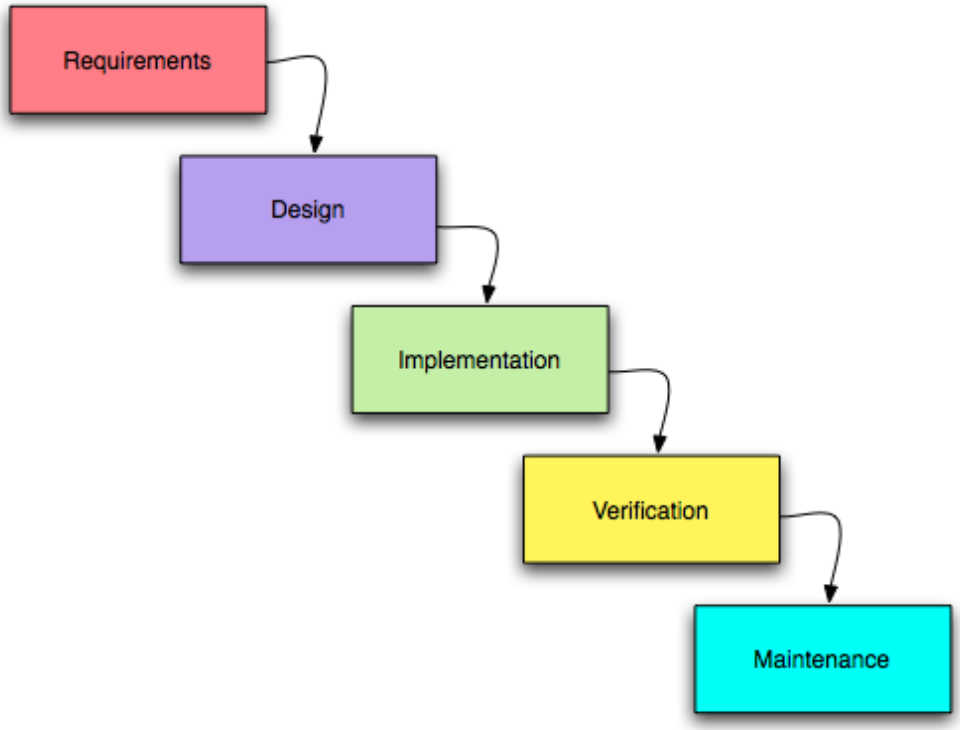


Figure 14: Traditional Waterfall Model Approach (Hughey 2009)

This methodology was chosen as it helped the team follow an outlined structure from the start to the very end. The model is very effective for smaller projects such as this, where requirements are clearly defined and understood by all stakeholders (Kumar and Shukla 2013). Another advantage for using this methodology was simply the ease of management due to its rigidity, with each phase having specific deliverables and review processes (Sabale and Dani 2012).

There are limitations when using Waterfall, one being that the project is inflexible and cannot make major changes to the system during development. This would cause issues for the developers in the long term (Alshamrani and Bahattab 2015). Furthermore, the Waterfall model is unsuitable if the requirements are not well understood or likely to change during the course of the project (Ragunath et al. 2010).

Provided enough time as been reserved to produce a detailed requirements specification, that should nullify the limitations that may occur.

3.4 QUALITY EVALUATION

The evaluation of the system usability was a crucial aspect in this project. Multiple techniques were required to be adopted provided that the usability coverage of the system was as high as possible when fully built. Further details on each technique is described below.

3.4.1 System Usability Scale (SUS)

Largely adopted by numerous international industries to test their systems, SUS is an industry standard due to its straightforward practice (Katsanos et al. 2012).

SUS is a minimalistic ten-item technique that assesses the usability of the application. Using a total of ten participants, aged between 20-60 to participate in the questionnaire inspired by John Brooke (Brooke, 1996, p.4), participants were inquired to score items with one of five responses ranging from *Strongly Disagree* to *Strongly Agree*. Participants were also kept anonymous throughout the process for safety purposes.
Figure 15 shows a visual representation of the response format described (Sauro 2019).

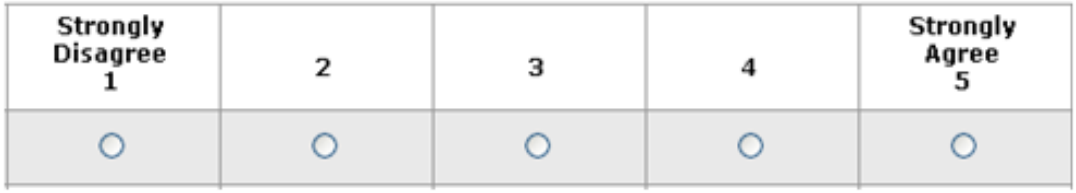


Figure 15: SUS Response Format (Sauro 2019).

Afterwards, the scale was then converted into a single number representing the usability score.

Figure 16 illustrates the final scores that are compared in relation to the average (Sauro 2018). A sample sheet that was provided to all participants for this project is found in **Appendix P**.

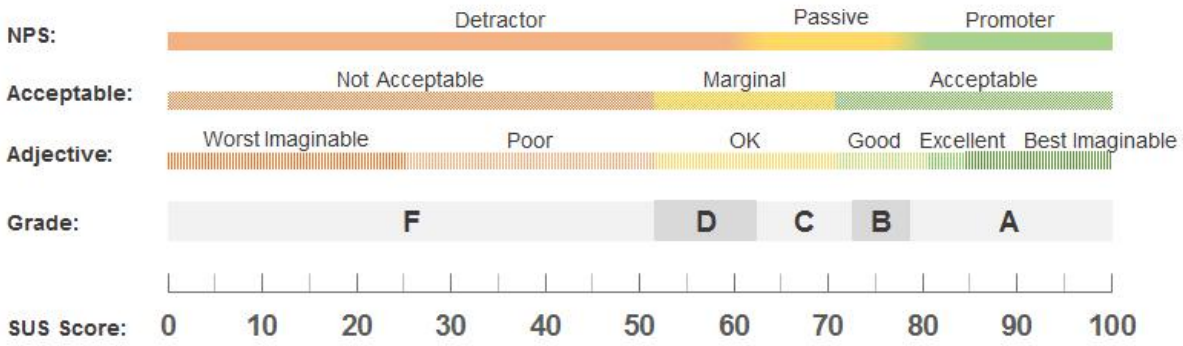


Figure 16: SUS Percentile Ranking (Sauro 2018)

3.4.2 Nielson's Heuristic Evaluation

Heuristic Evaluation is a method solely relying on experienced evaluators, an expert of the system to analyse the system on predefined characteristics and to identify common usability issues in the design (Desurvire et al. 2004). Advantage with using this technique includes how inexpensive it was and can be used in the early stages of development to find useful feedback (Designorate 2016).

All evaluators followed in detail Jakob Nielson's general principles (Nielsen 1995), and use their expertise and initiative to conduct the Heuristic Walkthrough. There they recorded any issues that they encountered and explain what heuristic were violated.

3.5 SOFTWARE TESTING METHODOLOGIES

Outlining the overall approach and testing strategy for the project was a high priority during the development and testing phases. This included using test case derivation techniques, with comprehensive evaluations as to why the chosen methods were selected.

The focus of the test cases was to produce an evaluation on the compliance of the whole system, giving a sense of validation that every area of the system was performing to the correct specifications.

The cases covered the performance and reliability of the system, including recorded user interactions and data outputs in which the program performed a given task. The testing techniques that were implemented*: Equivalence Partitioning, Boundary Value Analysis, Exploratory Testing and Error Guessing*.

3.6 ISO 31000:2018

In this project, the ISO standard for Risk Management was being followed. ISO 31000 was chosen as it is a high-level professional standard that can apply to many different situations (ISO 2019). This standard encourages good practices for risk management, while increasing the likelihood of achieving certain objectives (ISO 2018).

3.7 PROJECT PLAN

In order for time to be planned and measured effectively, a Gantt chart was used to both track the progress of the project as a whole. The initial Gantt chart plan was made up of three distinct milestones signifying the major phases of the project development.

First Milestone - The initial research and development is completed, which includes the requirements and design being gathered and written up in detail.

Second Milestone - The development of the artefact with user testing included.

Third Milestone - Final testing of the artefact and the completed writeup of the project. Below contains the final version of the Gantt chart.

3.8 GANTT CHART

ID	Task Name	Start	Finish	Duration
1	**Research**	**11/02/2019**	**24/02/2019**	**14d**
2	Research alternative language learning systems and gamification.	11/02/2019	13/02/2019	3d
3	Research and identify JavaScript tools required for the project	13/02/2019	15/02/2019	3d
4	Investigate the Verification JSON and its uses	15/02/2019	18/02/2019	4d
5	Background Study	11/02/2019	24/02/2019	14d
6	**Analysis**	**25/02/2019**	**03/03/2019**	**7d**
7	Requirements Analysis	25/02/2019	28/02/2019	4d
8	Specifications Development	01/03/2019	03/03/2019	3d
9	**Design**	04/03/2019	17/03/2019	14d
10	**Implementation**	21/03/2019	17/04/2019	28d
11	**Testing**	**21/04/2019**	**01/05/2019**	**11d**
12	Functional Testing	21/04/2019	25/04/2019	5d
13	Usability Testing	26/04/2019	01/05/2019	6d
14	**Evaluation**	02/05/2019	04/05/2019	3d
15	**Contingency Time**	05/05/2019	11/05/2019	7d
16	**Documentation**	11/02/2019	11/05/2019	90d
17	**Time Management**	11/02/2019	11/05/2019	90d

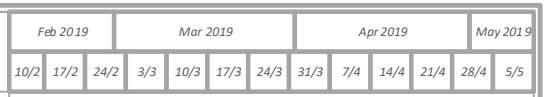


Figure 17: Updated Gantt Chart

3.9 CRITICAL SUMMARY

As a result of the methodology overview, the waterfall model of software development was examined and selected to use in this project. Waterfall was chosen as it was an effective methodology when producing hard systems that have a low chance of making system requirement changes. It was also a simple and easy to understand and use due to the rigidity of the model.

The means of project management was also discussed specifically with the decision to create project milestones and a Gantt chart. The Gantt chart helped assess how long the project should take and determine the resources required to complete certain tasks.

Testing strategies were also discussed, which were utilised during and after the development of the artefact.

4 REQUIREMENTS ANALYSIS

4.1 OVERVIEW

This section was used to seek and identify requirements to achieve the proposed solutions defined in **Chapter 1**. Semi-structured interviews were conducted in collaboration with MoSCoW to prioritise those requirements.

4.2 ELICITATION

4.2.1 Semi-structured Interviews

Three interviews were conducted with participants of a diverse language learning knowledge to elicit potential requirements. The following excerpts are colour coordinated for reader convenience. Comments from Ollie are in blue, Brandon in green and Ruben in red. Interview questions are available in **Appendix G**. The full transcripts are found in **Appendix H, I and J**.

Topic	Excerpt(s)
Browser Extension Issues	*"Some require an active login or synchronisation for them to work properly."* *"An issue locating specific extensions when trying to find a new one."*

Possible Features	*"Features that translate onscreen text into a different language."* *"Options for logging in/signing up so you can undertake gamifying tasks."* *"Translation to work effectively and to not interfere with my daily web surfing life".* *"Engaging in minigames that will give me a greater incentive to learn the language more."*
Security	*"An encrypted on on-screen password."* *"I expect my personal data to be secure and to not be released to the public."* *"I'd expect that my information is secure, protected and data is not being misused."*

Gamification	*"I think that it's an effective way to challenge users."* *"Earning badges and points definitely encourage me to use products."* *"Some sort of points system that lets you compete would be very beneficial."*
Language Learning Issues	*"Learning language requires a lot of motivation to continue the education."* *"Slang words, it is a massive obstacle for most second language learners."* *"Issue is that it can be very repetitive and can make it quite a boring experience."*

Design	*"A clear and aesthetically pleasing UI to enable the functionality."* *"Bold and concise results."* *"If it gives me opportunities to both input and output."* *"A Minimalistic approach"* *"A Dark Mode would be a bonus."*
Successful Product Requirements	*"Perform all intended functionality without negatively affecting the usability of a web page."* *"Does not affect the appearance of the webpage."* *"Performing all the functionality and getting that translation right."*

Table 6: Semi-structured Interview Excerpts

4.2.2 Results

With a total of 3 participants providing feedback for this project, it became clearer that many of the user requirements are centred to the security and functionality of the system. Users also demand a more minimalistic approach that does not hinder the experience of browsing the internet. Therefore, developers prioritise more on functionality and quality of life issues that improves the user experience, while making sure that the translation was as accurate as possible.

4.3 REQUIREMENTS GATHERING

4.3.1 MoSCoW

Requirements are expected to be prioritised in order to work more efficiently towards more significant goals with the time available in the project. The MosCoW approach was used as it makes it a simpler process to prioritise requirements effectively in a small development team (Khan et al. 2015). An advantage that distinguishes itself from similar techniques was that internal stakeholders are able to consider both what you should include in the system and what will not be included (Mirandolle et al. 2011).

The MoSCoW principle was initially developed by Dai Clegg (Kukhnavets 2016), and the principles are divided into four main identifiers. Those are the following:

1. **Must Have's** *(Mo)* – Essential requirements to the solution. Without these requirements, the solution could potentially be unsafe to release and therefore cancelled.
2. **Should Have's** *(S)* – Important requirements to the solution. The system was still viable without such requirements. However, it may impact the systems quality including usability and performance.
3. **Could Have's** *(Co)* – Desired requirements to the solution that can potentially be added if there was enough time to add. Not including such requirements doesn't severely impact the system quality.
4. **Won't Have's** *(W)* – Requirements that are included to give better insight on the project aim but was later removed due to time constraints and lack of resources. Such requirements may be included in future stages of development.

All requirements are split by their priority using the MoSCoW method, all gathered using research and interviews. The must requirements are completed first. "Should" and "Could" requirements during the later stages of development and if there was time during the contingency period.

Must Requirements	**Origin**
System must be a portable	Ollie
System must have a translation JSON file	Chris, Ruben, Ollie
System should allow users to view their vocabulary list.	Chris, Ollie, Ruben, Brandon
System must contain system icon on the browser with popup.	Ollie, Brandon
System must allow for input with a keyboard	Chris

Should Requirements	**Origin**
System should contain web page about the product.	Chris
System should translate words from Spanish to English.	Ollie
System should allow users to view translated words on a webpage.	Brandon
System should notify when the user gets points for inputting correct words when interacting with the translated words.	Brandon
System should have a factory reset feature to manage user defects and to give users the opportunity to start again at Level 1 if they wish.	Ruben
System should provide users with a step-by-step tutorial describing how to use the browser extension as effectively as possible.	Chris

Could Requirements	**Origin**
System could provide verification that user inputs are the correct translated words.	Chris
System could provide diagnostic prompts to the users	Chris
System could provide user logins for each individual	Ollie
System could have individual user level progress bars	Chris
System could have social media links	Chris
System could translate words back into English once the user has gained full knowledge in that particular Spanish word	Chris

Won't Requirements	**Origin**
System won't translate all words on webpages	Chris
System won't have multiple language learning support	Ollie
System won't have customisable user accounts	Ollie
System won't have world level ranking system	Ruben
System could have push notifications for added incentives	Chris

Table 7: MoSCoW Requirements

4.3.2 Requirements Prioritisation

Using the information gathered in all three user interviews, the development team produced the table below containing the functional and qualitative requirements set for this project. All are showing a MoSCoW rating to indicate the prioritisation that has been made for each requirement.

4.3.2.1 Functional Requirements

ID	Summary	Description	MoSCoW Rating
F1	System should allow users to view their vocabulary list.	User iterative list of words that they now know in Spanish. Vocabulary List is used to test the individual of their memory and gain points when correctly remembered.	Must Have
F2	System should contain system icon on the browser with popup.	Easy to identify icon logo on the top right of the Chrome browser for easy access to the application and its features.	Must Have
F3	System must allow for input with a keyboard	Input is used to add words to the vocabulary list as well as testing itself when words have been translated on the webpage.	Must Have
F4	System must have a JSON file.	JSON file contained in the system as a means of user input verification. Dictionary JSON file that can't be altered by the user.	Must Have

F5	System should contain a page about the product.	A simple page detailing the application to new users so they can begin using the many features in the system as fluently as possible.	Should Have
F6	System should translate words from Spanish to English.	English to Spanish and vice versa is the method of translation that will be used for this prototype system.	Should Have
F7	System should provide users with a tutorial page.	Providing all users with a clear step-by-step tutorial describing how to use the browser extension	Should Have
F7	System should allow users to view translated words on a webpage.	Translating words that only contained in the user's vocabulary list that they have made over time.	Should Have
F8	System should notify when the user gets points for inputting correct words when interacting with the translated words.	A simple notification when user inputs the correct answer when trying to remember the what the translated word is.	Should Have

F9	System should have a factory resetting feature for users to manage defects if discovered.	Button contained in the Settings page that clears the localStorage instantly.	Should Have
F10	System could provide diagnostic prompts to the users	Making sure that the system can be debugged in a simple way.	Could Have
F11	System could provide verification that user inputs are the correct translated words.	Dictionary JSON file will be used to make sure user input is verified.	Could Have
F12	System could have individual user level progress bars	Points and levelling system could be added to each user to make sure they get that sense of accomplishment when using the system.	Could Have
F13	System could have social media links	Linking social media could add more to the social aspect of using the product as well as gamification.	Could Have
F14	System could provide user logins for each individual	Added security when using the system.	Could Have

F15	System could have a Dark Mode feature that changes the application into a darker setting when in night time.	Changing the background colour and text when the user interacts with a button in the settings section	Could Have
F16	System could have translated all Spanish words on the webpage back to its existing English equivalent words	Once the user has correctly inputted the English equivalent word in the popup displayed when navigating the context menu, the webpage refreshes while translating the word back into English.	Could Have

Table 8: Functional Requirements

4.3.3 Qualitative Requirements

ID	Summary
Q1	System must be user-friendly
Q2	System must be quick.
Q3	System must be maintainable.
Q4	System must be future-proof.
Q5	System must be a portable

Table 9: Qualitative Requirements

4.4 CRITICAL SUMMARY

As a result of the requirements analysis, both the development team and readers gained a greater idea as to what requirements are set before the design and implementation stages have begun.

The priority in which objectives are made was selected in this project, requirements were fully prioritised using the MoSCoW method. A use case diagram was illustrated to define each step of the system and which actors are involved.

5 DESIGN & IMPLEMENTATION

5.1 DESIGN OVERVIEW

Designing the system was an important phase of development as it can have a large impact as to whether or not the product was fully accepted by the users. This chapter comprised the design of the artefact for this project, detailing the user interfaces that were devised.

The designs were also largely influenced by usability testing techniques, system requirements and a use case diagram. The naming of the artefact has been chosen prior to the development stages; the prototype has been codenamed ***Linguify***.

5.2 USE CASE DIAGRAM

Careful modelling was crucial in obtaining a correct and efficient system architecture. Use Cases are widely used as an effective tool for documenting system requirements, and for communication both between participants in the project, its future users, owners and misusers (Grechanik et al. 2007).

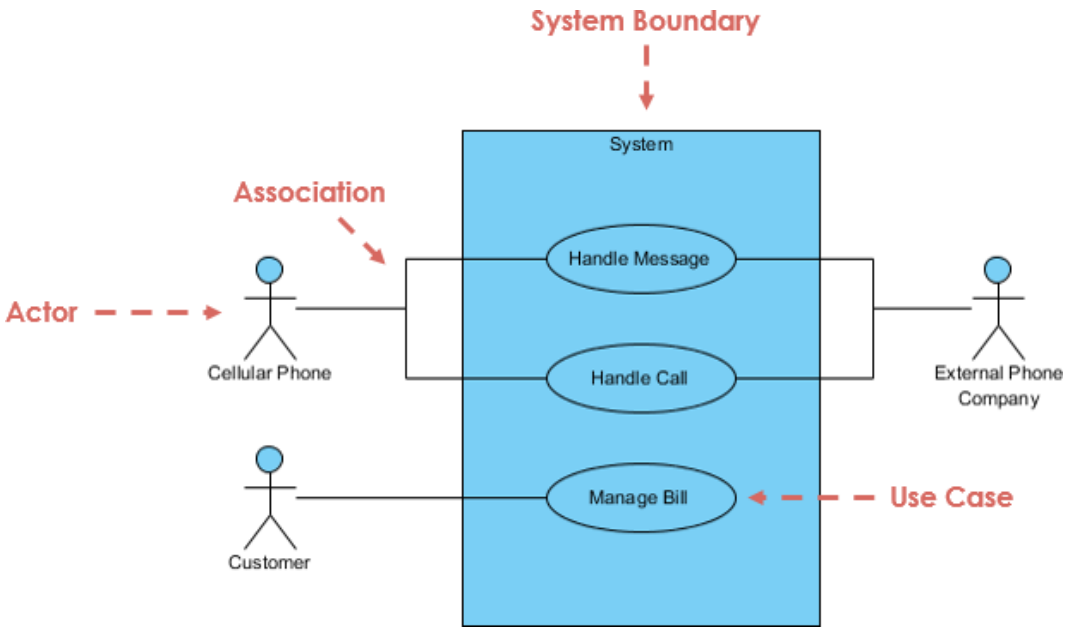


Figure 18: A Standard form of Use Case Diagram defined in the UML

Furthermore, they provided basic groundwork for the requirements specifications and test cases, whilst encouraging designers to envision outcomes before attempting to specify outcomes assists them with making requirements more proactive during development (Cockburn 1997).

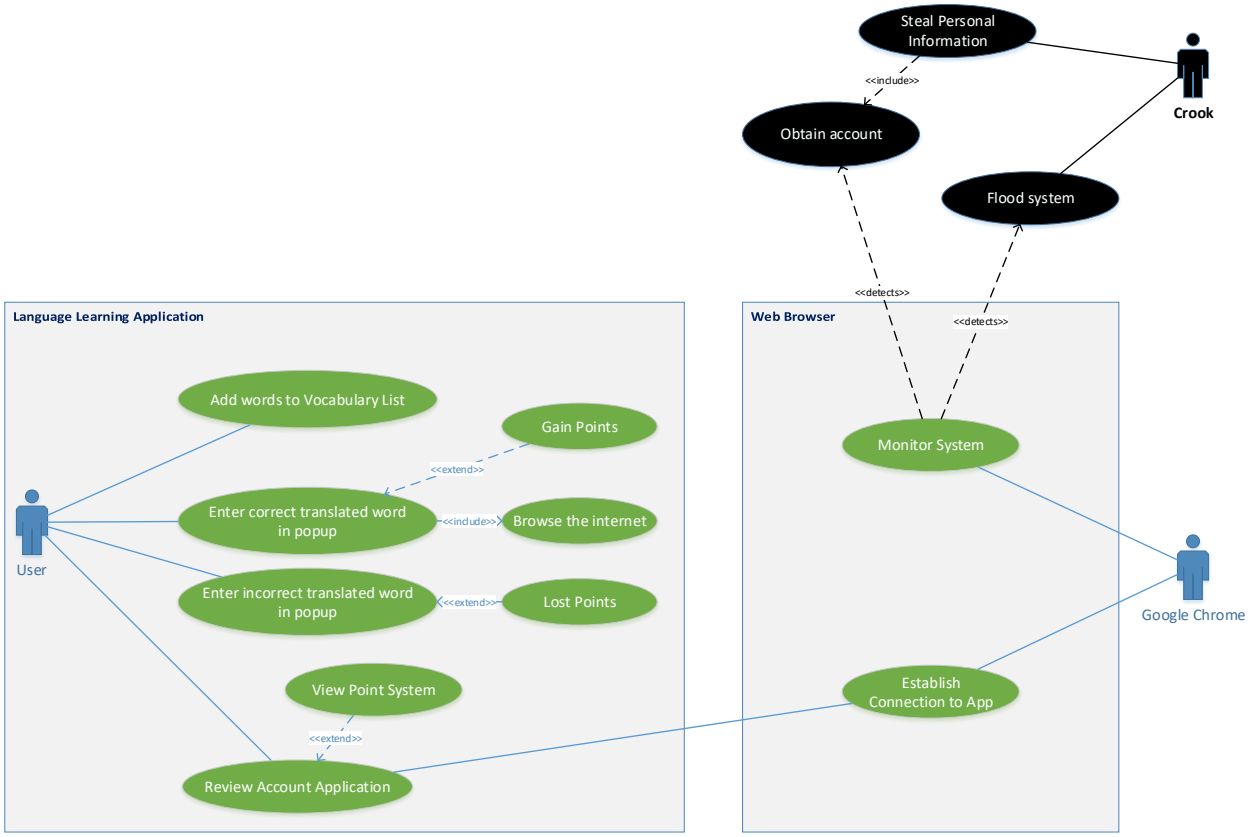


Figure 19: Use Case Diagram

While use cases are a very beneficial tool, it is rare to have a perfect version, but they always serve a useful purpose during the analytical process. **Figure 18** shows a typical example of a use case diagram that will be produced for this project.

In Use Case diagram found in **Figure 19**, it depicts the interactions among the elements in the system. The model contains a primary actor (*User*), an offstage actor (*Google Chrome*) and a hostile actor (*Crook*). Finally, it has a total of two system boundaries representing the interactions between the actors and the system.

