

Using NLP to Support English Teaching in Rural Schools

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Abstract

We present a web application for creating games and exercises for teaching English as a foreign language with the help of NLP tools. The application contains different kinds of games such as crosswords, word searches, a memory game, and a multiplayer game based on the classic battleship pen and paper game. This application was built with the aim of supporting teachers in rural schools that are teaching English lessons, so they can easily create interactive and engaging activities for their students. We present the context and history of the project, the current state of the web application, and some ideas on how we will expand it in the future.

1 Introduction

This paper presents an ongoing project on developing a web application that uses NLP tools for building exercises for teaching English as a foreign language (EFL). The aim of the platform, called CINACINA¹, is to assist teachers in the creation of activities based on some topic or text they are working in the classroom.

As we are a Spanish speaking country, the universalization of English teaching throughout all primary schools is one of the objectives of the national public education administration in our country. Some of the obstacles for achieving this goal in rural schools are the lack of qualified specialized teachers and the poor Internet connectivity in rural areas, which renders solutions based on videoconferencing impractical for these purposes. Consequently, a program was designed for these schools where classroom teachers, who may not have a good command of English, learn in conjunction with children, with remote support of English teachers. In this context, the application we are building is meant to be an aid to rural school teachers, providing exercises that could be used out of

the box, tools for creating new ones, and an interactive platform with exercises and games that helps to motivate the kids learning the language.

The rest of this document is structured as follows: section 2 presents related work and important concepts to understand the context of the project; section 3 introduces the history of the project, how and why we began creating it; section 4 describes the application built so far and its main features; section 5 presents the interactions we have had with the community and how it impacted the project; and finally section 6 shows some conclusions and future work.

2 Background

The interest in educational applications has been present in the NLP area since its beginnings (Litman, 2016), being the automatic correction of students' assignments one of the most explored topics. This interest has been increasing in the Computational Linguistics community, leading to the creation in 2017 of the Association for Computational Linguistics Special Interest Group for building EDUcational applications (SIGEDU)², which organizes an annual workshop specialized in this area, BEA: Workshop on Innovative Use of NLP for Building Educational Applications. The BEA workshop had its 17th edition³ this year, associated with the NAACL annual conference.

Within the area of Educational NLP, particular work has been done on the application of NLP to language teaching, a sub-area that has received the name Intelligent CALL or ICALL (CALL: Computer Assisted Language Learning) (Volodina et al., 2014). There is an annual workshop associated with this area (NLP4CALL), which will have its 11th edition in 2022⁴. Our work, framed in this sub-

¹<http://cinacina.fic.edu.uy/>

²<https://sig-edu.org/>

³<https://sig-edu.org/bea/2022>

⁴<https://spraakbanken.gu.se/en/research/themes/icall/nlp4call-workshop-series/nlp4call2022>

area of NLP for language teaching, focuses on the development of a platform of educational activities to support the teaching of English as a second language. An example of such an application for creating English exercises is Language Muse (Burstein et al., 2013), which allows to select a text from a catalog, or use own texts, and generate from them exercises that evaluate morphological, syntactic or semantic concepts. A similar application but for multiple languages, REVITA, is presented in Katin-skaia et al. (2018). In Agirrezabal et al. (2019), the development of activities for vocabulary learning from transformations of children's stories using NLP tools is described. A work that has an approach closely related to ours is Fenogenova and Kuzmenko (2016), which builds English exercises of different types, but mainly focused on learning collocations in English for more advanced students.

2.1 English teaching in our country

For several decades English and other foreign languages have been taught in secondary education. In 2006, the National State Education Administration (ANEP) set the goal of teaching English to primary school children nationwide⁵. However, the main problem was the lack of qualified teachers.

In 2007, the country adopted the One Laptop per Child (OLPC) program⁶, which is developed under the umbrella of Ceibal⁷. In 2012, a new program was developed to teach English via video-conferencing with qualified teachers teaching remotely and students using laptops and Internet-based resources under the guidance of the classroom teacher (Brovetto, 2015).

