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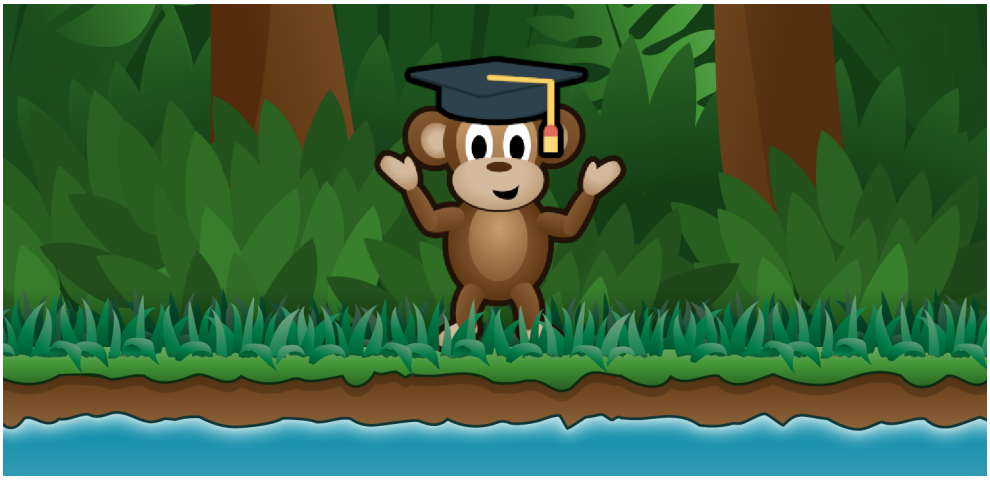

Fishing for Words: A game to learn grammatical gender in Portuguese

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“And by 1983, I had my dream. I could see the Dragon clearly in my mind’s eye. Let me tell you about my dream. I dreamed of the day when computer games would be a viable medium of artistic expression. An art form!”

Chris Crawford, “The Dragon Speech” at GDC 1992

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Abstract

Learning a language can be very useful and fun, but also a lot of work. Portuguese, a language with grammatical gender, can be particularly challenging for learners whose native language lacks this feature. In this thesis, we took a look at the history of language education and existing language-learning platforms, which served to inform our own efforts, and developed *Fishing for Words*[1], a videogame for Android and Windows that helps players memorize the gender of words in Portuguese at the A2 level of proficiency, featuring two word-selection systems (which balance the game's difficulty in real-time according to the player's performance): The classic Leitner System and a novel Tag System.

A full experimental procedure was developed and tested, with the purpose of validating its effectiveness, which revealed several pitfalls through which an experimenter evaluating such a game might fail to obtain results. In other words, we provide insight into how to get the participants to play the game and stick with it, which ours did not.

Our main conclusions were that the game should be tested with more advanced students (who we suspect have more interest in grammatical gender), that the students should be given more time & more encouragement to play and that the game should be available on a wider range of platforms (around half of our participants could not play due to not having Android nor Windows).

Keywords

Grammatical Gender, Language, Education, Games, Videogames, Learning

[1] The game can be downloaded here: https://petzi.itch.io/fishingforwords?secret=dzblEYB1vYFq9CvxNsmT3Yd2glQ

Resumo

Aprender uma língua pode ser muito útil e divertido, mas trabalhoso. O português, tendo género gramatical, pode ser particularmente difícil para pessoas cuja língua materna não tenha esta característica. Nesta tese revemos a história do ensino de línguas e plataformas de aprendizagem de línguas existentes, que serviu para informar o nosso projeto, e desenvolvemos *À Pesca de Palavras*[2], um jogo para Android e Windows para ajudar os jogadores a memorizar o género das palavras em português ao nível de proficiência A2. Inclui dois sistemas de escolha de palavras (que equilibram a dificuldade do jogo em tempo real, de acordo com o desempenho do jogador): O clássico sistemas Leitner, e o novo sistemas de Tags.

Um procedimento experimental completo foi desenvolvido e testado, com o propósito de validar a sua eficácia, o que revelou vários imprevistos que podem atrapalhar o investigador e impedir que haja uma recolha de dados bem sucedida. Por outras palavras, damos recomendações sobre como conseguir que os participantes joguem o jogo, contrariamente aos nossos.

As nossas conclusões principais foram que o jogo deve ser testado com alunos mais avançados (pois suspeitamos que tenham mais interesse em aprender género gramatical), que os alunos devem ter mais tempo & encorajamento para jogarem e que o jogo deve estar disponível em mais plataformas (cerca de metade dos participantes não puderam jogar por não terem Android nem Windows).

Palavras Chave

Género Gramatical, Língua, Educação, Jogos, Videojogos, Aprendizagem

[2] O jogo pode ser descarregado aqui: https://petzi.itch.io/fishingforwords?secret=dzblEYB1vYFq9CvxNsmT3Yd2glQ

Contents

List of Figures

List of Tables

1

Introduction

Contents

1.1 Motivation

In the face of ever-increasing globalisation and ease of communication and travel, knowing a foreign language is a valuable asset. Learning additional languages can lead to new work and business opportunities and open paths to other cultures, people, perspectives and ways of thought. Learning a language is also, on the other hand, a significant investment of time, money and effort. Fortunately, the last fifty years have introduced cheap and portable computers, the internet and videogames, technologies which can be used as novel tools to learn in a more fun, quick way. It is in the spirit of harvesting the potential of these technologies as learning tools that this thesis was developed.

As games, apps and platforms centred on learning languages rise in popularity, there is a need to analyse and compare the various approaches adopted by these existing efforts in light of older techniques and research done on the subject of language learning. Results from learning theory might help improve the methods applied by these systems to present challenges to the user through prediction or real-time analysis, identifying what topics the user is more likely to struggle with. Techniques used in game design and gamification can similarly be applied to motivate and guide the learner, grasping their interest, attention and effort away from distractions which might have defeated traditional learning exercises.

One specific problem of language education is that of learning grammatical genders. In many languages, nouns (and in some cases other words) are classified as being either *masculine* or *feminine* (and, in many languages, into other classes and genders), which is the case in Portuguese and Spanish, for example, but not English or Chinese. This masculine-feminine distinction is usually seemingly arbitrary and can vary even between closely related languages. The combination of gender variation between languages and linguistic interference (the way the languages a person learns affect each other) is one of the core issues we will attempt to address in this thesis through the development of a game for learning gender: *Fishing for Words*.

1.2 Problem description

People learning (or attempting to learn) any gendered language (in particular, Portuguese) must invariably memorize the gender of each noun, along with the grammar rules that govern them. Naturally, mastering this aspect of the language is a prerequisite to mastering the language itself. This can be a slow process, even for otherwise advanced learners, not only because there are many nouns to learn, but because the hints that may be used to guess the correct gender of a given word typically have exceptions, so one must learn both the regularities and the irregularities.

Any game that is proposed to accomplish a particular goal, be it artistic, educational, financial or scientific, must inexorably be evaluated to determine whether it reaches that goal. Since our goal is to

create a game to help with learning the gender of Portuguese words, it makes sense to test it in the same manner. Thus, our scientific problem, which this thesis aims to answer, is this:

How can a game to learn grammatical gender in Portuguese be tested to ensure that it fulfils its purpose?

1.3 Approach & Contributions

In this thesis, we present an overview of the literature on games for language education, including a brief history of language instruction and some of the existing games and platforms for learning languages. Based on this review of existing research, we created *Fishing for Words* (Section 3.3), a game for Android and Windows that aims to help players learn the gender of words in Portuguese which is a major contribution of this dissertation.

The game includes two word-selection models (which, through selecting the game words the player will be challenged with, tweak the game's difficulty in real-time based on the player's performance), one based on the classic Leitner System (Section 3.4.1) and the Tag System (Section 3.4.2), a novel system proposed by us based on the more complex model introduced by Catarino [1].

Another contribution and essential component of *Fishing for Words* is the list of words that appear in the game, based on the nouns that a learner of Portuguese should acquire during the A2 level of instruction. It was adapted to our purposes through a mixture of automated processes (web scraping and tagging) and manual reviewing by a native speaker (myself) with support from dictionaries and the advice of an expert on Portuguese teaching (co-supervisor Prof. Nélia Alexandre). Both the word list itself and the methodology and software used to create it may be useful for similar research projects.

Finally, we performed an experiment in which a total of 80 volunteer foreign students of Portuguese learning at *Faculdade de Letras da Universidade de Lisboa* were tested on their knowledge of gender in Portuguese, asked to play *Fishing for Words* for 10 days and asked about their opinion on the game and some of their learning preferences (not all 80 participated in all phases, however). In this document, we provide data from this event and a reflection on our experimental methodology with the purpose of exploring how player participation might have been increased, which ultimately serve to advise on future research by providing suggestions to improve both the game and the experimental procedure.

1.4 Document outline

This document is divided into 6 chapters and several appendices:

- **Chapter 1 Introduction:** Overview of the thesis.
- **Chapter 2 Literature Review:** A review of previous scientific work of importance to our research.

- **Chapter 3 Implementation:** The game, its development and secondary work performed.
- **Chapter 4 Experimental Procedure:** Description of how the experiment was conducted.
- **Chapter 5 Results:** Description and interpretation of our results.
- **Chapter 6 Conclusion:** Final remarks.
- **Appendix A Pre-Test:** First written test about grammatical gender in Portuguese.
- **Appendix B Post-Test:** Second written test about grammatical gender in Portuguese.
- **Appendix C Questionnaire:** Opinion survey about on the game and learning Portuguese.
- **Appendix D Consent Form:** Form signed by the participants.
- **Appendix E Linguistic Profile:** Form to gather the participants' linguistic background.

NOTE: The focus of the thesis is European Portuguese, the variety of the language spoken in Portugal, which will be referred to throughout the document simply as "Portuguese".

2

Literature Review

Contents

In this section, we will present our theoretical research on the relevant topics for the project. First, we will introduce concepts of linguistics and language learning as we explore the history of the field and the main schools of thought that appeared over the years. We will look at both more general theories and theories that specifically interest our project, such as gender acquisition and interference in multilinguals. After that, we will explore how games and gamification can be used to make tasks more engaging, illustrating these ideas with real-world examples.

2.1 Language Proficiency Scale

The *Common European Framework of Reference for Languages* (CEFRL) defines 6 levels of proficiency for users of a language, from beginner to native-like: A1, A2, B1, B2, C1 and C2[1].

The A2 level, which is the focus of our game (chosen for logistics reasons, based on which classes were available at *FLUL*), corresponds to a "basic user" who can have short, simple conversations and read and write simple texts on a few restricted subjects. It also happens to be the minimum level of proficiency in Portuguese required by law to obtain citizenship in the Republic of Portugal [2]. A C2 level student, on the other hand, would be expected to have a command of the language similar to a native speaker, being able to discuss and comprehend a wide variety of topics.

2.2 Grammatical Gender

2.2.1 In general

In many natural languages, nouns (and, depending on the language, other words, such as adjectives, determiners and numerals) are divided into several classes, often including gender as one of the criteria of these classes. Other possible criteria include animate versus inanimate, countable versus uncountable and human versus non-human. In languages with these features, grammatical gender allows speakers to, for example, easily clarify a being's real-life gender or sex by inflecting the noun, and they are useful in anaphora disambiguation (in some sentences, they allow the reader/listener to infer whom or what each pronoun is referring to) [3] [4] [5].

However, words' genders often seem to have been assigned arbitrarily, thus someone attempting to learn these languages must memorize the correct gender for each noun, as well as the rules pertaining to them in that particular language, which can include inflection (modification) of the noun itself, choosing other words to be in agreement with the noun or picking the correct gender according to the situation (in some languages, certain words can have more than one gender, usually those having to do with people or animals).

[1] https://europass.cedefop.europa.eu/resources/european-language-levels-cefr

2.2.2 In Portuguese

The Portuguese language retains two grammatical genders from its ancestral Latin: *feminine* and *masculine*, which are applied to nouns, pronouns, adjectives and determiners (not to verbs, though these may have a gendered pronoun affixed to them, written with a hyphen and not affecting the verb's stress). Some words may be used with either gender, which may cause them to suffer inflection, change meaning entirely and/or simply reflect the real-life gender or biological sex of the entity they refer to. We will refer to **noninflected** words that may be used with either gender as *double-gendered*.

Typically, masculine words end with *-o* while feminine words end with *-a*, but there are exceptions to this rule. There are also many other word endings that hint at a particular gender, most of which with exceptions of their own. This is a key concept used in our *Tag System*, which is described in Section 3.4.2 [6].

The way gender in Portuguese is used varies widely, depending on whether the nouns can be inflected and on whether they refer to entities with biological sex. Below is a list of these uses:

SEXED ENTITIES (mostly living things)

- Words that are inflected, depending on the entity's real-life gender or sex:

  gato/gata (**masculine**/**feminine**) = "cat/she-cat"

  rei/rainha (**masculine**/**feminine**) = "king/queen"
- Words with different stems that relate to an entity's real-life gender or sex:

  cavalo (**masculine**) = "horse"

  égua (**feminine**) = "mare (she-horse)"
- Words where the entity's real-life gender or sex is ignored:

  criança (**feminine**) = "child" (applied to any child, regardless of their sex).
- Words that are noninflected, but switch gender depending on sex (typically occupations):

  artista (**masculine** or **feminine**) = "artist"

SEXLESS ENTITIES (mostly inanimate things)

- Sexless words with a single gender:

  lápis (**masculine**) = "pencil"
- Sexless (inflected) words with different meanings depending on gender:

  bolso (**masculine**) = "pocket"

  bolsa (**feminine**) = "purse, pouch, grant or scholarship"
- Sexless (noninflected) words with different meanings depending on gender:

  a capital (**feminine**) = "the capital (city or letter)"

  o capital (**masculine**) = "the funds"

- Some sexless words are gender-inflected, yet the two versions are synonymous:

  pingo/pinga (**masculine**/**feminine**) = “droplet”

  peúgo/peúga (**masculine**/**feminine**) = “sock”

- Some (noninflected) sexless words can be used with either gender with the same meaning:

  cotonete (**masculine** or **feminine**) = “cotton bud” [7] [8] [9] [10] (sources disagree)

  bólide (**masculine** or **feminine**) = “meteor or something that moves fast” [11] [12]

Note that, if either gender can be applied to a noninflected word, then it can only be determined through the gender of other words in the sentence, such as adjectives or determiners, due to Portuguese requiring gender agreement (determiners *o* (**masculine**) and *a* (**feminine**) were used in some of the examples).

There is still the curious case of entities like Google in which the company is feminine (*a Google*), while the product/website is masculine *o Google*, possibly caused by elision of *a empresa* and *o site*, respectively.

2.3 History of Language Education

The first systematic language education method to appear in modern history, *grammar-translation method*, had its roots in the teaching of Latin which had existed in the West since medieval times. When the study of modern languages became a part of school curricula in Europe around the 18th century, a popular method of teaching was to mimic the way Latin was taught, leading to the emergence of this system. In the grammar-translation method, students were to memorize as much vocabulary and grammar rules as possible, then apply them by translating written texts. There was a focus on reading and writing, to the detriment of speaking and listening, so, unlike in most modern methods, there was little concern for exposing the learners to dialogue, thus teaching was usually done in the learners’ native language. The attention given to students’ individual learning strategies was limited to the commonly given suggestions on how to most effectively memorize the material [13].

Although prior to the 20th century there were other scholarly ideas on language education besides the traditional method, these did not gain widespread popularity [14] [15]. Instead, the next chapter in language education history is considered the *audio-lingual method*, which became very popular during World War II. In contrast to the grammar-translation method, the need to train soldiers with practical skills in the languages of allies and enemies shifted the importance from reading and writing to listening and speaking. Teaching was to be conducted entirely in the target language, again in contrast to the traditional method. The audio-lingual method was based on the behaviourist school of thought prevalent at the time, and so it was based on repetitive drills: after performing a particular exercise a number of times, the learners would memorize the correct response by being given feedback based on their

answer. There was little place in the classroom for individual learners to exercise creativity or to learn the way they preferred, and this was part of what made the language education community disillusioned with the audio-lingual method in the 1960s, when new ideas began to achieve a foothold and the old method fell into disuse [13].

One not very popular post-war system developed as a sort of antithesis to the audio-lingual system was the *silent method*, which maintained that the teacher should be as silent as possible. The proponent of this method, Gattegno, asserted that the focus should be on how the learners learn, not on how the teacher teaches. Thus, the role of the teacher becomes that of a facilitator, primarily leading students in the right direction and leaving them to explore on their own. Unlike in the audio-lingual, where learners were discouraged from taking initiative for fear of mistakes occurring, in the silent method errors are expected and learners' proficiency in their native language was viewed in a positive light, as a tool to be used to progress in their mastery of the target language (this is known as *transfer*, as will be discussed in more depth later in this document) [16] [17].

A more mainstream theory brought forth during the 1960s period was Chomsky's Universal Grammar. Unlike behaviourists, who viewed all learning as the consequence of operant conditioning (reinforcement and punishment), this theory held that humans possessed an innate capability to learn languages (a hypothetical *language acquisition device*) subject to a set of rules referred to as *universal grammar*. From these ideas, the notion of *interlanguage* was developed, which refers to the intermediate language system possessed by a learner (more on this later in the document). Interlanguage researchers of the 1970s and 1980s were interested in how the learners themselves (and their learning strategies) mattered to the learning process, an idea foreshadowed years earlier by Gattengo with his silent method [13].

On the opposite end of the spectrum, Krashen proposed that conscious language learning was not at all the answer. Before we go into his theory, we must first distinguish *language acquisition* from *language learning*. Though many terms in this field are not consensually defined, we will consider that *acquisition* refers to the unconscious way in which children learn their first language: they do not realize that they are learning, they simply make use of language naturally. *Learning*, on the other hand, refers to a process in which the learner is aware that they are gaining knowledge about the language. Krashen's *five hypotheses* are as follows:

Acquisition-Learning Hypothesis: Natural acquisition is more effective than consciously attempting to learn a language.

Natural Order Hypothesis: All learners acquire the features of a given language in the same order.