Figure 20 shows the Use Case Specifications for the diagram above. This document was used to capture specific details of the use case. Details including actors, preconditions, main flow, postconditions and alternative flows of the Use Case.

Language Leaning Browser Extension Use Case Specification
Description: User launching the Language Learning Program on their Chrome browser
Primary Actor: User
Secondary Actor: Google Chrome
Precondition: 1. Computer is turned on 2. User has Chrome Browser installed on their computer. 3. User has application installed on their Chrome browser. 4. User has enabled the application.
Main Flow: 1. User selects browser extension icon 2. User goes to vocabulary list page 3. User adds Spanish words to their vocabulary list. 4. System verifies whether the user input is valid. 5. User arrives on a website. 6. System translates words on the webpage that only exists on the user's vocabulary list. 7. User provides system with correct English translation when interacting with word. 8. System provides user with experience points.
Post-Condition: User has learned and practiced more on the Spanish language.

Alternative Flow:
1. User arrives on a website. 2. System translates words on the webpage that only exists on the user's vocabulary list. 3. User provides system with incorrect English translation when interacting with word. 4. System notifies user that the user input is incorrect, revealing the correct English translation.
Alternative Flow Post-Condition: User has learned and practiced more on the Spanish language.

Figure 20: Use-Case Specifications

5.3 USER INTERFACES

5.3.1 Paper Designs

In the beginning of the design phase, paper designs were drawn first in order to get the initial idea into place and give stakeholders a greater idea of what the designers had in mind for the system. It was an inexpensive method with not a lot of commitment, as it does not require hours of development time to produce. **Figures 21** contain examples of these illustrations of each feature. Additional examples are available in **Appendix K**.

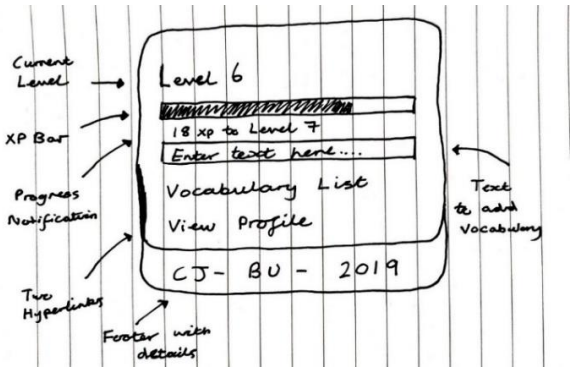


Figure 21: Popup.html paper design

5.3.2 Wireframe Designs

After the paper design stage, wireframe designs were produced to show a graphical skeleton of the application, helping stakeholders discuss further details of the application building. **Figure 22** shows the design of the popup.html interface previously shown in **Figure 15.** Additional examples of wireframe designs are found in **Appendix L**.

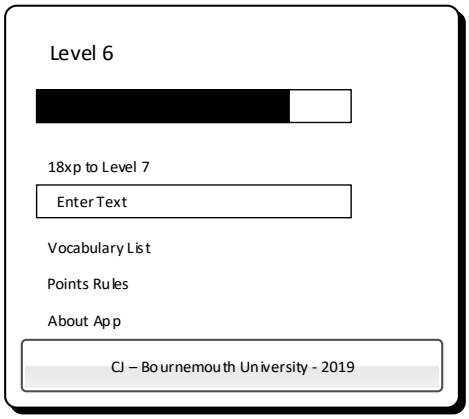
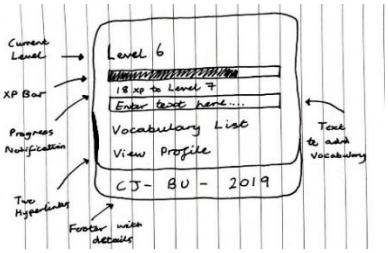
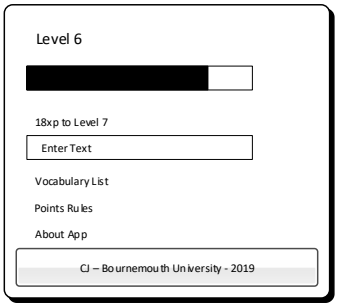
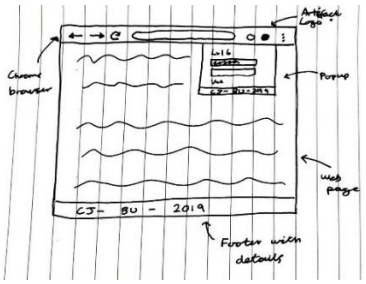
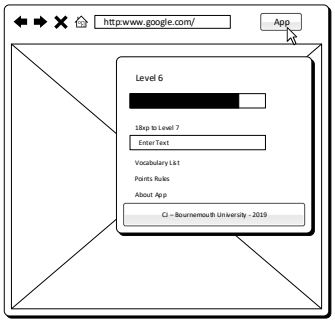
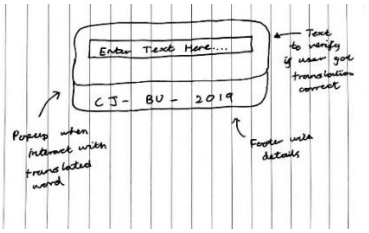
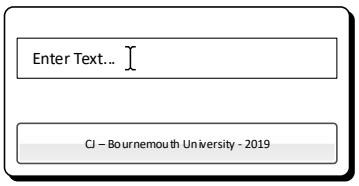
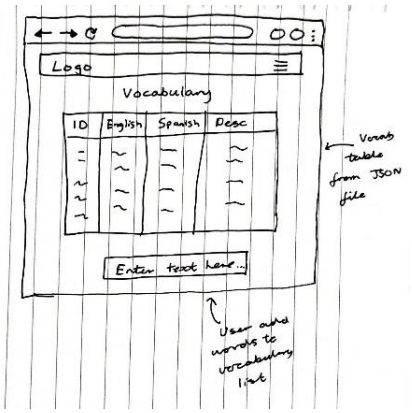
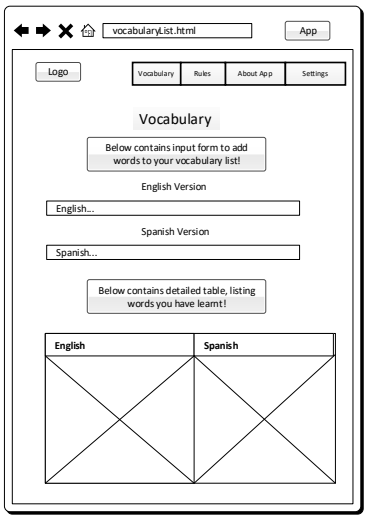


Figure 22: Wireframe design of Popup.html

5.3.3 Paper to Wireframe Design Iterations

Description	Paper Designs	Wireframe Designs	Iterations
Popup.html file. Appears when user clicks on logo on the Chrome browser.			**1.** Removed the "View Profile" page due to it deeming an unnecessary feature. **2.** Added "Points Rules" and "About App" page to give users a better understanding on the system.

Design of what the Popup.html will look like in relation to the Chrome browser and webpage.			**3.** Increasing the size of the popup for accessibility purposes **4.** Added colour changes depending on the user's level
Second popup when user interacts with a translated word on the webpage.			N/A
Vocabulary list page displaying the entire list for the user as well as an option to add more words.			**5.** Descriptions of the page in question. **6.** User inputting both the English and Spanish versions of the word to the vocabulary list array. **7.** Vocabulary List being displayed at the bottom of the page. **8.** "Vocabulary", "Rules" and "About App" hyperlinks at the top of the page.

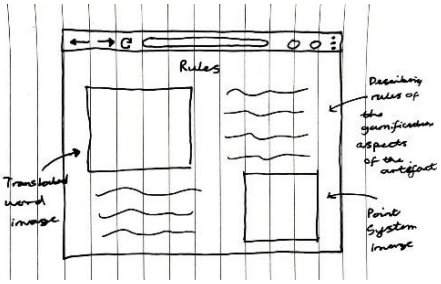
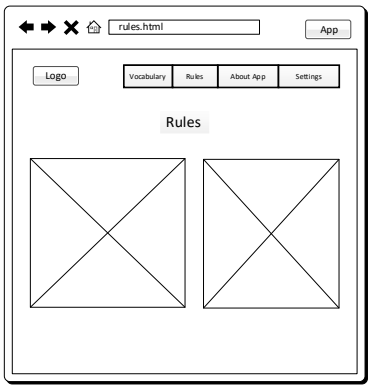
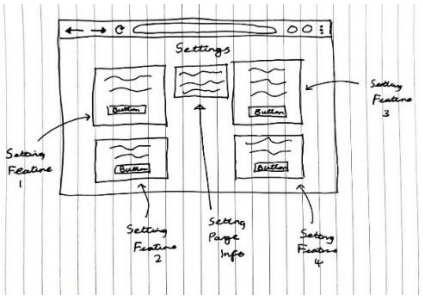
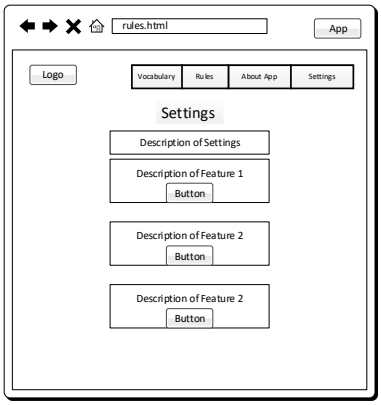
Rules list page displaying the how the points system words for this application.			**9.** Logo at the top of the page. **10.** “Vocabulary”, “Rules” and “About App” hyperlinks at the top of the page. **11.** Removed two cards as they were not needed anymore.
Settings page containing extra features made for the application			**12.** Change arrangement of the cards. **13.** Description of the page appearing first on the site.

Table 10: Design Iterations

5.4 VISUAL ELEMENTS

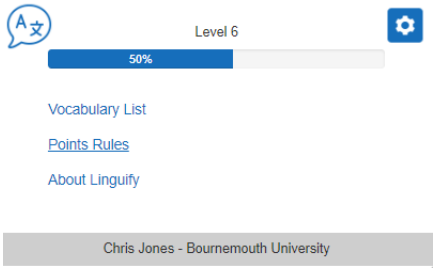
5.4.1 Artefact Logo

As a placeholder for the application, the decision was to find a free premade minimalistic logo as it gives the team extra development time to build important features in the system. Figure below contains a snippet of the logo that was used for this project which was provided by iconos8 (Iconos8 2019).

Figure 23: Artefact Logo (Icons8 2019).

5.4.2 Colour Schemes

It was decided by the designers of the application to follow a minimalistic white and blue approach as they are colours which blends well with most webpages and does not affect the experience of the user while browsing the internet. **Table 11** shows the colour schemes used for each element with screenshots of them.

Element	Colour	Example
Background	#166EBB	 Linguify Overall Popup

Text	#000000	Chris Jones - Bournemouth University Popup Text
Logos	#166EBB	 Linguify Logo
Selected Option	#0000EE #551A8B	Vocabulary List Points Rules About Linguify Linguify Links
Progress Bar	#A5A5A5 #166EBB #A53ED1 #FFD700	 Grey Progress Bar for Users at Levels 1-3  Blue Progress Bar for Users at Levels 4-6  Purple Progress Bar for Users at Levels 7-10 Gold Progress Bar for Users at Max Level (Level 11)

Table 11: Colour Schemes

5.5 IMPLEMENTATION OVERVIEW

5.5.1 Waterfall

Waterfall, the rigid software development methodology previously discussed, was chosen for development.

Although it encourages the development team to fully complete a development stage before continuing to the next stage, it was a very pragmatic technique to adopt as the requirements are rigid so it was very unlikely for changes to be made internally, it was beneficial due to the size of the team and the time constraints of the project.

5.5.2 Development Languages

The artefact for this project has been built using HTML, CSS and JavaScript. All these languages combined to produce the frontend of the system, making it as responsive as possible.

JavaScript was used for this project so user interaction can be made, particularly the user iterating on the Chrome localStorage. It was also chosen due to how fast it was on rendering to the end user. JavaScript is generally unhindered by network calls to the backend system and has no need to be compiled on the client side.

Although JavaScript is currently one of the most popular client-side languages, there are many rendering inconsistencies that persisted when using the language. Inconsistencies included client-side security where script can be exploited for malicious purposes. This security risk was further considered in the risk analysis phase. Screenshots of the end system as well as the static code analysis are found in **Appendix M and R** respectively.

5.5.3 Bootstrap

Bootstrap is a HTML, CSS and JavaScript framework used for developing a responsive web application. It provided important components that can be combined to help the developers build the frontend of the system.

This framework was used for this project as it allows high quality graphical user interface to be developed in a quick manner, leaving more time to product more complex features in the system.

5.5.4 jQuery

jQuery is a free JavaScript library, with its sole purpose to simplify the use of JavaScript on every page of the system. A lightweight tool that makes it easier to write many complex things including HTML/DOM manipulation, AJAX and CSS manipulation. In addition to this, using jQuery is the most popular framework, containing plugins for almost any task imaginable.

Lastly, jQuery runs exactly the same functionally in all major browsers including Google Chrome. This made it a viable tool to use for this project specifically.

5.5.5 User Input

The adoption of user input in this application was deemed beneficial with producing a detailed table containing the list of English words and their Spanish equivalents that they fully understand. As seen in **Figure 24,** users were using a keyboard to input the words onto a field set and clicking on the “Add to List”, this causes a refresh to the page while pushing the input onto the Chrome localStorage using the “setItem” method”.

Inputs are then verified via the produced JSON file, this was to make sure that both the English and Spanish words are correct and perfectly matching. An example being “Hello” being linked correctly with “Hola”.

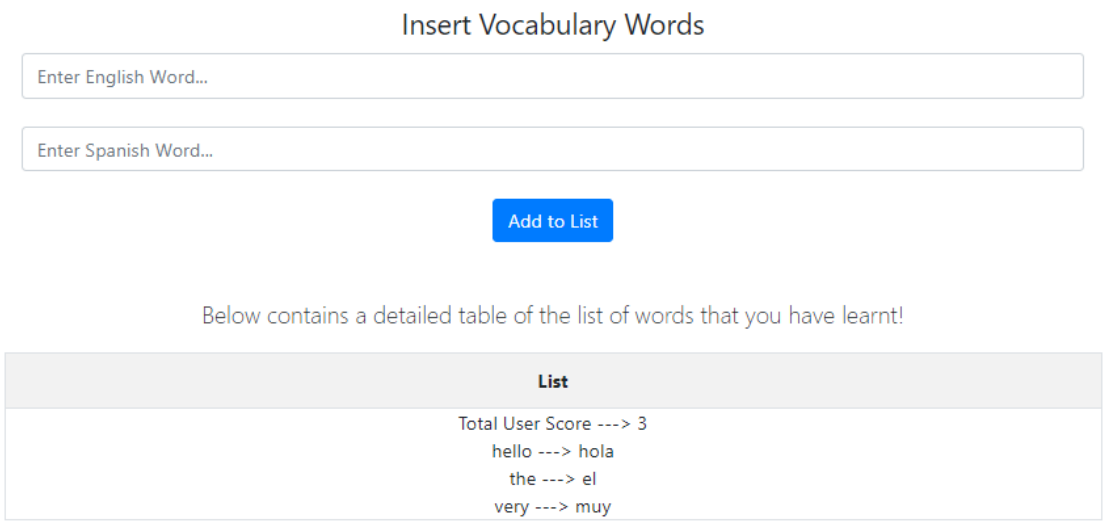


Figure 24: User Input – Vocabulary List

As Users can also interact with highlighted words on the webpage that are linked with the system Chrome localStorage, using keyboard and mouse input to insert the correct String in the context menu. Here users have the ability to input the English equivalent to test themselves.

Another area in the system which requires User Input was using the mouse to highlight specific translated words on a webpage. The user then gains the ability to right click the translated Spanish word which reveals the Linguify system in the context menu.

The user was provided with an input box, where they type in the English equivalent to be provided with 1XP that will automatically be added to their account. An incorrect input, however, with penalise the user with 1XP deduced from their overall total. **Figure 25** shows a snippet of the user input described.

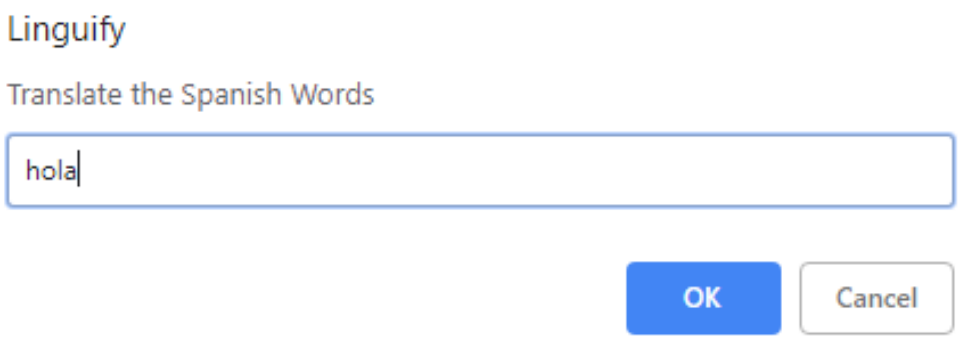


Figure 25: Translated Word – Dialog Box

5.5.6 Verification JSON File

In order to determine whether a user input was a valid English and Spanish word, an input verification feature needs to be implemented to eliminate potential errors in the system. The solution was to build large JSON files from the ground up, containing a dictionary of both English and Spanish words in a large array.

The JSON file remained a read-only file for this project and links with the user input to the Chrome localStorage with error messages appearing if the either English or Spanish inputs are invalid. If the user inputs are contained in the local JSON file, both inputs get pushed to the user Chrome localStorage as intended.
Figure 26 contains a snippet of the JSON file previously described.

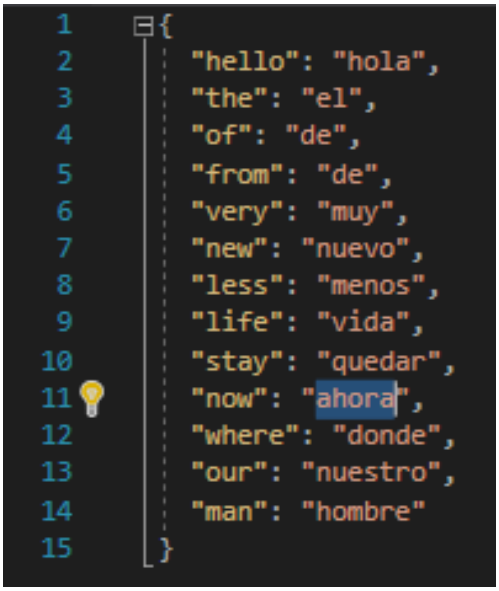


Figure 26: English/Spanish JSON File

Only words contained in the local JSON file are allowed to be added to the user vocabulary list. This decision was made to ensure that there were as few errors as possible in the final prototype. More words and phrases are to be added post-launch with consistent testing made alongside it.

5.5.7 Whitelisting Domains

In order to ensure that there are as few major defects as possible in the final prototype, only a handful of public domains were whitelisted in this system. This was a development team decision as to which domains are allowed, and which ones are not at this very moment. The websites that are compatible with this system are:

For security purposes and to not breach the Content Security Policy made by Google, users were permitted the access to decide which URLs they can use for this browser extension. Please visit **Appendix W** for more information as to which URLs the user were allowed to use for this final prototype.

5.5.8 Web Page Translation

Words are being translated on webpages based on the data pushed onto the user Chrome localStorage. Whitelisting was created so only a certain number of domains are containing translated words for this browser extension.

The translated words are then highlighted on the page to make it easier for the users to view the modifications that were made on the page.
Figure 27 contains a screenshot of a Wikipedia page with some English words being translated into Spanish with them being highlighted.

Figure 27: Website Snippet (Translated Words)

Users are then be given the opportunity to interact with said words and input what they believe the translated word represents. Below contains a snippet of the application translating words as well as the popup.

Figure 28 shows what the context menu will look like when the user highlights a word on the Chrome browser.

Figure 28: Context Menu (Translated Words)

5.5.9 Gamification

Words that are successfully inputted by the user are to be provided with points to give them with a sense of improvement and accomplishment when using the system on a regular basis. Users are not provided with points when inputting an incorrect word/phrase on the webpage.

Figure 29 below shows the early snippets of the user score above their personal vocabulary list. The integer increments every time the user adds words to their Chrome localStorage, if the list was empty, however, it initialises on zero. The score should always appear at the top of the list.

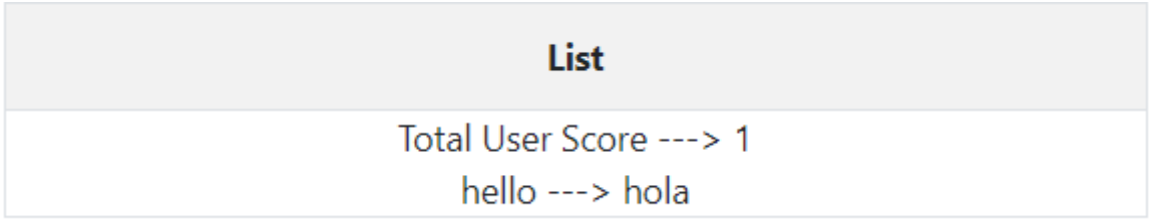


Figure 29: Spanish JSON File Snippet

Furthermore, we have **Figure 30** which was another gamification snippet showing the user progress bar to the next level on their account. It indicated to the user how many experience points are required to advance to the next level. In the final application, there are a total of 10 levels for the user to achieve. The colour of the progress bar changes depending on the user level, signalling an extra level of indication of the user progress.

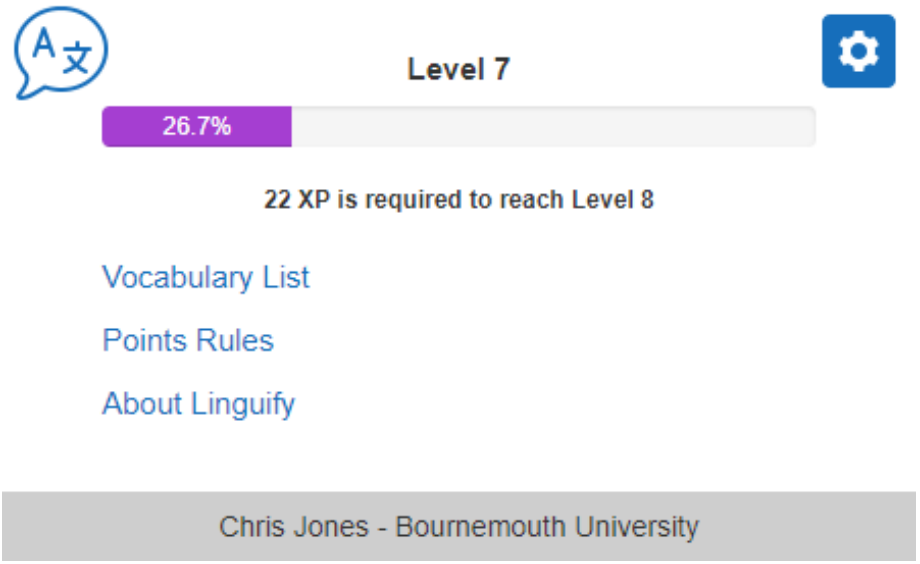


Figure 30: Gamification Progress Snippet

Users are given **1XP** for each Spanish word that has been added to the user vocabulary list. They are then levelling up depending on the number of experience points they have on their account. Users are also rewarded with new colours on their progress bar depending on their level.

Table 12 represents the progress bar levels for each stage as well as the number of experience points required to reach that specific level.

Level #	Level Colour	XP Required to Level
1	**White**	**0XP**
2		**10XP** (10XP from Level 1)
3		**20XP** (10XP from Level 2)
4	**Blue**	**30XP** (10XP from Level 3)
5		**50XP** (20XP from Level 4)
6		**70XP** (20XP from Level 5)
7	**Purple**	**90XP** (20XP from Level 6)
8		**120XP** (30XP from Level 7)
9		**150XP** (30XP from Level 8)
10		**180XP** (30XP from Level 9)
Max Level	**Gold**	**200XP** (20XP from Level 10)

Table 12: Levelling System

5.5.10 Factory Default

A software restore of the application to its original state was implemented in this project which erases all of the information stored on the Chrome localStorage. This was in an attempt to restore the device to its original released settings.

Users who interacted with the button in the settings page effectively erased all the English and Spanish words added to the user vocabulary list. This was added to helpfully fix potential issues with the system and for users to restart their progress if they choose.

