Building a Language-Learning Game for Brazilian Indigenous Languages: A Case of Study

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Abstract

In this paper we discuss a first attempt to build a language learning game for brazilian indigenous languages and the challenges around it. We present a design for the tool with gamification aspects. Then we describe a process to automatically generate language exercises and questions from a dependency treebank and a lexical database for Tupian languages. We discuss the limitations of our prototype highlighting ethical and practical implementation concerns. Finally, we conclude that new data gathering processes should be established in partnership with indigenous communities and oriented for educational purposes.

1 Introduction

Language learning games are key tools to vitalize endangered languages (Thomason, 2015; Xu et al., 2022; Neubig et al., 2020). LARA (Akhlaghi et al., 2019), a multi language learning assistant, is an example that has been key to support actions related to endangered languages protection (Rayner and Wilmoth, 2023; Bédi et al., 2022; Zuckermann et al., 2021). Despite the necessity of language learning tools to vitalize endangered languages, they are typically restricted to high-resource languages, such as english, and require significant effort to be extended to languages with few spoken and written resources. For example, "7000 languages" [1], a non-profit organization dedicated to build online courses for endangered languages, require 1 to 2 years to build a language course. As a result, despite the immediate need, language learning tools are expensive and, as they are developed today, are hard to scale to cover all the 2,680 languages in risk of being extinct by the end of this century (Wurm, 2001). In particular, Brazil hosts approximately 270 indigenous languages, all of which are endangered. Brazil indigenous languages, collectively known as Brazilian Indigenous Languages (BILs) henceforth, are spoken by at most 30 thousand people, few of which are young children and teenagers. Brazilian indigenous communities require language learning tools that can tech their native language to portuguese speakers. Since portuguese is a low-resource language, when compared to English for example, and due to the lack of data resources on BIL, brazilian indigenous communities are underserved by current learning tools.

In this work, we describe the process of building a language learning tool for BIL, which we will refer as "BILingo". BILingo is a language learning game app, heavily inspired by industry leaders on language learning apps (Duolingo [2] and Busuu [3]). We discuss in detail the challenges of building a language learning tool for BIL, such as the lack of written and phonetical resources, ethical concerns on available treebanks and databases used for exercise generation, and provide some suggestions on steps forward. We managed to build a minimal proof of concept course for Guajajara language divided in two sections. We employed dependency treebanks and a lexical database on BIL as source for exercise generation. The main contribution of this work is to present a case of study on building a language learning tool for BIL and, we hope, it will serve as an starting point for the development of an actual fully fledged language learning app that can be used to strengthen the culture of indigenous communities in Brazil.

The paper is organized as follows. Section 2 presents BILingo's design and describe its development process, including their data sources and exercise's format. In Section 3 we discuss the challenges and limitations of our prototype, we analyse our processes and resources from both a practical implementation and ethical perspective. Finally, in

[1] https://www.7000.org/

[2] https://www.duolingo.com/

[3] https://www.busuu.com/

Section 4 we offer concluding remarks.

2 Method and Results

BILingo's design follows the gamified language learning structure found in apps available in the industry (e.g. Duolingo) and in the literacy (Lightbown, 2021; von Ahn, 2006; Katinskaia et al., 2017). It has an inital course page as depicted in Figure 1. The student will progress linearly in the course by completing lessons. To complete a lesson the student needs to pass a series of exercises. Every time they make a mistake, they lose a "red gem", if the student is out of red gems, they have to wait 5 minutes before trying a lesson again. Once the student completes a lesson, they can advance to the next one. These are gamification aspects typically found in language learning apps in the industry.

When the student engages with a lesson, they can find three different types of language exercises: (1) "translate sentence" TS1, (2) "translate sentence in the target language" TS2 or (2) "concept match" CM, see Figure 2. In the TS1 exercise, depicted in Figure 2a, the student is presented with a sentence in portuguese and asked to select the tokens from the Guajajara language in the correct order to form the translated sentence; TS2 is the same but the initial sentence is presented in Guajajara and the student is asked to translate it to portuguese. CM exercises present a word in Guajajara and images of possible concepts that are represented by that word, then, the student is asked to select which one of the images correspond to the given word, see Figure 2b. Popular language learning assistants, such as LARA, employ phonetical exercises that are absent in our prototype. At this point, we focused on written exercises only, with the purpose of simplify the setup and because we couldn't find any phonetical databases readily available.