Input Hypothesis: A learner can acquire language by comprehending something slightly more difficult than what their current proficiency allows.

Affective Filter Hypothesis: Negative emotions prevent students from learning by reducing their ability to understand the target language.

Monitor Hypothesis: Learned language can be used to scan produced language for errors, but only acquired language can be used for actual production.

These five hypotheses have received widespread attention, though they have just as widely been denounced by other authors as being dogmatic, unverifiable and dependent on a distinction between *acquisition* and *learning* which may not actually exist [13].

Modern mainstream language learning theory does not follow Krashen's idea, though their influence in the field is recognized. It is generally accepted that learners influence the learning process in part with the learning strategies they adopt, consciously learning and adapting their strategies to what they have learned or failed to learn [13].

2.4 Language learning strategies

Gathering information on what strategies students use to learn is a complicated task because much of the learning may happen in an uncontrolled environment (i.e. outside the classroom) and learning is a mental process, thus the only way to truly observe the full procedure would be to read the students' minds, so to speak. One common way of studying the learning process is to interview and observe more successful language students to try to understand what it is that makes them more successful.

There is no single best way to learn a language, as different learners prefer different methods. Stevick [18] gives us an overview of 7 successful language students who employ radically different techniques, which sometimes work wonders for some and throw others into desperation: For example, one learner relied heavily on listening and reproducing the sounds she heard without seeing anything written down. Another attended a Hebrew course where her teacher tried a very similar approach and it gave her so much trouble that she resolved to buy the book so she could study the lessons in advance: only then could she follow any of the classes. Some of the students thrived when presented with repetitive drills, while others detested them. All of these students were successful at learning languages, yet each had their own idea of what was the "natural" way of learning languages. Stevick goes on to describe the parts of a larger pattern he saw in the students' reports: each student exhibited some parts of the pattern, but none exhibited all of them. He warns that language teachers may be tempted, for example, based on testimonials from students like "I prefer to learn words by ear before seeing them written down", to start recommending or adopting that method in the classroom. He warns against drastic measures taken on scarce evidence, and instead presents the steps he would personally take as an educator, based on this data: [18]

1. Concepts in the students' minds should be formed by both verbal and nonverbal (i.e. based on the senses) components.

2. Be aware of the students' differences in comprehension.

3. Don't discourage students from memorizing material, but be aware of what they have memorized and make use of it.

4. Only explain what is necessary, or that which students have asked to be explained.

5. Motivate students to make use of their speaking abilities.

6. Be aware of how your students prefer to learn and avoid focusing on a single type of learner.

Naiman *et al* took a similar approach and concluded that successful learners find strategies that suit them, being aware of the learning process and the language itself. Rubin found that the strategies chosen by students are dependent on target language competence, age and socio-cultural differences [13].

Some scholars, however, have taken a different approach. Attempting to correlate learning strategies to proficiency has yielded mixed results. O'Malley *et al* found that students of all levels of proficiency reported using a broad set of strategies, but more advanced students reported a higher use of *metacognitive* strategies (strategies about governing the learning process itself, rather than strategies related to the target language specifically). Another study with a similar approach, however, found that only cognitive strategies (strategies based on awareness of the target language's patterns and grammar), including reading for pleasure, were positively correlated with the students' proficiency at the end of the language course. A large-scale study by Green and Oxford discovered that a particular set of core strategies were used equally frequently by students regardless of their competence level and speculated that, although they may be effective, they may not be sufficient to improve the speed at which less successful students progress [13].

There have also been a few studies on the strategies used by unsuccessful students. One such study by Porte found that, although the strategies used by unsuccessful students were similar to the ones employed by successful ones, the first appeared to "demonstrate less sophistication and a less suitable response to a particular activity", which was speculated to be a cause of the discrepancy. Another way of studying learners' choice of learning strategies is by examining other factors. Researchers have also attempted to find correlations between learning strategies and sex, Myers-Briggs personality type, nationality, age and proficiency, but their findings have often lead to contradicting conclusions [13].

One study by Griffiths compared students' and teachers' ideas regarding language learning strategies and found 71% agreement between which strategies students reported typically using and which strategies teachers regarded as highly important. This high number is atypical, as previous studies found a high discrepancy between the two groups' perceptions, which could be partly due to the way the strategies were selected (the definition of *language learning strategy* is elusive, and there is no consensus on how to group them). These studies serve to highlight the importance of teacher-student communication and cooperation [19].

From these ideas of focusing on the learners' mental processes and on the learners' preferred strate-

gies, it may be tempting to conclude that learners would be better off left to their own devices, but it is worth remembering that even in the silent method, which relies heavily on students' curiosity and initiative, there is always a teacher present to direct the learner's attention. It is also worth noting that strategies a student feels more comfortable using are not necessarily the most suitable for them. Students may be more comfortable practicing skills they are better at, so they may avoid practicing those that they need to practice the most (because it feels less comfortable to them). More successful students are typically at ease with committing errors and making use of their incomplete language knowledge [20] [21].

2.5 Linguistic interference

One factor of major importance in second language learning is what is called *linguistic interference* (or *transfer*) from previously learned languages. This means that the learner employs concepts, rules and habits from the other languages they know when using the target language, which can either help (*positive interference*) or hinder (*negative interference*) the learner's acquisition of the target language, depending on whether the target language is similar with regard to the aspect that was transferred. Negative transfer tends to be more noticeable, since it leads to errors, while positive transfer tends to go unnoticed. Another detail is that transfer is multidirectional, for example, elements from a third language can transfer to the speaker's native language [22].

2.5.1 Contrastive analysis

The *contrastive analysis hypothesis* was introduced in 1957. This approach works by comparing the native language and the target languages, so that, in aspects where the two are different, learners are expected to have difficulties. Thus, errors arise from persisting native language **habits** being transferred when using the target language. Though this was not the first time the existence of this phenomenon was noted, this theory provided systemic methods for comparing languages.

The strong hypothesis, that negative transfer is the cause of all errors and contrastive analysis is capable of predicting those errors was eventually disproven, as empirical evidence showed that not only did learners not commit all errors predicted by contrastive analysis, but some errors occurred independently of the learner's native language and many errors were not caused by transfer. The weaker hypothesis states that only some errors are caused by negative transfer and that contrastive analysis could be used to explain the origin of errors, but not predict them. This weaker hypothesis was also considered inadequate, however, which led to the theory waning in popularity in the 1970s and evolving into theories that stress more strongly that transfer is only a part of the learning process [23].

2.5.2 Interlanguage

The term *interlanguage*, coined by Selinker in 1972, is defined as "the separate linguistic system evidenced when adult second-language learners attempt to express meaning in a language they are in the process of learning." [24] It refers not only to the personal language a learner has at a particular point in time, but to the "interlanguage continuum", the systems that characterize the learner's progress over time. The interlanguage theory (as well as other theories of this period) focuses on individuals' cognitive processes responsible for language acquisition [23]. An interlanguage is considered characteristically separate from both the native language and the target language: it is not simply the native language with its vocabulary replaced by equivalents from the target language, and yet it is not the target language as one of its native speakers would use it.

According to the original theory, interference is central to the development of the learner's interlanguage but, unlike contrastive analysis, interlanguage theory aims to consider the learners' conscious learning efforts and strategies. Some interlanguage researchers argue that interference only happens when learners are making a conscious effort to learn the target language, and, based on certain results, concluded that children are not subject to interference due to acquiring language unconsciously. This is related to the idea that children have access to their *language acquisition device* (a hypothetical part of the human mind responsible for the acquisition of a native language) while adults, for neurological reasons, do not.

Since the 1990s, the interlanguage theory has evolved. One of the changes was that the limitation described above, that children did not experience interference when learning a second language, has come into question. Secondly, there is an ongoing debate between linguists over whether interlanguage is a natural language in itself, which would imply that it is subject to the same restrictions (the so called *universal grammar*) that govern the appearance and development of natural languages. Thirdly, there was the realization that interlanguage develops differently depending on the social context, so learners may commit less errors in some environments than others. Another issue developed is about *fossilization*, which refers to the phenomenon of the interlanguage stagnating, remaining the same without further development. Fossilization was previously assumed to be inevitable and a consequence of the brain's development into adulthood, but more recent versions of the interlanguage theory suggest that it may be instead caused by a sociolinguistic phenomena, such as the social necessity to fit in with one's peers in terms of language use.

The interlanguage theory has become a sort of basis for the study of fundamental questions on second language acquisition. Since the discovery that contrastive analysis could not predict learners' difficulties, researchers have gone back to the question of how instances of negative transfer can be predicted and prevented, and how this research can be used to improve language education [24].

2.6 Third language acquisition

Third language acquisition has for a long time tended to be bundled together with second language acquisition, as it had not been subjected to much research, but more recently there have been studies focused on this specific topic.

One such study examined how a group of secondary school students, who had Spanish and/or Basque as their native and/or second language(s) and English as their third language, used the languages at their disposal in compositions they were asked to write (one in each language) and when communicating with their classmates. It is worth noting that, although the geographical proximity of these languages has caused centuries of influence and borrowing, they come from different families: English and Spanish are both from the Indo-European macrofamily, but English is Germanic while Spanish is a Romance language, and Basque is a language isolate with no attested relatives [25] [26] [27]. This study showed that students often mix languages in informal communication, but show instances of language transfer even when writing the compositions (which is a more formal context). The students displayed instances of language transfer in all directions (from each language they knew to each of the others) [28].

Third language acquisition is interesting to our project, as our participants will be tested on Portuguese which is at least their third language (possibly fourth, fifth or beyond). Studies like the one described above could be useful in understanding if and how our results might relate to second language acquisition by providing insight into the differences between learning a second language and learning a third language.

2.7 Spaced repetition

Spaced repetition is a simple technique used for memorizing large numbers of items and retaining them in long-term memory. The basis for this method is that humans more easily retain information studied repeatedly over long periods with time intervals between moments of study. The classic system is the Leitner method published in the 1970s, in which flashcards (cards on which the items to be remembered are written) are placed in numbered boxes and moved upward when remembered correctly and downward when remembered incorrectly. The lower the box's number, the more frequently the cards within will be practiced, therefore the least-remembered items will be remembered more often (for example, box 1 may be practiced every day and box 2 every 2 days) [29] [30]. Computer implementations of spaced repetition (such as Anki, Mnemosyne, Brainscape or Duolingo) usually implement some variation of Leitner's system or of the more complex SuperMemo system [29]. The Leitner System was implemented in our game, as described in Section 3.4.1.

Spaced repetition can be applied to any field of knowledge that requires mechanical memorization,

but it is particularly useful for learning languages. It cannot be used by itself to become fluent in a language because the fundamental purpose of languages is to communicate with humans, which requires the learner to develop understanding and production of both speech and writing, but can be effective for learning vocabulary, grammar rules and alphabets (or, more generally, characters and rules of writing systems). This knowledge can then be used to complement other learning techniques.

2.8 Flow

Flow is a termed coined by Csíkszentmihályi to describe the psychological state in which a person is completely immersed in the task they are performing. It is a crucial concept in games, as games are typically played for enjoyment and experiencing enjoyment is part of the state of flow. Flow can even be used a way of measuring enjoyment in games [31] [32] [33]. Persons in this state are described as being totally absorbed in the activity at hand, being concentrated on completing it while becoming unaware of the passage of time, their physical surroundings and even their own self existence and their basic physiological needs. Another component of the state of flow is that the person derives pleasure from the task (it is intrinsically enjoyable, or "autotelic"), they feel that they are using their maximum capabilities (the task is challenging to them), that they feel that they have control of the task and that they can overcome all the challenges which will be presented to them further ahead (in other words, the person must not feel helpless).

A crucial condition for flow to occur and be maintained is the balance between the person's abilities and the task's difficulty (or perceived difficulty): if the task becomes too difficult, the person will begin to feel helpless from being unable to progress, and if the task becomes too easy, the person will begin to feel boredom from a lack of challenge. If the task becomes too easy or too hard, the person must be able to adjust either their skill level or the difficulty of the task, otherwise they cannot re-enter the state of flow (possibly abandoning the task in frustration). Another condition is that the person has clear goals to achieve and immediate feedback on how their actions affect their progress to said goals. Finally, the person must be in a distraction free environment, in order to become fully engaged in the task.

As explained above, activities in which a state of flow is achieved are rewarding by themselves, which causes the individual to seek to repeat the activity. And because the state of flow implies that the individual is working at his full potential, systematically achieving flow in a task causes individuals to become more and more proficient at it, which in turn fosters the necessary conditions for flow to be maintained [34] [35].

2.9 Gamification

Gamification is an umbrella term for applying elements from game design to non-game tasks with the goal of increasing the users' motivation and engagement in those tasks. Though a proper definition for the term is disputed, it has grown in popularity in the last decade [36]. It is not a technique restricted to the digital medium: they have been applied to areas such as commerce, education, health, sustainable consumption, work and innovation [37] [38].

Later in this document we will look at Duolingo, a particular case of a gamified language learning platform.

2.10 Games and apps

In this next section, we will look into games, apps and platforms for language learning. These are interesting to us as examples of what can be done and some of the implications of what can be done, providing insight and inspiration for our own solution.

2.10.1 Duolingo

Duolingo[2] (2012) is a gamified language-learning platform created by von Ahn and Hacker. In Duolingo, the user selects the language they wish to learn and progresses along a (mostly) linear chain of lessons, each of which consists of a short text introduction to the topic at hand and a series of very short (typically involving a single sentence) exercises. In each exercise, the user is asked to perform a task such as translating, reading aloud or write what they hear, which elicits immediate feedback from Duolingo (whether the answer was adequate and what mistakes were made). This give-answer-get-feedback loop is essential to Duolingo's approach and one aspect of it being gamified. Another aspect of its gamification is in giving the users virtual rewards such as *experience points* and *lingots*, which can be shown off to friends and traded in to unlock some extra features, respectively. These rewards have little mechanical impact on the way the system works, but serve to reward and motivate the users. Duolingo also provides some social mechanisms, allowing users to engage in friendly competition and answer each other's questions.

Duolingo employs space repetition, which is visible to the users in the lesson menu (pictured in Figure 2.1). The system estimates how well the user remembers each lesson based on how many times they practiced it and when, with lessons practiced less or less recently being considered "weaker", prompting the system to remind the user to practice them. Besides being quite popular, it has been shown by studies that it is an effective learning tool [39] [40].

[2] www.duolingo.com

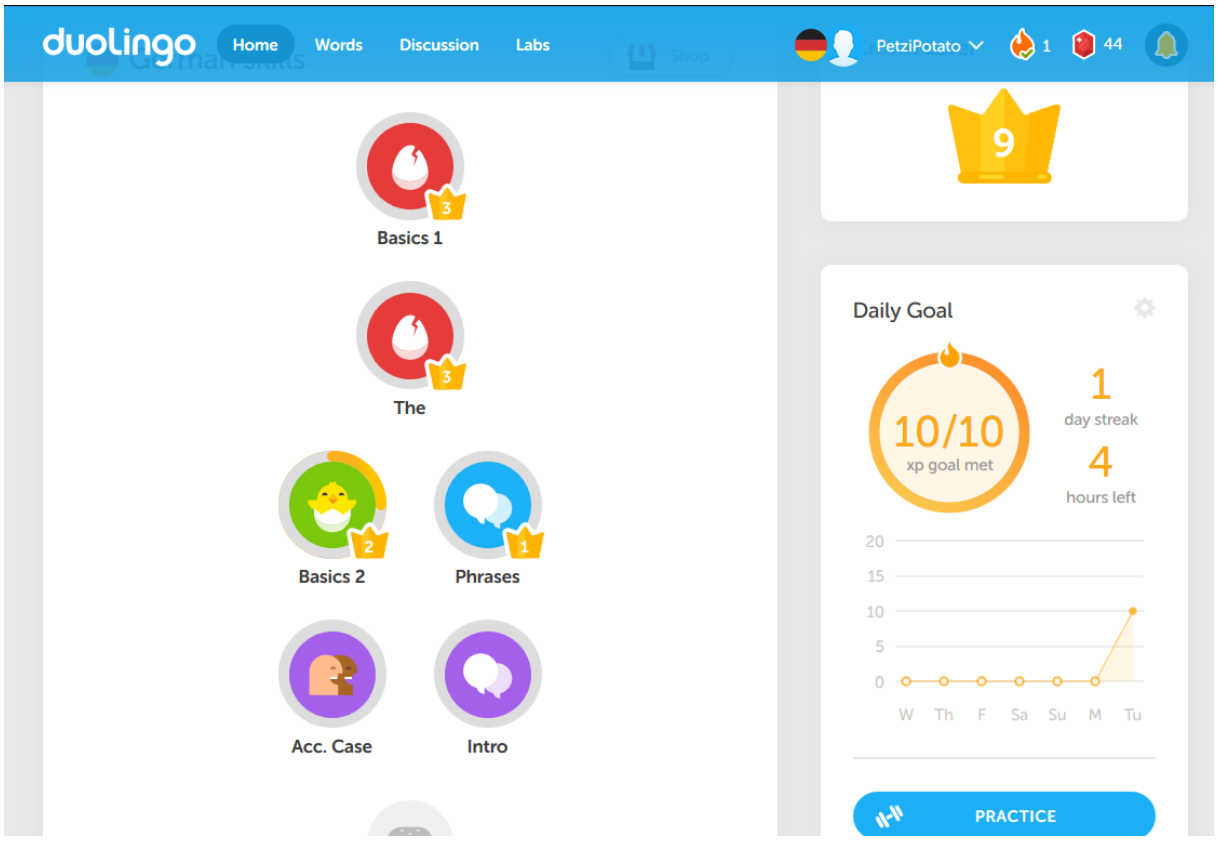

Figure 2.1: Duolingo. Main menu of a German course in a web browser. Notice how the lesson **Basic 2** has been practiced recently, the red Lingots on the top right corner, and the **day streak** counter. These gamification elements aim to keep users engaged with the platform.