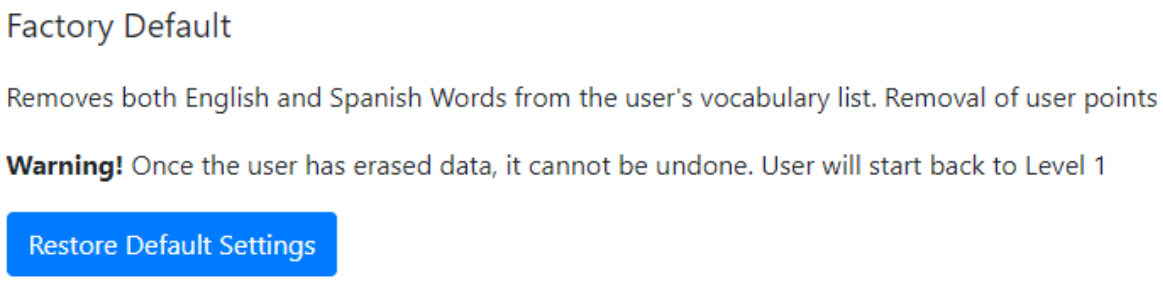


Figure 31: Restore Default Settings Snippet

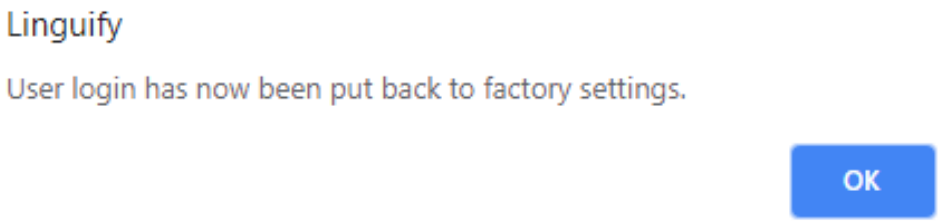


Figure 32: Restore Default Dialogue Box Snippet

5.6 CRITICAL SUMMARY

As a result of the design and implementation, readers have full access to the processes used to design and create the prototype.

Paper designs and wireframes were created as the initial structure of the system. After this the prototype of the system was created considering the prioritisation of features discovered when using the MoSCoW method.

The words on webpages were translated using the replace() method, with the words being highlighted in yellow to make it easy to detect the translated words. The verification JSON file was a read-only file that makes sure the words added to the vocabulary list are verified. The full conclusion of the project is provided in **Chapter 7**.

6 EVALUATION

6.1 OVERVIEW

It was an essential step to measure both the software quality, and the usability of the system. The techniques to assess the software quality included Equivalence Partitioning with Boundary Value Analysis, Error Guessing and Exploratory Testing. Whereas the techniques used to monitor the usability of the system were both System Usability Scale (SUS) and Nielson's Heuristic Evaluation.

6.2 SOFTWARE TESTING

6.2.1 Overview

The purpose of this stage was to evaluate the compliance of the entire artefact system, giving the users a sense of validation that every section of the artefact was performing to the required specifications. Test Cases are covering the performability and reliability of the system, this includes detailed recordings of the user interaction, data input/output and the speed in which the program performs given tasks.

In this project, the testing techniques that were used:

- Equivalence Partitioning
- Boundary Value Analysis
- Error Guessing
- Exploratory Testing

The full testing records are found in **Appendix N** which follows the testing plan format displayed below in **Table 13.** Detailed analysis was provided to make sure that a high testing coverage has been achieved throughout the process. This includes severity/priority and duplication/obsolete testing reviews. Assumptions based on the requirements specifications were made throughout.

No.	Test Case	Justification	Input	Expected Output	Actual Output	Condition	Comments
18	Popup.html appearing when user clicked.	Making sure that popup.html is working as intended.	**Input**: User clicking on the system logo on the top right of the Chrome browser. **Output**: Popup.html loaded.	Popup.html working with no errors occurring.	Popup.html appearing for the user with no delay or errors appearing.	**P**	

Table 13: Test Case Sample

During the testing phase, severity scale, output condition and defect outcome tables have been produced to simplify the test cases for readers found. Both showing three conditions that each have; a passed test, partially passed test and a failed test.

6.2.2 Equivalence Partitioning (EP) and Boundary Value Analysis (BVA)

Equivalence Partitioning was a very favourable technique which divided the system into smaller partitions, allowing the number of test cases to diminish without compromising the test coverage of the system. Furthermore, this method reduced the testing time of the system as checking every value in each partition would be extremely time-consuming (Callahan et al. 1996).

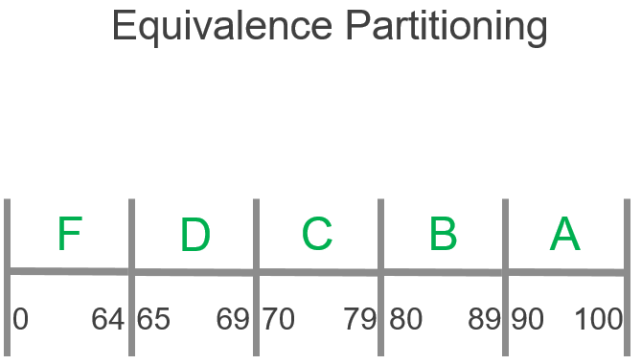


Figure 33: EP Visualised Sample (Deriskqa 2017)

Boundary Value Analysis was an efficient technique that works when used in conjunction with Equivalence Partitioning. This technique was about testing between the extreme boundaries of equivalence classes (Khan and Khan 2012). It was also known that developers fail to test the system at the boundaries of the partitions (Nidhra and Dondeti 2012).

Both methods were chosen to derive test cases for this project due to the large number of possible inputs for the program in the levelling system and user inputs to the vocabulary list. The key was to obtain the highest testing coverage possible while minimising the test cases made, which both techniques help to achieve effectively.

6.2.3 Error Guessing (EG)

There was a high chance that singular errors could still be in the system and left unnoticed, which causes the system quality to be affected (QATestLabs 2019). Those particular tests could potentially be found with the use of Error Guessing.

EG was an experienced-based and successful at compensating for the incompleteness that EP and BVA techniques tend to bring (Myers et al. 2004). This technique was chosen for this project as the project team had the highest understanding of the overall system, which saved time spent on testing.

6.2.4 Exploratory Testing (ET)

Under scripted testing techniques like EP & BVA, the team designed test cases first and then later proceeded with the test execution. Scripted Test Executions usually require minimal reasoning where testers execute the test steps and compare the actual results with the expected ones (Itkonen and Rautiainen 2006).

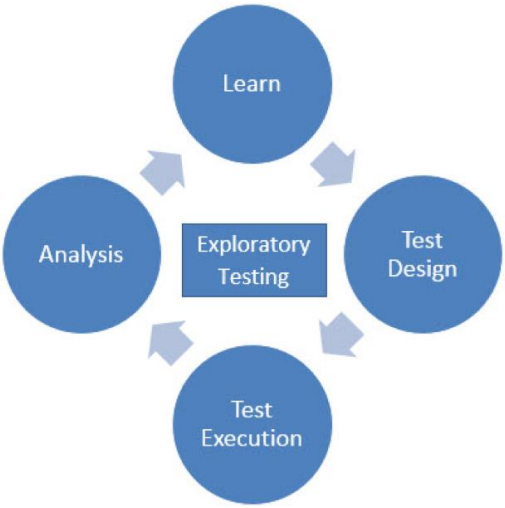


Figure 34: EP 4 Stages (3Pillar 2017)

ET is a structured ad-hoc testing approach that followed a 4-stage session-based test management cycle; creating a bug classification, producing a test charter, producing a time box, reviewing the results (Eriksson 2019). Using an approach that was more about learning and adapting in conjunction with the existing test techniques was a beneficial addition to this project (Bach 2003).

The advantages with using ET in this project was that it involved a more investigative process which helped find more bugs than the normal testing processes (Bach 2004). It also helped expand the knowledge of all the testers as more test cases are executed, thus improving the productivity.

6.2.5 Results

With a total of 50 functional tests received from the test plan, the use of multiple functional testing techniques became a necessary investment to improve the testing coverage. Defects were successfully found which will help improve the performance and maintainability of the system, which included reproducing steps and severity/priority reasonings for developers during the future phases of development.

6.2.5.1 Output Conditions

Equivalence Partitioning & Boundary Value Analysis		
Passed Tests	**Partially Passed Tests**	**Failed Tests**
22 88%	**3** 12%	**2** 8%

Error Guessing		
Passed Tests	**Partially Passed Tests**	**Failed Tests**
7 50%	**7** 50%	**0** 0%

Exploratory Testing		
Passed Tests	**Partially Passed Tests**	**Failed Tests**
5 50%	**1** 10%	**4** 40%

Table 14: Percentage/Number of Fully Passed, Partially Passed and Failed Tests.

6.2.5.2 Test Technique Review

	Technique	Test Cases	Defects Found	Detection of Defects %
	Equivalence Partitioning	25	5	20%
	Error Guessing	7	7	50%
	Exploratory Testing	10	5	50%
Total	-	**50**	**17**	**34%**

Table 15: Percentage of New Defects Detected

6.3 USABILITY EVALUATION

6.3.1 Nielson's Heuristic Evaluation

A total of 3 evaluators were used in this technique to examine the interface and judge the application compliance with recognising certain usability principles. The evaluator used their judgement and expertise to conduct the Heuristic Walkthrough, recording both positive and negative findings. The list of usability heuristics is found in **Appendix O**.

Positive Findings

Finding No.	Heuristic Complied	Task/Issue/Description
1	1, 2	Informs users what level they're profile is with the number of XP it currently has
2	3	Users have the logo contained at the top-right of the Chrome browser at all times for easy access to all the system features.
3		Users require no step-by-step login steps to use the application.
4	3, 7	System informs the user when words have been added to the Vocabulary List.
5	4	Inactive application is greyed out on the Chrome browser platform; good level of consistency.
6	3,10	Quick downloading of application onto the Chrome browser platform; contact information and support.
7	4.8	Aesthetic design of the application and web pages; appropriate use of font and colours, level of consistency.
8	1,3,7	Logical structure of the application and web pages; simple navigational menu.

Table 16: Heuristic Evaluation Positive Findings

Negative Findings

Finding No.	Heuristic Violated	Task/Issue/Description
1	1, 3	No feedback when keys are pressed.
2		Not all icons are labelled.
3	3, 4	Sound is not used to signal an error
4	5, 9	Error messages don't suggest the cause of the problem as effectively as it should.
5	4	Colour-coding not found throughout the system.
6	4	Not all icons are concrete and familiar.

Table 17: Heuristic Evaluation Negative Findings

The positive findings that the evaluators discovered were related to the system's compliance to user control and freedom as well as keeping them informed about what was currently happening in the system.

Nielson's Heuristic Evaluation also revealed multiple findings which hindered user progress while performing tasks on the system. In the perspective of new users, it can be difficult to view important error messages as effectively as possible because it was not as descriptive as it should be. Some issues can be resolved by making sure that every known error message was well written and helps the user to fix the issue as much as possible.

6.3.2 System Usability Scale

The SUS score requires the participant scores for each question to be converted into a new integer. The scores are then added together, multiplied by **2.5** to convert the original scores of **0-40 to 0-100**. The scores only considered in terms of their percentile rankings. 10 participants are used for this technique, all provided with the relevant information and consent forms shown in **Appendix Q and R.** All the results including the SUS score calculations are found in **Appendix S** showing an okay to good score overall.

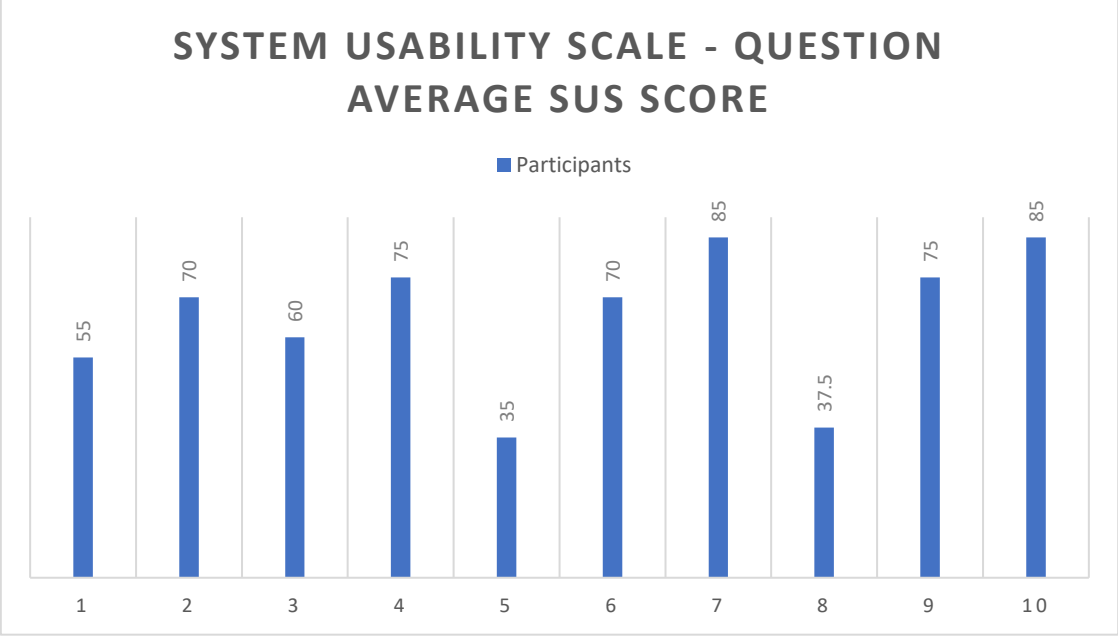


Figure 35: Bar chart containing average SUS scores for each participant

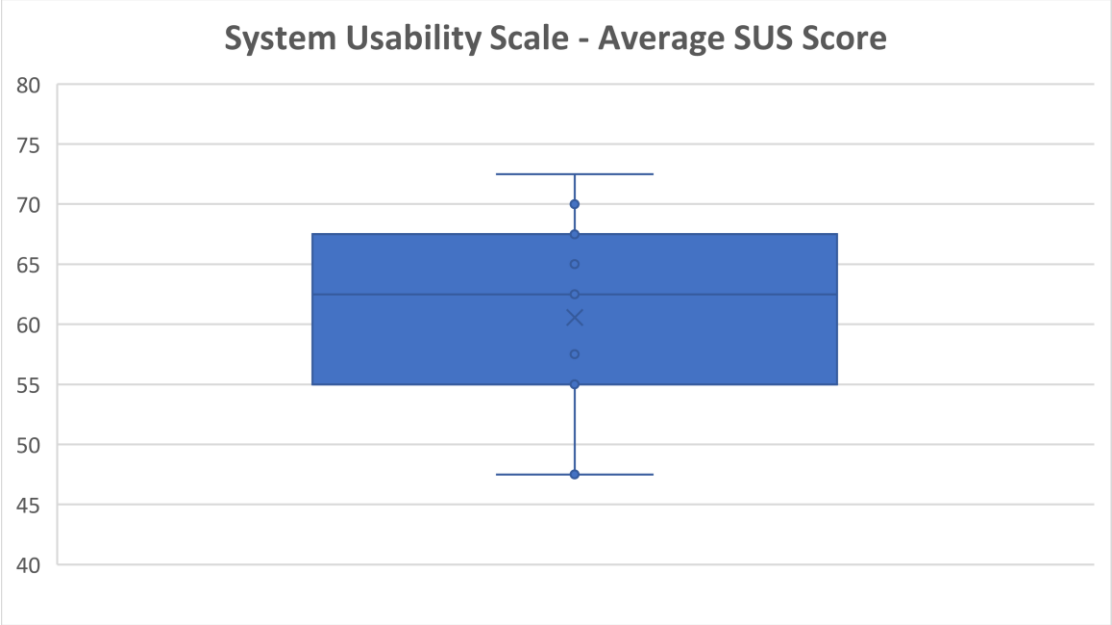


Figure 36: Box-and-whisker plot containing user scores (10 SUS statements)

Figure 35 contains a bar illustrating the SUS score for each test user; most are showing a score that exceeds the benchmark expectations. Overall the system has obtained an average SUS score of **64.25**, sitting just below the benchmark of 68, thus showing a score falling between "**Okay**" and "**Good**".

Furthermore, **Figure 36** shows a Box-and-Whisker plot containing the 10 SUS statement scores. The diagram displays both the scores of the median and distributions, with the mean of the diagram being a mean of 62.5 which was a fair result for this system.

With a SUS score of **80.0** for question 10, it showed that the users have evaluated the system to be a simplistic application that does not require much training to begin using it on their Chrome browsers. Due to its ease of use, it makes it a valuable platform for newcomers to begin working on.

6.4 CRITICAL SUMMARY

As a result of the software evaluation, multiple testing methods were used to great effect, discovering potential usability and performance issues that are in the prototype. The software testing has shown minor issues with the functionality. However, where possible these have been corrected by the development team.

Each evaluation method was very beneficial at discovering how effective the system was when performing given tasks. Using multiple usability techniques, users found the system to be extremely usable and overall workload to be low.
The full conclusion of the project is given in **Chapter 7**.

7 CONCLUSION

7.1 CONCLUSION OVERVIEW

The overall aim for this project was to design and produce the foundations of a highly technical Chrome browser extension for educational purposes. This was to find out how effective this method of learning was compared to the existing methods currently being used by users all around the world. The aim was successfully met, with many important tools being used to meet the targets that were previously set.

7.2 EVALUATION OF OBJECTIVES

The project managed to successfully test how effective it is to use this method of language learning. The objectives for this project that was determined prior to the design and implementation phases have been met. Refer to the **Table 18** below to find additional details on how each objective has been fulfilled.

ID	Objective	Achieved?	Description
1	Background studying has been thoroughly researched, containing aspects relating to the web-based artefact.	**Yes**	The background study was successfully conducted, finding important information surrounding gamification and language learning techniques. Literature that helped give the author a greater understanding on the project to assist them with the consecutive stages. **Please visit chapter 2.**

2	Optimal methodology has been selected/applied while considering the project characteristics.	**Yes**	Initially the author researched multiple methodologies, learning the benefits and limitations with them all. Waterfall was then chosen due to its rigidity and past successes when producing hard systems. Techniques were then used to capture the requirements for this project. They were then analysed and further prioritised using the MoSCoW method. **Please visit chapters 3 & 4.**
3	Requirements process has been followed correctly, while being integrated seamlessly into the methodology and development of the system	**Yes**	The system was designed using paper and wireframe designs, which were influenced by requirements in objective 1 and 2. It was then developed using HTML, CSS and JavaScript with the assistance of jQuery and Bootstrap libraries. **Please visit chapter 5.**
4	Artefact delivers a well-featured system providing the essential requirements as a bare minimum	**Yes**	Design phase was completed successfully. Some features in the final product were left missing due to time constraints. Bare minimum has been achieved. Nielson's Heuristic Evaluation and System Usability Scale were conducted to improve the usability of the product, found in sections 5.7.1 and 5.7.2. **Please visit chapter 6.**

5	The system has been evaluated and conducted throughout the development process	**Yes**	Limitations of the overall project including recommendations for future work to the system was explored. A full usability and software quality evaluation was also achieved. **Please visit chapter 7.**

Table 18: Objectives Met

7.3 PROJECT SUCCESSES

7.3.1 Project Research

Prior to the project beginning, additional research about the basis of language learning, language learning and gamification were received. All the founded documentation was advantageous with aiding the developers with the overall project, thus providing important information and providing the team with a solid foundation to conduct the design of the artefact (*prototype*).

7.3.2 Methodology

Each methodology chosen were used to its fullest potential, making sure that the maximum success given the time constraints were achieved, with each playing an important role in the project being completed to its highest capability. The final output of the system benefited from the chosen methodologies.

Correctly applying the MoSCoW method lead to a clearer way to completing this project. All members involved with the project knew exactly what was required to be done initially, when it had to be completed, and why the task was so important. Assigning priorities to all requirements became more manageable and easier to meet the deadline.

The Waterfall SDLC allowed the team to make early design changes, and making it great when perfecting the specifications documents in the initial development stages, as alterations can be made quickly as no implementation has been taken place at that point.

7.3.3 Software Quality & Testing

The Software Testing strategy that was chosen for this project deemed effective, providing a high testing coverage and a large number of test/defect case when using three functional testing techniques. Each methodology that was chosen was used to its potential, each playing a major role in the project being completed as effectively as possible. The final artefact was benefitted from the techniques chosen.

7.4 PROJECT IMPROVEMENTS

Many challenges were faced during this project, but most of the time it was foreseen that these issues may occur during the risk assessment. This was because there was a detailed plan in dealing with most of those issues in the most beneficial way.

Table 19 describes the potential improvements that could have been made for each initial project objective if worked on again.

ID	Objective	Potential Improvements
1	Produce a detailed background study which conducts aspects of the digital learning market including gamification, digital app retention and methods to effectively evaluate the usability of alternative products.	Research more on the similar alternative platforms and how they were developed.
2	Elicit the optimal methodology for this project.	Provide more time to the system requirements to ensure that no changes will be made during the development process.

3	Develop a browser extension system applying Software Engineering practices, using the knowledge from the background study.	Increase the number of domains that are whitelisted in the system. Increase the number of words that can be added to the user's vocabulary list. Fix potential tag errors when using replace() method.
4	Critically evaluate the system using the appropriate software testing methods, utilising the research from the background study.	Using more structural testing methods which evaluates the code specifically.

Table 19: Objectives Improvements

7.4.1 Usability Evaluation

The overall usability study on the effectiveness of the artefact answered many important questions. When comparing it with alternative language learning systems via the usability benchmark (**68.0**), it fell just short of the goal (**64.25**) which can be improved with future patches to the system.

7.4.2 Participants

It was proven to be difficult to find potential participants willing to be part of the project while having a diverse pool of language learning skills. If the same development team were performing the project again, more time would have been put in place to ensure that there was enough time to find replacement participants if any request to not take part.

Overall though, the team found a total of three individuals that all had a different first language. Each participant took part in an individual one-to-one interview for design prioritisation purposes.

7.4.3 Final Prototype System

The testing phase of the project was a long and difficult procedure, with many defect being found when going through each functional testing technique. If the team could undergo this project again, more time would have been put in the software testing which would have reduced the number of defects appearing in the final version.

With only a handful of domains being whitelisted in the final project, the team would also work on adding more popular domains to the whitelist whilst minimising serious defects that affect the user experience. More English and Spanish words and phrases would be added, with tasks that were in the Could/Won't category in the MoSCoW method to be implemented as well.

7.5 FUTURE WORK

For this project, the team was given 3 months to complete all areas of the project with additional information being required.

This project requiring future work; further design improvements, development and usability testing to increase the overall testing coverage, as well as additional features that participants requested to improve the quality of the system.

7.5.1 Implementation & Software Testing

Regarding the testing strategies that was enacted for this project, it would be used again for more similar systems that need developing due to its ease of testing and test coverages that were achieved.

Structural testing techniques would be considered as it has the potential to complement the existing functional techniques by having a high code coverage. Also, providing the ability for the extension to retranslate the webpages back to its original form when inputting the correct English words. This would have given the users more of a sense of pride and accomplishment when correctly inputting English words in the dialog box.

The artefact was designed for the Chrome browser, it has not yet been decided whether to make this compatible for other web regarded web browsers. It will be an essential step to conduct a large survey to find out what web browser people use and to provide services for the most popular browsers, increasing the potential user base.

It would be predicted that both Firefox and Safari will be popular platforms so it could possibly be a necessary step to provide the browser extension for both platforms.

7.5.2 Usability Evaluation

Heuristic Evaluation proved to be a difficult technique and showed clearly that the team can't simply rely on the results of a single individual conducting the tests. The results of a heuristic evaluation results ultimately are significantly improved once more people are conducting the evaluation.

Using this method became very useful as it did not require advance planning and can be used in the early stages of development. Therefore, in similar future work, this technique would be used again and done with between three and five evaluators. So long as the user expectation was kept to a realistic level, browser extensions for educational purposes are a great secondary resource for newcomers to start learning and not interfere with everyday life.

The ability to learn while browsing the internet was an effective tool that should be analysed further, stakeholders are to continue iterating and producing more content in this manner, while maintaining an impressive usability score.

Word Count (Main Body of the Report): 9,969

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APPENDIX A – PROJECT PROPOSAL FORM

Undergraduate Project Proposal Form

Please refer to the **Project Handbook Section 4** when completing this form

Degree Title:	**Student's Name:**
Software Engineering	**Christopher Jones**
	Supervisor's Name: **Nan Jiang**
	Project Title/Area: **Build a Browser Extension for People to learn Speaking Languages more effectively**

Section 1: Project Overview

1.1 Problem definition - use <u>one sentence</u> to summarise the problem:

Difference in languages have been the largest cultural barrier that people face around the world, as people that speak different languages cannot communicate with each other as effectively as they want. Learning a new speaking language can prove to be a difficult task, with many users unsure how to start or if they have enough time of the day to work on it.

1.2 Project description - briefly explain your project:

According to EuroStats, population aged 25-64 were surveyed and only 34.6% of UK citizens can speak multiple languages, even though students all get the option to learn a new language at primary and secondary school (EuroStats, 2018). This is showing that the methods put into place to teach students the valuable skill of a new language is not as effective as we want it to be. There is also a fall in the number of students taking up foreign languages. (Independent, 2017)

There are thousands of applications that try to assist people with learning a new speaking language, many of which requires the consumers to pay a large fee to get access to their services. However, these methods require the user to leave some of their valuable time and money solely to learn.

There is no incentive for anyone to continue learning this way, they also might feel that they don't have the time every day to work solely on learning a new language.

I want to produce the foundations of a web browser plugin that assists users with learn speaking languages while they're browsing the web every day, making it fun and exciting for users of all ages and background to gain a valuable skill wherever they are.

Every user will have their own vocabulary list that will increase the more words the user learns.

It will also be gamified by adding a point system and leaderboard to give users greater incentives to continue using the extension. The application will test the user by changing certain words on the web pages, users will be given points based on their performance.

Every user will have their own aggregated rating which determines how experienced they are on a language.