However, many rural schools could not introduce the teaching of English due to access or connectivity issues in rural areas. Rural schools represent almost half of the schools in the country⁸. Of 1040 rural schools, 60% do not have a stable Internet connection or are accessible for teachers of English to come to teach at the school⁹.

Consequently, a new program was designed in 2018 (Romano, 2019), in which the classroom

⁵<https://www.anep.edu.uy/sites/default/files/images/Archivos/publicaciones-direcciones/Politicasylinguisticas/documentos/comisionpoliticaslinguisticaseducacion%20publica.pdf>

⁶<https://laptop.org/>

⁷<https://www.ceibal.edu.uy/es/institucional>

⁸<https://www.anep.edu.uy/15-d/m-s-17000-ni-y-ni-os-asisten-escuelas-rurales-en-todo-el-pa-s>

⁹<https://www.anep.edu.uy/15-d-noticias-pol-ticas-linguisticas/programa-anep-ingl-s-sin-l-mites-se-implementar-en-paraguay>

teacher is regarded as a professional trained to facilitate learning. Classroom teachers may not have a good command of English, but the program is designed to allow teachers and students to learn in conjunction. Technology plays a crucial role in this program.

Most importantly, this English teaching program can be adapted to the distinct multigrade and multi-serviced pedagogy necessary for teaching in rural schools. Presently, over half of rural schools use it. Also, it is worth pointing out that it is also used in 42 special needs schools. As a result, it is expected that the country will soon be able to reach the goal of teaching English to all primary school children.

2.2 University extension

The concept of university extension, especially in Latin American universities, refers to an activity in which university and non-university actors collaborate to solve problems that affect a community, particularly with a focus on often neglected populations. During an extension project, it is expected that all the actors contribute with their respective knowledge, so that all can share to and learn from the rest in order to create new knowledge (Arocena, 2010). This has points in common with other concepts such as university outreach and engagement, although it is not exactly the same. Notice that the focus on often neglected populations implies that this kind of projects will generally be related to social good, and try to make a positive impact.

In our university in particular, extension is considered one of the three main functions of the university, together with teaching and research. The current trend is to try to create spaces that articulate the three functions, where researchers (often teachers), students, and members of the community interact in order to come up with a solution to a problem. These spaces are called *integral training spaces*. In this project, our target community are the teachers and students at rural schools. Throughout the years tens of undergraduate students have collaborated in this project, interacting with the community in very enriching ways, which complements their training as professionals.

3 History of the project

In 2016 we worked on a prototype system for automatically building crosswords from news text. The system would first extract suitable definitions from the news and then create the crosswords puzzle (Es-

teche et al., 2017). The national public education authorities saw that work and considered it had the potential to be applied in teaching. They were starting a project for trying to universalize English teaching at elementary schools, with special focus on bringing English classes to rural schools that were far away from the urban areas and had connectivity issues. Because of this, one constraint was that the tools we built had to use minimal bandwidth and should ideally run on the OLPC laptops.

Beginning in 2018, we started creating a series of prototypes of different tools and games that could be used in the context of teaching English to schoolchildren. Our aim was to bring NLP tools into the classroom that would help teachers create exercises and activities for their classes. The first attempts included: a prototype for a game application that created crosswords, word search puzzles, and a version of the battleship game adapted to practicing English oral skills (Percovich et al., 2019); and a prototype for a tool that built classic English practice exercises such as multiple choice, fill in the blanks, and joining definitions (González et al., 2021). These prototypes were tested in three rural schools during 2018, obtaining very positive feedback that helped to keep us going. However, we noticed two important things: the prototypes were still too raw to be used in a classroom without assistance, and more importantly the level of English needed to solve the exercises in the system was too high, we needed to simplify them.