2.10.2 Crystallize

Crystallize[3] is an academic project created at Cornell University. It is a 3D online multiplayer videogame focused on teaching Japanese to English speakers which has gone through several iterations, though the following description is of the version released on 2015-09-06. In Crystallize, the learners play foreign students at a Japanese school where they roam, interacting with computer-controlled Japanese students (known as non-player-characters or NPCs), as seen in Figure 2.2. When the player talks to an NPC, the NPC will speak in Japanese (the game features the option of switching between Japanese characters and Latin characters). The player can add words spoken by the NPCs to their in-game *dictionary*, which allows them to say those words to NPCs in conversation (after performing some practice exercises to help the player learn the words in real life). This mechanic leads to the player to gradually building up both their in-game dictionary and actual vocabulary, as the words they unlock allow them to respond adequately to NPCs, which in turn opens up the possibility to talk to more NPCs. At the same time, the player is rewarded with in-game currency and cosmetic items. Thus, Crystallize's main gameplay loop

[3] http://crystallize-online.com/

can be described as: learn word, practice word, use word.

The game has been used to explore and study several design approaches to language-learning games, including multiplayer controlled laboratory play sessions [41] and using virtual reality to achieve a heightened sense of physical presence in the players [42]. The latest version, partially described in the previous paragraph, is similar to a Massive Multiplayer Online Role-Playing Game (but without the "massive" part). Crystallize allows players to play in the same virtual world, socializing as they perform the game tasks, and includes "quests", which entail players talking to an NPC who asks them to perform a specific task, typically requiring the player to learn and use some specific words, walk to a particular place within the game world or interact with specific objects or other NPCs.

The study conducted by Andersen *et al* (in which the game was released on Reddit for anyone to join) suggested that the social aspect of the game enhanced the experience by allowing players to practice their Japanese or chat about all kinds of topics, but simply having other players present was also reported to be enjoyable and motivating. This is in spite of the game not having many multiplayer features (players cannot collaborate in quests, for example). Indeed, Bartle's taxonomy of player types lists *socializers* as one of the four player types, described as MMORPG players who are mainly interested in chatting with other players, observing and being part of the community while treating the game itself as more of a side activity [43]. Talking to other people in the target language is also a crucial part of learning it, so this aspect of the game should improve the players' proficiency as long as they use the target language when communicating through it [44] [45]. The game's logs show that this happens, as players sometimes communicated using Japanese words from the game when chatting with each other.

The study also concluded that players were engaged with the game's world and scenarios, as they were motivated by the rewards and preferred the feeling of interacting with characters rather than with inanimate machines (one user contrasted the game's NPCs with the images shown in *Rosetta Stone*, a platform in which learners must match pictures to words and sentences). The paper explains that the game's design was thought out in a way that would provide context, which research tells us helps people remember by tying ideas to situations.

Finally, we must acknowledge that, while Crystallize players reported enjoying the game (as described above) and it had a relatively high return rate of 13%, the collected data suffered from a small sample size as well as sample bias (most players had experience in Japanese, were "tech-savvy" and were all recruited from the same online community) [46].

Figure 2.2: Crystallize. The player character is shown here in the centre, surrounded by NPCs. The player is listening to a conversation two of them are having, and obtained the word **endai** from it. Once the player has obtained enough words, they must practice them in their room before they can obtain more. Other visible interface elements include the chat box (used to communicate with other human players), the player's money and confidence, the list of quests (currently empty) and the mini-map (on the top right corner).

2.10.3 Content-based platforms

Some platforms, like LingQ[4], Bliu Bliu[5], Yabla[6], Memrise[7] and FluentU[8] seek to motivate learners by allowing them to select which content in the target language they wish to be exposed to. They aim to achieve this by aggregating material (i.e. video, audio and text) from third-party sources, which deal with varied content such as news stories, vlogs, folk tales or history lessons. Learners are exposed to this content (which, ideally, is that which interests them most) not only passively, but also interact with it by translating it, choosing particular words to study later, rating its quality or, in some cases, uploading it themselves. Some of these platforms also allow users to communicate directly with other learners as another way of being exposed to their target language. They tend to have some form of gamification to track the learner's progress and motivate them to continue learning [47] [48] [49]. These platforms provide access to genuine material in the target language, contrasting with material written specifically with the purpose of language education (or recorded by professional voice actors), which language

[4] www.lingq.com/en/
[5] www.bliubliu.com/
[6] www.yabla.com
[7] www.memrise.com
[8] www.fluentu.com

educators regard as beneficial [50] [51].

One problem this kind of platform faces is content curation. Because they aggregate third-party content, sometimes even uploaded by users rather than experts employed by the website, content must be filtered for quality, difficulty, correctness and type. This can be hard to achieve and it is a common target of criticism [52].

2.11 Gender symbols

There does not appear to be a standard symbol to indicate grammatical gender, which would be useful for this project. The most sensible solution seems to be to rely on symbolism associated with real-world gender, as it may be the closest alternative. The most universal pictograms associated with gender are very likely to be the standard toilet symbols established by the *International Organization for Standardization*, which are used to indicate toilets for males and females (or unisex toilets, when presented simultaneously, as seen in Figure 2.3) [53]. However, due to their association with toilets and human gender in specific, it was decided that more generic, less pictographic symbols were appropriate for this project, and so the ancient symbols of Venus and Mars were selected (Figure 2.4). The earliest known association of these symbols with sex was their use by the famed scholar Carl Linnaeus in his work on botany, *Species Plantarum*. They are part of larger family of symbols whose history goes back to classical antiquity, being used mainly in astronomy, astrology and alchemy, to represent gods, planets and chemical elements (in this case, Venus & copper and Mars & iron). The Venus and Mars symbols are widely associated with gender in the West, but no research was found that measured their recognition outside Europe and the Americas [54] [55] [56].

Figure 2.3: These pictograms denote toilets (for males, females or both) and are part of a worldwide standard.

Figure 2.4: The Venus and Mars symbols (left and right, respectively) are used in *Fishing for Words* to represent the feminine and masculine genders.

Note that, although the symbols in Figure 2.4 are ancient, the colors and attributed to them here and in *Fishing for Words* (pink and blue) only became associated with gender in the first half of the 20th century, as a result of marketing by the textile industry to sell childrens' clothes [57]. Data is lacking on how strong and widespread this association is outside Western culture, but research indicates that it at least is present in some parts of the world, such as China [58] [59] [60] [61].

2.12 Conclusion of the Literature Review

In this chapter, we reviewed the basics of learning a language, the history of the main schools of thought of language education, some important language learning games & platforms and a brief overview of what symbols we might use to represent gender in our project.

This last element is directly reflected in our game, as the Venus and Mars symbols, with the pink and blue colors shown in Figure 2.4 are present in *Fishing for Words*, as seen in the screenshot of the game in Figure 3.1, and the platforms and language-learning techniques helped shape our vision of what a successful educational game for learning gender may look like.

In the next chapter, Implementation, we will present a detailed overview of our solution, including the game and all auxiliary work that went into creating and supporting it.

3

Implementation

Contents

3.1 Approach

Our original problem can be summarized as "how can we make learning gender in Portuguese easier through the use of videogames?" For our solution, we have developed a game called *Fishing for Words* (*À Pesca de Palavras*)[1] in which the player is presented with Portuguese words, which they must classify as either masculine or feminine.

The game went through several stages of design and implementation before reaching its current form and, before describing it in detail, we will briefly review the history of the game's development and the decisions that shaped it.

3.2 Game Development history

Our original proposal for the game was thus: "we will develop two versions of the same game: in each of them, the player will be presented with Portuguese words, which they must classify as masculine or feminine. In the first game, the player must drag each word onto the label with the appropriate article to classify it according to its gender, while in the second, the player must speak each word, accompanied by the appropriate article, into a microphone."

The original plan was to compare these two versions of the game (one where the player had to produce speech, and one where the player simply had to recognize written text). Though some basic tests with voice recognition technology for Portuguese were performed, the idea was abandoned before ever being integrated with the game, as it had several disadvantages: State-of-the-art speech recognition is far from perfect (due to the notorious difficulty of the problem [62]), it may have prevented playing in loud environments [63] and the literature suggests that speech & writing, production & recognition, are all important for learning a language (though learners have different preferences), therefore comparing two of them may not yield interesting results (they are complementary, not exclusionary). We also considered varying the game's output (one version with audio output, one version with text output), but this idea was abandoned for similar reasons.

3.3 Game Description

Fishing for Words mostly takes place on a main screen representing a lake in a rainforest, in the centre of which stands a fisher on their boat. The boat is flanked by a pink barrier on the left and a blue barrier on the right, representing the feminine and masculine genders, respectively (as seen in Figure 3.1). The meaning of these colors and symbols outside of Portuguese culture is touched upon in Section 2.11.

[1] The game can be downloaded here: https://petzi.itch.io/fishingforwords?secret=dzblEYB1vYFq9CvxNsmT3Yd2glQ

In each round, the lake is filled with 5 fish, each with a Portuguese noun written on it. The player must then *solve* each word by passing each fish through either the pink or blue barrier to paint it the right colour (corresponding to the written word's gender) and place it on the top-right corner of the screen. The game will flash green or red after each fish, indicating whether the player's answer was correct or not, respectively.

Double-gendered words are also present (such as *dentista* and *cliente*). These are always accepted as correct, regardless of the player's answer, but the game alerts the player to the fact that this was a special, double-gendered word.

The game includes a score system. In each round, the player is presented with 5 aquariums for the 5 fish. Each aquarium has a different score: 5, 10, 15, 20 and 25 points, and they are all presented to the player in a random order, one by one. Once the player is presented with an aquarium, they must solve one of the remaining fish/words in the lake: if they solve it correctly, they will receive the number of points the presented aquarium is worth, otherwise they receive zero points. Therefore, to maximize their score, a smart player will choose an easy word-fish when presented with a high-scoring aquarium and a difficult word-fish when presented with a low-scoring aquarium (to minimize the chance of answering incorrectly). Each game is composed of 3 rounds with 5 fish each, so in each game it is possible to accumulate a maximum of 225 points.

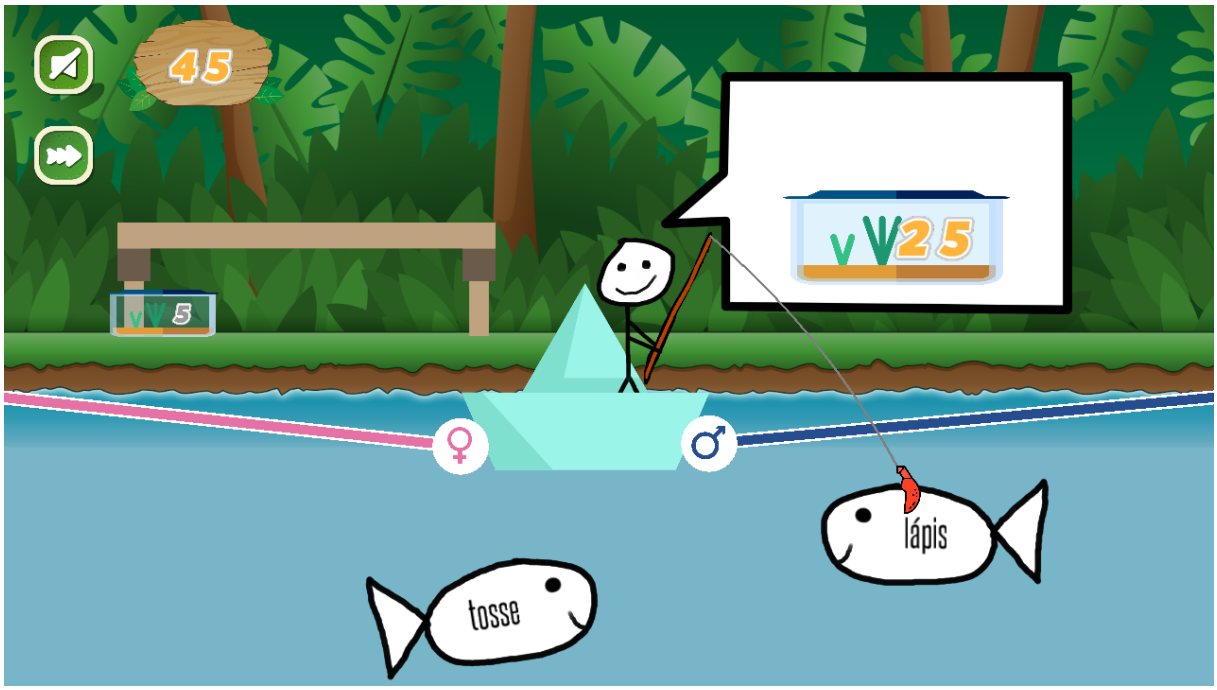

Figure 3.1: Screenshot of the game. The player is grabbing the fish with the word "lápis" and is about to pass it through either the pink or the blue barrier to paint it the correct colour (to later place it on the speech bubble).

3.3.1 Tutorial

Fishing for Words includes some basic instructions and tutorial to help make it easier to understand when playing for the first time. The instructions are a static, wordless illustration that appears when the player presses the help button ? in the main menu (Figure 3.2).

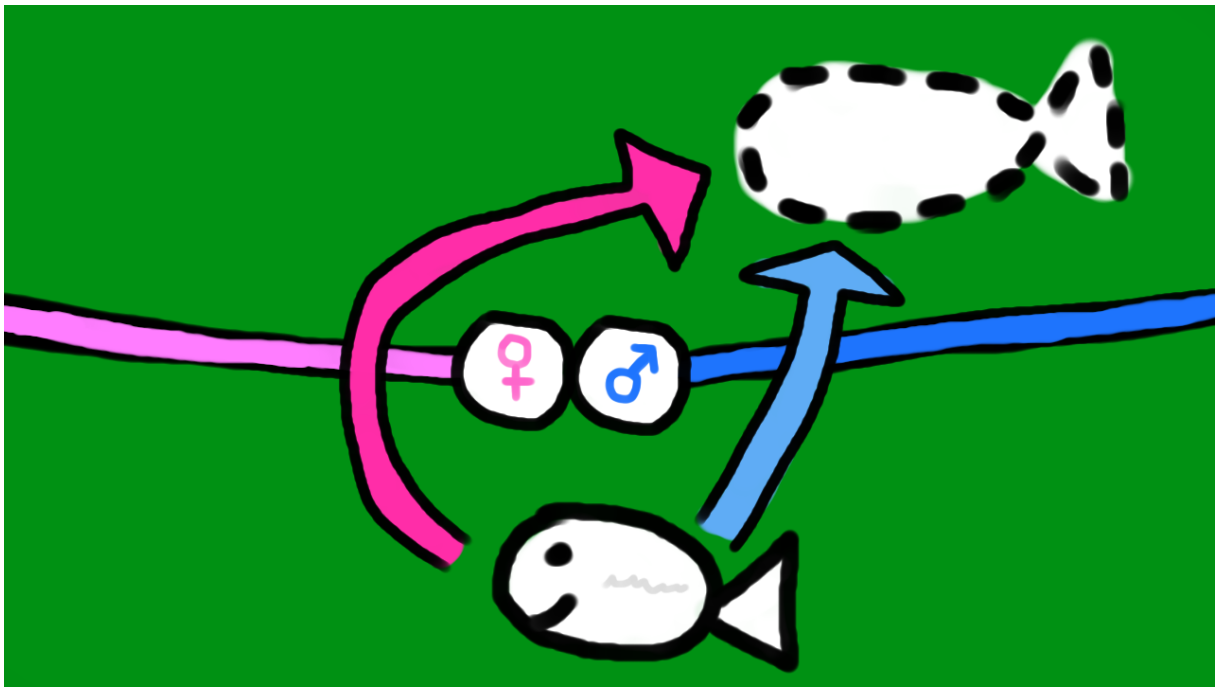

Figure 3.2: Static instructions that appear when the player presses the help button ? .

The tutorial, on the other hand, is a set of small modifications that appear during the player's first two games, which are all present during the very first round and get removed one by one, such that by the 6th round (the final round of the second game), they have all been removed and the tutorial is over. The modifications are, in the order in which they disappear: having a single fish (instead of the usual 5), having a darkened game area, so only the fish and the zone in which the fish must be placed are clearly visible, having a large yellow around pointing at the aforementioned fish-placement zone, having one large arrow over each coloured line (pink and blue) to encourage the player to pass the fish through them and, finally, having the gender lines and corresponding symbols quiver and be much larger than usual (Figure 3.3).

3.3.2 Boats

As a mechanism to reward the player, the game includes 34 different boats that the player can choose from after accumulating enough points. The boats are simply a visual feature, appearing during the game without changing any aspect of the gameplay.

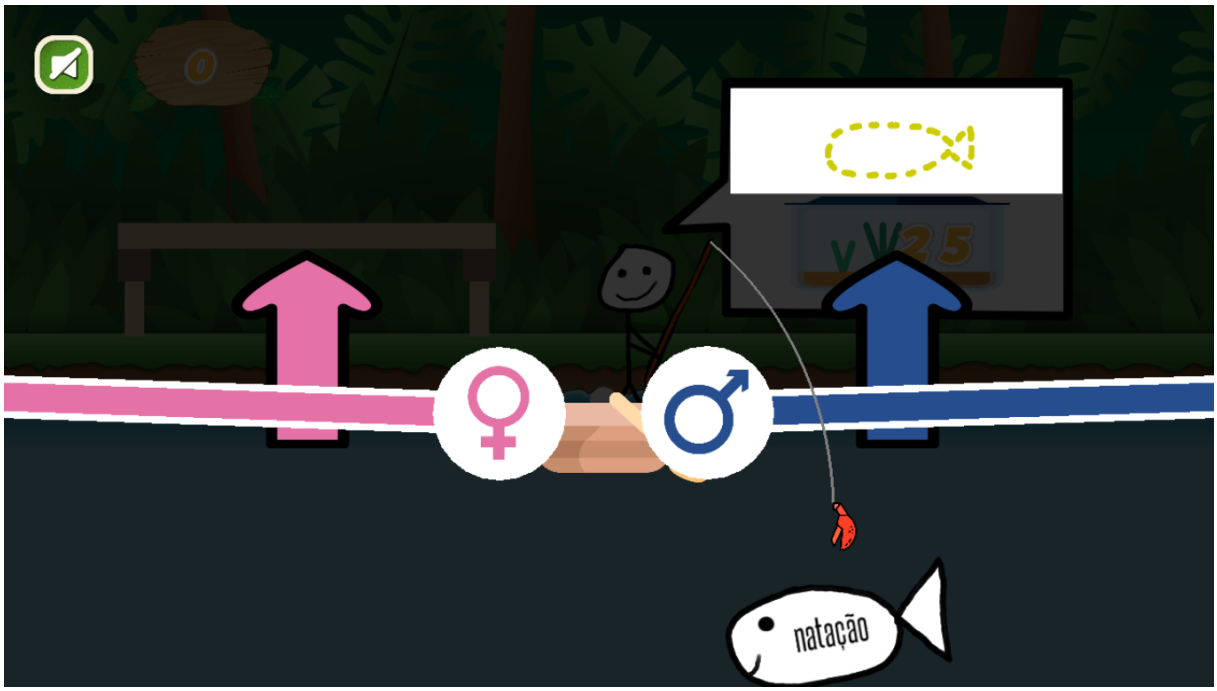

Figure 3.3: The very first round of the game has all of the tutorial's special effects: a single fish, darkened screen and large, animated arrows and symbols.