The application will only have one difficulty and will get progressively harder the more the application is being used and the higher the user's score is. The user will learn the basics (numbers and letters) and will be tested on that. New words will be introduced to the user

when they improve their score. However, words will be removed if they have a poor recent score.

I will be using HTML, CSS and JavaScript to build my own launcher, connecting to relevant APIs for the translation to work, and should be compatible with all the major browsers the people use around the world.

1.3 Background - please provide brief background information, e.g., client:

There are multiple reasons why someone would like to learn a second language.

- It improves their opportunities and their working experience
- Makes travelling more enjoyable
- Gives greater understanding on another person's culture
- Sharpens life skills

Giving the users a progressive way of learning the language that adapts to how much they use the application and their progress whilst gamifying it can help people out of the pitfalls of trying to learn a language and not seeing any noticeable improvements.

Users will state the language that they want to learn and can change languages whenever they want, receiving different rankings for each.

1.4 Aims and objectives – what are the aims and objectives of your project?

The aim for this project is to produce a system that's convenient and accessible to all ages that successfully helps them learn new speaking languages. Instead of people putting aside some time to learn the language, they can instead be learning all the time while on the internet, saving time and money. This will give people of all ages can learn a valuable skill and at their own pace.

Project Aims:

1. Make it easier and rewarding for individuals to learn a new language wherever they are. Making it a browser extension with the correct features should give them that ability.
2. Create important documentation/research that give a greater understanding of why there are not many people currently in the UK that know multiple languages.
3. Intense planning and testing across the development stages, making it easier for stakeholders to understand the planning/testing decisions in this project.

The objectives in this project is to create a thorough design and implementation strategy to create the best system I possibly can. During the implementation stage, using an Agile methodology, I will gradually iterate the system by adding new features. Testing phase will be using beta testing to find errors in the prototype and make changes based on the discovered bugs and general consensus about the application.

Project Objectives:

1. The users will have access to their list of words/phrases that they have learnt, increasing or decreasing the list as they please.
2. Words in the user's vocabulary list will be translated to the required language when browsing the web. Giving them a multiple-choice question when interacting with the work on the site.
3. Users will have their personal language score rating which tells them their progress with learning the language. Increases and decreases depending on if they get answers correct or incorrect.
4. Will have access to a leaderboard containing everyone's score rating to compete with friends and family.

Section 2: Artefact

2.1 What is the artefact that you intend to produce?

I want to produce the foundations of the project which should include the vocabulary list that will increase/decrease depending on the user. My artefact will only be for users learning one specific language (Spanish) due to time constraints. The ability to get certain words that's in the user's vocabulary list to appear on the web page in the alternative language, giving the user the ability to test themselves, providing points if they get the word right.

It should also contain some form of gamification, to incentivise users to keep using the application in a daily basis. Features include a points system which tells users their learning process, leaderboard to compare with their friends.

2.2 How is your artefact actionable (i.e., routes to exploitation in the technology domain)?

The artefact will be an actionable web browser plugin that users will interact with on all websites. The plugin will have many different features that the user can interact including full access to their language vocabulary list, where they can add and remove words in real time.

Words appearing on the list will be translated when the user visits a webpage that contains those words. When the word is highlighted, you will be given a multiple-choice question (What is this word?). User points will be increased/decreased if they get the question correct or incorrect.

Users will be able to view a leaderboard and compare their points with other users.

Section 3: Evaluation

3.1 How are you going to evaluate your work?

In terms of evaluating my artefact, I will have a multiple questionnaire surveys with respected users to find out more about the views and experiences of people. I will provide questions that will give more information than a simple yes/no answer.

Evaluating the project is taking in all the information and work that I made throughout the process and conclude whether the project made a big step towards helping people learn a language in a simplistic and effective way.

Part of my evaluation will be to invite selected users to beta test my solution to see if the translation is working as expected. This will give me important information onto what in my system needs optimising and what features should be added/removed.

3.2 Why is this project honours worthy?

This project also allows me to use the programming skills gained during my first two years at Bournemouth University and my 12-month placement at a digital advertising company to build a web-based solution (HTML, CSS and JavaScript).

To access the extent in which the artefact solves the problem that it was intended on, I will be using user feedback to make sure it meets the designated requirements. During the testing phase, I will be using beta testing to improve the features as it will hopefully find unknown bugs.

This project contains many risks including the accuracy of the translation as well as API issues I may face. I will be managing these issues by having a more iterative approach to the artefact, as I will be slowly implementing more words during the implementation process. I will also be researching APIs early in the planning stages to minimise the potential issues I can face with the APIs.

It's a unique and exciting project that will benefit many people that's interested in gaining new skills and improving their career profile by reducing the cultural barrier of speaking different languages.

3.3 How does this project relate to your degree title outcomes?

This is related to the degree title of Software Engineering as it allows me to use the logical and technical skills to write up a specification and

I will be performing regular tests on my project, using the skills I am currently learning in Hussain's Human Factors of Computer Systems to create a User Experience that will satisfy my users, such as creating Conceptual Models and Rich Pictures.

I will be adapting the attributes gained in the Software Quality and Testing module which includes beta testing and other relevant structural testing (Stress and Compliance Testing).

My artefact will be the production of a front-end, web-based solution, which meets the classifications provided in the project handbook.

3.4 How does your project meet the BCS Undergraduate Project Requirements?

This project meets the BCS Undergraduate Project Requirements provided. Stated within the BSC Criteria, the project should "apply practical and analytical skills present in the programme as a whole".

Also, in the Project Handbook, my project states that "Students will be expected to demonstrate a software engineering approach to the production of a software artefact." My artefact will be a front-end system that will be built using the software engineering skills learnt in the first few years of University.

Building a web browser extension allows me to use the HTML, CSS and JavaScript skills learnt in my previous years at Bournemouth University to build a unique product that improves the cultural barrier of different languages.

3.5 What are the risks in this project and how are you going to manage them?

Risk	Probability of Risk	Severity of Risk	Effect on Project	Actions to Reduce Risk
Coding error causing some words to not translate properly	Medium	High	Will product inaccurate and unreliable translations for people to test themselves on.	Going through the correct agile methodology, continually integrating to find errors early. Fixing before beta tests start.
Difficult to obtain the correct methods to translate certain words on the page (Potential APIs)	Medium	Medium	Lack of tools to translate the words would result in a poor working concept, could leave unknown errors within the solution.	Begin my research early, gaining greater understanding on the tools used to translate words on a page effectively without manual approaches.
User experience of the application to interfere with the user	Low	Medium	Bad UX will cause users to not use the system anymore. Reducing userbase	Research similar browser extensions and create surveys to find out what my demographic likes in an

				extension and doesn't like.
Translation not fully accurate throughout the system.	Medium	Medium	The application is built to teach the user the language, inaccuracy will cause a large issue in the long term	Constant testing to determine the accuracy of the translation, changes made as soon as errors are found.

Section 4: References

4.1 Please provide references if you have used any.

1. Foreign Language skills statistics, 2018 [online], available from https://ec.europa.eu/eurostat/statistics-explained/index.php/Foreign_language_skills_statistics [Accessed on 30/09/2018]

2.Fall in Number of Students Taking Modern Foreign Languages, Independent, [online], available from https://www.independent.co.uk/news/education/education-news/fall-in-number-of-students-taking-modern-foreign-languages-brexit-british-council-prompts-concerns-a7877491.html [Accessed on 30/09/2018]

Section 5: Ethics (please delete as appropriate)

5.1 Have you submitted the ethics checklist to your supervisor? Yes / No

5.2 Has the checklist been approved by your supervisor? Yes / No

Section 6: Initial Proposed Plan (please attach your Gantt chart below)

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
Research Translation and Developing tools for web browsers																
Build Web Browser Extension with translation tools - Basic Artefact Prototype																
Design User Interface of Artefact																
Implementation/Testing of UI																
Additional Artefact features (Gamification features etc.)																
Testing Efficiency and Accuracy of Translations																
Beta Testing Process																
Review Beta Testing																
Artefact changes based on Beta Testing findings																
Evaluation																
Project Defence + Finishing Touches																

APPENDIX B – ETHICS LIST

1. Student Details

Name	Christopher Jones
School	Faculty of Science & Technology
Course	BSc Software Engineering
Have you received external funding to support this research project?	No
Please list any persons or institutions that you will be conducting joint research with, both internal to BU as well as external collaborators.	

2. Project Details

Title	**Building a browser extension to help users of all ages and cultures learn speaking languages more effectively**
Proposed Start Date	28-January-2019
Proposed End Date	31-August-2019 – **Note this is not the submission deadline!**
Supervisor	Nan Jiang
Summary (including detail on background methodology, sample, outcomes, etc.)	

People knowing different languages around the world is a large cultural barrier that people face, people speaking different languages cannot communicate with each other as effectively as they want. Learning a new speaking language can prove to be a difficult task, with many users unsure how to start or if they have enough time of the day to work on it.

I want to produce a web browser extension that assists users with learn speaking languages while they're browsing the web every day, making it fun and exciting for users of all ages and background to gain a valuable skill wherever they are. It should also be compatible with all the major web browsers.

3. External Ethics Review (Answer "Yes" go to 4, "No" go to 5)

Does your research require external review through the NHS National Research Ethics Service (NRES) or through another external Ethics Committee?	No

4. External Ethics Review Continued

Answered "Yes" to question 3 will conclude the BU Ethics Review so you do not need to answer the following questions. Note you will need to obtain external ethical approval before commencing your research.

5. Research Literature (Answer “Yes” go to 6, “No” go to 7)

Is your research solely literature based?	No

6. Research Literature Continued (Either answer will conclude the review)

Will you have access to personal data that allows you to identify individuals OR access to confidential corporate or company data (that is not covered by confidentiality terms within an agreement or by a separate confidentiality agreement)?	No
Describe how you will collect, manage and store the personal data (taking into consideration the Data Protection Act 2018, General Data Protection Regulation (GDPR) and the Data Protection Principles).	

7. Human Participants Part 1 (Answer “Yes” go to 8, “No” go to 12)

Will your research project involve interaction with human participants as primary sources of data (e.g. interview, observation, original survey)?	No

8. Human Participants Part 2 (Answer **any** "Yes" go to 9)

Does your research specifically involve participants who are considered vulnerable (i.e. children, those with cognitive impairment, those in unequal relationships— such as your own students, prison inmates, etc.)?	No
Does the study involve participants age 16 or over who are unable to give informed consent (i.e. people with learning disabilities)? NOTE: All research that falls under the auspices of the Mental Capacity Act 2005 must be reviewed by NHS NRES.	No
Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (i.e. students at school, members of self-help group, residents of Nursing home?)	No
Will it be necessary for participants to take part in your study without their knowledge and consent at the time (i.e. covert observation of people in non-public places)?	No
Will the study involve discussion of sensitive topics (i.e. sexual activity, drug use, criminal activity)?	No

9. Human Participants Part 2 Continued

Describe how you will deal with the ethical issues with human participants?

1. Human Participants Part 3 (Answer **any** "Yes" go to 11, **all** "No" go to 12)

Could your research induce psychological stress or anxiety, cause harm or have negative consequences for the participant or researcher (beyond the risks encountered in normal life)?	No
Will your research involve prolonged or repetitive testing?	No
Will the research involve the collection of audio materials?	No
Will your research involve the collection of photographic or video materials?	No
Will financial or other inducements (other than reasonable expenses and compensation for time) be offered to participants?	No

2. Human Participants Part 3 Continued

Please explain below why your research project involves the above-mentioned criteria (be sure to explain why the sensitive criterion is essential to your project's success). Give a summary of the ethical issues and any action that will be taken to address these. Explain how you will obtain informed consent (and from whom) and how you will inform the participant(s) about the research project (i.e. participant information sheet). A sample consent form and participant information sheet can be found on the Research Ethics website.

3. Final Review

Will you have access to personal data that allows you to identify individuals OR access to confidential corporate or company data (that is not covered by confidentiality terms within an agreement or by a separate confidentiality agreement)?	No
Will your research take place outside the UK (including any and all stages of research: collection, storage, analysis, etc.)?	No

Please use the below text box to highlight any other ethical concerns or risks that may arise during your research that have not been covered in this form.

Review Completion Date: 01-October-2018 – Double click to change it!

The following section is to be filled by the supervisor only

Supervisor's Review: Choose an item.

Please leave your comments:

APPENDIX C – CODE LIBRARIES REFERENCES

Name	Description	Source
Bootstrap	HTML and CSS library which assisted with quality factors including the portability and maintainability of the system.	https://getbootstrap.com/
JSON	Industry standard file format. Using text to transmit data objects which consist of attributes.	https://www.json.org/
jQuery	A free and open-source JavaScript library used to simplify the JavaScript event handling.	https://jquery.com/ https://github.com/jquery/jquery

APPENDIX D – MID PROGRESS REPORT

Department of Computing and Informatics

Undergraduate Project Interim Review

To be completed and signed by the Supervisor and student during week **commencing 4 March 2019**.

Student: Christopher Jones	**Supervisor: Nan Jiang**

Assessment

1. Define the Problem *Has the problem been defined, has the artefact been identified and have objectives been set?*	Yes
Comments:	
2. Review of Other Work *Is there evidence of appropriate research?*	Yes
Comments:	
3. Analysis, Design & Implementation of Artefact *Is there evidence of appropriate analysis of the problem and development of a solution?*	To some extent
Comments:	
4. Dissertation *Have sections of the dissertation been written and has the Supervisor seen these?*	To some extent
Comments:	

5. Planning & Progress *Is there an acceptable plan for this project and is it being followed?*	Yes
Comments:	
6. Overall Assessment	Satisfactory
Signed: Supervisor: …Nan Jiang……. Student: ……Christopher Jones……..... Date: …11/03/19……	

- Supervisor to retain the signed form and supply the student with a copy if required.
- Supervisor to upload the form on Brightspace and grade the student as *Satisfactory*, *Uncertain* or *Unsatisfactory*.
- Supervisor to notify the Project Coordinator if the student is at risk of failing the Project.

APPENDIX E – INTERVIEW PARTICIPANT INFORMATION FORM

Participant Information Sheet - Interview

Designing of a language learning Chrome browser extension.

Invitation Overview

Our team are conducting a design and implementation project into educational browser extensions for the Google Chrome platform named Linguify.

You are one of the participants invited to taking part in this project. It is crucial you every member to understand why the project is taking place and what it consists. Please take time to read and fully understand the following information carefully and discuss it with other individuals if you wish. Contact the team if there is anything that is not entirely clear or would like more information. It's important to take one's time to decide whether or not you wish to take part in the project.

Who is Organising the Project?

This project has been organised by Bournemouth University Development team all funded by the university.

What is the Purpose of the Project?

To build a browser extension platform, allowing users of diverse skill levels to safely browse the internet while being challenged educationally. In our prototype, it is catered towards the foreign language aspect of learning.

The browser extension will feature Spanish-English only. Further analysis on the system will also be made which includes software quality & testing as well as usability evaluations.

Why have I been chosen?

You have been selected to be interviewed as we feel your opinion and knowledge of foreign languages would be a valuable part in this project.

Is it compulsory to take part?

It is 100% up to you to decide whether or not to take part in this project. If you decide to take part, you will be given this information sheet and a participant consent form.

You can withdraw from the project at any time up to the interview process day. Personal information is kept private and not kept after the project has been completed. You do, however, need to provide a reason to withdraw. Deciding to take part will not impact your treatment or studies at Bournemouth University.

What would taking part involve?

You will be involved in a face-to-face interview for 90 minutes where we will ask relevant questions and ask recommendations on design and implementation activities.

Will I be recorded?

Audio recordings of your activity made during this project will be used only for analytical purposes and the transcription of the recording. No other use will be made without written permission. No external parties will be allowed access to original recordings.

Contact for additional information

Chris Jones
i7467340@bournemouth.ac.uk

Thank you for considering taking part in this project.

APPENDIX F – INTERVIEW PARTICIPANT AGREEMENT FORM

Below contains a copy of the consent form that each participant was required to read and sign before they take part in the project.

Participant Agreement Form - Interview

Title of Project: Investigation on Browser Extensions to Enhance the Actions of Foreign Language Learning

Name of Project Owner: Christopher Jones

Contact Details of Project Owner: i7467340@bournemouth.ac.uk

Name and Contact Details of Supervisor: Nan Jiang, njiang@bournemouth.ac.uk

	Please Initial
I confirm that I have fully read and understood the Participant Information Sheet provided for the above study. I got the opportunity to consider the information, asked relevant questions and received such answers satisfactorily.	
I understand that I am free to withdraw from the project at any time, so long as I provide a reason for doing so.	
I understand that my participation is 100% voluntarily.	
I understand that I am free to decline to answer any particular question(s) to complete a test or give relevant samples for the project.	
I understand that taking part in this project will be recorded, but the recordings will then be deleted once it has been transcribed.	

I agree to take part in the above project.	
I understand that no personal details will be recorded throughout the entire project.	

Participant's Name……

Participant's Signature……

Date……..…..

TO BE COMPLETED BY THE DEVELOPERS ONLY

Researcher's Name……...

Researcher's Signature……

Date……

Consent form should be signed and dated by all parties after the participant receives and reads the copy of the participant information sheet. Agreement forms should be kept with the project owner's main documents, kept in a secure location.

APPENDIX G – INTERVIEW QUESTIONS

Each participant was provided with a set of questions for the project. Below contains the list of questions. Please refer to Appendix J, K and L to see the full transcripts of the interview by each interviewee.

Interview Questions

1) What is your current profession?
2) What's your background regarding foreign languages?
3) What web browser do you currently use?
4) Can you think of any issues that you encountered when using browser extensions?
5) What features would you expect to see in this system?
6) Are there any accessibility features you wish was in this product?
7) Regarding security features, what would you expect to see?
8) Do you think that gamification would encourage you to use the product more?
9) What's the most important thing for the success of the application?
10) What current issues in language learning do you face, if any?
11) What design features would entice you to use this application?
12) What is needed to make this project successful?
13) Any further points you'd like to add?

APPENDIX H – FULL INTERVIEW TRANSCRIPT 1

Interview with Participant/Potential User of Linguify (*1.5 hours*)

O – Participant

I – Interviewer

OLLIE

What is your current profession?
O: *I'm currently a student at Bournemouth University studying Computing.*
What's your background regarding foreign languages?
O: I have some background, but not too much.
I: What languages do you know?
O: *Just English, I did undertake compulsory GCSE Spanish and French lessons but never actively pursued learning a new language.*
What web browser do you currently use?
O: *Right now, I have been using Google Chrome.*
What experience do you have using browser extensions?
O: On my computer, I have multiple Google Chrome extensions that facilitate different services. I know how to add, maintain and remove existing extensions for Chrome.
I: Are there any particular extensions that you use every day?
O: Yeah, there is this extension called Honey that I use regularly when shopping on the internet. It lets me save money every day.
Can you think of any issues that you encountered when using browser extensions?
O: *Yes, some extensions, such as theme or VPN extensions require an active login or some synchronisation for them to work properly.*
I: *Right, any other issues?*
O: *Umm, well I also have an issue locating specific extensions when trying to find a new one.*
I: *How do you think we can solve that issue?*
O: *I would say by making the application stand out, giving it a minimalistic approach. There is a lot of copycat extensions that are lacking the authenticity of the original.*
I: *So, quality is always important for browser extensions?*
O: *Always.*
What features would you expect to see in this system?
O: *I would expect to see features that translate onscreen text into a different language. The ability to amend settings regarding what language the text is translated to.*
I: *I see, so giving the user the ability to learn more than one language on one application is important to you?*
O: *Yes, it centralises the learning environment. I would also expect to see options for logging in/signing up so you can undertake gamifying tasks.*

Are there any accessibility features you wish was in this product?
O: *I would expect to see a selectable icon in the top right that indicates that the extension is active. Also, would want to select this icon to amend the settings.*
Regarding security features, what would you expect to see?
O: *That's a tough one, I guess an encrypted on on-screen password would be good, with the option to recover login details.*
I: *They're not much of a priority you think?*
O: *I would say the functionality of the system outweighs the security as there isn't any personal information being stored.*
I: *Anything else regarding security?*
O: *Stay logged in feature would be helpful, not sure about anything else.*
I: *That's more than enough information.*
Do you think that gamification would encourage you to use the product more?
O: *Yes, definitely. I think that its an effective way to challenge users.*
I: *Any features in mind?*
O: *Perhaps a leaderboard but it's not a must.*
What's the most important thing for the success of the application?
O: *I'd say that the translation is working and does not affect the appearance of the webpage.*
I: *Sure, so the app does not interfere with your web browsing?*
O: *Yeah, no interference.*
What current issues in language learning do you face, if any?
O: *I don't go out of my way to try and learn a language, but I would say that learning language requires a lot of motivation to continue the education. Gamification would amend this issue.*
What design features would entice you to use this application?
O: *Just a clear and aesthetically pleasing UI to enable the functionality. Bold and concise results.*
What is needed to make this project successful?
O: *Just to perform all intended functionality without negatively affecting the usability of a web page.*
Any further points you'd like to add?
O: *Not on the top of my head, no.*
I: *Perfect, thank you for your time. This was really useful!*
O: *No problem!*

APPENDIX I – FULL INTERVIEW TRANSCRIPT 2

Interview with Participant/Potential User of Linguify (*1.5 hours*)

B – Participant

I – Interviewer

BRANDON

What is your current profession?
B: *I'm a student at Bournemouth University studying Computing.*
What's your background regarding foreign languages?
B: *Yes, so my home language is Japanese. English being my second language.*
I: *How long have you been studying English?*
B: *More than a decade. I did not have productive English lessons for the first six years in Japan.*
I: *Why was that?*
B: *It's just the way teaching English is carried out in Japan, it focusses more on University Admission Exams.*
I: *What methods did you use to learn English?*
B: *One of the ways I have been teaching myself apart from the reading/writing method is to read something and then write about it during my spare time.*
I: How effective is that method?
B: *Pretty effective, just doing either reading or writing on its on is not very efficient because if you put focus on reading too much, you eventually lost the vocabulary you have learnt. On the other hand, you can't just write and not read any content.*
What web browser do you currently use?
B: *I used to use Firefox all the time, but right now I am currently using Chrome.*
What experience do you have using browser extensions?
B: *Not a crazy amount, I use small extensions like AdBlock and VPNs but not too many extensions are on my PC.*
Can you think of any issues that you encountered when using browser extensions?
B: *Not that I can think of, I don't have too much experience in browser extensions to find an obvious issue.*
What features would you expect to see in this system?
B: *For this product, just the translation to work effectively and to not interfere with my daily web surfing life. I also always have a soft spot for Dark Mode in applications, so having that would be a bonus!*
Are there any accessibility features you wish was in this product?
B: *If there is time, maybe to have features that benefit colour-blind individuals.*
Regarding security features, what would you expect to see?
B: *I expect my personal data to be secure and to not be released to the public of course. I am not too sure if we're being technical.*
Do you think that gamification would encourage you to use the product more?