Now that we presented our tool, we describe the details of its implementation. In order to build BILingo's question database for BIL, we used a simple exercise generation method based on available treebanks and lexical databases. In this work we used TuLeD (Gerardi et al., 2022b) and TuDeT (Gerardi et al., 2022a), which are respectively a lexical database and a dependency treebank for several Tupian languages, including Guajajara. These databases compile several resources from the literature on Tupian languages and structure them into a single format suitable for analytical purposes. TuDeT treebank offers several dependency trees in the original indigenous language with some correspondent sentences in other mainstream languages, such as english, spanish, portuguese and french. For example, the token list ("oho", "kara", "ipiaromo") corresponds to the sentence "Ela foi buscar inhame" in portuguese. On the other hand, TuLeD offers a lexical database with the ontological concept associated to each term. So, in our example, you will find that the word "kara" means "yam". In order to link both databases, we first conducted a search of all the concepts available in TuLeD on TuDeT sentences, so that we could tell which concepts were present in each dependency tree. Here, we considered a hit if the exact same form that appeared in each dependency tree was present in the lexical database. For example, we could tell that the sentence "oho kara ipiaromo" refers to the concept "yam" on the word "kara".

As we presented, BILingo consists in 3 concepts: "course section", "lesson" and "exercise". First, we had to determine with the available resources at hand, our unified TuLeD and TuDeT database, which topics or subjects we could cover in our prototype. To select the topics, we grouped the available dependency trees for each language by concept, and then manually inspected which concepts were suitable for building course sections. For example, concepts like "yam", "pineapple" and "pepper" appear in a significant number of sentences, e.g. more than 10, we can tell that "food" can be a good candidate as course subject. Once we selected the subjects for a given course section, we can filter only the sentences related to the listed concepts. Now we can generate CM exercises by sampling from the listed concepts within the same section. Furthermore, we can also use the dependency trees, with their correspondent translation in portuguese, to build class TS1 and TS2 exercises. To generate tokens other than the correct ones for the TS1 and TS2 exercises, we can simply select a sample set of dependency trees from the same language, shuffle their tokens and apply a random sampling. The lessons were generated by randomly sampling a predefined number of exercises, e.g. 4, from our set, always ensuring to have two of each kind. In this work, we were able to generate exercises for two course sections, each one comprising 4 lessons. Table 1 presents an example list of exercises generated through our process.

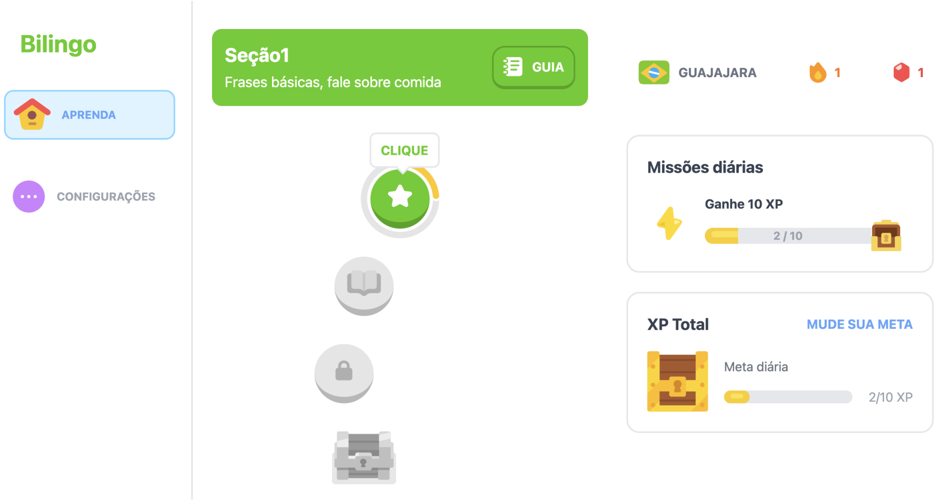
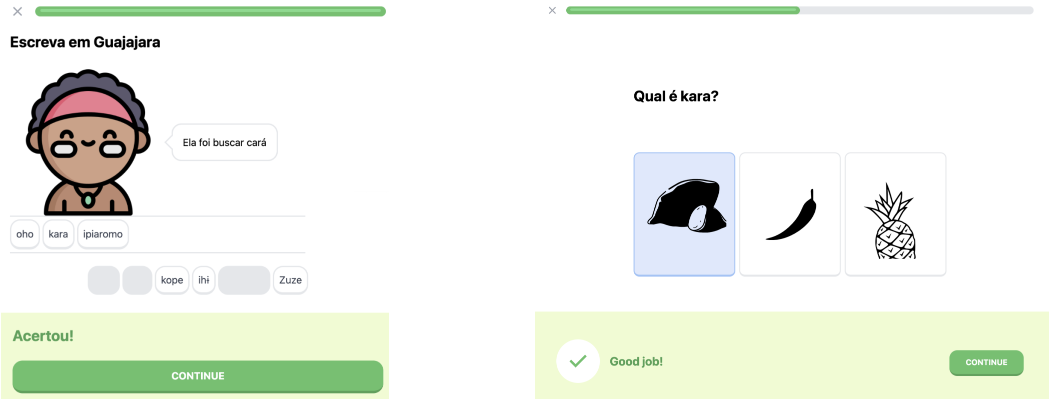


Figure 1: Landing page of BILingo. It displays a linear progress trajectory of lessons and incorporates gamification aspects such as daily quests and daily streak.