At the beginning of the game, only one boat is available and all others are locked away. After each session, a bar is shown which fills up with the points the player obtained during that session. Once the player accumulates enough points and the bar is full, a new boat is unlocked and the player is able to select it from the boat menu (Figure 3.4). The number of points required increases with each boat unlocked, so each boat requires a few more points than the last. The order in which the boats are unlocked is randomized. In the main menu, the current bar is always visible, along with the number of points required to unlock the next boat. Note that points accumulate over several sessions, so low-scoring players will still unlock boats over time, though at a slower rate than high-scoring players.

The required points increase linearly with each boat and were calculated by fixing the first requirement at 75 and using estimates about much the participants should play over the two weeks: we expected 3 minutes per session with 13.6 sessions per day over 9 days and an average score of 112.5 per session. In the end, each boat requires about 10 more points to unlock than the last, with the final boat taking 392 points and a total of 7692 points needed to unlock all boats combined.

3.4 Word selection systems

One critical aspect of the game is what words from the list are shown to the player at a given time (the list itself and its creation are described later, in Section 3.5). The words must be varied and provide a

Figure 3.4: Screenshot of the boat menu. From here, the player can select which boat the fisher rides while playing the game. Note the name of the current boat accompanied by a short "flavour text".

challenge of appropriate difficulty, otherwise the player will become either bored or frustrated and will abandon game (as explained in Section 2.8), especially since, in *Fishing for Words*, the player has no control whatsoever over this process, besides playing the game.

The basic idea of these systems was touched upon in Section 2.7. The basic implication of this idea is that, as you might expect, words the student has more difficulty with should be practiced more often. With this knowledge in mind, we implemented two systems for word selection in the game, one based on the classic Leitner System and one designed by us (the Tag System), which are described in the next sections. Note that we never mix these two systems in *Fishing for Words*, they are kept completely separate, in two separate versions of the game.

3.4.1 Leitner System (Flashcards)

One of the systems used in the game to select the next words to present to the player is known as the Leitner System, named after Sebastian Leitner, who published it in 1972. It was devised before personal computers became common, so it was originally accomplished using physical boxes and cards (*flashcards*), and it was created to help learners memorize any kind of knowledge (not just language) [64].

Our version of the Leitner System is very similar to the original (though it uses a computer in place of physical components). We have 443 "cards" (in our case, the Portuguese words that the player is

meant to learn, represented in-game by fish) and 5 boxes numbered 1, 2, 3, 4 and 5. Initially, every word is in box 1. Box 1 will be reviewed every session, box 2 will be reviewed every 2 sessions, box 3 will be reviewed every 3 sessions and so on (as Table 3.1 illustrates). In a given session, the player processes each word (from all the boxes due to be reviewed during that session) by answering the word's grammatical gender. If the player answers correctly, the word gets advanced to the next box (if it was in box 1, it goes into box 2 and if it was in box 2, it goes into box 3, *et cetera*). If the player answers incorrectly, the word gets placed in box 1, regardless of its previous position. In *Fishing for Words*, this entire process is done behind the scenes, so the player only sees the words they have to answer and whether the gender they answered was correct.

Because boxes with lower numbers are repeated at higher frequencies, the player will see words they have answered wrongly more often than those they have answered correctly. Figure 3.5 shows an illustration of the Leitner System flashcard progression.

Note that, in our implementation, what we call a "session" is not a temporal session, like in the usual sense. In the classic Leitner System, the learner would perform a single session once a day while, in *Fishing for Words*, a single Leitner session may be broken up into many game sessions, because the player is not forced to finish each session in one sitting. Again, our Leitner sessions are not seen by the player, but are an internal mechanism of the game and regularly are ended and started in the middle of play sessions.

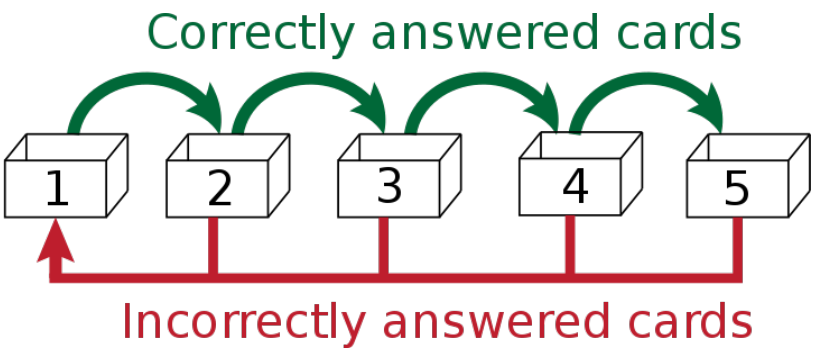

Figure 3.5: Illustration of the Leitner System. Flashcards answered correctly are advanced, while incorrectly answered ones are placed back in box 1. Image from the Wikimedia Commons[2]

Session Number	0	1	2	3	4	5	6	7	8	9	10	11
Boxes to be reviewed	1	1	1,2	1,3	1,2,4	1,5	1,2,3	1	1,2,4	1,3	1,2,5	1

Table 3.1: Boxes to be reviewed in each session in the Leitner System. Our implementation includes a session 0, in which only box 1 is reviewed. This way, the second session (1) will only include the words the player failed in the first session (0). Note that, in *Fishing for Words*, game sessions are completely separate from the Leitner sessions; a Leitner session is usually performed over many game sessions.

[2] en.wikipedia.org/wiki/File:Leitner_system_alternative.svg

3.4.2 Tag System

We call the other system for selecting the words to be presented to the player the *Tag System*. It is a modified version of a dynamic game difficulty adjustment system developed by João Catarino [1]. As discussed in Section 2.2.2, the ending of Portuguese words hints at what their gender might be (the most common of these being *-a* for feminine nouns and *-o* for masculine nouns). Table 3.2 shows the word endings used for the game and the gender they hint at, based on research, expert input by Professor Nélia Alexandre and patterns observed in our word list, as no comprehensive study of these endings was found [65].

The idea of this system is that players only need to learn these word-ending patterns and their exceptions, rather than every individual word. This is accomplished by adding a *tag* (a piece of extra information) to each word, to indicate which pattern it falls into. When a word is presented to the player and they answer it, their performance for that word's tag is recorded (1 for correct, 0 for incorrect). Note that the performance is recorded for the tags, not for individual words! When the game needs to select words to present to the player, it will use the latest 10 performance values recorded for a given tag to estimate what the player's performance will be for words with that tag and then use that estimate to present a challenge composed of words with an appropriate level of difficulty.

3.4.2.A Difficulty

The difficulty with the Tag System of *Fishing for Words* is not constant, but a sine function modified to have a range between 0 and 0.7 and to have a wider wave, as seen in Equation (3.1) and Figure 3.6. When the function's output is 0.7, the player is expected to correctly answer 70% of the words, but when the output is 0, they are expected to fail almost all of them. In practice, the player will usually answer correctly at least 50% of the words because they may answer randomly (the exception to this is when the player actively believes the wrong gender to be correct). The function's input is the game number, while each game is divided into 3 rounds. So the input is actually increased in third, with for the very first round $x = 0$, for the second round $x = 1/3$, etc.

$$\frac{\sin(1.5x - \frac{\pi}{2}) + 1}{2} \cdot 0.7 \tag{3.1}$$

where:

$x =$ game number (always a multiple of $1/3$ because each game is comprised of 3 rounds)

When presenting words to the player (from the list described later in Section 3.5), the game creates a *challenge* composed of 5 words where the player's estimated performance for those words is as close as possible to the value indicated by the difficulty function. Recall that a word's estimated performance is

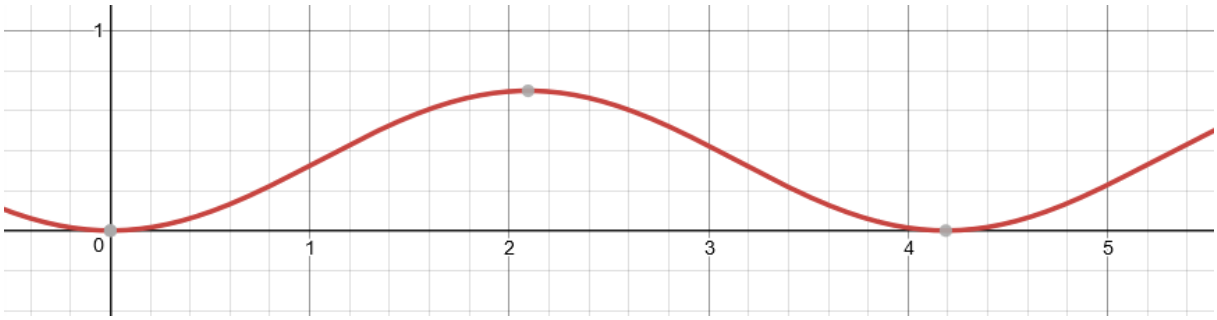

Figure 3.6: Estimated performance of the player for each game (percentage of words we expect them to correctly answer).

the same as the estimated performance of that word's tag. A tag's estimated performance is calculated using a list containing (at most) the last 10 recorded performances recorded for that tag. The **desired** performance is subtracted from each **obtained** performance from the list and the result is squared: the average of these operations is the estimated performance for that tag. If no performance values have yet been recorded ($N = 0$), then the tag's performance value is assumed to be 0. This process is illustrated in Equation (3.2)

$$EstimatedPerformance(tag) = \begin{cases} 0 & N = 0 \\ \frac{\sum_{i=1}^{N}(x_i - d)^2}{N} & N \neq 0 \end{cases} \tag{3.2}$$

where:

x_i = obtained performance values
d = desired performance value
N = number of performance values, $N \in \{0, 1, 2, 3, ..., 10\}$

NOTE: To make it clear, the expected performance of a challenge (5 fish) is an average of the expected performance of its 5 fish, calculated according to Equation (3.2).

3.4.2.B Word selection

The Tag System generates challenges by first generating 500 of them randomly using words from the word list (Section 3.5). Then, the game calculates a desired performance P using the difficulty function previously described (Equation (3.1) and Figure 3.6) with the game number as input. The game then calculates the difference between P and the estimated performance of each of the 500 random challenges using Equation (3.2). The challenge (out of the 500) with the lowest difference will be selected to be presented to the player, in other words, the challenge which as the estimated performance closest to the desired performance P.

3.4.2.C Difficulty refinement

The Tag System's difficulty mechanism was balanced by playing around a dozen playthroughs of *Fishing for Words* with varied parameters, such as challenge size (5 fish or 15 fish) and different versions of the estimated performance function. The most significant departure from Catarino's model was the removal of the *variety* component [1], which yielded better results than any variation of it that we tested. Testing with the parameters ultimately included in the game showed that words of all tags were represented to some degree within about half an hour of playing and tags which the player tended to answer wrongly were represented more frequently than others.

3.4.2.D Tags

In our game, each word has exactly one tag. This tag was chosen depending on two factors: the word's gender and its ending (based on the endings shown in Table 3.2). These tags are simply a pair of elements where the first is "F", "M" or "D" (to indicate that the word's gender is feminine, masculine or double-gendered, respectively) or "S" (always and only used when the ending does not give a clue about the word's gender). The second element of a tag indicates the word's ending and, if multiple endings are valid, the longest is chosen. Therefore, if a word ends in *-ão*, *-e* or does not correspond to any ending in the table, it will begin with S, otherwise, it will begin with the letter corresponding to its true gender.

In Table 3.3, we can observe some examples of words and their tags. The word "elefante" received the tag **Mante** because its gender is masculine and its ending (from Table 3.2) is *-ante*. "Ajuda", on the other hand, received the tag **Fa** because its gender is feminine and its ending is *-a*. The word "amante" received the tag **Dante**, because it is double-gendered and has the ending *-ante*. The word "avião" is one of the special cases: even though it is masculine, it received the tag **São** because its ending, *-ão*, does not hint at any particular ending (words with this kind of ending receive the special initial letter "S", as described previously).

Note that words such as "mapa", in which the ending hints at a gender **different** from the real one, are exceptions that must be memorized by the students and, as such, are of particular interest to students, teachers and our research.

3.5 Word List

Because our game's purpose is to teach the gender of Portuguese words, it was necessary to obtain a list of words to be taught and classify them according to their gender (and assign tags to them, as discussed in Section 3.4.2.D). The words chosen were taken from four lexicons students of Portuguese should know at different levels of proficiency (A1, A2, B1 and B2, from lower to higher) created by Prof.

Feminine	Masculine	Double	Either (no hint)
-a	-o	-ante	-ão
-dade	-r	-ente	-e
-agem	-t	-ista	(endings not in this table)
-esa	-l		
-essa	-z		
-ina	-s		
-inha	-i		
-isa	-u		
-ora	-ema		
-triz			
-ã			
-ana			
-oa			
-ona			
-ção			

Table 3.2: Noun endings that hint at the word's gender. "Double" refers to non-inflected words that can be used with either gender (usually occupations or professions) and "Either" refers to endings that are not found more frequently in any particular gender.

Word	Word Gender	Ending	Gender ending hints at	Tag
plano	masculine	-o	masculine	Mo
elefante	masculine	-ante	double	Mante
mapa	masculine	-a	feminine	Ma
ajuda	feminine	-a	feminine	Fa
situação	feminine	-ção	feminine	Fção
belga	double	-a	feminine	Da
amante	double	-ante	double	Dante
lã	feminine	(none)	(no hint)	S_
avião	masculine	-ão	(no hint)	São

Table 3.3: Examples of word tags. Notice that the word's gender determines the first element of the tag **unless** its ending is a **(no hint)** ending. See Section 3.4.2.D for explanations on some of these examples.

Jorge Pinto for the *Perfil de PLE* project (a partnership between *Instituto da Cultura e Língua Portuguesa* and *Centro de Exames de Português Língua Estrangeira*).

The *Perfil de PLE* lexicons are cumulative, therefore the B1 lexicon included all the words from the A2 lexicon, which in turn included all words from the A1 lexicon (and naturally, the B2 lexicon had the words of all three lexica combined). We removed these duplicate words, so they only appear in the word list where they were first introduced, making the lists no longer cumulative (so, for example, the A2 list no longer contained any words found in the A1 list). This was done to avoid saturating the lists with words the students were already comfortable with.

NOTE: The criteria for choosing words changed over time and, though initially all four lists were processed, it was eventually decided that the target audience for the game (and therefore, the participants in the experiment) would be A2-level students. The A2 level was chosen because it was the most convenient in terms of logistics and because it possessed a reasonably large number of students. Due to this decision, the A2 list is the only one used in the game and was the only one to be refined with the criteria described here, while the remaining three lists were only partially processed (with outdated

criteria). Henceforth, we will refer only to the A2 list, though some of these changes may have been applied to the unused A1, B1 and B2 lists.

The next step to process the word list was to remove undesired words. The two main classes of gendered words in the Portuguese language are nouns and adjectives, but we decided that the game would only include the former because almost every adjective can be used with nouns of either gender, so our game would not be as suited for them (a more interesting exercise for adjectives could be centred around learning how to correctly inflect them for gender, for example). Thus, the most obvious candidates for removal were adjectives and genderless words, such as verbs and adverbs, but the task was not as simple as it might seem, because all three of these classes can be nominalized (turned into nouns), thus becoming gendered. For example, the verb *comer* "to eat" can be nominalized to mean "food" (the exact word, "comer", without any inflection, such as in "O comer está pronto").

Various criteria were used to solve these ambiguities over whether or not a given word should be excluded from the list, some more subjective than others.

1. Nominalized verbs in the infinitive form were always excluded (including the example given previously, *comer*). This is because they have a very distinct ending (*-ar*, *-er*, *-ir* and *-por*) which makes them easy to identify and asking students the gender of a verb is likely to confuse them. They are also always masculine, so the rule is fairly easy to acquire.

2. Multiple words that appeared in the lexicon together as single, common expressions were either removed or isolated, e.g. *agência de turismo* "tourism agency", *agência imobiliária* "estate agency", *cinto de segurança* "safety belt".

3. Where applicable, the feminine forms of words were **added** to the list because, by default, only the masculine form was present, e.g.: *bisavô* "grandfather" was present, so *bisavó* "grandmother" was added.

4. Adjectives were removed unless they were in common use as nouns, taking into consideration how likely students were to be familiar with that usage. E.g.: *tinto*, most commonly used as "red" in the expression "red wine" was removed, since in that expression it is used as an adjective (though speakers may omit the word *vinho*. *Detergente* "detergent" was kept, because its use as an adjective is comparatively rare.

5. Double-gendered words (that is, noninflected words that can be used with either gender) were **kept**. Initially, these were slated for removal, but it was later decided (at the suggestion of Prof. Nélia) that they should be integrated in the game, even if the player was incapable of answering them incorrectly (since both options are always correct). To compensate the fact that the player cannot possibly fail when answering these words, the game alerts the player to their double-gender status.