B: *Yeah, I think so, earning badges and points definitely encourage me to use products. For example, if you visit a few websites written in a different language a day with the product, you can earn a badge like "3 days learning badge".*
What's the most important thing for the success of the application?
B: *Most important part is to keep me motivated when using the product for a long-term period.*
What current issues in language learning do you face, if any?
B: *The big one is slang words, it is a massive obstacle for most second language learners. Idioms are also one of the issues because it basically comes from plentiful experience.*
What design features would entice you to use this application?
B: *If it gives me opportunities to both input and output, it would boost the experience and the vocabulary I earned could be more memorable.*
What is needed to make this project successful?
B: *Performing all the functionality and getting that translation right is top priority to make this project successful, that's what I would say.*
Any further points you'd like to add?
B: *None for me!*
I: *Perfect, thanks your time. This was really useful!*
O: *Welcome, was a pleasure!*

APPENDIX J – FULL INTERVIEW TRANSCRIPT 3

Interview with Participant/Potential User of Linguify (*1.5 hours*)

R – Participant

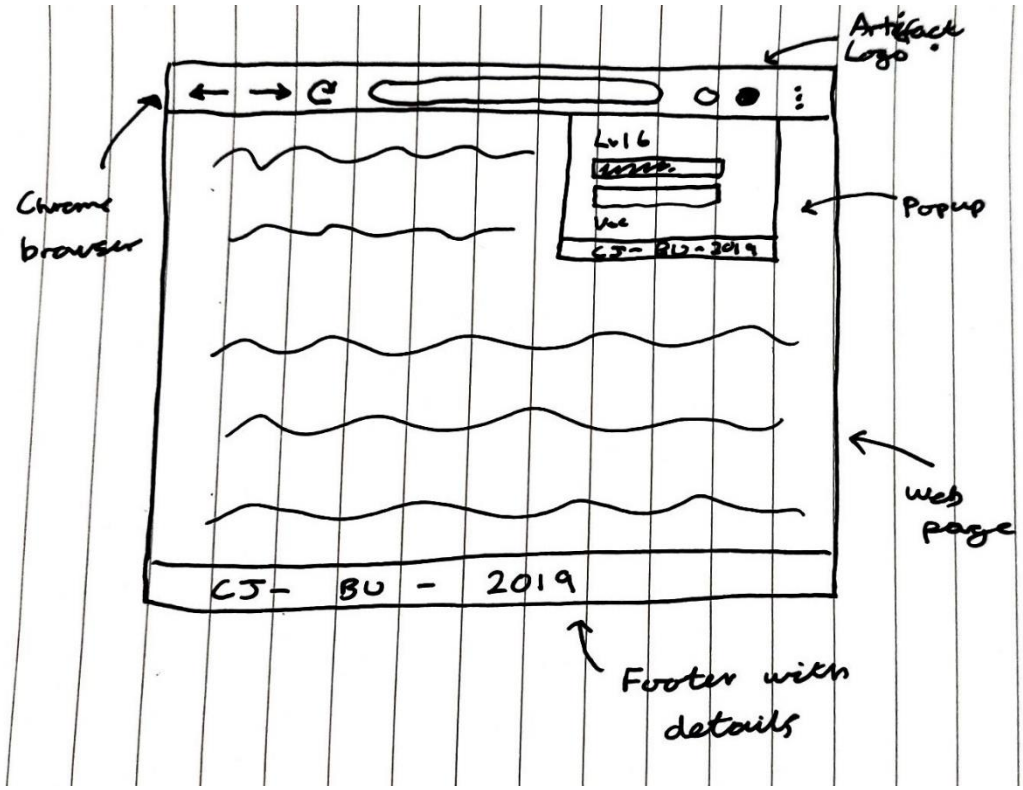
I – Interviewer

RUBEN

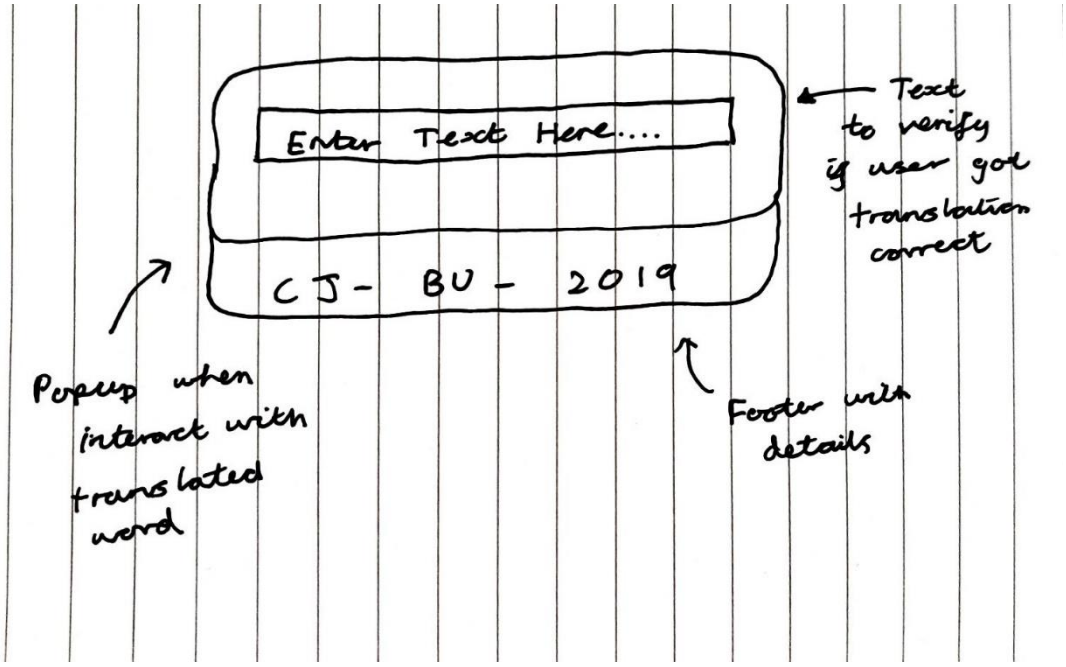
What is your current profession?
R: *Yeah, I'm currently a student at Bournemouth University studying Software Engineering.*
What's your background regarding foreign languages?
R*: I am a Portuguese national, my first language is Portuguese, studied English my whole life and did a bit of Spanish at GCSE level.*
I: *Any techniques you use to learn those particular languages?*
R: *Yeah so, my techniques was usually to watch TV shows in those languages and the read, cover say method.*
What web browser do you currently use?
R: *I currently use Google Chrome*
What experience do you have using browser extensions?
R: *I have used an adblocker browser extension which was easy to install using the Google App Store.*
Can you think of any issues that you encountered when using browser extensions?
R: *Not at the top of my head, it depends on the browser extension but adblocker works well on my computer. So far, I have had no issues.*
What features would you expect to see in this system?
R: *Probably engaging in minigames that will give me a greater incentive to learn the language more. It can be difficult to keep the momentum while learning a language. Perhaps an online scoring system to compete with friends and users around the world.*
I: *Anything else?*
R: Most applications have a factory reset feature built into the system if they want to clear all their data instantly. I think that should be available for users in this application too.
Are there any accessibility features you wish was in this product?
R: *Personally, I don't use any accessibility features on websites, but it would be nice to add features like allowing users to be able to listen to text for the visually impaired.*
Regarding security features, what would you expect to see?
R: *Well, if an online scoring system is to be implemented, I'd expect that my information is secure, protected and data is not being misused.*
Do you think that gamification would encourage you to use the product more?
R: *Yes. Some sort of points system that lets you compete would be very beneficial.*
What's the most important thing for the success of the application?
R: *Maintaining the user base of the product. Getting users to come back and learn more of the language every day is key.*

What current issues in language learning do you face, if any?
R: *Issue is that it can be very repetitive and can make it quite a boring experience. Once all the basics are done it can get complicated depending on the language as well.*
What design features would entice you to use this application?
R: *In terms of design features, I am not too sure. Minimalistic approach perhaps.*
What is needed to make this project successful?
[Already been discussed]
Any further points you'd like to add?
R: *None for me*
I: *Perfect! Thanks for your time, it has been very helpful!*
R: *Anytime!*

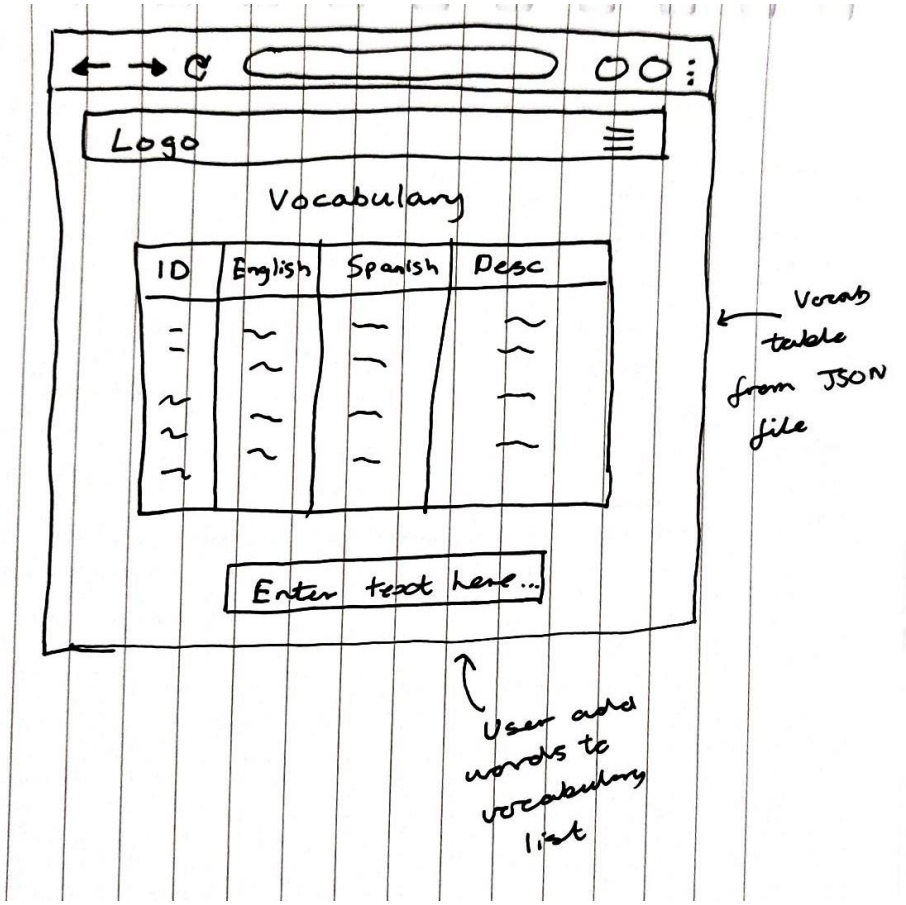
APPENDIX K – PAPER DESIGNS



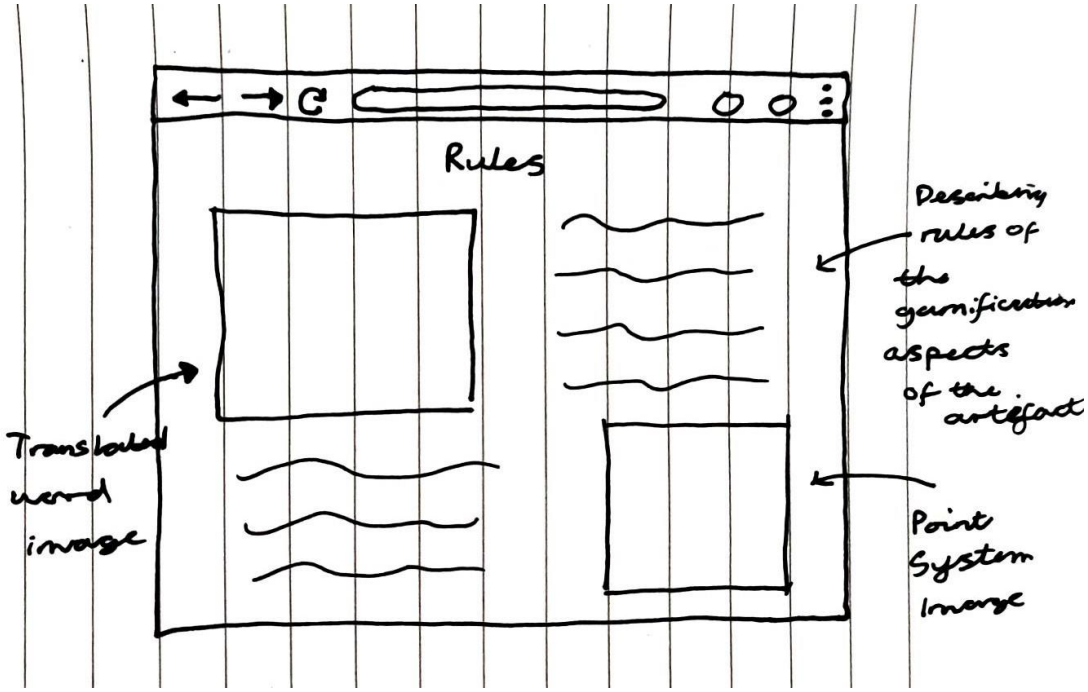
Paper design showing where the popup is presented



Paper design showing where the popup is presented

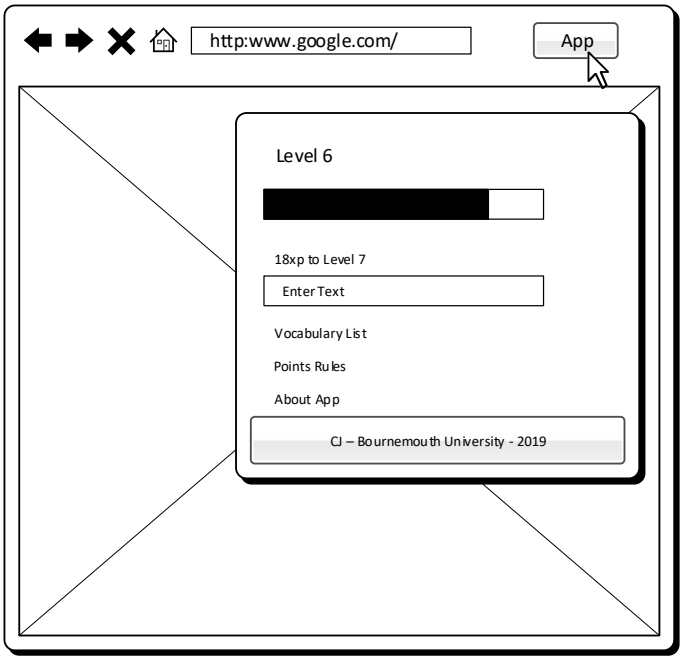


Vocabulary HTML page paper design

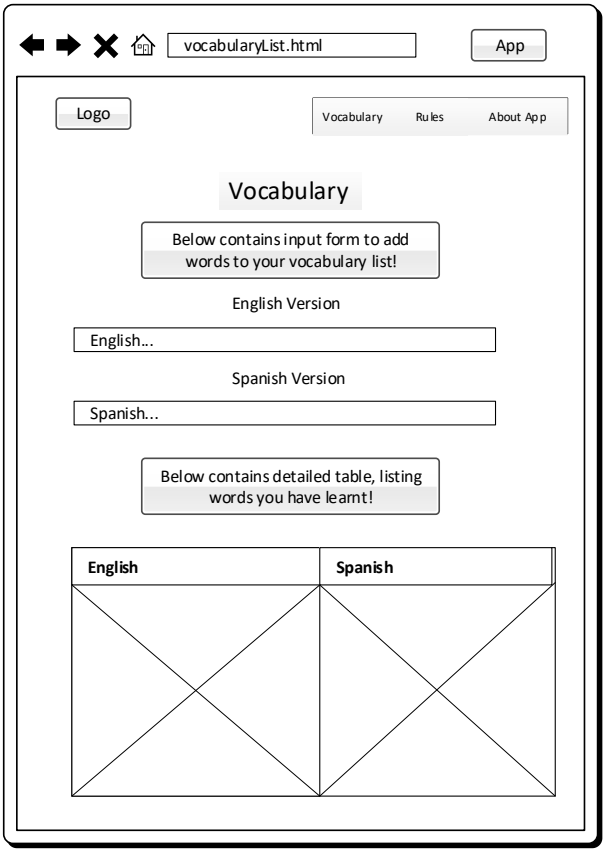


Rules HTML page paper design

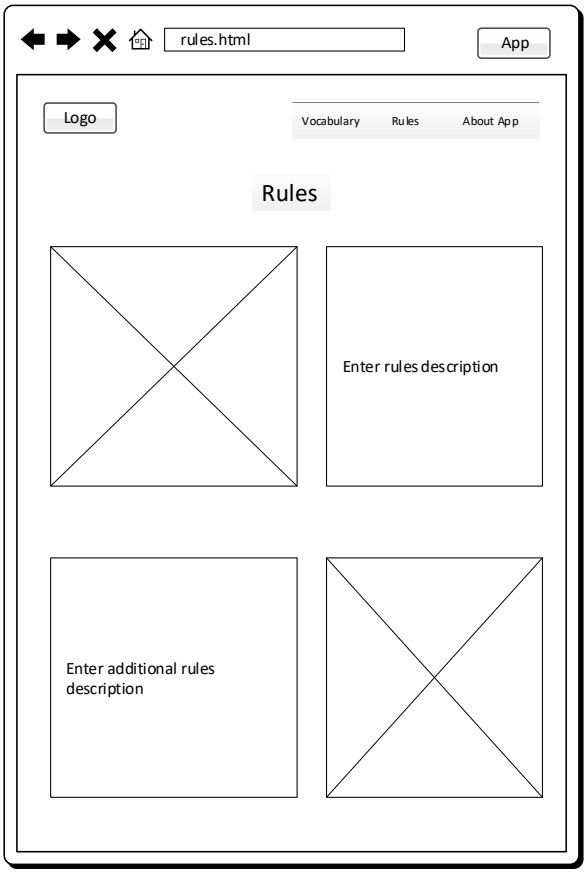
APPENDIX L – WIREFRAME DESIGNS



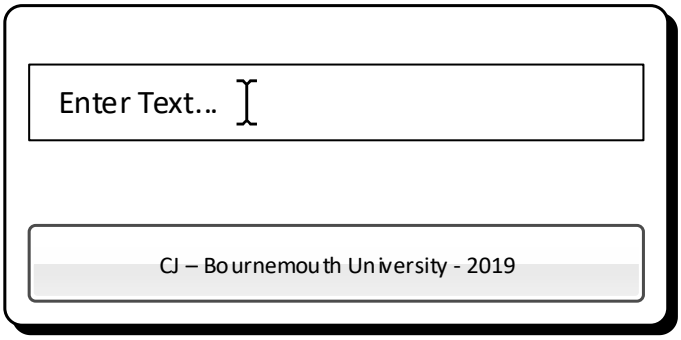
Wireframe design showing where the popup is presented on the browser



Vocabulary HTML page wireframe design

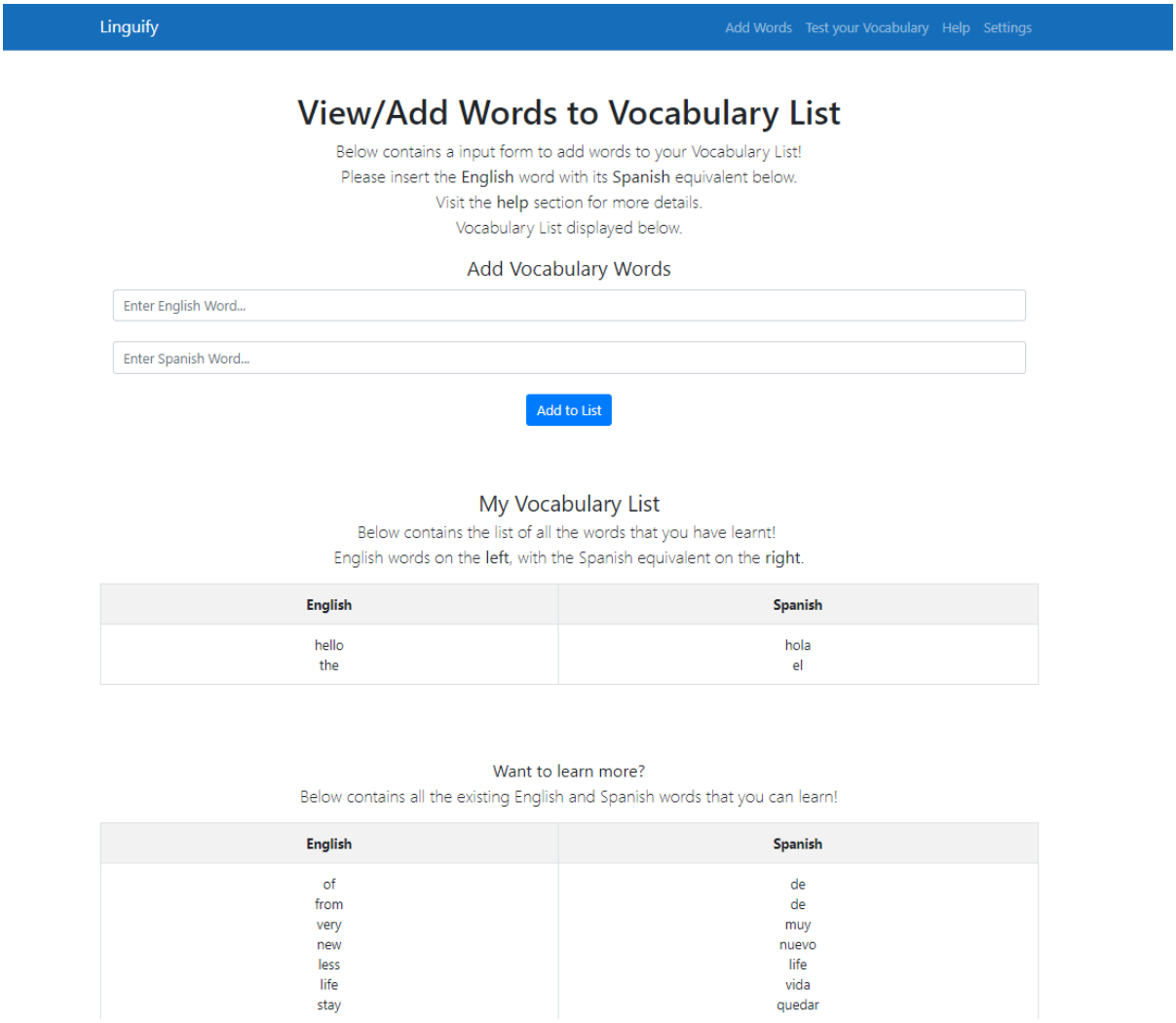


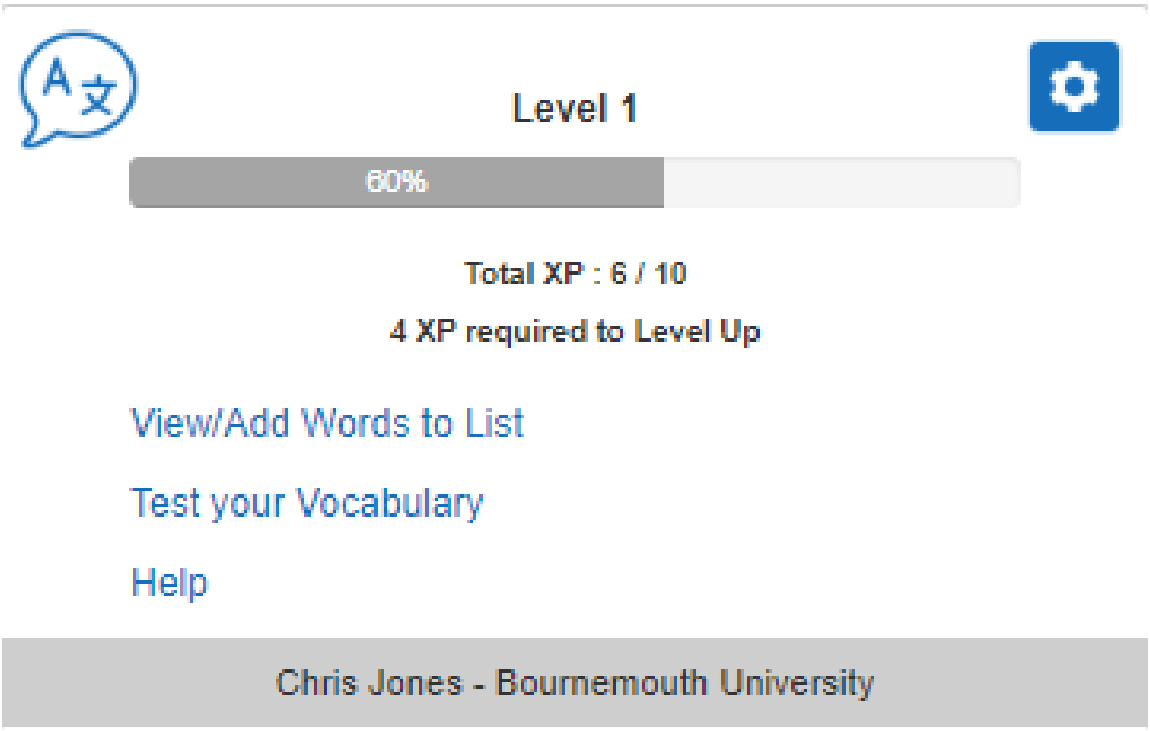
Point rules HTML page wireframe design

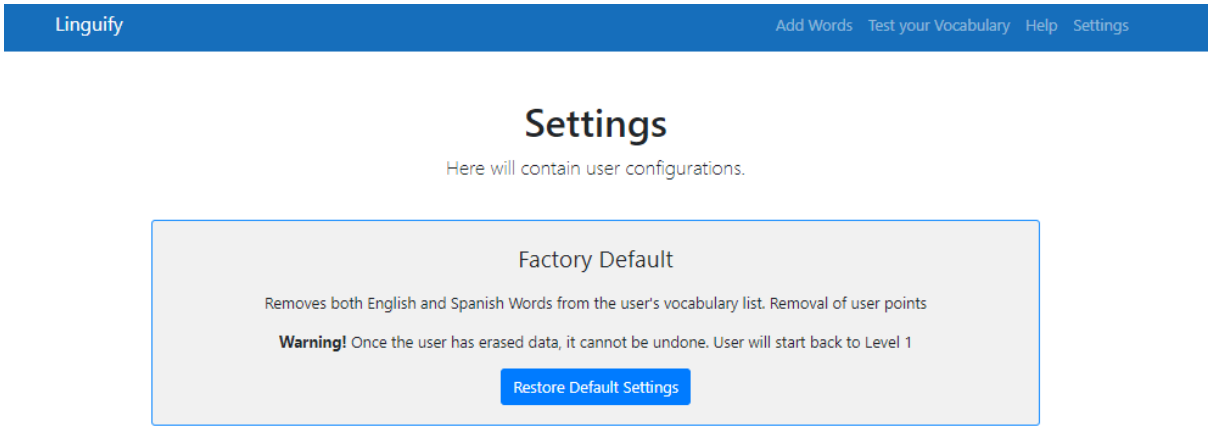


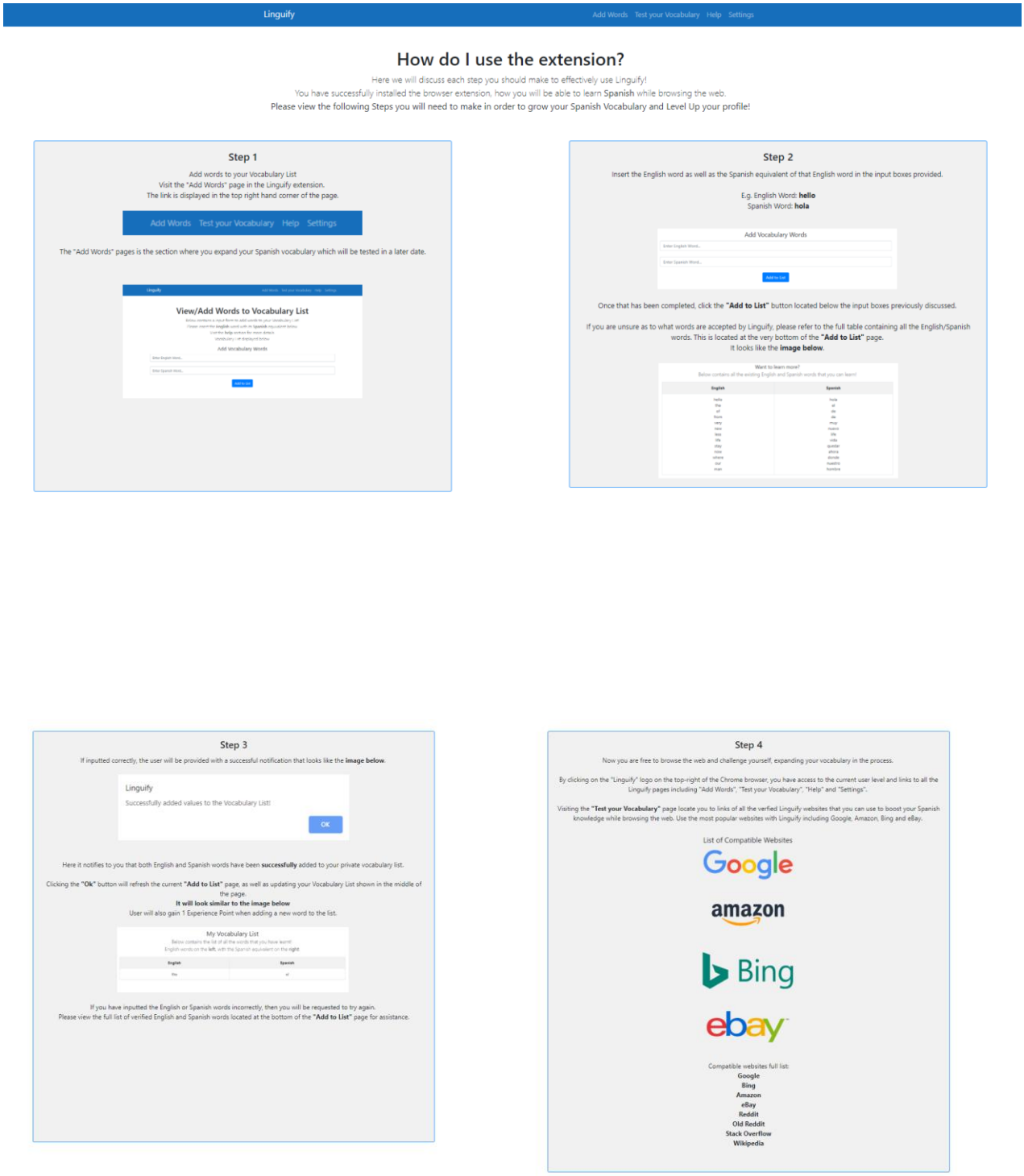
Wireframe design showing where the popup is presented