In 2020, more researchers with background in linguistics and teaching English as a foreign language joined the team. They started analyzing the tool and the content we had created, trying to adapt it and also to build new content for a more beginner level based on texts provided by the Education Administration. This helped improve the contents of the prototypes, and further visits to rural schools showed that this was very useful. However, we must note that using only manually curated content was not one of the objectives we had in mind when we started working on this: we want to use NLP tools to facilitate the teachers' jobs. So at the same time we continued to explore ways to improve the tools, and create new types of games and exercises. For example some teams worked on generating QA exercises for reading comprehension automatically generated from texts (Morón et al., 2021; Berger et al., 2022), while others focused on automatic correction of texts and automatic simplification.

So far, the prototypes we had been building were all separate tools, which complicated their use in the classroom. In 2021 we were granted funding from our country's National Research and Innovation Agency (Agencia Nacional de Investigación e Innovación - ANII¹⁰), and we could hire a web developer that would create a unified platform to integrate the different prototypes. The aim was to create a web tool that could integrate the different games and exercises we had built. The platform would let the users quickly fix the errors that the NLP tools introduced, and also would serve as an environment to develop and deploy new tools and exercises.

Furthermore, since 2019 we have created several instances of *extension workshops*, which are small courses in which undergraduate students can get credits for participating in extension related projects. In our case, the students participated in the design and prototyping of new games or exercises, and also had to participate in a visit to a rural school where they could show the work and interact with the teachers and children. These activities are very enriching for the undergraduate students, because they can get out in the field to know other contexts and ways of working that they are not used to, which helps in their training.

4 Description of the application

We developed a web application that can be accessed by teachers and students. So far there are three types of users: students (with limited access), teachers (with more permissions like creating and managing games and exercises), and superusers that could also do administrative tasks.

Our intention is to make the application open source under the CC BY-NC-SA 4.0 license. Since the application is rapidly evolving as we regularly add new features and content, we are waiting to reach a stable version before releasing the code. For now the application is available to use and we are open for any suggestions. In the following sections we will describe only the most relevant content that is currently included.

4.1 Words and Definitions

The platform has a database of words and definitions. These <word, definition> pairs can be added manually on demand, but they can also be extracted using automatic processes, so it is important that

¹⁰<https://www.anii.org.uy/>

in the platform all words and definitions can be edited. Each word belongs to one or more categories, which can also be defined and assigned on demand. This base of words and definitions are used throughout the platform for generating the different games, e.g they are used as clues for crosswords, or as words to search in the word search puzzles.

In the first games application prototype (Percovich et al., 2019) we included a simple automatic definition extraction process. That process was rule-based and was very simple, so the number of <word, definition> it could extract from arbitrary text was very limited. The extractor was run over all of Simple English Wikipedia¹¹ content, obtaining an initial set of definitions, but these had two main problems: Sometimes the definition was too complex (even coming from Simple English Wikipedia); and often the definition obtained was not usable in the context of a crossword intended for children (e.g. obtaining a definition for the surname ‘Brown’ instead of the color ‘brown’). This set of pairs were used as the first word base for the platform, and they were later on manually curated and simplified.

During the development of the first prototype, the Education Administration provided us with a list of English words that should be learned by kids at the beginners level, together with their simple categories such as ‘animals’, ‘colors’ and ‘family’. This initial list was expanded using word embeddings (Mikolov et al., 2013) based technique: trying to find the closest words to the starting set that still belonged to the original category. Then we manually inspected the resulting words to see if they belonged to the correct category.

4.2 Games and exercises

The current version of the platform includes five games and exercises that can be built automatically. They all use the words and definitions base, and some can also take an input text, such as a story or article a teacher wants to work in class, to generate the exercise.