3.5.1 Processing the Word List

The first part of processing the word list was to automatically classify words by gender or exclude them if they could not be used as nouns. For this purpose, a small *web scraping* program was created with Python to search each word in the Priberam online dictionary and check whether it was classified as a feminine noun, masculine noun or double-gendered noun (naturally, we first confirmed that this was permitted by the site's *robots.txt* file). Words that had no noun classification were automatically rejected and words with an unambiguous gender were automatically accepted, while the rest were set aside to be manually checked later and were annotated either with their gender or as having conflicts. (See Section 3.5.2 for a more detailed description of this automation step.)

Once this automated step was complete, words were manually processed by a native speaker according to the criteria presented in the previous section (3.5), excluding inappropriate words missed by the automated step and ensuring that each word was annotated with the correct gender (masculine, feminine or double-gendered).

The final processing step was to annotate the words with tags, necessary for the tag system described in Section 3.4.2. Once the word endings were decided, this was a mostly automated process in which a word's ending and gender were used to attribute the correct tag. (Again, see the last paragraph of Section 3.5.2 for more details.)

3.5.2 Processing automation

As mentioned in the previous section, the creation of the word list was partially automated using two Python programs: the first one to search the Priberam online dictionary for each word's class & gender and the second to tag words according to their ending.

The first program used web scraping: for each word, it retrieves the HTML code for its corresponding web page in the Priberam online dictionary[3] and removes the portions that are not related to the word (using markers specific to the Priberam website). Once those unwanted portions have been removed, the program searches for categories to which that word belongs, such as *substantivo masculino*, *substantivo feminino*, *dois géneros* or *verbo*. Most words belong to several categories due to having multiple meanings, some of which are rare, only applicable in certain regions or used only in niche contexts. Words without at least one category indicating that they were a noun were automatically discarded, while words whose noun and gender status was unequivocal (where only noun categories with a particular gender were found) were automatically accepted and annotated with the appropriate gender (masculine, feminine or double-gendered). The remaining words were set aside as "ambiguous", to later be processed manually by a native speaker (myself) to ensure that they should be considered nouns for the

[3] For example, the URL for the word *detergente* is https://dicionario.priberam.org/detergente

purpose of this list and that the gender was annotated correctly.

The second program comes into play after the words have been manually selected and annotated with their gender. Its function is simply to tag them, as described in the Section 3.4.2.D. If the program looks at each word's ending and finds which ending from Table 3.2 applies to it (if any), solving ties by choosing the one with the largest number of characters. If the ending is from the "Either (no hint)" column, the first character of the tag will be "S". Otherwise, it will be "M", "F" or "D", depending on whether the noun's true gender is masculine, feminine or both (double-gendered).

3.6 Data Collection

Fishing for Words features a system to automatically collect data about how the game is being played. A log file is simply a text file where certain game-events are recorded (along with when they happened) and a log file is created for each new game played or each time the game is opened (whichever comes first). A sample log file is included in Appendix F. Examples of the recorded events are:

- The game was opened
- A menu button was pressed
- The game was saved or loaded (and what the contents of the save file were)
- A fish was answered, whether the answer was correct and how many points it was worth

As long as the player's device has an internet connection, the game will periodically transmit the contents of unsent log files to a server that simply receives the log files and stores them so that the experimenter can later retrieve and analyse them (see Section 3.6.1 for technical details). The game also features a small indicator which shows how many files are still unsent, so the player can leave the game on if necessary.

In order to be able to match the log files to the player who generated them, the game prompts the player to introduce their email address before being able to play. The game does not need an internet connection to login: since the email addresses of the students who would play was known, the MD5 hash value[4] of those addresses were pre-calculated and added to a list in the game (so no actual email addresses are stored, only hash values, which helps protect the participants' privacy). When a player inputs their email address, the game calculates its MD5 hash value and checks whether it is present in the list, only allowing the player to proceed if it is. The hash value is then stored in the player's save file and added to every log file to help identify it.

[4]The MD5 hash function is widely used in computation. It converts any piece of data into a fixed-size "hash value", which by itself cannot be used to obtain the original piece of data. Thus, given an email address and a hash value, it is easy to verify whether the hash value was calculated from the email address; but the email address cannot be obtained solely from the hash value.

The login system just described is not meant as security, but rather to avoid having to manually match log files to player profiles and to prevent players making mistakes when identifying themselves, both which would make data collection more difficult.

3.6.1 Technical details

The server created to collect data from the game was developed in Python 3 and kept running on a virtual machine hosted by *Instituto Superior Técnico*. Once the server program is executed (and made to run in the background using the *nohup* command), it will listen for HTTP Post messages on port 12745 (chosen arbitrarily, simply because it is not commonly used). *Fishing for Words* will send a log file as the content of these HTTP Post messages with lines separated by the ≫ character, the first line representing the file's name and the rest representing the log file's content. The server will duly save this data into a file and immediately send a response with the text string "LogReceived". Upon receiving this response, the game marks the log file as having been successfully sent and will not attempt to send it again. As long as it is running, game will attempt to send all unmarked log files every 30 seconds.

4

Experimental Procedure

Contents

4.1 Experimental Procedure Overview

This chapter is divided into two parts: the first part describes the preliminary usability tests and the experiment proper, while the second part describes the documents and forms used.

4.2 Usability Tests

Informal usability tests to assess how easily players could understand the game were performed throughout the game's development cycle with native Portuguese speakers, but the game was also tested with 5 foreign students of Portuguese at *Faculdade de Letras da Universidade de Lisboa* on the 21st and 22nd of January, in which students were asked to try the game without a tutorial, only being told that it was videogame to help learn Portuguese. These tests revealed that some players understood the game after just a few seconds, while others would take longer and tended to ask for help. These user tests led to the implementation of a basic tutorial in the game, described in Section 3.3.1.

4.3 Experiment

The experiment was carried out at 9 classes of A2-level students of the Portuguese language being taught at *Faculdade de Letras da Universidade de Lisboa*, with a total of 80 students agreeing to participate in the research.

4.3.1 Pre-test Visit

The first step of the experiment proper involved visiting the students' classes to explain the research being performed and to ask for their participation, which included asking them to fill out three documents (described later in this chapter): the *consent form* (4.4.4), the *language profile* (4.4.5) and the *pre-test (4.4.1)*.

4.3.2 Division into groups

After the pre-test visit, we examined the number and characteristics of our participants in order to divide them into three experimental groups: one control group (which would not receive the game), one group to receive a version of the game using the Leitner System (see Section 3.4.1) and a third group to receive a version of the game using the Tag System (see Section 3.4.2). Once we had decided the members of these groups, the students who were part of the latter two received the game by email (on the 13th of April) and were asked to play for 10 days (until the 23rd of April).

In this case, all 34 students who could be identified and claimed to regularly use Android or Windows were included in the groups due to receive the game. Preference was given to the Android version, so students with only Android or both operating systems only received the game for Android, while those who only had Windows received the game for Windows. Let us call these groups A (those with Android) and W (those with Windows and not Android). Both group A and W were subdivided: half of each received a version of the game with the Leitner System and the other half received a version with the Tag System.

4.3.3 Post-test Visit

The 23rd of April was the day of the second visit to the classrooms, where the students were asked to answer the *post-test* and fill out the *questionnaire*. Furthermore, one of the students, who stood out for having played the game much longer than anyone else, was informally interviewed.

NOTE: The students were on holiday from the 6th to the 15th of April.

4.4 Documents

In this section, we will look at the documents used in the experiment.

4.4.1 Pre-test

The pre-test, included in Appendix A, is a written test containing 3 Portuguese language exercises related to gender, targeted at students with A2-level proficiency in the language. The purpose of this test was to assess the students' ability to use gender before the experiment took place.

The first exercise consists of 10 sentences with a blank space each, which must be filled with an article of the appropriate gender.

The second exercise consists of two columns, one with 4 feminine articles *a* and 6 masculine articles *o*, and the other with 10 words which must be connected to an appropriate article.

In the third exercise, the student must identify and correct gender-related grammatical errors in 10 sentences (some sentences have more than one to find).

4.4.2 Post-test

The post-test, included in Appendix B, is identical to the pre-test, but with a fourth exercise added, which consists in writing the appropriate definite article (*a* or *o*) of 10 words.

4.4.3 Questionnaire

The questionnaire, included in Appendix C, was presented to the participants after the playing period had ended in order to better understand their needs as a target audience. It is composed of various sections, which are targeted at different subgroups of participants, each smaller than and contained in the last: the first section is meant to be answered by all participants, the second by those who received the game, the third by those who installed it and the final two by those who played it and who did not play it, respectively.

4.4.4 Consent Form

The purpose of the consent form, included in Appendix D, was to explain to the students of the research being formed, so they could make an informed decision on whether or not they wished to participate. By consenting that we make use of the necessary data, they were then considered participants in the experiment (information they provided in these documents, their email address and any data collected from their experience playing the game). Participants were also given the option to have their name listed in this thesis, in recognition of their contribution (as can be seen in the Participants section of the Acknowledgements, in page *v*).

4.4.5 Linguistic Profile

The linguistic profile document, was filled out by the participants during the pre-test visit to obtain information about their linguistic background: what languages they speak with what proficiency, their native language(s) and their experience with Portuguese specifically. This form also asked which operating systems the student usually used.

4.4.6 Video Tutorial

The video tutorial[1] was sent to the students by email, along with the game. It is a simple 5m27s video explaining how to play the game and how to ensure the gameplay data it collects is transmitted to the server (data collection is explained in Section 3.6).

[1] https://youtu.be/LoJFpQ5vdmw

5

Results

Contents

5.1 Overall Results

During the two weeks the students were given to play the game, the logs received indicated that only a total of 3 students had played: two for less than 15 minutes and one for around 2 hours and 30 minutes (taking about 2 hours to unlock all the boats). While this sample of gameplay data is not large enough to perform statistical analysis about how playing the game might impact the students' knowledge (and possibly comparing the Leitner System with the Tag System), the students' answers to the questionnaire provide us with valuable information to speculate about the reason for this low amount of participation.

Thus, the results of this thesis are divided into two main sections: the analysis of the two written tests performed by the students and the qualitative evaluation of the game and methodology based on the outcome of the experiment and the students' feedback. A third, smaller section covers the experience of the student who played the game the most.

5.2 Written Test Results

The students performed two written tests (the *pre-test* and the *post-test*) with a two week interval between them, included in Appendices A & B and described in Sections 4.4.1 & 4.4.2, respectively. Our sample size for these written tests was 50 students.

The tests were not used in their entirety: exercise 4 was ignored, because it was only included in the post-test, making comparison impossible. Exercise 3 was also ignored, because the students had some unforeseen problems answering it: it consisted in finding mistakes in sentences, but some students did not realize that each sentence might have more than one mistake to find. Others did not realize that the test had a second page and therefore left the question partially or completely unanswered. Finally, some tests had to be discarded due to students missing one of the classes (and therefore answering only one of the tests) and things such as the students forgetting to identify their test, not properly filling out the consent form or using alternative names (as Chinese students in the West commonly do).

To study the students' change in performance over this time interval, we counted how many words each student answered correctly, yielding a grade from 0 to 10 for each exercise. In exercise 1, only the gender was taken into account when grading the tests, so a masculine word would be considered correct even if the student failed to agree in number, (improperly) used an indefinite article or (improperly) used contractions, as long as the word they used was masculine. For example, *O Pedro partiu do nariz* was considered correct, even though *do* was used, instead of *o*, resulting in an ungrammatical sentence. Genderless words were considered incorrect (e.g.: *em*, *de*).

In exercise 2, if a single item in each column was left unmatched, the pair was automatically matched (it was assumed that the student simply forgot the last pair), while the case of more than one unmatched pair did not receive this treatment, with both words being considered incorrect. If the student decided to

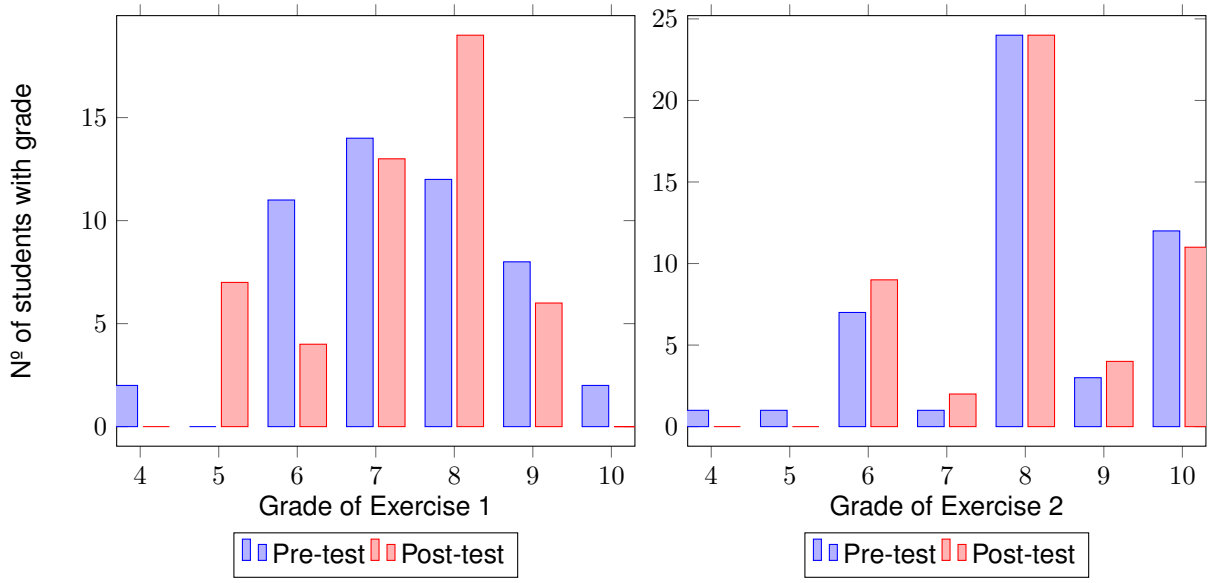

Figure 5.1: Distribution of grades in exercises 1 and 2 of the pre-test and post-test. The X axis shows the grade (number of words the student answered correctly) and the Y axis shows how many students achieved that grade.

replace or modify any of the articles on the left column, this was allowed, as long as the gender remained correct.

The Shapiro-Wilk test revealed that the grades did not follow a normal distribution and a Wilcoxon signed-rank test showed that there was no statistically significant change between the pre-test grades and the post-test grades, yielding $Z = -0.414^b, p = 0.679$ for exercise 1 and $Z = -0.625^c, p = 0.532$ for exercise 2.

Note in Figure 5.1, exercise 2 (graph on the right), that grades 7 and 9 are very underrepresented. This is likely due to this exercise being of the "connect items" type: students have a high likelihood of "switching" two connections, leading to two wrong answers at once.

5.3 Opinion Questionnaire

We have identified several factors that may have led to fewer students playing the game, some of which are supported by the students' answers in the questionnaire (included in Appendix C).

NOTE: The graphs in this section indicating whether the participant agreed or disagreed with a certain statement are labelled 1 to 5 on the X axis to save space in this document. In the questionnaire, instead of numbers, students were given five possible text-based answers, as shown in Table 5.1

First, there are some aspects of the game itself which could be improved:

Strongly Disagree	1
Disagree	2
Neither agree nor disagree	3
Agree	4
Strongly Agree	5

Table 5.1: The possible answers to "Agree or Disagree" statements were shown in text, not on a 1 to 5 scale. In this document, they are shown on a 1 to 5 scale for the sake of readability.

5.3.1 Platform Support

The game only works on the Android and Windows operating systems and only 35 of our 80 participants used at least one of the two. Thus, supporting a wider range of devices (in particular, iOS, which 40 out of the 80 students reported using) would likely lead to greater acceptance. Lack of iOS support was a common complaint.

5.3.2 Installation

In the case of Android, the game was distributed as an APK file which had to be installed. Though the process is usually a simple matter of opening the APK file, users are often more familiar and may be more comfortable with using an app distribution service, such as the Play Store, or visiting a website through a browser. Out of 17 students that said they had received the game, 6 did not try to install it and 3 were not able to due to technical problems. Figure 5.2 shows that most participants agreed with the statement "*The instructions by email on how to install the game were clear*" and, indeed, none of them indicated lacking instructions as a reason to not install (though some of the "technical issues" they experienced could be due to lack of familiarity with this method of installation).