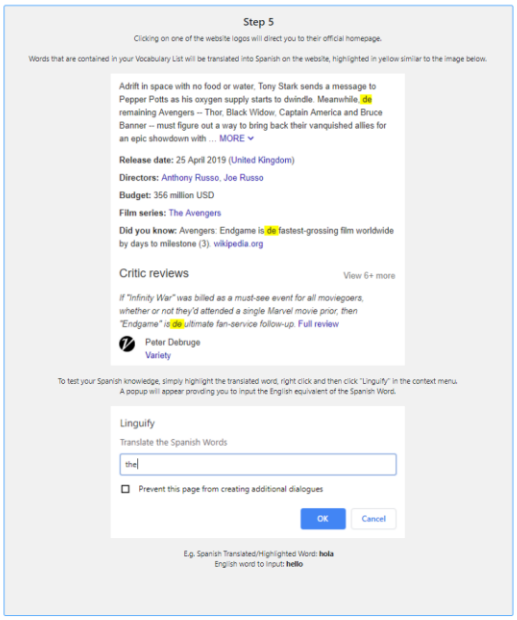
APPENDIX M – INTERACTIVE PROTOTYPE SCREENSHOTS

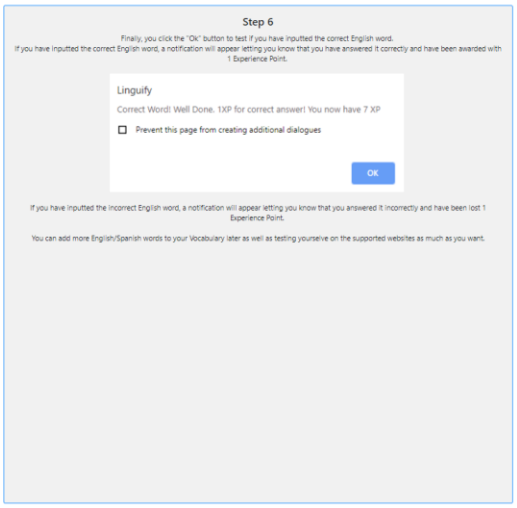



Level 1
60%
Total XP : 6 / 10
4 XP required to Level Up
View/Add Words to List
Test your Vocabulary
Help
Chris Jones - Bournemouth University


Linguify
Add Words
Test your Vocabulary
Help
Settings
Settings
Here will contain user configurations.
Factory Default
Removes both English and Spanish Words from the user's vocabulary list. Removal of user points
Warning! Once the user has erased data, it cannot be undone. User will start back to Level 1
Restore Default Settings

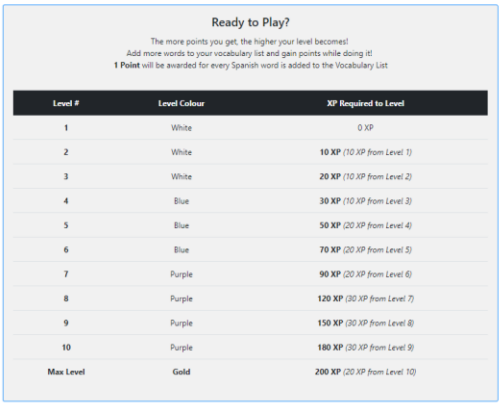

Linguify
Add Words Test your Vocabulary Help Settings
How do I use the extension?
Here we will discuss each step you should make to effectively use Linguify!
You have successfully installed the browser extension, how you will be able to learn Spanish while browsing the web.
Please view the following Steps you will need to make in order to grow your Spanish Vocabulary and Level Up your profile!
Step 1
Add words to your Vocabulary List
Visit the "Add Words" page in the Linguify extension.
The link is displayed in the top right hand corner of the page.
Add Words Test your Vocabulary Help Settings
The "Add Words" pages is the section where you expand your Spanish vocabulary which will be tested in a later date.
View/Add Words to Vocabulary List
Add Vocabulary Words
Step 2
Insert the English word as well as the Spanish equivalent of that English word in the input boxes provided.
E.g. English Word: hello
Spanish Word: hola
Add Vocabulary Words
Once that has been completed, click the "Add to List" button located below the input boxes previously discussed.
If you are unsure as to what words are accepted by Linguify, please refer to the full table containing all the English/Spanish words. This is located at the very bottom of the "Add to List" page.
It looks like the image below.
Step 3
If inputted correctly, the user will be provided with a successful notification that looks like the image below.
Linguify
Successfully added values to the Vocabulary List!
OK
Here it notifies to you that both English and Spanish words have been successfully added to your private vocabulary list.
Clicking the "Ok" button will refresh the current "Add to List" page, as well as updating your Vocabulary List shown in the middle of the page.
It will look similar to the image below
User will also gain 1 Experience Point when adding a new word to the list.
My Vocabulary List
English
Spanish
If you have inputted the English or Spanish words incorrectly, then you will be requested to try again.
Please view the full list of verified English and Spanish words located at the bottom of the "Add to List" page for assistance.
Step 4
Now you are free to browse the web and challenge yourself, expanding your vocabulary in the process.
By clicking on the "Linguify" logo on the top-right of the Chrome browser, you have access to the current user level and links to all the Linguify pages including "Add Words", "Test your Vocabulary", "Help" and "Settings".
Visiting the "Test your Vocabulary" page locate you to links of all the verified Linguify websites that you can use to boost your Spanish knowledge while browsing the web. Use the most popular websites with Linguify including Google, Amazon, Bing and eBay.
List of Compatible Websites
Google
amazon
Bing
ebay
Compatible websites full list:
Google
Bing
Amazon
eBay
Reddit
Old Reddit
Stack Overflow
Wikipedia



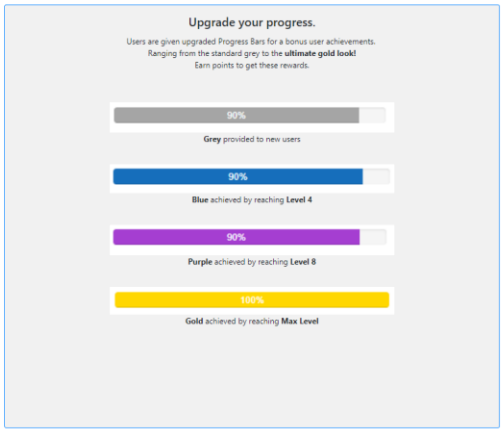


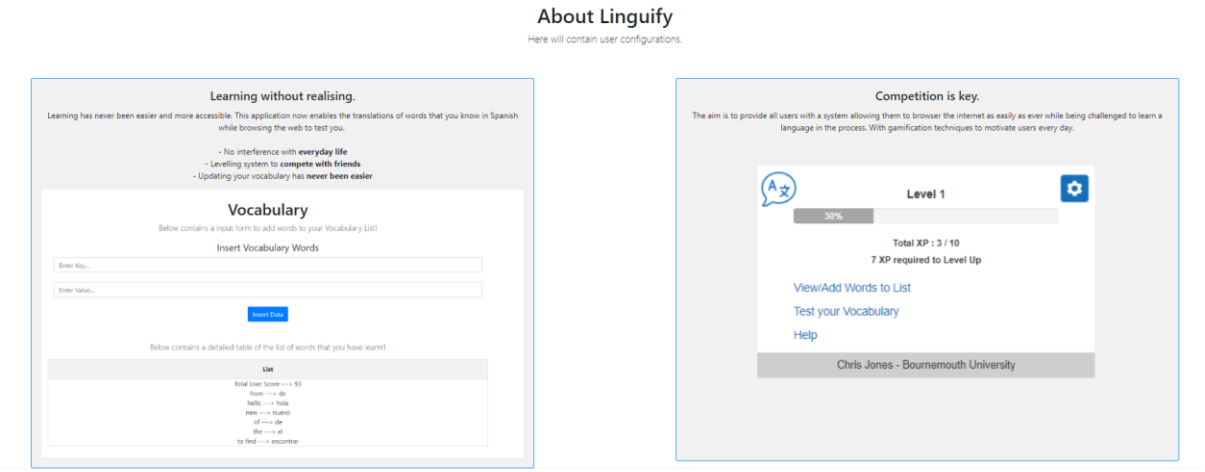
How does the Point System work?

Here we will discuss how the point system works for Linguify!



Level #	Level Colour	XP Required to Level
1	White	0 XP
2	White	10 XP *(10 XP from Level 1)*
3	White	20 XP *(10 XP from Level 2)*
4	Blue	30 XP *(10 XP from Level 3)*
5	Blue	50 XP *(20 XP from Level 4)*
6	Blue	70 XP *(20 XP from Level 5)*
7	Purple	90 XP *(20 XP from Level 6)*
8	Purple	120 XP *(30 XP from Level 7)*
9	Purple	150 XP *(30 XP from Level 8)*
10	Purple	180 XP *(30 XP from Level 9)*
Max Level	Gold	200 XP *(20 XP from Level 10)*

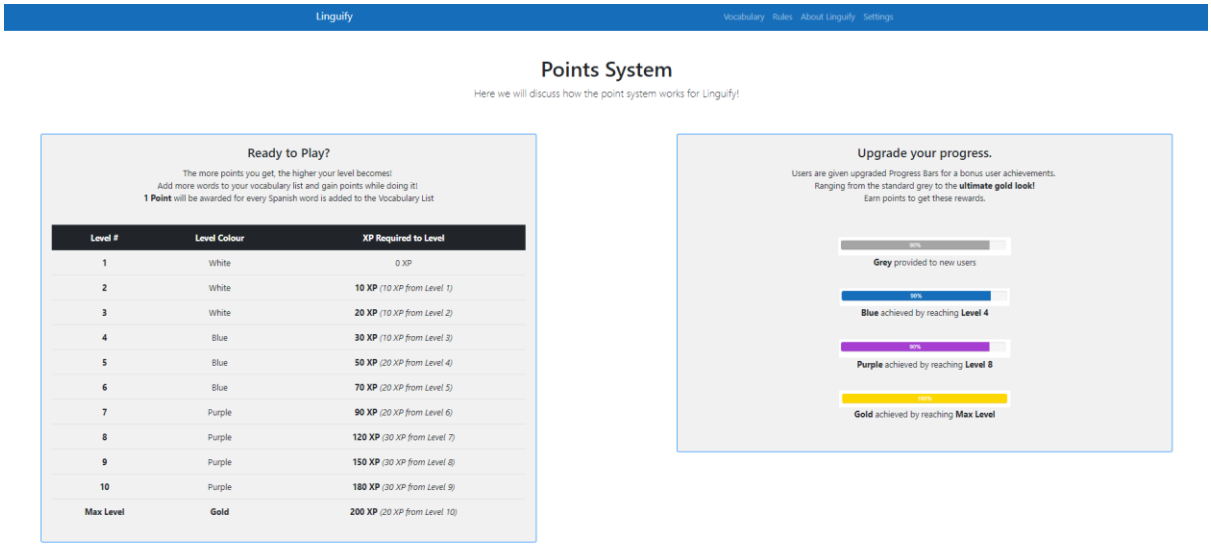


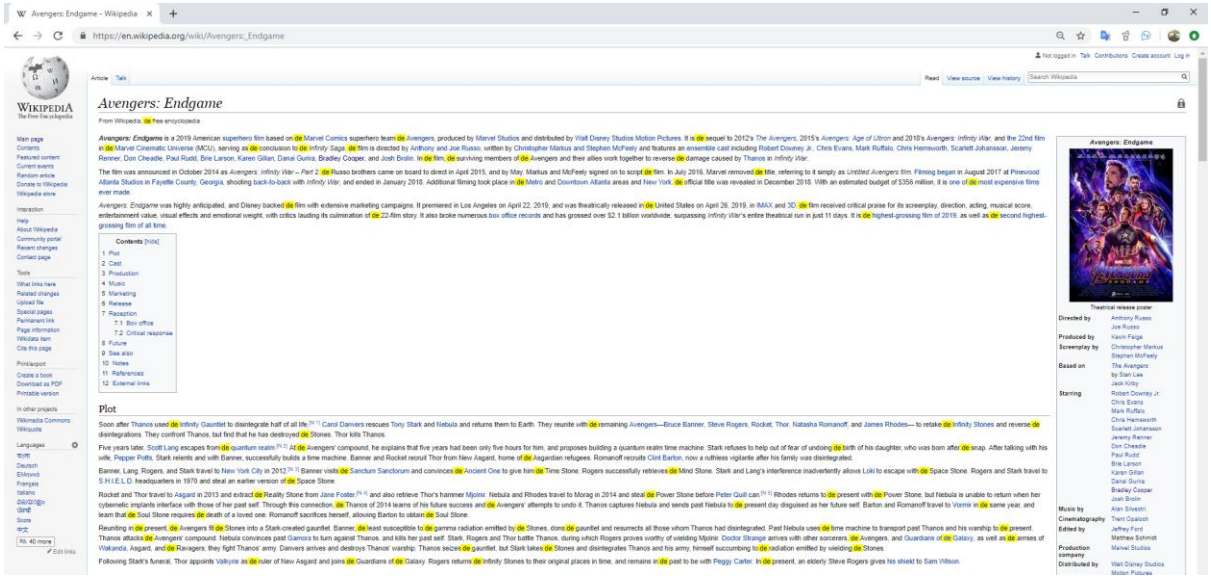


Ready to Play?

The more points you get, the higher your level becomes!
Add more words to your vocabulary list and gain points while doing it!
1 Point will be awarded for every Spanish word is added to the Vocabulary List

Level #	Level Colour	XP Required to Level
1	White	0 XP
2	White	**10 XP** *(10 XP from Level 1)*
3	White	**20 XP** *(10 XP from Level 2)*
4	Blue	**30 XP** *(10 XP from Level 3)*
5	Blue	**50 XP** *(20 XP from Level 4)*
6	Blue	**70 XP** *(20 XP from Level 5)*
7	Purple	**90 XP** *(20 XP from Level 6)*
8	Purple	**120 XP** *(30 XP from Level 7)*
9	Purple	**150 XP** *(30 XP from Level 8)*
10	Purple	**180 XP** *(30 XP from Level 9)*
Max Level	**Gold**	**200 XP** *(20 XP from Level 10)*


Linguify
Vocabulary Rules About Linguify Settings
Points System
Here we will discuss how the point system works for Linguify!
Ready to Play?
The more points you get, the higher your level becomes!
Add more words to your vocabulary list and gain points while doing it!
1 Point will be awarded for every Spanish word is added to the Vocabulary List
Level # | Level Colour | XP Required to Level
1 | White | 0 XP
2 | White | 10 XP (10 XP from Level 1)
3 | White | 20 XP (10 XP from Level 2)
4 | Blue | 30 XP (10 XP from Level 3)
5 | Blue | 50 XP (20 XP from Level 4)
6 | Blue | 70 XP (20 XP from Level 5)
7 | Purple | 90 XP (20 XP from Level 6)
8 | Purple | 120 XP (30 XP from Level 7)
9 | Purple | 150 XP (30 XP from Level 8)
10 | Purple | 180 XP (30 XP from Level 9)
Max Level | Gold | 200 XP (20 XP from Level 10)
Upgrade your progress.
Users are given upgraded Progress Bars for a bonus user achievements.
Ranging from the standard grey to the ultimate gold look!
Earn points to get these rewards.
Grey provided to new users
Blue achieved by reaching Level 4
Purple achieved by reaching Level 8
Gold achieved by reaching Max Level


Avengers: Endgame - Wikipedia
https://en.wikipedia.org/wiki/Avengers:_Endgame
Avengers: Endgame
Plot

APPENDIX N– EQUIVALENCE CLASSES

1. User levels are correct the XP they have (*valid*)
2. Progress Bar colours are correct to the XP the user has (*valid*)
3. Supported User Input to Vocabulary List is selected (*valid*)
4. Unsupported User Input to Vocabulary List is selected (*invalid*)
5. Webpage dimensions are supported (*valid*)
6. Correct User Input for User Memory Testing (*valid*)
7. Incorrect User Input for User Memory Testing
8. Supported words in Vocabulary List displayed to the user (*valid*)

APPENDIX O – TESTING RECORDS

Output Conditions

Equivalence Partitioning & Boundary Value Analysis

Passed Tests	Partially Passed Tests	Failed Tests
22	**3**	**2**
88%	12%	8%

Figure: *Percentage and number of fully passed, partially passed and failed test Equivalence Partitioning tests.*

Error Guessing

Passed Tests	Partially Passed Tests	Failed Tests
7	**7**	**0**
50%	50%	0%

Figure: *Percentage and number of fully passed, partially passed and failed test Error Guessing tests.*

Exploratory Testing

Passed Tests	Partially Passed Tests	Failed Tests
5	**1**	**4**
50%	10%	40%

Figure: *Percentage and number of fully passed, partially passed and failed test Exploratory tests.*

Test Technique Review

	Technique	Test Cases	Defects Found	Detection of Defects %
	Equivalence Partitioning	25	5	20%
	Error Guessing	7	7	50%
	Exploratory Testing	10	5	50%
Total	-	**50**	**17**	**34%**

Figure: *Table containing the percentage of new defects getting detected and the test per defect ratio organised per technique.*

Legends

Defect Outcome	Definition
P	**Passed Test** – Test produced the correct output and containing no known defects.
PP	**Partially Passed –** Tests that produce the correct Hypervolume output while containing minor defects that are quality concerns. *E.g. Misspelt error messages*
F	**Failed Test** – Test fault occurred which caused an incorrect output to be incorrect. *E.g.*

Table: *Small legend describing the potential defect outcomes for each test case.*

Severity/Defect Scale	Definition
High **(H)**	Affects the system in a large scale. Defect causing the user to get insufficient results or information explaining the error. Top priority.
Medium **(M)**	Defect that affects the result for users but not a frequent defect to discover.
Low **(L)**	Does not affect the results of the system. Very unlikely for typical users to find the defect. Not a huge priority.

Table: *Legend describing the severity and defect scale with descriptions.*

Test Case Records

Equivalence Partitioning and Boundary Value Analysis

No.	Test Case	Justification	Input	Expected Output	Actual Output	Condition	Comments
01	Testing **Level 1** User Profile Partition	Analysing this partition to check if a user with a total XP between **0 and 10** are assigned to a **Level 1** profile. New users should start at **Level 1**.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 6*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description.*	**Output Contains:** Grey Level 1 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Grey Level 1 Progress Bar.* *60% completion.* **Contains script:** *"Total XP: 6/10. 4 XP required to Level Up"*	**P**	
02	Testing **Level 2** User Profile Partition	Analysing this partition to check if a user with a total XP between **10 and 20** are assigned to a **Level 2** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 15*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description.*	**Output Contains:** Grey Level 2 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Grey Level 2 Progress Bar.* *50% completion.* **Contains script:** *"Total XP: 15/20. 5 XP required to Level Up"*	**P**	

03	Testing **Level 3** User Profile Partition	Analysing this partition to check if a user with a total XP between **20 and 30** are assigned to a **Level 3** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 25*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Grey Level 3 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Grey Level 3 Progress Bar.* *50% completion.* **Contains script:** *"Total XP: 25/30. 5 XP required to Level Up"*	**P**	
04	Testing **Level 4** User Profile Partition	Analysing this partition to check if a user with a total XP between **30 and 50** are assigned to a **Level 4** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 40*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Blue Level 4 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Blue Level 4 Progress Bar.* *50% completion*. **Contains script:** *"Total XP: 40/50. 10 XP required to Level Up"*	**P**	

05	Testing **Level 5** User Profile Partition	Analysing this partition to check if a user with a total XP between **50 and 70** are assigned to a **Level 5** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 60*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Blue Level 5 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Blue Level 5 Progress Bar.* *50% completion*. **Contains script:** *"Total XP: 60/70. 10 XP required to Level Up"*	**P**	
06	Testing **Level 6** User Profile Partition	Analysing this partition to check if a user with a total XP between **70 and 90** are assigned to a **Level 6** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 80*** *User open popup.html* **Output:** *Popup.html indicates Level via progress bar & description*	**Output Contains:** Blue Level 6 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Blue Level 6 Progress Bar.* *50% completion*. **Contains script:** *"Total XP: 80/90. 10 XP required to Level Up"*	**P**	

07	Testing **Level 7** User Profile Partition	Analysing this partition to check if a user with a total XP between **90 and 120** are assigned to a **Level 7** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 105*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Purple Level 7 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Purple Level 7 Progress Bar.* *50% completion*. **Contains script:** *"Total XP: 105/120. 15 XP required to Level Up"*	**P**	
08	Testing **Level 8** User Profile Partition	Analysing this partition to check if a user with a total XP between **120 and 150** are assigned to a **Level 8** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 135*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Purple Level 8 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Purple Level 8 Progress Bar.* *50% completion*. **Contains script:** *"Total XP: 135/150. 15 XP required to Level Up"*	**P**	

09	Testing **Level 9** User Profile Partition	Analysing this partition to check if a user with a total XP between **150 and 180** are assigned to a **Level 9** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 165*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Purple Level 9 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Purple Level 9 Progress Bar.* *50% completion*. **Contains script:** *"Total XP: 165/170. 15 XP required to Level Up"*	**P**	
10	Testing **Level 10** User Profile Partition	Analysing this partition to check if a user with a total XP between **180 and 200** are assigned to a **Level 10** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 190*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Purple Level 10 Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Purple Level 10 Progress Bar.* *50% completion*. **Contains script:** *"Total XP: 190/200. 10 XP required to Level Up"*	**P**	