The crossword game (Fig. 1) can build crosswords using the definitions base for the clues. Teachers or students can create crosswords randomly or by selecting a category of words. As mentioned above, the initial process for extracting definitions was not comprehensive enough, so

¹¹<https://simple.wikipedia.org/>

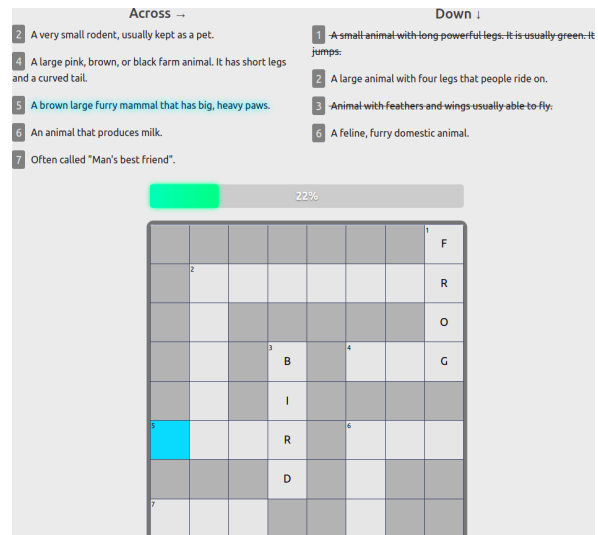


Figure 1: Crosswords game, words are selected from the ‘animals’ category.

the feature for creating crosswords by extracting clues from free text is currently disabled. We are currently working on the integration of a new definition extractor based both on rules and on a definition generation model that uses the T5 architecture (Raffel et al., 2020), which showed very promising results in our initial tests.

However, a teacher has another functionality for creating a static crossword from the word categories. They can then manually edit its definitions in case there are any errors, and save it. This creates a URL that can be accessed by their students, so all the classroom can solve the same crossword.

The platform can also build word search puzzles with words selected from the categories (Fig. 2). Originally the easy mode showed the textual words as clues, and the hard mode only displayed the

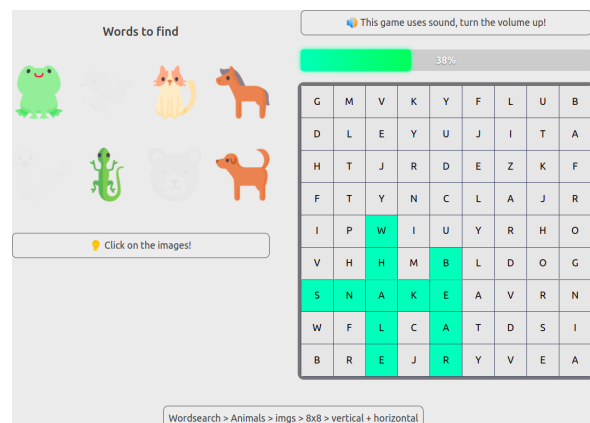


Figure 2: Word search game using the pictures mode, words are selected from the ‘animals’ category.



Figure 3: Language practice game in easy mode, the student must select the picture that represents a word.

category. But after some visits to schools, many school teachers requested we added also a game mode that shows pictures of the words to search.

The language practice game (Fig. 3) is a more classical type of exercise, where the students must select the picture that corresponds to a word (easy mode) or the correspondence between definitions and pictures (hard mode).

The story game is a game (Fig. 4) in which the students must first read a short story, and then they are shown a shuffled list of sentences extracted from the story that they must put in the correct order. The process obtains lemmas and named entities from the text, and calculates a score for each term based on how frequent it is and if it is included in the title, as children stories often include prominent entities in the title. Then it selects sentences that are the most salient based on the inclusion of

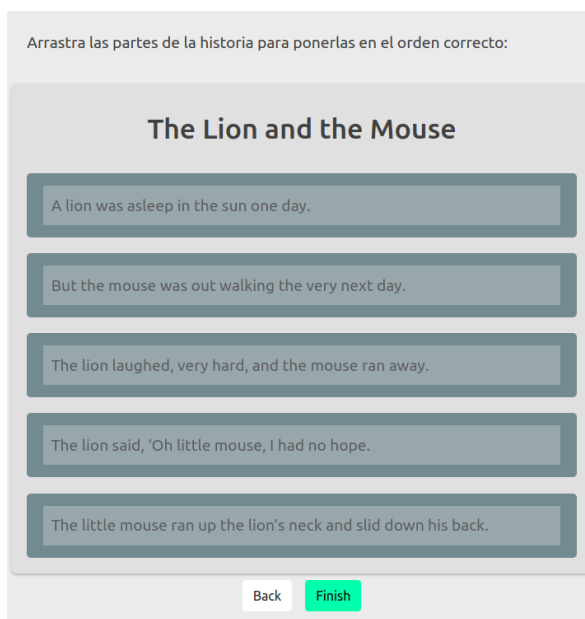


Figure 4: Story game with sentences shuffled, the student must put them in the correct order.