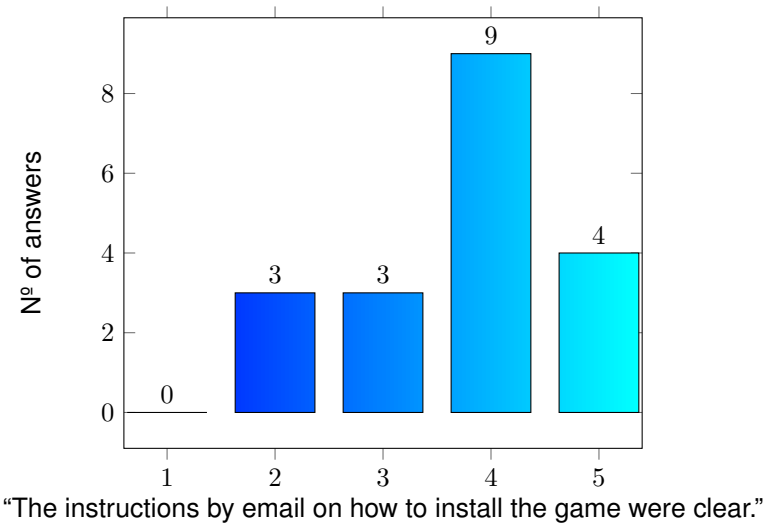

Figure 5.2: Students that selected each level of agreement from Strongly Disagree (1) to Strongly Agree (5)

5.3.3 Video Tutorial

The game's tutorial is rather basic and not all players immediately understand the game. As a time-effective way of mitigating this issue, a video tutorial was sent to the participants, which explained how to play, but many students did not watch the video. Figure 5.3 shows that players have a slight tendency to find the game and tutorial easy to understand (rather than confusing), but there is clearly room for improvement, with one comment reading:

"*It's difficult to understand what should we do in this game. Beter to make some demo or write rules. Also I couldn't understant how to finish the game and close this app. There is no any buttom for this.*"

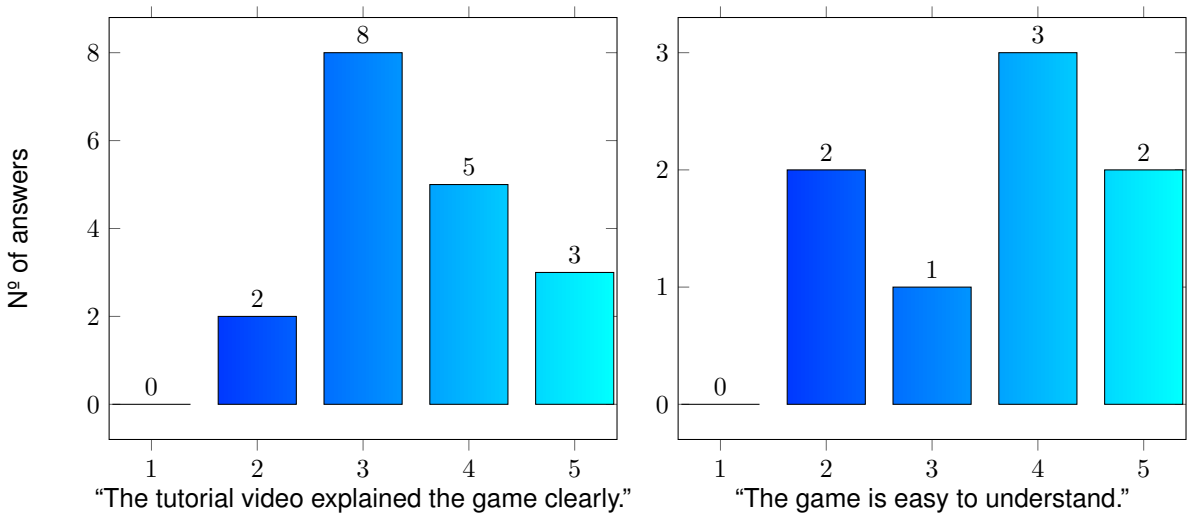

Figure 5.3: Students that selected each level of agreement from Strongly Disagree (1) to Strongly Agree (5)

5.3.4 Game tone

The game may seem too childish for some students due to its cartoony graphics, which leads to them losing interest. This may be a difficult problem to avoid because language learners, as a target audience, cover a wide range of demographics and tastes, but it may be alleviated by adding diversity to the game, so players have more options on which parts of the game to explore and experience and also by carefully tuning the way it is presented ("marketed," if you will) to avoid alienating too many potential players. Figure 5.4 shows mixed reactions to the statement "*The game looks like it's for children*" as well as "*You like playing smartphone games*" showing that a surprisingly high number of students simply are not interested in games. Two of them wrote:

"*I like apps like Duolingo because they are concrete. I don't like learning games.*"

"*I do not like games.*"

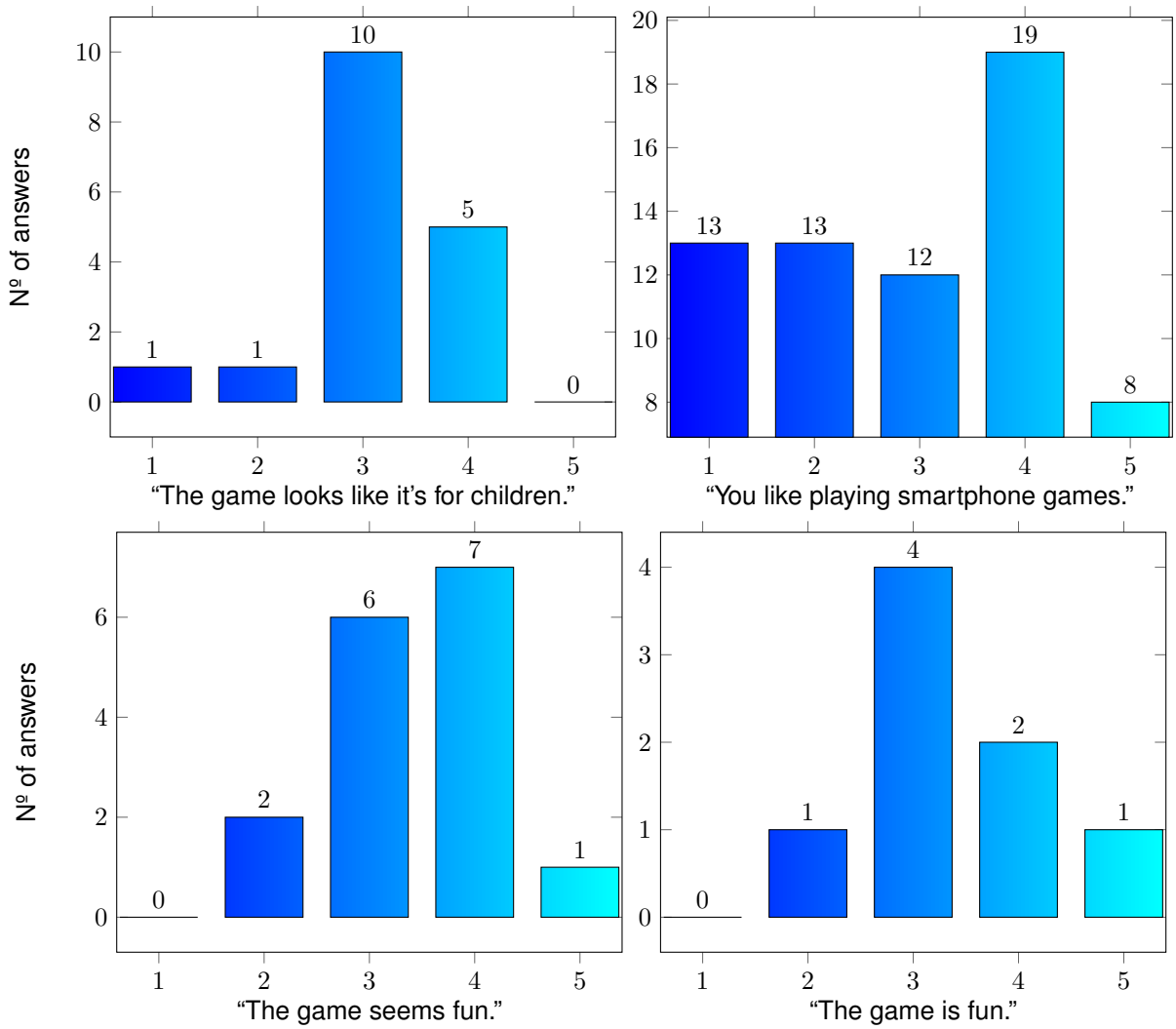

Figure 5.4: Students that selected each level of agreement from Strongly Disagree (1) to Strongly Agree (5). Note that "*The game is fun*" was only asked to participants who claimed to have played the game, while "*The game seems fun*" was asked to all participants who claimed to have received it by email.

Other factors in this list are not related to the game itself, but rather the experimental procedure and conditions:

5.3.5 Time-frame

Because the time-frame during which the students were asked to play coincided with their Easter holiday, they may have had less incentive to play, whereas a game to study for an upcoming exam might have been more alluring to them. Most participants felt that the time-frame given to play was not enough (Figure 5.5). In the open-ended question, one student replied that "*It would be nice to have longer time to try it. It came in the middle of school work, and right before easter. Simply didn't have time!*"

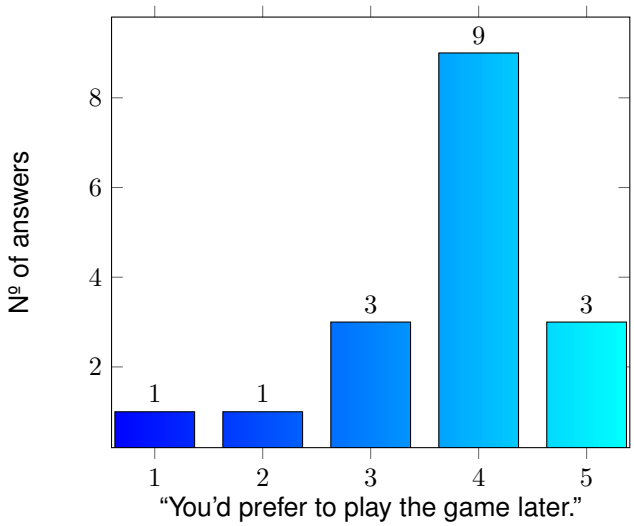

Figure 5.5: Students that selected each level of agreement from Strongly Disagree (1) to Strongly Agree (5)

5.3.6 Perceived importance of grammatical gender

Grammatical gender is not an essential part of communication in Portuguese, as a speaker can typically still be understood when they break gender agreement. This may mean that some students choose to attribute less importance to these grammar rules, especially at the A2 level of proficiency (to which our participants belonged). Furthermore, for most Portuguese words, gender can be guessed correctly knowing only the simplest hint (that an *-o* ending indicates masculine and an *-a* ending indicates feminine) and, in our word list, this was true for 63.80% of words. With this insight, we conclude that a game to teach gender may be more appealing to students at higher proficiency levels, which can already communicate effectively and are more interested in perfecting their language skills (as opposed to simply being able to communicate). Figure 5.6 shows that the vast majority of students believes that learning gender is important at their level of proficiency (A2). However, this may not necessarily imply that they deem it more important that other parts of the language curriculum, or important enough to warrant playing a game that exclusively teaches it. In the open-ended question, a student replied:

"*Sorry, I don't even practice with Duolingo, which is a fully developed 'game'. I spend too much time at my phone anyways.* ***My priority would be to learn words before knowing more genders***", which indicates that they seem memorizing gender less important than learning vocabulary, even though they answered *Neither Agree nor Disagree* in relation to the sentence of Figure 5.6. Another student stated:

"*I hope to have more pronunciation training.*" also implying that another part of the curriculum is more important than gender, though they replied *Strongly Agree* in relation to the sentence.

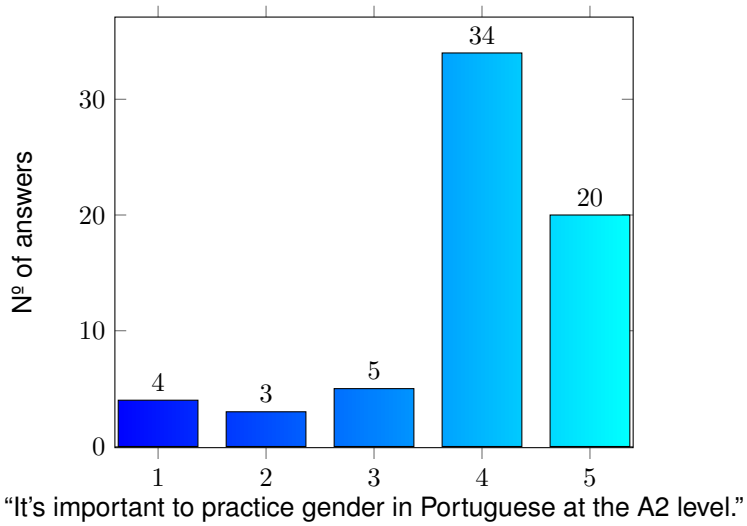

Figure 5.6: Students that selected each level of agreement from Strongly Disagree (1) to Strongly Agree (5)

5.4 Gameplay Data

Though few students played the game, a single participant stood out for having played for around 2 hours and 30 minutes, unlocking all boats (and continuing to play for around 30 minutes after unlocking all boats).

The estimated time per session of 3 minutes turned out to be remarkably accurate, at least for the student that played the most, whose average session was 2m54s long, but the average score per session was 183, rather than our estimate of 112.

Not much noteworthy information was obtained from interviewing the player, but she reported to have enjoyed the game and left some suggestions in the questionnaire: *"I want time limit lever or challenge level also! And I wish there was a place where I could see the fish I saw (genders)."*

6

Conclusion

Contents

6.1 Contributions

Fishing for Words – The main contribution of this thesis is the game itself, as it is prepared to be used as a test-bed for different word-selection models (as we did in this thesis) and can be extended or modified for other purposes, particularly games focused on binary choice (or multiple choice, even, by visually rearranging the game space). It can also be used as-is by students of Portuguese, although its feature set is limited.

Annotated word list for A2 – One of the components of the game that can be used separately is the word list. A baseline list of nouns that A2 students of Portuguese should know annotated with their gender may be useful for other projects of this sort.

Word processing program – Complementing the word list, the code used for accessing the Priberam online dictionary to retrieve words' genders and automatically tag them (according to their ending) might be useful to reuse in other linguistic projects.

Tag System – Another component of the game that could be used separately is the Tag System. Although this research does not draw conclusions about its effectiveness, the simplified version developed for *Fishing for Words* may have advantages for some applications (in relation to the more general approach developed by João Catarino [1]).

Methodology – Our final contribution is the methodology used to test the game with the students. Anyone wishing to test the game (with or without modifications) in a context similar to our research will find it useful to implement (or at least take into consideration) our suggestions and results gathered from this experiment, including the result that no change in performance was observed between the pre-test and the post-test in students who had not played the game.

6.2 Other languages in *Fishing for Words*

6.3 Conclusions – Written Tests

The statistical analysis of the pre-test and post-test results (Section 5.2) shows that students of Portuguese do not gain nor lose performance in a written grammatical gender test after two weeks (one of which they spent on holiday). This information may be useful for future tests of this sort: though a control group is always indispensable for any such research, this data may serve as a baseline for experiments in a similar context, as it gives researchers an idea of what to expect.

One must, of course, consider the many uncontrolled variables present. The sample size was 50 participants of A2-level proficiency, all living in Portugal. Extrapolating from these results should be done with care, especially so if many differences can be identified between these conditions and those for which we are extrapolating.

6.4 Conclusions – Methodology

On evaluating our experiment's methodology, we conclude that some factors had more significance than others in their contribution to the low number of players. The factors we considered are as follows:

Perceived importance of grammatical gender – We found that while students generally consider practicing grammatical gender to be important at the A2 level, some of them commented that it is of less importance to them than other facets of the curriculum (vocabulary and pronunciation).

Linguistically, we know that it is possible to communicate effectively without following the rules of gender, though it is obviously necessary to be able to use the language correctly. Furthermore, the gender of most nouns can be guessed correctly by knowing only the most basic rule.

Though the evidence for low perceived importance of grammatical gender in students of Portuguese could be stronger, it compels us to recommend that future gender-based studies that rely on the participants' interest be preferentially performed on more advanced students (even native-like C2 speakers are known to have trouble with gender).

Platform support – Having the game work on more platforms would certainly increase the number of players: a little more than half our participants could not play simply because they did not use Android nor Windows, so some students who may have been interested in playing the game did not get an opportunity to play it.

A more advanced form of multiplatform support would be to allow each player to play on more than one platform, though this raises the issue of synchronicity (the player's progress must be synchronized across all platforms) and the research problem that players may have different gameplay experiences depending on which platform they choose, which introduces an extra variable to the experiment.

Usability – The game suffers from some usability problems that could be avoided, both in understanding the game itself and during installation. The players who tried the game did not play it for very long (with a single exception), therefore increasing player retention is an important factor.

This was shown by both the preliminary usability tests and the questionnaire answers, particularly by the written feedback. However, the usability tests also indicated that players found the game easy and quick to understand when it was explained to them by the researcher.

One solution for improving usability is to improve the tutorial, which would allow anyone to learn to play the game without any added external help, as long as it was properly tested with users.

An effective solution without the need for further game development would be to have researchers guide the participants through the installation process in the classroom and explain how to play the game, which should eliminate both the need for a more elaborate tutorial and any installation issues that the participants might have otherwise encounter. This, of course, is only viable if the game is being tested in a similar context, where the research interacts directly with the participants (as opposed to, for example, publishing the game on the internet for anyone to play).

6.5 Future Work

The previous section was an evaluation of our methodology, including suggestions for how to improve it. Future research on *Fishing for Words* may implement these changes to achieve a more active participation by the students and, ultimate, discover how useful the game is at fulfilling its purpose. Further research could focus on comparing the word-selection models we implemented (or novel ones), or test whether a game like this is useful to mitigate the effects of linguistic interference.

Although difficult to measure, the social approach taken by the researcher when dealing with the (potential) participants is likely to have a considerable impact in how they perceive the research and the game and, ultimately, whether and how much they participate. This question of marketing was not included in the results, as we have no data indicating how strong this effect is or how this aspect of the experiment may be improved, but it should not be ignored in any experimental setting that requires humans to voluntarily participate. In our case, installing the game with the students in class and explaining how to play would likely be very effective.

More content being added to the game could also help with player retention. Participants have different tastes and desires, so extra features may be added to the game to cater to those different tastes, based on player profiles already existing in the industry, such as Bartle's Taxonomy [43] [66]. For example, an online leaderboard allowing students to compare their scores with their classmates' would be rewarding for more competitive players, while exploration-oriented players might appreciate different environments to play in (besides the jungle).

The game might be adapted to other gendered languages, which may require the "two lines" design element to be modified (particularly, if the language has more than two genders). The word list would also have to be built from scratch, based on the instructional standards of that language, and the Tag System will have to be modified, since Portuguese word endings do not apply to other languages (and there may be languages in which a word's ending may be completely unrelated to its gender).

Ultimately, it should not be lost that in games, the focus is on the player's experience being fun, and word-selection models are but one piece of that puzzle, because a player who has fun is a player who stays motivated and has a higher chance of not giving up on learning the language they wish to learn. It

is in motivating the players that lies the true strength of games, and by motivating them to learn a useful skill, rather than to spend money (as some profit-oriented companies tend to do), we can slowly turn boring tasks into delightful pastimes.

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A

Pre-Test

This appendix contains the *pre-test*, described in Section 4.4.1, meant to assess the participants' mastery of gender in Portuguese before the experiment.