11	Testing **Max Level** User Profile Partition	Analysing this partition to check if a user with a total XP of **200+** are assigned to a **Max Level** profile.	**Input:** *User add words to Vocabulary List to gain XP* ***Total User Score = 210*** *User open popup.html* **Output:** *Popup.html indicates user Level via progress bar and description*	**Output Contains:** Gold Max Level Progress bar containing the correct number of XP required to level up successfully.	**Output Contains:** *Gold Max Level progress bar.* *100% completion* **Contains script:** *"Total XP: 210/210"*	**P**	
12	Progress Bar Partition – **Grey**	Analysing the partition that displays the progress bar in a grey colour. Levels 1 to 3.	**Input:** *Total User Score = 15* *User open popup.html* **Output:** *Popup.html indicates user progress bar*	**Output Contains:** Grey progress bar	**Output Contains:** *Grey Progress Bar.*	**P**	
13	Progress Bar Partition – **Blue**	Analysing the partition that displays the progress bar in a grey colour. Levels 4 to 6.	**Input:** *Total User Score = 35* *User open popup.html* **Output:** *Popup.html indicates user progress bar*	**Output Contains:** Blue progress bar	**Output Contains:** *Blue Progress Bar.*	**P**	

14	Progress Bar Partition – **Purple**	Analysing the partition that displays the progress bar in a grey colour. Levels 7 to 10.	**Input:** *Total User Score = 190* *User open popup.html* **Output:** *Popup.html indicates user progress bar*	**Output Contains:** Purple progress bar	**Output Contains:** *Purple Progress Bar.*	**P**	
15	Progress Bar Partition – **Gold**	Analysing the partition that displays the progress bar in a grey colour. Max Level only.	**Input:** *Total User Score = 210* *User open popup.html* **Output:** *Popup.html indicates user progress bar*	**Output Contains:** Gold Max Level Progress bar	**Output Contains:** *Purple Progress Bar.*	**P**	
16	**Vocabulary List** – Verified User Input	Testing to see if the user can successfully add a word to their personal vocabulary list. Chosen word **is included** in the JSON verification file.	**Input:** *English Input: Hello* *Spanish Input: Prueba* *Both words added to JSON verification file.* **Output:** Words added to list.	**Output Contains:** Successful incrementation . Webpage refreshes with words added to the localStorage.	**Output Contains:** Website refresh with correct user input word.	**P**	

17	**Vocabulary List** – Unverified User Input	Testing to see if the user can successfully add a word to their personal vocabulary list. Chosen word is **not included** in the JSON verification file.	**Input:** *English Input: Hello* *Spanish Input: Prueba* *Both words not added to JSON verification file.* **Output:** Words not added to list.	**Output Contains:** Error message notifying that the input was not valid with detailed reason to why.	**Output Contains:** Dialog box appears showing that the words are not valid.	**PP**	The system must contain a more detailed Error Message for the user.
18	**Vocabulary List** – All words appearing on the table for users to view.	Testing to see if all the words that the user has added to the Vocabulary List are appearing in the table shown in the "Vocabulary List" webpage.	**Input**: *User visiting popup.html and clicking on the "Vocabulary List" hyperlink* **Output**: *Chrome opens list.html*	**Output Contains:** list.html opened as intended showing the user's vocabulary + score.	**Output Contains:** Chrome successfully opens the vocabulary list via list.html	**P**	

19	**Memory Testing** – User Input correct English translation	Testing to see if inputting a verified English word will be accepted + provide the user with 1 XP.	**Input:** User visiting https://old.reddit.com/ and vising a thread. Then highlight a translated word, right clicking and navigating to the system via the context menu. Inputting correct English translation **Output:** Correct answer message appearing.	**Output Contains:** Success message + 1XP provided to the user's overall level.	**Output Contains:** Message notifying to the user that the input was correct. 1XP added to user account. Letting user know how much XP they have on their account now.	**PP**	The system must contain a more detailed Error Message for the user.
20	**Memory Testing** – User Input incorrect English translation	Testing to see if inputting an unverified English word will be accepted + deducting the user with 1 XP.	**Input:** User visiting https://old.reddit.com/ and vising a thread. Then highlight a translated word, right clicking and navigating to the system via the context menu. Inputting an incorrect English translation **Output:** Correct answer message appearing.	**Output Contains:** Incorrect message + 1XP deducted to the user's overall level.	**Output Contains:** Message notifying to the user that the input was correct. 1XP added to user account. Letting user know how much XP they have on their account now.	**PP**	The system must contain a more detailed Error Message for the user.

21	**Chrome Dimensions** – Desktop dimensions on each page on the application	Testing the desktop dimensions for each app page that has been created. Making sure the functionalities still work well for users using a desktop.	**Input:** Using desktop dimensions 1920x1080 Interacting with all hyperlinks and buttons. **Output:** Hyperlinks and buttons clicked.	**Output Contains:** Expecting all pages to be running as intended.	**Output Contains:** Images successfully responsive and inside the cards as intended. Hyperlinks and buttons working	**P**	
22	**Chrome Dimensions** – Tablet dimensions on each page on the application	Testing the tablet dimensions for each app page that has been created. Making sure the functionalities still work well for users using a tablet.	**Input:** Using tablet dimensions 768x1024 (iPad) Interacting with all hyperlinks and buttons on each page. **Output:** Hyperlinks and buttons clicked.	**Output Contains:** Expecting all pages to be running as intended.	**Output Contains:** Images are not responsive for that size, overlapping issues. Text is successfully responsive. Cannot navigate to the other existing pages from this dimension.	**F**	Website is responsive as it should. However, developers have not worked on maintaining the system for tablet users.

23	**Chrome Dimensions** – Mobile dimensions on each page on the application	Testing the mobile dimensions for each app page that has been created. Making sure the functionalities still work well for users using a mobile phone.	**Input:** Using tablet dimensions 411x731 (Pixel 2) Interacting with all hyperlinks and buttons on each page. **Output:** Hyperlinks and buttons clicked.	**Output Contains:** Expecting all pages to be running as intended.	**Output Contains:** Images are not responsive for that size, overlapping issues. Text is successfully responsive. Cannot navigate to the other existing pages from this dimension.	**F**	Website is responsive as it should. However, developers have not worked on maintaining the system for mobile users.
24	Accessing the "**Vocabulary List**" page	Testing the navigation to the user's vocabulary list.	**Input**: *User visiting popup.html and clicking on the "Vocabulary List" hyperlink* **Output**: *Chrome opens list.html*	**Output Contains:** Expecting list.html to open as intended showing the user's vocabulary + score.	**Output Contains:** Chrome successfully opens the vocabulary list via list.html	**P**	
25	Accessing the "**Points Rules**" page	Testing the navigation to the user's rule page.	**Input**: *User visiting popup.html and clicking on the "Points Rules" hyperlink* **Output**: *Chrome opens points.html*	**Output Contains:** Expecting list.html to open, showing a detailed description on the gamification rules.	**Output Contains:** Chrome successfully opens the vocabulary list via points.html	**P**	

26	Accessing the "**About Linguify**" page	Testing the navigation to the user's about page.	**Input**: *User visiting popup.html and clicking on the "About Linguify" hyperlink* **Output**: *Chrome opens points.html*	**Output Contains:** Expecting list.html to open as intended showing a detailed description on the system.	**Output Contains:** Chrome successfully opens the vocabulary list via about.html	**P**	
27	Accessing the "**Settings**" page	Testing the navigation to the user's settings page.	**Input**: *User visiting popup.html and clicking on the "Settings" hyperlink* **Output**: *Chrome opens settings.html*	**Output Contains:** Expecting list.html to open as intended showing a detailed settings system.	**Output Contains:** Chrome successfully opens the vocabulary list via settings.html	**P**	

Error Guessing

Contained a Total of **14 Test Cases** for this Technique.

No.	Test Case	Justification	Input	Expected Output	Actual Output	Condition	Comments
28	Testing Vocabulary List **Incrementing Phrase**	Making sure that the user can successfully add a phrase to their personal vocabulary list. Phrase has been added to the JSON verification file prior to test.	**Input:** *This is a test* *Esto es una prueba* **Output:** Phrase added to vocabulary list.	**Output Contains:** Successful incrementation Webpage refreshes with words added to the localStorage.	**Output Contains:** Website refreshes with correct user input phrase.	**P**	
29	Testing Vocabulary List **Incrementing Large Inputs**	Testing the performance of the system. Any technical issues occur when adding large inputs onto the system. Phrase has been added to the JSON verification file prior to test.	**Input:** *[100+ words in English]* *[100+ words in Spanish]* **Output:** *Words successfully added.*	**Output Contains:** Successful incrementation Webpage refreshes with words added to the localStorage.	**Output Contains:** Website refreshes with correct user input phrase.	**P**	
30	Testing Vocabulary List **Incrementing Empty Inputs**	Making sure that the user can't input null to the vocabulary list.	**Input:** *[EMPTY]* *[EMPTY]* **Output:** *Error message*	**Output Contains:** Error Message notifying to the user that they can only input characters.	**Output Contains:** Error Message occurring claiming that the input was invalid	**PP**	The system must contain a more detailed Error Message for the user.

31	Compatible with Google Chrome	Testing the performance of the system on the Google Chrome platform	**Input:** *Clicking installation button on Chrome* **Output:** *Installing the application on Google Chrome via Extensions.*	**Output Contains:** Successful installation of the application.	**Output Contains:** Installs instantly on the user's Google Chrome system.	**P**	
32	Testing Vocabulary List **Incrementing Numbers**	Making sure that the user can only input lettered Strings to their vocabulary list.	**Input:** *11* *11* **Output:** *Error message*	**Output Contains:** Error Message notifying to the user that they can only input characters.	**Output Contains:** Error Message occurring claiming that the input was invalid.	**PP**	The system must contain a more detailed Error Message for the user.
33	Capabilities in Firefox	Testing the performance of the system on the Firefox platform	**Input**: *Installing the application on Firefox via Addons.* **Output:** *Error message*	**Output Contains:** Unsuccessful installation of the application showing error message in the process	**Output Contains:** Application cannot be installed on Firefox, no error message appearing	**PP**	

34	Disabling the Browser Extension on Chrome	Testing the ability for users to disable the system when browsing the web on Chrome.	**Input**: *Right clicking the application and disabling the system.*	**Output Contains:** Icon disappearing + application being disabled on Chrome for the user.	**Output Contains:** Application successfully disabled	**P**	
35	Visiting a webpage that doesn't contain words on the user's vocabulary list	Checking to see if errors occur when the user visits a webpage that doesn't contain any words on their vocabulary list.	**Input**: *Visiting https://old.reddit.com/ that doesn't contain vocabulary list words. Minimise the number of words on the Vocabulary List.* **Output**: *Chrome opening the webpage*	**Output Contains:** No known errors + translation occurring.	**Output Contains:** Webpage functioning as requested.	**P**	
36	Visiting a more JavaScript heavy webpage that do contain words on the user's vocabulary list	Making sure that the application doesn't affect the heavy lifting websites when words are appearing on the page to translate	**Input**: Visiting https://apple.com/uk/ that contains words in the vocabulary list. **Output**: *Chrome opening the webpage with translated words*	**Output Contains:** No known errors + translation occurring.	**Output Contains:** Words translated successfully. Some HTML errors occurring on the website. Site loads as fast as usual	**PP**	HTML issues occurring. Needs high priority support.

36	Visiting a webpage that contains words on the user's vocabulary list	Expecting words that appear on the user's vocabulary list to be translated successful	**Input**: *Visiting https://old.reddit.com/ that doesn't contain vocabulary list words. Maximise the number of words on the Vocabulary List.* **Output**: *Chrome opening the webpage*	**Output Contains:** No known errors + translation occurring.	**Output Contains:** Webpage functioning as requested.	**P**	
37	Vocabulary List - Both input values just being a whitespace only.	Checking if whitespaces cause an error in the list.html.	**Input**: *[SPACE] and [SPACE]* **Output**: *Error message*	**Output Contains:** Expecting a detailed error message which notifies the user what the issue is and how to resolve it.	**Output Contains:** Error Message occurring claiming that the input was invalid.	**PP**	The system must contain a more detailed Error Message for the user.
38	Removing the system on the Chrome browser	Testing to see whether the users can remove the application from Chrome with ease.	**Input**: *User visiting the extension list and uninstalling the application.* **Output**: *Application being removed from the browser*	**Output Contains:** Expecting the user's version of Chrome to delete the application.	**Output Contains:** Chrome successfully deletes the application in seconds.	**P**	

39	Vocabulary List - Negative Data Value Inputs in Vocabulary List	Checking if negative values cause an error in the list.html.	**Input**: *-1* *and* *-5* **Output**: *Error message*	**Output Contains:** Expecting a detailed error message which notifies the user what the issue is and how to resolve it.	**Output Contains:** Error Message occurring claiming that the input was invalid.	**PP**	The system must contain a more detailed Error Message for the user.
40	Decimals Data Values in Vocabulary List	Checking if decimal values cause an error in the list.html.	**Input**: *-1* *and* *-5* **Output**: *Error message*	**Output Contains:** Expecting a detailed error message which notifies the user what the issue is and how to resolve it.	**Output Contains:** Error Message occurring claiming that the input was invalid.	**PP**	The system must contain a more detailed Error Message for the user.

Exploratory Testing

Contained a Total of **10 Test Cases** for this Technique.

No.	Test Case	Justification	Input	Expected Output	Actual Output	Condition	Comments
41	Popup.html appearing when user clicked.	Making sure that popup.html is working as intended.	**Input**: *User clicking on the system's logo on the top right of the Chrome browser.* **Output**: *Popup.html loaded.*	**Output Contains:** Popup.html working with no errors occurring.	**Output Contains:** Popup.html appearing for the user with no delay or errors appearing.	**P**	
42	Factory Reset of localStorage	Testing to see if the factory reset button located in the settings is working effectively.	**Input**: *User clicking on the system button in the settings section of the application named "Restore Default Settings"* **Output**: Popup notifying the user that the system has reset.	**Output Contains:** localStorage to be cleared as intended and refresh the page.	**Output Contains:** localStorage resets. Popup message appears notifying the user. System refreshes.	**P**	
43	Checking Levels when Factory Reset	Testing to see if the levelling system and user progress has been reset in the popup.html as intended.	**Input**: *User clicking on the system's logo on the top right of the Chrome browser.* **Output**: *Popup.html loaded with changes*	**Output Contains:** Popup.html working with no errors occurring – Level 1 and no XP	**Output Contains:** Popup.html appearing for the user with no delay or errors appearing. User is now	**P**	

					Level 1 with zero XP		
44	Navigating to the User Memory Testing Input Box without highlighting the translated word. (Highlighting a non-translated word)	Testing to see if highlighting the correctly translated word on the webpage is required to visit the application via the context menu.	**Input**: *Visiting https://old.reddit.com/ that doesn't contain vocabulary list words. Maximise the number of words on the Vocabulary List.* Highlighting un-translated word on the webpage and right click **Output**: Context menu appears.	**Output Contains:** Linguify context menu appearing only when the user highlights the translated words.	**Output Contains:** Linguify context menu appears regardless of what the user highlights.	**F**	Change needs to be made to ensure that the feature appears in given words that are highlighted.
45	Testing the system that contains a lot of text to translate. High demanding HTML site.	Testing how demanding the application is for website that contain a lot of text. (i.e. Wikipedia)	**Input**: Visiting https://en.wikipedia.org/wiki/Barack_Obama Maximise the number of words on the Vocabulary List. **Output**: Website appears.	**Output Contains:** Website successfully appears with translations at a quick pace.	**Output Contains:** Takes over 25 seconds for the page to full load. Translations are appearing successfully. Some HTML tags are negatively affected.	**F**	Application requires further optimisation, to maintain browser loading speeds.

46	Testing to see if the translation affects images on a site.	Making sure that the application doesn't interfere with the images of the site.	**Input**: Visiting https://tinyurl.com/y45zc9mb Maximise the number of words on the Vocabulary List. **Output**: Website appears.	**Output Contains:** Website successfully appears with all images appearing.	**Output Contains:** Page loads successfully. Some of the images are loading successfully, some appeared and disappeared.	**PP**	Make sure that all image tags are working effectively on websites,
47	User Input – Cancelling the input box.	Testing to see if the user can cancel the input box requiring them to input the English translation on the webpage.	**Input**: Highlighting a translated word + clicking "Linguify" in the context menu. Clicking cancel on the input box.	**Output Contains:** Successfully removes the input box for the user.	**Output Contains:** Message appears notifying that the user has inputted the incorrect value.	**F**	System still treated the cancel as an input which was rejected. Quality of Life changes need to be made.
48	Visiting a high demanding video streaming service website.	Making sure that highly used sites like YouTube and Twitch are not affected by this application.	**Input**: Visiting https://youtube.com/ Maximise the number of words on the Vocabulary List. **Output**: Website appears.	**Output Contains:** Website successfully appears with all videos appearing.	**Output Contains:** Website not functioning. Black white page.	**F**	Major defect needs direct changing as soon as possible. Application directly affects certain popular website.

49	**Dimensions** – Tablet dimensions on a website.	Testing if the translations are still occurring successfully in Tablet dimensions.	**Input:** *Visiting* https://old.reddit.com/ Using tablet dimensions 768x1024 (iPad) Interacting with all hyperlinks and buttons on each page. **Output:** Page visited	**Output Contains:** No known errors + translation occurring.	**Output Contains:** Webpage functioning as requested.	**P**	
50	**Dimensions** – Mobile dimensions on a website.	Testing to see if translations are still occurring successfully in Mobile dimensions.	**Input:** *Visiting* https://old.reddit.com/ Using tablet dimensions 411x731 (Pixel 2) Interacting with all hyperlinks and buttons on each page. **Output:** Page visited.	**Output Contains:** No known errors + translation occurring.	**Output Contains:** Webpage functioning as requested.	**P**	

Defect Records

Records of the defects occurring in each of the tests are displayed with additional information and solutions to solve the issue. This report included quality of life (QOL) defects that affect user experience instead of current software performance.

Initially discovered by test 17

Defect No	01	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Quality of Life	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	17, 19, 20, 30, 31, 37, 39, 40	**Severity**	Low
Program Title	Linguify	**Priority**	Medium
Tester	Christopher Jones		

Defect Description

When the user gets the program to execute an incorrect input,
it produces an error message that doesn't help them understand what made the inputs invalid.

Expected Output	Actual Output
System outputs detailed and unique error messages notifying users exactly what the issue is and how to resolve them.	System outputs generic error messages, notifying users to try again.

Reproducing Steps

1. Opening Google Chrome and Enabling Linguify.
2. Navigate to the "Vocabulary List" webpage via the Linguify extension.
3. Enter an invalid user input.
4. Attempt to add the invalid strings to the Vocabulary List.
5. Program output error message.

Severity and Priority Reasoning

Severity:
Quality of Life issue contains minimal effect to the system performance.

Priority:
Defect visible to all users. Decreases the user experience.

Additional Testing

Test 19: Testing the Input Error when User is testing their vocabulary knowledge.
Showing an equally minimal error message for the users.

Initially discovered by test 22

Defect No	02	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Functionality	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	22	**Severity**	Medium
Program Title	Linguify	**Priority**	High
Tester	Christopher Jones		

Defect Description
Linguify application not functioning properly when using tablet dimensions on Google Chrome.

Expected Output	**Actual Output**
System functioning as expected in tablet dimensions	System functionality not working properly. Including navigating to other Linguify webpages.

Reproducing Steps
1. Opening Google Chrome and Enabling Linguify on Tablet dimensions. **2.** Navigate to the “Vocabulary List” webpage via the Linguify extension. **3.** Program output defect.

Severity and Priority Reasoning
Severity: Changing the dimensions cause moderate effects to the system performance. **Priority:** Defect visible to all users that use a tablet. Decreases the user experience.

Additional Testing
N/A

Initially discovered by test 23

Defect No	03	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Functionality	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	22	**Severity**	Low
Program Title	Linguify	**Priority**	Medium
Tester	Christopher Jones		

Defect Description
Linguify application not functioning properly when using mobile dimensions on Google Chrome.

Expected Output	**Actual Output**
System functioning as expected in mobile dimensions	System functionality not working properly. Including navigating to other Linguify webpages.

Reproducing Steps
1. Opening Google Chrome and Enabling Linguify on Mobile dimensions. **2.** Navigate to the “Vocabulary List” webpage via the Linguify extension. **3.** Program output defect.

Severity and Priority Reasoning
Severity: Quality of Life issue contains minimal effect to the system performance. **Priority:** Defect visible to all users. Decreases the user experience.

Additional Testing
N/A

Initially discovered by test 36

Defect No	04	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Quality of Life	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	22	**Severity**	Low
Program Title	Linguify	**Priority**	Medium
Tester	Christopher Jones		

Defect Description
Application causes HTML tags to break on certain websites.

Expected Output	**Actual Output**
System outputs all websites effectively with no HTML tag issues found.	System outputs webpages but with some tags having issues. HTML code appearing on websites.

Reproducing Steps
1. Opening Google Chrome and Enabling Linguify. **2.** Navigate to https://old.reddit.com/ **3.** System outputs defect.

Severity and Priority Reasoning
Severity: Quality of Life issue contains minimal effect to the system performance. **Priority:** Defect visible to all users. Decreases the user experience.

Additional Testing
N/A

Initially discovered by test 44

Defect No	05	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Functionality	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	44	**Severity**	High
Program Title	Linguify	**Priority**	High
Tester	Christopher Jones		

Defect Description
Context Menu feature appearing regardless of whether the user highlights a translated word/phrase on the webpage.

Expected Output	**Actual Output**
System outputs detailed and unique error messages notifying users exactly what the issue is and how to resolve them.	System outputs generic error messages, notifying users to try again.

Reproducing Steps
1. Opening Google Chrome and Enabling Linguify. **2.** Navigate to https://old.reddit.com/ **3.** Highlight an untranslated word and right click **4.** System outputs defect.

Severity and Priority Reasoning
Severity: User is not testing their vocabulary knowledge based on which translated word they highlighted. Changes need to be made ASAP. **Priority:** Severe issue that would confuse users with highlighting and what words to input. Changes need to be made.

Additional Testing
N/A

Initially discovered by test 46

Defect No	06	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Functionality	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	46	**Severity**	Low
Program Title	Linguify	**Priority**	Medium
Tester	Christopher Jones		

Defect Description
Some images are disappearing on the webpage when application is enabled.

Expected Output	**Actual Output**
System outputs all images on webpages.	System outputs all images at first, but some disappear after page is fully loaded.

Reproducing Steps
1. Opening Google Chrome and Enabling Linguify. **2.** Navigate to https://tinyurl.com/y45zc9mb **3.** System outputs defect.

Severity and Priority Reasoning
Severity: Quality of Life issue contains minimal effect to the system performance. **Priority:** Defect visible to all users. Decreases the user experience.

Additional Testing
N/A

Initially discovered by test 47

Defect No	07	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Functionality	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	47	**Severity**	Low
Program Title	Linguify	**Priority**	Medium
Tester	Christopher Jones		

Defect Description
User clicking the button when no data has been inputted. Program thinks that the user inputted null and gives no error message.

Expected Output	**Actual Output**
System accepts the dialog box without data and terminates.	System outputs no generic error messages, without notifying users to try again.

Reproducing Steps
1. Opening Google Chrome and Enabling Linguify. **2.** Navigate to https://old.reddit.com/ **3.** Highlight an untranslated word and right click. **4.** Click Linguify in Context Menu **5.** Click “Ok” in the Input Dialog Box **6.** System outputs defect.

Severity and Priority Reasoning
Severity: Issue contains minimal effect to the system performance. **Priority:** Doesn’t allow users to cancel their request. User experience affected. All users may see the defect,

Additional Testing
N/A

Initially discovered by test 48

Defect No	08	**Operating System**	Microsoft Windows 10 Pro x64
Defect Type	Functionality	**Testing Tool**	Google Chrome v.73.0.
Tests ID affected by Defect	48	**Severity**	High
Program Title	Linguify	**Priority**	High
Tester	Christopher Jones		

Defect Description

Some high quality and demanding websites are not functioning at all.
Black white page appears instead.

Expected Output	**Actual Output**
System outputs webpages successfully with all functionality and features working.	System outputs a blank page.

Reproducing Steps

1. Opening Google Chrome and Enabling Linguify.
2. Navigate to https://www.youtube.com/
3. System outputs defect.

Severity and Priority Reasoning

Severity:
Highly severe as it causes users to not be able to access popular websites while using the application. First defect to resolve,

Priority:
Visible to all users, negatively effects all users. User experience affected drastically. Change needs to be made ASAP.

Additional Testing

N/A

Defect List

1. Unverified User Input – Dialog Box Information
2. Chrome Webpage Dimensions – Tablet
3. Chrome Webpage Dimensions – Mobile
4. HTML Tag Error during Translation
5. Context Menu Highlighting
6. Images on websites disappearing
7. Accept empty input Issue – User Input Dialog Box
8. Websites not Functioning

APPENDIX P – NIELSON'S HEURISTICS

Nielson's Usability Heuristics

Below contains the ten usability heuristics that the evaluators will be basing their results on. These heuristics were produced by Jakob Nielson (*Nielson 1995*).

1. Visibility of System Status

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

2. Match between system and the real world

System should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms.

3. User control and freedom

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

4. Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

5. Error prevention

Even better than good error messages are a careful design which prevents a problem from occurring in the first place.

6. Recognition rather than recall

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another.

7. Flexibility and efficiency of use

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users.

8. Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

9. Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language, precisely indicate the problem, and constructively suggest a solution.

10. Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation.

APPENDIX Q – SYSTEM USABILITY SCALE PARTICIPANT INFORMATION SHEET

Participant Information Sheet – System Usability Scale

Testing the usability of a language learning Chrome browser extension.

Invitation Overview

Our team are conducting a design and implementation project into educational browser extensions for the Google Chrome platform named **Linguify**.