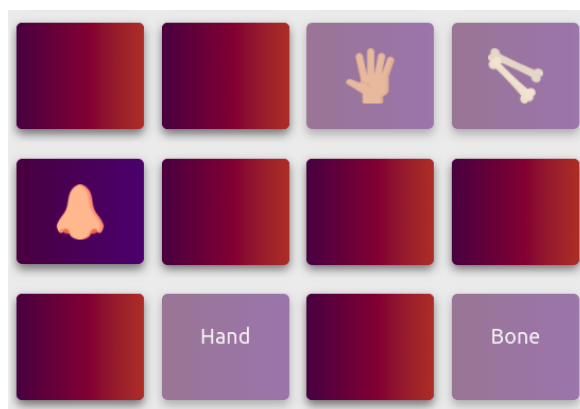


Figure 5: Memory game in easy mode using words selected from the 'body' category.

the main terms of the text. It is also possible to create a story game based on a free text input by the teacher.

The memory game (Fig. 5) is a simple game of cards where students must try to match a word to an image (easy mode), or a definition (hard mode). Although this game does not use any advanced NLP tools, it was greatly sought after by the teachers at rural schools.

The Sea Animals (Fig. 6) game is the only multi-player competitive game in the platform. Probably because of this, it is the game that is enjoyed the most by the kids in the classroom. The game is based on the classical battleship pencil and paper game, adapted to practice oral English skills in the classroom: instead of encoding the coordinates as letters and numbers, the map displays subjects and predicates. One player must read aloud the subject and predicate they want to target, and the other player must understand it in order to correctly play the game, which encourages practicing oral skills. The subjects and predicates are extracted automatically from the parse trees of a collection

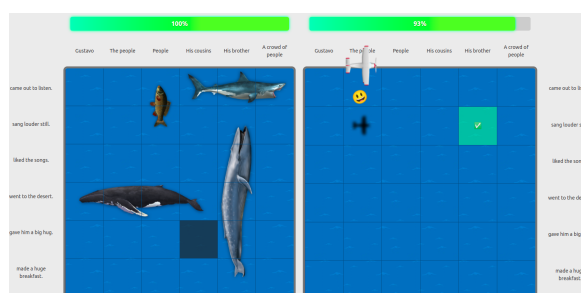


Figure 6: Sea Animals, inspired in the battleship game, the players must read aloud sentences (subject + predicate) to indicate coordinates in the grid.

of texts, and they are categorized so that they form grammatical sentences for the same map.

4.3 Expected use case

We will describe an expected interaction between users for this application. In this example the idea is that the teacher wants to use a custom crossword in their class, based on a text they are already working with.

1. A teacher logs in the application and uses the “Create crossword” functionality.
2. They paste a text they want to work with during class.
3. The application extracts as many clues as it can from the text, and creates a crossword using those clues and completing with preloaded clues.
4. The teacher checks the resulting crossword, fixing any errors that could be introduced by the process.
5. When the crossword is ready, the app returns a URL that the teacher can distribute among their students, so that everyone can work on the same crossword.

5 Contact with the community

As mentioned in section 2.2, an extension project involves many actors, and it must include an interaction, a dialogue between the university and the target community. It is expected that all actors are impacted in some way by the project. Our main ways of interacting with the community in this project have been the visits to rural schools and the training sessions with rural school teachers.

5.1 Visits and impact

Between 2018 and 2022, we have made 18 visits to a total of 14 rural schools from all over the country, each school had between 5 and 30 students. Only one of the visits had to be done remotely using videoconferencing tools, due to the sanitary situation in 2020 caused by the COVID-19 pandemic. Around 50 undergraduate students of the Engineering and Communications careers have participated in the project since its beginning.