FLUL LETRAS LISBOA

ICLP Instituto de Cultura e Língua Portuguesa

Ficha: *O género em Português Língua Estrangeira*

Nível: _____

Data: ____/____/_____

Aluno: _____

1. Complete as frases com o <u>artigo</u> das palavras indicadas no género e número corretos.

(a) Eu perdi _____ **bagagem** no aeroporto.
(b) João, viste _____ **acidente**.?
(c) Qual é _____ **clima** de França?
(d) _____ **sabão** verde está em cima da bancada.
(e) O Pedro partiu _____ **nariz**.
(f) _____ **liberdade** é um bem valioso.
(g) Maria, apaga _____ **luz**, por favor.
(h) Vou lavar _____ **alface** para o jantar.
(i) Comemos _____ **morangos** à sobremesa.
(j) _____ **dieta** da Maria é eficaz.

2. Com uma seta, faça corresponder os artigos, na coluna A, aos nomes, na coluna B.

A		B
O		dia
O		festa
O		cor
O		irmão
O		chave
O		chá
A		país
A		imagem
A		filme
A		lápis

3. Sublinhe e corrija os erros de género das seguintes frases.

(1) Fui às compras e comprei uma jornal. _____

(2) Convidei o João para um viagem aos Açores. _____

(3) Gosto de observar a céu azul. _____

(4) Perdeste a mapa do cidade de Lisboa? _____

(5) Tenho as lápis no mochila verde. _____

(6) Vamos entrar no avião depois da almoço. _____

(7) Os flores daquela jardim são grandes. _____

(8) O Pedro visitou a Castelo de S. Jorge. _____

(9) O lata de tinta caiu. _____

(10) O canção do Salvador Sobral ganhou a concurso. _____

B

Post-Test

This appendix contains the *post-test*, described in Section 4.4.2, meant to assess the participants' mastery of gender in Portuguese after the experiment.

FLUL LETRAS LISBOA

ICLP Instituto de Cultura e Língua Portuguesa

Ficha: ***O género em Português Língua Estrangeira***

Turma: _____

Nome: _____

1. Complete as frases com o <u>artigo</u> das palavras indicadas no género e número corretos.

(a) Eu perdi _____ **bagagem** no aeroporto.
(b) João, viste _____ **acidente**.?
(c) Qual é _____ **clima** de França?
(d) _____ **sabão** verde está em cima da bancada.
(e) O Pedro partiu _____ **nariz**.
(f) _____ **liberdade** é um bem valioso.
(g) Maria, apaga _____ **luz**, por favor.
(h) Vou lavar _____ **alface** para o jantar.
(i) Comemos _____ **morangos** à sobremesa.
(j) _____ **dieta** da Maria é eficaz.

2. Com uma seta, faça corresponder os artigos, na coluna A, aos nomes, na coluna B.

A		B
O		dia
O		festa
O		cor
O		irmão
O		chave
O		chá
A		país
A		imagem
A		filme
A		lápis

3. Sublinhe e corrija os erros de género das seguintes frases.

(1) Fui às compras e comprei uma jornal. _____
(2) Convidei o João para um viagem aos Açores. _____
(3) Gosto de observar a céu azul. _____
(4) Perdeste a mapa do cidade de Lisboa? _____
(5) Tenho as lápis no mochila verde. _____

(6) Vamos entrar no avião depois da almoço. _____
(7) Os flores daquela jardim são grandes. _____
(8) O Pedro visitou a Castelo de S. Jorge. _____
(9) O lata de tinta caiu. _____
(10) O canção do Salvador Sobral ganhou a concurso. _____

4. Coloque o <u>artigo definido</u> antes de cada palavra, com o género correto.

(a) _____ camioneta
(b) _____ cêntimo
(c) _____ esquina
(d) _____ álcool
(e) _____ holandês
(f) _____ sal
(g) _____ leoa
(h) _____ letra
(i) _____ embalagem
(j) _____ aquecimento

C

Questionnaire

This appendix contains the opinion questionnaire, described in Section 4.4.3, used to gather data on the participants' opinion of the game and more (even those who did not play).

À Pesca de Palavras - Questionário

Olá! Gostaria de perceber o que achou do jogo (caso tenha jogado) ou o que podemos mudar para tornar o jogo mais interessante (caso não tenha jogado). A sua opinião é muito importante para melhorar o jogo! Muito obrigado pela sua participação.

NOTA: Este questionário é anónimo e demora aproximadamente 5 minutos a completar.

Hi! I'd like to know what you thought of the game (if you played) or what we can change to make it more appealing (if you didn't play). Your opinion is very important to improve the game! Thank you very much for your participation.

NOTE: This questionnaire is anonymous and takes around 5 minutes to complete.

*Required

1. **Marque se concorda ou discorda de cada frase / Mark whether you agree or disagree with each sentence**
   Mark only one oval per row.

	Discordo Fortemente / Strongly Disagree	Discordo / Disagree	Não concordo nem discordo / Neither agree nor disagree	Concordo / Agree	Concordo Fortemente / Strongly Agree
O género em português é importante de praticar ao nível A2 / It's important to practice gender in Portuguese at the A2 level					
Gosta de jogar jogos no telemóvel / You like playing smartphone games					
Prefere aprender género oralmente / You prefer to learn gender orally					
Prefere aprender género através da escrita / You prefer to learn gender through written words					

2. **Recebeu o jogo por email? / Did you receive the game by email?** *
   Mark only one oval.

   - Sim / Yes
   - Não / No *Skip to question 9.*
   - Não tenho a certeza / I'm not sure *Skip to question 9.*

3. **Marque se concorda ou discorda de cada frase / Mark whether you agree or disagree with each sentence**
Mark only one oval per row.

	Discordo Fortemente / Strongly Disagree	Discordo / Disagree	Não concordo nem discordo / Neither agree nor disagree	Concordo / Agree	Concordo Fortemente / Strongly Agree
As instruções por email para instalar o jogo eram claras / The instructions by email on how to install the game were clear					
O videotutorial explicou o jogo de forma clara / The tutorial video explained the game clearly					
O jogo parece divertido / The game seems fun					
O jogo parece ajudar a aprender o género / The game seems to help with learning gender					
O jogo parece para crianças / The game looks like it's for children					
Preferia jogar o jogo mais tarde / You'd prefer to play the game later					

4. **Conseguiu instalar o jogo? / Were you able to install the game?** *
Mark only one oval.

- Sim / Yes *Skip to question 6.*
- Não / No *Skip to question 5.*
- Não tentei / I didn't try to *Skip to question 5.*

5. **Porque razão não conseguiu instalar o jogo? / Why weren't you able to install the game?**
Tick all that apply.

- [ ] Não tenho um dispositivo com Android nem Windows / I don't have a device with Android nor Windows
- [ ] As instruções para instalar não foram claras / The installation instructions were not clear
- [ ] Não vi o email com o jogo / I didn't see the email with the game
- [ ] Não tentei instalar o jogo / I never tried to install the game
- [ ] Other: _____

Skip to question 9.

6. **Jogou o jogo? (pelo menos uma vez) / Did you play the game? (at least once)** *
Mark only one oval.

- ( ) Sim / Yes *Skip to question 7.*
- ( ) Não / No *Skip to question 8.*

7. **Marque se concorda ou discorda de cada frase / Mark whether you agree or disagree with each sentence**
Mark only one oval per row.

	Discordo Fortemente / Strongly Disagree	Discordo / Disagree	Não concordo nem discordo / Neither agree nor disagree	Concordo / Agree	Concordo Fortemente / Strongly Agree
O jogo é fácil de entender / The game is easy to understand	( )	( )	( )	( )	( )
O jogo é divertido / The game is fun	( )	( )	( )	( )	( )
O jogo ajuda a aprender género / The game helps to learn gender	( )	( )	( )	( )	( )

Skip to question 9.

8. **Marque as razões principais para não ter jogado / Mark the main reasons why you didn't play**
   Tick all that apply.

   - [ ] Não consegui entrar com o meu endereço de email / I couldn't login with my email address
   - [ ] Estive ocupado nessa altura / I was busy during that time
   - [ ] Não quis estudar português durante esse tempo / I didn't want to study Portuguese during that time
   - [ ] O jogo não funciona no meu dispositivo / The game doesn't work on my device
   - [ ] Acho que praticar o género não é muito importante / I think practicing gender isn't very important
   - [ ] Acho que o jogo não ajuda a aprender o género / I think the game doesn't help with learning gender
   - [ ] Não gosto de jogar videojogos / I don't like to play videogames
   - [ ] Other: _____

Skip to question 9.

Sugestões / Suggestions

Se tem alguma sugestão para tornar o jogo mais interessante (mesmo que não tenha jogado!) por favor diga-nos aqui!

If you have any suggestions on how to make the game more appealing (even if you didn't play it!) please let us know here!

9. **O que devemos fazer para o jogo ser mais interessante para si? / What should we do to make the game more appealing to you?**

   _____
   _____
   _____
   _____
   _____

D

Consent Form

This appendix contains the consent form, decribed in Section 4.4.4, which students filled out to confirm that they wished to participate in the experiment.

U LISBOA UNIVERSIDADE DE LISBOA · FLUL LETRAS LISBOA	**Instituto de Cultura e Língua Portuguesa** **Consentimento informado / Informed consent**	ICLP Instituto de Cultura e Língua Portuguesa

Consentimento / Consent

(for the compilation and exploitation of written data)

Presentation of the project

As part of a master's thesis research project on language education, we are seeking volunteers to play a new videogame (called *Fishing for Words*) that aims to help students learn the gender of Portuguese words. The goal of this experiment is to evaluate the game's value as a learning tool and provide insight on how this (and future) game(s) can be improved.

We therefore ask for your consent and participation to collect data on your experience while playing the game and your email address, as well as your linguistic background (provided in this form). The data you provide will only be used for this research project and will not be shared with third-parties. Participation is entirely voluntary, it will not impact your course marks and you may withdraw consent at any time.

We thank you advance for your time and cooperation, and hope our game can provide you with a fun and useful learning experience.

Responsible for data treatment:
Instituto Superior Técnico, Avenida Professor Doutor Cavaco Silva, 2744-016 Porto Salvo, Portugal

Represented by: Pedro Bertrand Cabral pedro.b.cabral@tecnico.ulisboa.pt

Supervisors:
Carlos António Roque Martinho
Nélia Maria Pedro Alexandre

Data Protection Officer:
Carlos Ribeiro, Vice-Reitor da Universidade de Lisboa, carlos.ribeiro@reitoria.ulisboa.pt

The data will be maintained for the duration of the research project.

Your rights:
Access: You have the right to obtain access to your personal data from the responsible for data treatment.
Rectification: You have the right to demand that the responsible for data treatment rectifies your personal data as soon as possible, in case they prove to be inaccurate.
Portability: You have the right to receive, from the responsible for data treatment, the personal data that you have provided, in a structured, commonly used, machine-readable format, and to transmit it to another responsible for data treatment.
Withdrawal of consent: You have the right to withdraw your consent at any time. Withdrawal of consent does not compromise the lawfulness of consent-based treatment prior to withdrawal.

You can exercise these rights by contacting pedro.b.cabral@tecnico.ulisboa.pt

Complaint to a competent authority: You have the right to file a complaint with the National Commission for Data Protection (Comissão Nacional de Proteção de Dados - CNPD).

Authorization (check explicitly the selected options)

Name: _____

I, the undersigned,

☐ Allow IST to collect text written by me in the scope of the *Fishing for Words* research project.
☐ Consent to the use of the transcription of this data in digital format, provided they are made anonymous (see below)

- ☐ for validating my identity within the game
- ☐ for treatment and use within the scope of this master's thesis
- ☐ for dissemination to the research community

☐ Take note that for all these scientific uses, the data thus collected will be made anonymous, which means that any information that may lead to the identification of participants' names will be eliminated or replaced by a pseudonym (for instance, a code).

☐ Wishes the following additional constraints to be met:

(OPTIONAL) I would like my name to be listed in the MSc thesis document as a participant in the experiment: **Yes** ☐ **No** ☐

Done at: _____

On (date): _____

Signature:

E

Linguistic Profile

This appendix contains the linguistic profile, described in Section 4.4.5, in which students informed us of their linguistic background.

Instituto de Cultura e Língua Portuguesa

Perfil linguístico* / Language profile*

Perfil Linguístico / Language Profile

Nome: **Turma:**

1. **Quais destes sistemas operativos usa agora regularmente?**

   Which of these operating systems do you currently use regularly?

   Android ☐ **iOS** ☐ **Windows** ☐ **macOS** ☐ **Linux** ☐

   Outros/Others: ☐

2. **Língua(s) materna(s)** / Mother tongue(s)

   ☐ ☐ ☐

3. **Língua(s) falada(s) em casa (até aos 14 anos)** / Language(s) spoken at home (until the age of

   ☐ ☐ ☐

4. **Em que língua aprendeu matemática?** / In which language did you learn mathematics?

   ☐

5. **Outras língua(s) estrangeira(s) que fala** / Other foreign language(s) that you speak

Línguas estrangeiras / Foreign languages	**Nível de proficiência** / Level of proficiency (A1-C1)

6. **Há quanto tempo estuda Português?** / How long have you studied Portuguese?

   ☐

   Nunca estudou português / You never studied Portuguese ☐

7. **Onde aprendeu Português?** / Where did you learn Portuguese?

   ☐

8. **Em que situações usa o Português?** / When do you speak Portuguese?

   Família / Family ☐ **Amigos** / Friends ☐

   Trabalho ou escola / Work or school ☐ **Nunca** / Never ☐

* Todos os itens são de preenchimento obrigatório / All items are mandatory

F

Sample Log File

This appendix contains a sample log file, which are described in Section 3.6. It some data we received from the players in its raw, text form.

001: 7a283950ea639c7cc78c89802ff48976_2019_4_22_19h36m36s.log
002: 0
003: TAGS
004: 2019_4_22_19h36m36s$ButtonPlay
005: 2019_4_22_19h36m36s$LogReceived_2019_4_22_19h30m44s
006: 2019_4_22_19h36m37s$NewRound
007: 2019_4_22_19h36m37s$ChallengeStats_0_0_0.14_0
008: 2019_4_22_19h36m37s$GetWord_rato_masculino
009: 2019_4_22_19h36m37s$GetWord_farmácia_feminino
010: 2019_4_22_19h36m37s$GetWord_patrão_masculino
011: 2019_4_22_19h36m37s$GetWord_pente_masculino
012: 2019_4_22_19h36m37s$GetWord_tradução_feminino
013: 2019_4_22_19h36m42s$FishGrabbed_rato_803.94
014: 2019_4_22_19h36m44s$WordSolved_rato_5_1_-25_25_masculino
015: 2019_4_22_19h36m45s$FishGrabbed_farmácia_621.33
016: 2019_4_22_19h36m46s$MonkeyTeacherSpeechStart
017: 2019_4_22_19h36m47s$MonkeyTeacherSpeechNext
018: 2019_4_22_19h36m49s$WordSolved_farmácia_10_1_-25_25_feminino
019: 2019_4_22_19h36m50s$FishGrabbed_pente_649.40
020: 2019_4_22_19h36m51s$MonkeyTeacherSpeechNext
021: 2019_4_22_19h36m59s$WordSolved_pente_20_1_-25_25_masculino
022: 2019_4_22_19h36m59s$FishGrabbed_patrão_158.06
023: 2019_4_22_19h37m1s$MonkeyTeacherSpeechStart
024: 2019_4_22_19h37m1s$MonkeyTeacherSpeechNext
025: 2019_4_22_19h37m9s$WordSolved_patrão_25_1_-25_25_masculino
026: 2019_4_22_19h37m9s$FishGrabbed_tradução_1230
027: 2019_4_22_19h37m11s$MonkeyTeacherSpeechStart
028: 2019_4_22_19h37m12s$MonkeyTeacherSpeechNext
029: 2019_4_22_19h37m24s$WordSolved_tradução_15_1_-25_25_feminino
030: 2019_4_22_19h37m26s$MonkeyTeacherSpeechStart
031: 2019_4_22_19h37m27s$MonkeyTeacherSpeechNext
032: 2019_4_22_19h37m28s$NewRound
033: 2019_4_22_19h37m29s$ChallengeStats_0_0_0.30_0
034: 2019_4_22_19h37m29s$GetWord_talho_masculino
035: 2019_4_22_19h37m29s$GetWord_facto_masculino
036: 2019_4_22_19h37m29s$GetWord_lavatório_masculino
037: 2019_4_22_19h37m29s$GetWord_malmequer_masculino
038: 2019_4_22_19h37m29s$GetWord_lata_feminino
039: 2019_4_22_19h37m30s$FishGrabbed_facto_523.92
040: 2019_4_22_19h37m32s$FishGrabbed_talho_959.03
041: 2019_4_22_19h37m32s$FishGrabbed_lata_925.05
042: 2019_4_22_19h37m33s$FishGrabbed_malmequer_542.96
043: 2019_4_22_19h37m33s$FishGrabbed_lavatório_257.44
044: 2019_4_22_19h37m35s$FishGrabbed_facto_720.27
045: 2019_4_22_19h37m35s$FishGrabbed_facto_197.02
046: 2019_4_22_19h37m36s$FishGrabbed_facto_1091.72
047: 2019_4_22_19h37m37s$FishGrabbed_facto_288.48
048: 2019_4_22_19h37m38s$FishGrabbed_malmequer_167.82
049: 2019_4_22_19h37m39s$FishGrabbed_facto_258.27
050: 2019_4_22_19h37m50s$FishGrabbed_lata_1212.54
051: 2019_4_22_19h37m52s$FishGrabbed_lavatório_147.52
052: 2019_4_22_19h37m53s$FishGrabbed_facto_1050.21
053: 2019_4_22_19h37m54s$FishGrabbed_malmequer_64.70
054: 2019_4_22_19h37m54s$FishGrabbed_lata_800.77
055: 2019_4_22_19h38m4s$FishGrabbed_talho_1113.95
056: 2019_4_22_19h38m6s$FishGrabbed_facto_603.31