You are one of the many participants invited to take part in this project. It is crucial you and every member understand why the project is taking place and what it consists. Please take time to read and fully understand the following information carefully and discuss it with other individuals if you wish. Contact the team if there is anything that is not entirely clear or would like more information on. It's vital to take one's time to decide whether or not you wish to take part in the project.

Who is Organising the Project?

This project has been organised by Bournemouth University Development team all funded by the university.

What is the Purpose of the Project?

To build a browser extension platform, allowing users of diverse skill levels to safely browse the internet while being challenged educationally. In our prototype, it is catered towards the foreign language aspect of learning.

The browser extension will feature Spanish-English only. Further analysis on the system will also be made which includes software quality & testing as well as usability evaluations.

Why have I been chosen?

You have been selected to be surveyed as we feel your knowledge of foreign languages would be a valuable part in this project. We require a diverse group of individuals to test the usability of the system to see how it matches with its competitors.

Is it compulsory to take part?

It is 100% up to you to decide whether or not to take part in this project. If you decide to take part, you will be given this information sheet and a participant consent form.

You can withdraw from the project at any time up to the interview process day. Personal information is kept private and not kept after the project has been completed. You do, however, need to provide a reason to withdraw. Deciding to take part will not impact your treatment or studies at Bournemouth University.

What would taking part involve?

This role would involve using the system for 1 week and answer 10 usability questions ranging from Strongly Agree to Strongly Disagree, ultimately providing the system with a usability score that will be used to manage future development decisions.

Contact for additional information

Chris Jones
i7467340@bournemouth.ac.uk

Thank you for considering taking part in this project.

APPENDIX R – SYSTEM USABILITY SCALE PARTICIPANT AGREEMENT FORM

Participant Agreement Form – System Usability Scale

Title of Project: Investigation on Browser Extensions to Enhance the Actions of Foreign Language Learning

Name of Project Owner: Christopher Jones

Contact Details of Project Owner: i7467340@bournemouth.ac.uk

Name and Contact Details of Supervisor: Nan Jiang, njiang@bournemouth.ac.uk

Please Initial

I confirm that I have fully read and understood the Participant Information Sheet provided for the above study. I got the opportunity to consider the information, asked relevant questions and received such answers satisfactorily.	
I understand that I am free to withdraw from the project at any time, so long as I provide a reason for doing so.	
I understand that my participation is 100% voluntarily.	
I understand that taking part in this project will be recorded.	
I agree to take part in the above project.	
I understand that no personal details will be recorded throughout the entire project.	

Participant's Name……

Participant's Signature……

Date…….....

TO BE COMPLETED BY THE DEVELOPERS ONLY

Researcher's Name……...

Researcher's Signature…….

Date……

Consent form should be signed and dated by all parties after the participant receives and reads the copy of the participant information sheet. Agreement forms should be kept with the project owner's main documents, kept in a secure location.

APPENDIX S – SYSTEM USABILITY SCALE EXAMPLE PARTICIPANT DOCUMENT

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently					
	1	2	3	4	5
2. I found the system unnecessarily complex					
	1	2	3	4	5
3. I thought the system was easy to use					
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.					
	1	2	3	4	5
5. I found the various functions in this system were well integrated					
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.					
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly					
	1	2	3	4	5
8. I found the system very cumbersome to use.					
	1	2	3	4	5
9. I felt very confident using the system.					
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.					
	1	2	3	4	5

Total Score =

SUS Score =

APPENDIX T – SYSTEM USABILITY SCALE RESULTS

PARTICIPANT 1

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently			✔		
	1	2	3	4	5
2. I found the system unnecessarily complex		✔			
	1	2	3	4	5
3. I thought the system was easy to use				✔	
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.			✔		
	1	2	3	4	5
5. I found the various functions in this system were well integrated	✔				
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.		✔			
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly			✔		
	1	2	3	4	5
8. I found the system very cumbersome to use.		✔			
	1	2	3	4	5
9. I felt very confident using the system.					✔
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	✔				
	1	2	3	4	5

Total Score = 2 + 3 + 3 + 2 + 0 + 3 + 2 + 3 + 4 = **22**

SUS Score = 22 * 2.5 = **55.0**

PARTICIPANT 2

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently					✔
	1	2	3	4	5
2. I found the system unnecessarily complex		✔			
	1	2	3	4	5
3. I thought the system was easy to use				✔	
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.				✔	
	1	2	3	4	5
5. I found the various functions in this system were well integrated		✔			
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.			✔		
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly					✔
	1	2	3	4	5
8. I found the system very cumbersome to use.		✔			
	1	2	3	4	5
9. I felt very confident using the system.				✔	
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	✔				
	1	2	3	4	5

Total Score = 4 + 3 + 3 + 1 + 1 + 2 + 4 + 3 + 3 + 4 = **28**

SUS Score = 28 *2.5 = **70.0**

PARTICIPANT 3

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently	✔				
	1	2	3	4	5
2. I found the system unnecessarily complex	✔				
	1	2	3	4	5
3. I thought the system was easy to use				✔	
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.		✔			
	1	2	3	4	5
5. I found the various functions in this system were well integrated			✔		
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.			✔		
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly				✔	
	1	2	3	4	5
8. I found the system very cumbersome to use.		✔			
	1	2	3	4	5
9. I felt very confident using the system.			✔		
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.			✔		
	1	2	3	4	5

Total Score = 0 + 4 + 3 + 3 + 2 + 2 + 3 + 3 + 2 + 2 **= 24**

SUS Score = 24 * 2.5 = **60.0**

PARTICIPANT 4

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently				✔	
	1	2	3	4	5
2. I found the system unnecessarily complex		✔			
	1	2	3	4	5
3. I thought the system was easy to use				✔	
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.	✔				
	1	2	3	4	5
5. I found the various functions in this system were well integrated					✔
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.		✔			
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	✔				
	1	2	3	4	5
8. I found the system very cumbersome to use.	✔				
	1	2	3	4	5
9. I felt very confident using the system.				✔	
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.		✔			
	1	2	3	4	5

Total Score = 3 + 3 + 3 + 4 + 4 + 3 + 0 + 4 + 3 + 3 = **30**

SUS Score = 30 * 2.5 = **75.0**

PARTICIPANT 5

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently				✔	
	1	2	3	4	5
2. I found the system unnecessarily complex				✔	
	1	2	3	4	5
3. I thought the system was easy to use		✔			
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.		✔			
	1	2	3	4	5
5. I found the various functions in this system were well integrated			✔		
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.					✔
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	✔				
	1	2	3	4	5
8. I found the system very cumbersome to use.				✔	
	1	2	3	4	5
9. I felt very confident using the system.		✔			
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.			✔		
	1	2	3	4	5

Total Score = 3 + 1 + 1 + 3 + 2+ 0 + 0 + 1 + 1 + 2 **= 14**

SUS Score = 14 * 2.5 = **35.0**

PARTICIPANT 6

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently					✔
	1	2	3	4	5
2. I found the system unnecessarily complex	✔				
	1	2	3	4	5
3. I thought the system was easy to use				✔	
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.		✔			
	1	2	3	4	5
5. I found the various functions in this system were well integrated				✔	
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.			✔		
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly		✔			
	1	2	3	4	5
8. I found the system very cumbersome to use.		✔			
	1	2	3	4	5
9. I felt very confident using the system.			✔		
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.		✔			
	1	2	3	4	5

Total Score = 4 + 4 + 3 + 3 + 3 + 2 + 1 + 3 + 2 + 3 **= 28**

SUS Score = 28 * 2.5 = **70.0**

PARTICIPANT 7

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently					✔
	1	2	3	4	5
2. I found the system unnecessarily complex	✔				
	1	2	3	4	5
3. I thought the system was easy to use					✔
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.	✔				
	1	2	3	4	5
5. I found the various functions in this system were well integrated				✔	
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.		✔			
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly			✔		
	1	2	3	4	5
8. I found the system very cumbersome to use.		✔			
	1	2	3	4	5
9. I felt very confident using the system.				✔	
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	✔				
	1	2	3	4	5

Total Score = 4 + 4 + 4 + 3 + 3 + 2 + 3 + 3 + 4 **= 34**

SUS Score = 34 * 2.5 = **85.0**

PARTICIPANT 8

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently			✔		
	1	2	3	4	5
2. I found the system unnecessarily complex				✔	
	1	2	3	4	5
3. I thought the system was easy to use		✔			
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.				✔	
	1	2	3	4	5
5. I found the various functions in this system were well integrated		✔			
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.					✔
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly			✔		
	1	2	3	4	5
8. I found the system very cumbersome to use.			✔		
	1	2	3	4	5
9. I felt very confident using the system.		✔			
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.	✔				
	1	2	3	4	5

Total Score = 2 + 1 + 1 + 1 + 1 + 0 + 2 + 2 + 1 + 4 = **15**

SUS Score = 15 * 2.5 = **37.5**

PARTICIPANT 9

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently		✔			
	1	2	3	4	5
2. I found the system unnecessarily complex	✔				
	1	2	3	4	5
3. I thought the system was easy to use				✔	
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.		✔			
	1	2	3	4	5
5. I found the various functions in this system were well integrated			✔		
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.			✔		
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly					✔
	1	2	3	4	5
8. I found the system very cumbersome to use.		✔			
	1	2	3	4	5
9. I felt very confident using the system.				✔	
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.		✔			
	1	2	3	4	5

Total Score = 1 + 4 + 3 + 3 + 2 + 2 + 4 + 3 + 3 + 3 = **28**

SUS Score = 28 * 2.5 = **70.0**

PARTICIPANT 10 SHEET

System Usability Scale

Using SUS

The system usability scale is to be used ***after*** the respondent has been provided the opportunity to use the system. Participants are required to be asked to record their responses to each item.

All items are to be ***checked only***. If the participant is unsure about a question, they should answer the question as ***neutral***.

Scoring of the SUS

SUS scores are calculated first by getting the sum of the scores from each item. Each item contributes to a score ranging from 0 to 4.

Items 1,3,5,7,9 – Score is the scale position minus 1

Items 2,4,6,8,10 – Score is 5 minus the scale position.

The total score is then ***multiplied by 2.5*** to obtain the final value of System Usability. SUS score ranges from 0 to 100.

Please complete the SUS table below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently				✔	
	1	2	3	4	5
2. I found the system unnecessarily complex	✔				
	1	2	3	4	5
3. I thought the system was easy to use					✔
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system.		✔			
	1	2	3	4	5
5. I found the various functions in this system were well integrated		✔			
	1	2	3	4	5
6. I thought there was too much inconsistency in this system.		✔			
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly					✔
	1	2	3	4	5
8. I found the system very cumbersome to use.	✔				
	1	2	3	4	5
9. I felt very confident using the system.				✔	
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system.		✔			
	1	2	3	4	5

Total Score = 3 + 4 + 4 + 3 + 3 + 3 + 4 + 4 + 3 + 3 = **34**

SUS Score = 34 * 2.5 = **85.0**

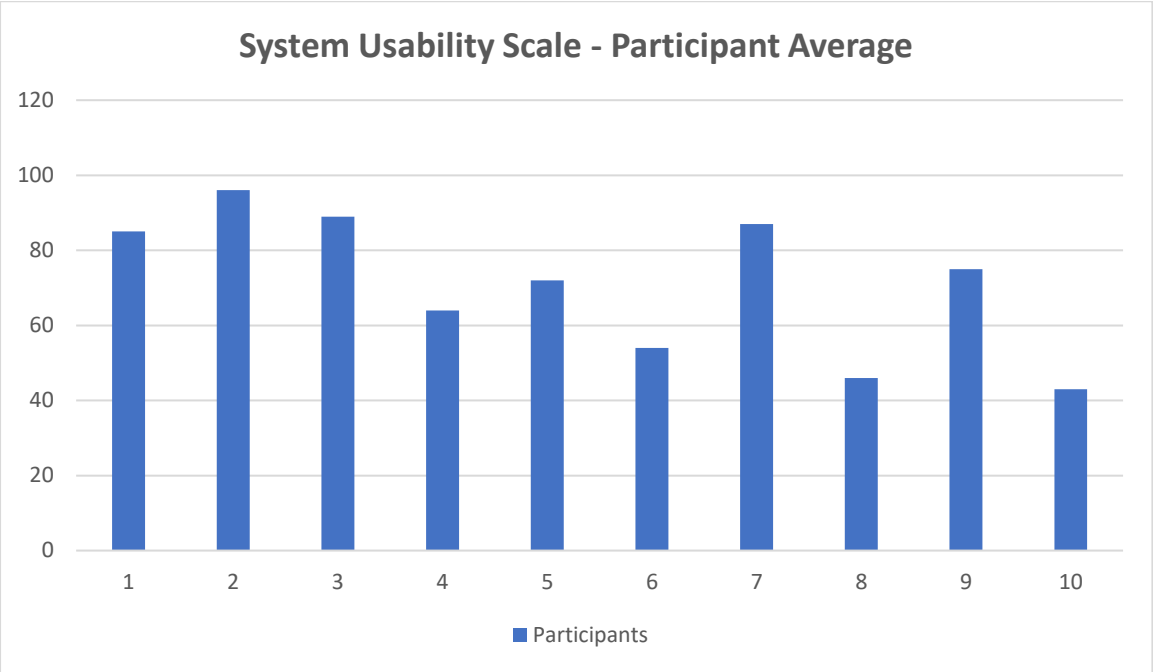
OVERALL PARTICIPANT RESULTS

Participant #	Total Score	Overall SUS Score
1	22	55.0
2	28	70.0
3	24	60.0
4	30	75.0
5	14	35.0
6	28	70.0
7	34	85.0
8	15	37.5
9	28	70.0
10	34	85.0
		64.25

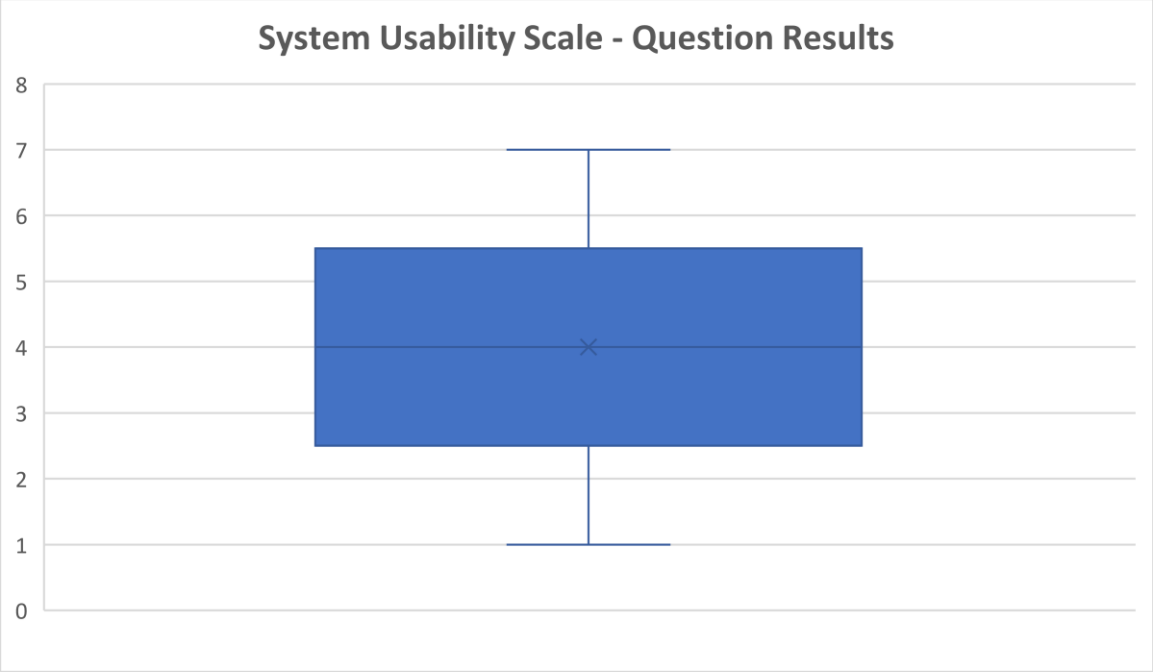
OVERALL QUESTION RESULTS

Question #	Total Score	Overall SUS Score
1	26	65.0
2	23	57.5
3	28	70.0
4	27	67.5
5	19	47.5
6	19	47.5
7	22	55.0
8	29	72.5
9	25	62.5
10	32	80.0

OVERALL RESULTS – BAR CHART AND BOX-AND-WHISKER

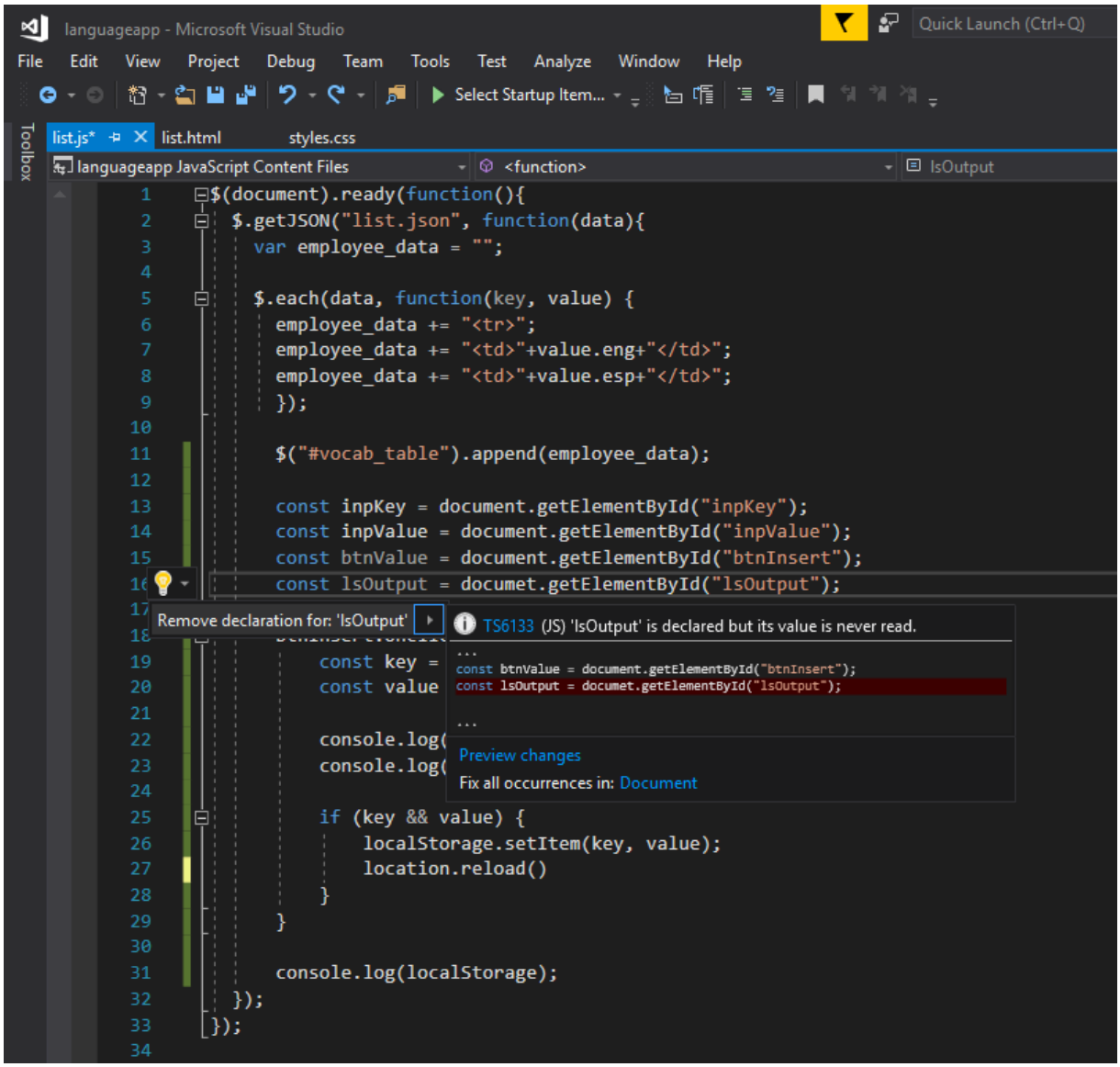


Bar Chart of SUS Results – Per Participant



Box-And-Whisker Chart

APPENDIX U – STATIC CODE ANALYSIS



APPENDIX V – ARTEFACT LIST OF CONTENTS

CSS

- **bootstrap.min.css**

An open-source CSS framework used for responsive front-end web development. Simple to install and provides the team with the aesthetics of certain items in the system (buttons and progress bar).

- **scroll-nav.css**

Smooth scrolling animations added to the system on each webpage (Vocabulary List, Points Rules, About Linguify, Settings).

- **styles.css**

Styling sheet that contains the main styling of the application including padding, font and font-size.

IMG

- **greyLevel.png**

Snippet of the progress bar when the user is Level 1-3. This image will be added to the "Points System" page.

- **blueLevel.png**

Snippet of the progress bar when the user is Level 4-7. This image will be added to the "Points System" page.

- **purpleLevel.png**

Snippet of the progress bar when the user is Level 8-10. This image will be added to the "Points System" page.

- **maxLevel.png**

Snippet of the progress bar when the user is Max Level. This image will be added to the "Points System" page.

- **levelSnippet.png**

Snippet containing the Total User Score in the Vocabulary List table. This image will be added to the "Points System" page.

- **listSnippet.png**

Snippet containing the Vocabulary List as a whole. This image will be added to the "Points System" page.

- **logo.png**

A 50x50 image of the "Linguify" logo. This will be added to multiple areas including each page of the application and in the Chrome sidebar.

- **logo-large.png**

A 100x100 image of the "Linguify" logo. Added to certain areas that require a larger image.

- **popupSnippet.png**

A snippet illustrating what the popup.html will look like when the user clicks the "Linguify" logo in the Chrome sidebar.

- **settings.png**

A free to use settings cog image that will be in popup.html. User clicking this image will take them to the Settings page (settings.html).

- **vocabSnippet.png**

A snippet containing both the user inputs to add the English and Spanish words, and the current version of their vocabulary list.

- **amazon.png**

Image containing the Amazon logo in the "Test your Vocabulary" page

- **bing.png**

Image containing the Bing logo in the "Test your Vocabulary" page

- **ebay.png**

Image containing the eBay logo in the “Test your Vocabulary” page

- **wikipedia.png**

Image containing the Wikipedia logo in the “Test your Vocabulary” page

- **reddit.png**

Image containing the new Reddit logo in the “Test your Vocabulary” page

- **oldreddit.png**

Image containing the old Reddit logo in the “Test your Vocabulary” page

- **google.png**

Image containing the Google logo in the “Test your Vocabulary” page

JS

- **bootstrap.min.js/bootstrap.min.js**

An open-source CSS framework used for responsive front-end web development. Makes the system more responsive.

- **eventPage.js**

Script that enables users to highlight translated words on webpages and test themselves to see if they know the English equivalents. Points are added/removed if correct or incorrect answers are made. Linguify app added to the context menu.

- **jquery-3.3.1.min.js**

A JavaScript library which simplifies event handling and CSS animations. Free and simple to install.

- **list.js**

Script which adds English and Spanish words onto the user's localStorage. Creates a window that notifies whether the English and Spanish words are legitimate by connecting with the list.json file.

- **list.json**

A JSON array containing both the English and Spanish words that are successfully verified and allowed in this system.

- **popup.js**

Script that provides the levelling system and progress bar that updates automatically when the user gains more XP.

- **script.js**

Script that connects to the user's localStorage and replaces words on webpages depending if that word is contained in the localStorage (Vocabulary List). Highlights the replaced word yellow.

- **settings.js**

Feature that allows users to factory reset their account, clearing all the words and points in their localStorage.

HELP.HTML

About webpage is used to describe the browser extension in a clear and concise way for newcomers. Users can visit the page by clicking the "Help" link in the Popup (popup.html).

ADD.HTML

The Vocabulary List page lets users add more words to their list as well as view their XP and entire vocabulary list. Also views the English and Spanish words that can be added to the user's vocabulary list.

MANIFEST.JSON

JSON file that notifies the Chrome browser about the web application and how it should behave on the desktop. This file is required by Google Chrome. Includes whitelisting certain sites.

SITES.HTML

The "Test your Vocabulary" page provides the user with links to all compatible sites to test their Spanish vocabulary knowledge. Visiting the sites and testing their memory.

POPUP.HTML

The Popup page provides users the level they currently are on their account, the total XP and how many is required to Level Up. Three hyperlinks that take to the "View/Add Words", "Test your Knowledge" and "Help" pages respectively.

README.TXT

A detailed ReadMe text file that explains how to successfully use the system for newcomers. What is required to use the browser extension in the optimum way.

SETTINGS.HTML

The Settings page that allows users to reset their localStorage.

APPENDIX W – LIST OF SUPPORTED WEBSITES

- Wikipedia (https://en.wikipedia.org/wiki/Main_Page/)
- Bing (https://www.bing.com/)
- New Reddit (https://www.reddit.com/)
- Old Reddit (https://old.reddit.com/)
- Stack Overflow (https://www.stackoverflow.com/)
- Amazon UK (https://www.amazon.co.uk/)
- eBay UK (https://www.ebay.co.uk/)