(a) Translate sentence exercise type example. The student was asked to form the sentence “She went to look for yam” using the Guajajara word set.

(b) Concept match exercise type example. The student was asked to tell which of the images corresponded to the Guajajara word “kara” that means yam.

Figure 2: Exercise types in our learning language tool. Depicts scenarios where the student has answered correctly.

Table 1: BILingo example exercises.

Section	Question (translate sentence)	Answer
food	ela foi buscar cará	oho kara ipiaromo
food	a mãe de josé foi a roça para buscar carã	oho zuze ihi kope kara ipiaromo
food	tem abacaxi na roça de josé	heta nana zuze kope
food	ele colhe cacau	opo?o aka?u a?e
animal	a mulher envolveu o peixe	owan kuza pira a?e
animal	foi o queixado	tazahu ru?u
animal	o que foi que o queixado comeu na roça	ma?e tazahu u?u kope ra?e
animal	o homem alimentou o peixe	opoz awa pira a?e

Table 2: Statistics on sources for exercise generation. For each language, we have the count of sentences that had at least a single concept associated (has_concept) and their respective translations to portuguese (pt) and english (en).

language	has_concept	pt	en
Tupinamba	True	0	140
Tupinamba	False	0	409
Teko	True	0	19
Teko	False	0	95
Munduruku	True	22	22
Munduruku	False	155	156
Makurap	True	0	15
Makurap	False	0	37
Karo	True	0	260
Karo	False	0	664
Kaapor	True	0	58
Kaapor	False	0	83
Guajajara	True	719	487
Guajajara	False	1172	806
Akuntsu	True	25	186
Akuntsu	False	36	325

3 Challenges and Limitations

Our prototype falls short in several aspects, from the difficulties of working with limited sources of data for exercise generation to ethical concerns, now we examine all the learnings and challenges to actually build a working system for BIL. As we discussed, our work relies on TuLeD and TuDeT as source for exercise generation. Both databases were developed by compiling several sources from the literature, so there was no structured data gathering process and, thus, the data may be seem questionable in many senses. First, we could observe that it is severely incomplete, notably when we consider coverage of dependency trees with translation to portuguese. Since many works that were used as source for TuDeT were carried out by foreigner research groups, most of the translations are in english, see Table 2. The lack of portuguese translations hinder their application for language learning purposes targeting brazilian people. In fact, we only had portuguese translations for "Guajajara", "Munduruku" and "Akuntsu" out of the 8 languages available. Additionally, we applied a data cleaning process to fix spelling and remove citations in the sentences themselves. Often the translated sentence would include a citation to its original work. For example, the sentence "opo?o aka?u a?e" was escorted by its portuguese translation "ele colhe cacau (harrison, 2013:12)", where there is a citation to the Portuguese-Guajajara dictionary (Harrison and Harrison, 2013). The link between the treebank and TuLeD also face issues related to coverage, see Table 2. Finally, it is worth to note that the material available in the treebank was not necessarily designed for educational purposes and, thus, require moderation if ever properly applied in practice.

Besides the practical limitations of our data sources, it is worth to comment on some ethical concerns. BILingo prototype and its underlying data sources were designed without substantial indigenous community involvement (Pinhanez et al., 2023). First, since TuLeD and TuDeT compile plenty sources from the literacy, it is hard to ensure that their data gathering procedures were compliant with ethical guidelines (Lewis et al., 2020), for example Los Pinos Declaration [4], or even if all their translations are validated by actual indigenous speakers. Here we should note that any language learning tool on BIL should rely on data sources that were carefully designed in partnership with indigenous communities.

4 Conclusion

In this case of study, we explored the development of a language learning tool for BIL. We described how such a tool could work by detailing the student progression through course sections, lessons and exercises. We managed to use an existing dependency treebank (TuDeT) and a lexical database (TuLeD) to generate exercises. We were able to produce a working prototype and validate the potential of using dependency trees associated with lexical database to automatically generate exercises. Finally, we discussed the challenges and limitations of such system from practical and ethical perspectives.

Future work should develop data gathering protocols for creating treebanks and lexical databases with indigenous communities, and oriented for educational purposes so that we can have sufficient and reliable data sources to build effective learning tools in practice. Additionally, once it is possible to release such a system, research should be conducted to evaluate the engagement on indigenous communities and optimize the learning system so that students stay engaged.

[4] https://unesdoc.unesco.org/ark:/48223/pf0000374030

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