057: 2019_4_22_19h38m8s$WordSolved_facto_10_1_-25_25_masculino
058: 2019_4_22_19h38m9s$FishGrabbed_lavatório_522.11
059: 2019_4_22_19h38m10s$MonkeyTeacherSpeechStart
060: 2019_4_22_19h38m11s$FishGrabbed_talho_357.99
061: 2019_4_22_19h38m11s$MonkeyTeacherSpeechNext
062: 2019_4_22_19h38m13s$WordSolved_talho_25_1_-25_25_masculino
063: 2019_4_22_19h38m14s$FishGrabbed_malmequer_1230.16
064: 2019_4_22_19h38m15s$FishGrabbed_lavatório_395.82
065: 2019_4_22_19h38m16s$MonkeyTeacherSpeechNext
066: 2019_4_22_19h38m32s$WordSolved_lavatório_20_1_-25_25_masculino
067: 2019_4_22_19h38m32s$FishGrabbed_lata_1230
068: 2019_4_22_19h38m34s$MonkeyTeacherSpeechStart
069: 2019_4_22_19h38m35s$MonkeyTeacherSpeechNext
070: 2019_4_22_19h38m37s$WordSolved_lata_15_1_-25_25_feminino
071: 2019_4_22_19h38m39s$FishGrabbed_malmequer_50
072: 2019_4_22_19h38m40s$MonkeyTeacherSpeechNext
073: 2019_4_22_19h38m49s$WordSolved_malmequer_5_1_-25_25_masculino
074: 2019_4_22_19h38m51s$MonkeyTeacherSpeechStart
075: 2019_4_22_19h38m52s$MonkeyTeacherSpeechNext
076: 2019_4_22_19h38m57s$NewRound
077: 2019_4_22_19h38m58s$ChallengeStats_0_0_0.47_0
078: 2019_4_22_19h38m58s$GetWord_edifício_masculino
079: 2019_4_22_19h38m58s$GetWord_regresso_masculino
080: 2019_4_22_19h38m58s$GetWord_página_feminino
081: 2019_4_22_19h38m58s$GetWord_atenção_feminino
082: 2019_4_22_19h38m58s$GetWord_fronteira_feminino
083: 2019_4_22_19h39m2s$FishGrabbed_atenção_373.84
084: 2019_4_22_19h39m6s$WordSolved_atenção_25_1_-25_25_feminino
085: 2019_4_22_19h39m7s$FishGrabbed_fronteira_404.87
086: 2019_4_22_19h39m8s$MonkeyTeacherSpeechStart
087: 2019_4_22_19h39m9s$MonkeyTeacherSpeechNext
088: 2019_4_22_19h39m9s$FishGrabbed_edifício_481.67
089: 2019_4_22_19h39m12s$FishGrabbed_página_494.89
090: 2019_4_22_19h39m12s$WordSolved_página_15_0_-25_25_masculino
091: 2019_4_22_19h39m13s$FishGrabbed_edifício_1059.31
092: 2019_4_22_19h39m13s$MonkeyTeacherSpeechStart
093: 2019_4_22_19h39m14s$MonkeyTeacherSpeechNext
094: 2019_4_22_19h39m17s$FishGrabbed_regresso_1231.42
095: 2019_4_22_19h39m18s$FishGrabbed_edifício_588.71
096: 2019_4_22_19h39m19s$FishGrabbed_regresso_652.80
097: 2019_4_22_19h39m23s$WordSolved_regresso_20_1_-25_25_masculino
098: 2019_4_22_19h39m23s$FishGrabbed_edifício_760.46
099: 2019_4_22_19h39m25s$MonkeyTeacherSpeechStart
100: 2019_4_22_19h39m25s$MonkeyTeacherSpeechNext
101: 2019_4_22_19h39m29s$WordSolved_edifício_10_1_-25_25_masculino
102: 2019_4_22_19h39m30s$FishGrabbed_fronteira_271.87
103: 2019_4_22_19h39m32s$MonkeyTeacherSpeechNext
104: 2019_4_22_19h39m48s$WordSolved_fronteira_5_1_-25_25_feminino
105: 2019_4_22_19h39m51s$MonkeyTeacherSpeechStart
106: 2019_4_22_19h39m51s$MonkeyTeacherSpeechNext
107:
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e_limit":10,"variety_limit":10,"tag_performance":{"Da":[1,1],"Dente"
:[1],"Dista":[1],"Dl":[1],"Fa":[1,1,1,0,1,1,1,1,1,1,null],"Fagem":[0
,0,0,1],"Fana":[],"Fante":[1],"Fdade":[0,1,1,0],"Fente":[],"Fesa":[]
,"Fessa":[1],"Fina":[1,0],"Finha":[1],"Fisa":[1],"Fista":[1],"Fl":[0

],"Fm":[],"Foa":[],"Fona":[1],"Fora":[1,1,1],"Fr":[1],"Fz":[0,1,1],"Ma":[1,0],"Mante":[],"Mente":[1,1],"Mi":[0,1],"Ml":[1,1,1,1,1,1],"Mm":[1,1,1],"Mo":[1,1,1,1,1,1,1,1,1,1,null],"Mr":[1,1,1],"Ms":[1],"Mu":[1],"Mz":[1],"S_":[1,0,1],"Fção":[1,0,0,0,0,0,1,1,1,1,null],"São":[1,0,1,1,0,1],"Se":[0,1,1,0,0,0,1,1,1,1]},"tag_use_list":{"Da":[0,0,0,0,0,0.4,0,0,0,0,null],"Dente":[0,0,0,0,0,0,0,0,0,0,null],"Dista":[0,0,0,0,0,0,0,0,0,0,null],"Dl":[0,0,0,0,0,0,0.2,0,0,0,null],"Fa":[0.4,0.2,0.8,0.2,0.2,0,0,0.2,0.2,0.2,null],"Fagem":[0,0,0,0.2,0,0,0,0,0,0,null],"Fana":[0,0,0,0,0,0,0,0,0,0,null],"Fante":[0,0,0,0,0,0,0.2,0,0,0,null],"Fdade":[0,0,0.2,0.2,0,0,0,0,0,0,null],"Fente":[0,0,0,0,0,0,0,0,0,0,null],"Fesa":[0,0,0,0,0,0,0,0,0,0,null],"Fessa":[0,0,0,0,0,0,0,0,0,0,null],"Fina":[0,0,0,0,0,0,0,0,0,0.2,null],"Finha":[0,0,0,0,0,0,0,0,0,0,null],"Fisa":[0,0,0,0.2,0,0,0,0,0,0,null],"Fista":[0,0,0,0,0,0,0,0,0,0,null],"Fl":[0,0,0,0,0,0,0,0,0,0,null],"Fm":[0,0,0,0,0,0,0,0,0,0,null],"Foa":[0,0,0,0,0,0,0,0,0,0,null],"Fona":[0,0,0,0,0,0,0,0,0,0,null],"Fora":[0,0,0,0,0,0,0,0,0,0,null],"Fr":[0,0,0,0,0,0,0,0,0,0,null],"Fz":[0,0,0,0,0.2,0,0,0,0,0,null],"Ma":[0,0,0,0,0,0,0,0,0,0,null],"Mante":[0,0,0,0,0,0,0,0,0,0,null],"Mente":[0,0,0,0,0,0,0,0.2,0,0,null],"Mi":[0,0,0,0,0,0,0,0,0,0,null],"Ml":[0.2,0,0,0,0,0.2,0,0,0,0,null],"Mm":[0,0,0,0,0,0,0,0,0,0,null],"Mo":[0.4,0.2,0,0,0,0,0.2,0.2,0.8,0.4,null],"Mr":[0,0.2,0,0,0,0,0,0,0.2,0,null],"Ms":[0,0,0,0,0,0,0,0,0,0,null],"Mu":[0,0,0,0,0,0,0,0,0,0,null],"Mz":[0,0,0,0,0,0,0,0,0,0,null],"S_":[0,0,0,0,0,0,0,0,0,0,null],"Fção":[0,0,0,0.2,0.4,0,0,0.2,0,0.2,null],"São":[0,0.2,0,0,0,0,0,0.2,0,0,null],"Se":[0,0.2,0,0,0.2,0.4,0.4,0,0,0,null]},"tag_use_count":{"Da":2,"Dente":1,"Dista":1,"Dl":1,"Fa":32,"Fagem":4,"Fana":0,"Fante":1,"Fdade":4,"Fente":0,"Fesa":0,"Fessa":1,"Fina":2,"Finha":1,"Fisa":1,"Fista":1,"Fl":1,"Fm":0,"Foa":0,"Fona":1,"Fora":3,"Fr":1,"Fz":3,"Ma":2,"Mante":0,"Mente":2,"Mi":2,"Ml":6,"Mm":3,"Mo":35,"Mr":3,"Ms":1,"Mu":1,"Mz":1,"S_":3,"Fção":11,"São":6,"Se":10},"challenge_performance":[0.818181818181818,0.733333333333333,0.8,0.8,0.866666666666667,0.866666666666667,0.733333333333333,0.666666666666667,0.933333333333333,0.933333333333333],"challenge_variety":[],"gender_use_count_total":146,"gender_use_count":{"masculino":62,"feminino":77,"dois":7}}#{"mute":false,"hurry_setting":1,"usercode":"7a283950ea639c7cc78c89802ff48976","random":7988037736,"logs_sent":{"2019_4_22_13h2m19s":1,"2019_4_22_13h4m40s":1,"2019_4_22_13h9m14s":1,"2019_4_22_13h11m5s":1,"2019_4_22_13h13m18s":1,"2019_4_22_13h15m24s":1,"2019_4_22_13h17m31s":1,"2019_4_22_15h41m53s":1,"2019_4_22_19h27m7s":1,"2019_4_22_19h30m44s":1},"first_log":true,"game_count":10,"points_history":[145,165,180,200,195,180,165,145,205,210],"fish_history":[9,11,12,12,13,13,11,10,14,14],"tutorial":0,"boats_next":[31,16,14,26,23,34,22,24,6,17,15,20,13,32,25,8,12,27,2,33,null,null,null,null,null,null,null,null,null,null,null,null,null,null],"boats_new":{"1":0,"4":0,"10":0,"11":0,"9":0,"19":0,"21":0,"29":0,"18":0,"5":0,"7":0,"30":0,"3":1,"28":1},"boats":{"1":1,"4":1,"10":1,"11":1,"9":1,"19":1,"21":1,"29":1,"18":1,"5":1,"7":1,"30":1,"3":1,"28":1},"boat_current":30}#

108: 2019_4_22_19h39m55s$ButtonBoats
109: 2019_4_22_19h39m56s$BoatSelect_12
110: 2019_4_22_19h39m58s$BoatSelect_3
111: 2019_4_22_19h40m4s$BoatOK
112: 2019_4_22_19h40m4s$LogClose

G

Word List

This appendix contains the list of words used in the game, accompanied by their gender (D for double-gendered, F for feminine and M for masculine) and their tag (required by the Tag System). The word list and its creation are described in detail in Section 3.5.

D belga [Da]
D carioca [Da]
D guia [Da]
D cliente [Dente]
D doente [Dente]
D paciente [Dente]
D artista [Dista]
D fadista [Dista]
D profissional [Dl]
F abelha [Fa]
F agência [Fa]
F ajuda [Fa]
F aldeia [Fa]
F alfândega [Fa]
F altura [Fa]
F ambulância [Fa]
F aparência [Fa]
F areia [Fa]
F assinatura [Fa]
F assistência [Fa]
F assoalhada [Fa]
F balança [Fa]
F baleia [Fa]
F banda [Fa]
F bandeira [Fa]
F banheira [Fa]
F barra [Fa]
F bateria [Fa]
F bica [Fa]
F bilheteira [Fa]
F bombeira [Fa]
F cabra [Fa]
F cabrita [Fa]
F caixa [Fa]
F camioneta [Fa]
F centena [Fa]
F certeza [Fa]
F chamada [Fa]
F charcutaria [Fa]
F cirurgia [Fa]
F ciência [Fa]
F clínica [Fa]
F cobra [Fa]
F coitada [Fa]
F companheira [Fa]
F companhia [Fa]
F consulta [Fa]
F conversa [Fa]
F cozinheira [Fa]
F culinária [Fa]
F descoberta [Fa]
F despedida [Fa]
F dezena [Fa]
F dieta [Fa]
F diferença [Fa]
F discoteca [Fa]
F distância [Fa]
F doença [Fa]
F embaixada [Fa]
F empresária [Fa]
F escrita [Fa]
F estadia [Fa]
F estrada [Fa]
F experiência [Fa]
F farmácia [Fa]
F fatia [Fa]
F fila [Fa]
F floresta [Fa]
F fronteira [Fa]
F frutaria [Fa]
F funcionária [Fa]
F fábrica [Fa]
F galeria [Fa]
F ganga [Fa]
F garganta [Fa]
F ginástica [Fa]
F gravata [Fa]
F grávida [Fa]
F guitarra [Fa]
F história [Fa]
F igreja [Fa]
F informática [Fa]
F inveja [Fa]
F jardineira [Fa]
F lata [Fa]
F letra [Fa]
F livraria [Fa]
F lua [Fa]
F lâmpada [Fa]
F macaca [Fa]
F maneira [Fa]
F manga [Fa]
F mercearia [Fa]
F mesquita [Fa]
F miúda [Fa]
F mobília [Fa]
F mochila [Fa]
F moradia [Fa]
F morena [Fa]
F mosca [Fa]
F multa [Fa]
F nata [Fa]
F noiva [Fa]
F notícia [Fa]
F oferta [Fa]

F ovelha [Fa]
F padaria [Fa]
F palavra [Fa]
F papelaria [Fa]
F passageira [Fa]
F pasta [Fa]
F pastelaria [Fa]
F pedra [Fa]
F peixaria [Fa]
F pilha [Fa]
F pimenta [Fa]
F pintura [Fa]
F praça [Fa]
F próxima [Fa]
F reformada [Fa]
F reforma [Fa]
F residência [Fa]
F rocha [Fa]
F rotunda [Fa]
F salsicha [Fa]
F sanita [Fa]
F sapataria [Fa]
F senhoria [Fa]
F serra [Fa]
F sinagoga [Fa]
F tarefa [Fa]
F temperatura [Fa]
F tenda [Fa]
F terra [Fa]
F transferência [Fa]
F urgência [Fa]
F ursa [Fa]
F vila [Fa]
F zebra [Fa]
F área [Fa]
F bagagem [Fagem]
F carruagem [Fagem]
F embalagem [Fagem]
F paisagem [Fagem]
F angolana [Fana]
F estante [Fante]
F faculdade [Fdade]
F saudade [Fdade]
F verdade [Fdade]
F cidade [Fdade]
F gente [Fente]
F empresa [Fesa]
F holandesa [Fesa]
F pressa [Fessa]
F cantina [Fina]
F disciplina [Fina]
F esquina [Fina]
F inquilina [Fina]
F marroquina [Fina]
F oficina [Fina]
F página [Fina]
F campainha [Finha]
F farinha [Finha]
F galinha [Finha]
F linha [Finha]
F coisa [Fisa]
F entrevista [Fista]
F tosta-mista [Fista]
F capital [Fl]
F margem [Fm]
F leoa [Foa]
F patroa [Foa]
F azeitona [Fona]
F zona [Fona]
F abóbora [Fora]
F agricultora [Fora]
F autora [Fora]
F compositora [Fora]
F fotocopiadora [Fora]
F jogadora [Fora]
F trabalhadora [Fora]
F utilizadora [Fora]
F cor [Fr]
F dor [Fr]
F flor [Fr]
F luz [Fz]
F voz [Fz]
M clima [Ma]
M dia [Ma]
M grama [Ma]
M mapa [Ma]
M elefante [Mante]
M acidente [Mente]
M ambiente [Mente]
M detergente [Mente]
M ingrediente [Mente]
M pente [Mente]
M boi [Mi]
M esqui [Mi]
M andebol [Ml]
M animal [Ml]
M basquetebol [Ml]
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M encontro [Mo]
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M estudo [Mo]
M estômago [Mo]
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M facto [Mo]
M fado [Mo]
M fogo [Mo]
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M marroquino [Mo]
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M urso [Mo]
M vidro [Mo]
M agricultor [Mr]
M ar [Mr]
M autor [Mr]
M carregador [Mr]
M caráter [Mr]
M compositor [Mr]
M despertador [Mr]
M jogador [Mr]
M malmequer [Mr]
M milhar [Mr]
M talher [Mr]
M trabalhador [Mr]
M utilizador [Mr]
M ananás [Ms]
M cais [Ms]
M holandês [Ms]
M lápis [Ms]
M país [Ms]
M céu [Mu]
M nariz [Mz]
M xadrez [Mz]
D fã [S_]
F bisavó [S_]
F chaminé [S_]
F lã [S_]
M bisavô [S_]
M boné [S_]
M chá [S_]
M pó [S_]
F alimentação [Fção]
F atenção [Fção]
F canção [Fção]
F constipação [Fção]
F correção [Fção]
F decoração [Fção]
F divisão [São]
F explicação [Fção]
F exposição [Fção]
F inscrição [Fção]
F ligação [Fção]
F localização [Fção]
F natação [Fção]
F ocasião [São]
F promoção [Fção]
F relação [Fção]
F situação [Fção]
F solução [Fção]
F tradução [Fção]
M algodão [São]
M avião [São]
M balcão [São]
M botão [São]
M feijão [São]
M irmão [São]
M leão [São]
M patrão [São]
M sabão [São]
M salmão [São]
M tubarão [São]
D agente [Se]
D chefe [Se]
D hóspede [Se]
F alface [Se]
F arte [Se]
F carpete [Se]
F classe [Se]
F dose [Se]
F febre [Se]
F gripe [Se]
F higiene [Se]
F morte [Se]
F parte [Se]
F raquete [Se]
F rede [Se]
F saúde [Se]
F sorte [Se]

F tempestade [Se]
F torre [Se]
F tosse [Se]
F chave [Se]
M chocolate [Se]
M clube [Se]
M continente [Se]
M costume [Se]
M embarque [Se]
M envelope [Se]
M exame [Se]
M filme [Se]
M forte [Se]
M interesse [Se]
M pacote [Se]
M perfume [Se]
M quiosque [Se]
M romance [Se]
M sangue [Se]
M teste [Se]
M tigre [Se]
M xarope [Se]