There are 1600 rural school teachers, and 800 work in schools where they are the only teacher in charge. 100% of rural schools follow a multigrade

Survey 2019	Survey 2022
Memory game	Improve difficulty management
Improve difficulty management	Games for speech and listening
Improve texts and definitions	More multiplayer games
More games	Graphical and usability improvements
Offline mode	Accessibility improvements
	Social media features
	Offline mode
	Keep open source and free
	Unique users for teachers

Table 1: Main highlights and requests for improvements to the tool according to a teachers’ survey in 2019 and in 2022.

pedagogy. This is not only because some have very few students but also because multigrade pedagogy gives room to a particular circulation of knowledge (Santos, 2016). This model does influence the learning of English in the way students interact with one another. Our classroom observations support this, where children of different ages (from 4 to 12 years old) interacted and helped each other to play the games on the platform. We noticed a great level of engagement with the tool, especially with the Sea Animals game but also with the rest of the games.

We have offered two training sessions for teachers: one via videoconferencing (30 participants) and one face-to-face (40 participants) in a city far away from the capital city and within easy access to teachers in the region. In these sessions we provided a quick introduction to NLP and the project, and the teachers had the chance to experiment with the platform and provide feedback. Table 1 shows the main requests that the teachers had for the tool. The left side shows the main improvement ideas mentioned in 2019 (an earlier version of the tool) and the right side shows the results for the latest survey in 2022.

We note that some of the topics brought up in 2019 were solved, such as creating the memory game, and others remain. For example, we took steps towards managing the language difficulty in the games. Most of the content has been curated and preloaded since many rural school teachers are

not proficient in their knowledge of the English language. However, more language-proficient teachers will be able to edit the tool's results in order to fix issues or to tailor them to their needs. We strive to ensure the project will adapt to the language proficiency of most teachers. Another frequent request is that we add more games to the tool, but upon analyzing the suggested game ideas and other requests, we noticed that the suggestions made this year generally ask for more complex features. This could mean the teachers are starting to understand the potential of the tool and want to push the limits of what it can do.

One interesting point that was mentioned in both surveys is the possibility of "offline mode". As mentioned before, the connectivity in rural areas is not the best. In 2019 the prototype worked in a completely offline mode, and this was highlighted in the surveys as a nice feature. However, as the platform grew, we needed to move much of the heavy processing to a server, while still trying to use as little bandwidth as possible. Thus, in 2022 there is a new request to bring back some offline functionalities, for example solving crosswords or other games offline once they are already created.

In all our school visits and teacher workshops, there was agreement on the need for a web platform for games and activities adapted to the EFL national curricula. Further insights into the nature of NLP, and access to manipulate them to suit teachers' needs, are exceptionally relevant for English language teachers. NLP developments have posed the language teaching field unprecedented challenges.

Further proof of the web application's positive impact is that we have been contacted by material writers and authorities from one of the other two existing English teaching programs, Department of Second Languages (Departamento de Segundas Lenguas¹²), which is a face-to-face program that works with 10% of schools and heavily relies on the use of technology as well. Much of their interest lies in the fact that using this application can free them, to a certain extent, from relying on paid websites. The department has informally agreed to help the project collect data to develop a tool for the automatic correction of texts. This is hugely relevant to the project and a healthy signal of the interest it sparks.

For undergraduate students, the project provided

them with an invaluable and unique opportunity to gain insights into education in rural areas.

During the course of the project, our team became more interdisciplinary. The work of engineers, linguists, and specialists in education and in the field of communication studies opened new horizons to the project. Some of them have already been identified and submitted for funding, namely, the need to cater for accessibility and improve the graphic design and user interface.

5.2 Issues

In the first prototypes, we found out during the visits that the English level of the exercises was too high. On top of this, the initial hands on experiences with teachers showed that the performance of the NLP tools, such as the definition extractor, was not good enough or comprehensive enough for the types of texts a school teacher might use. We want to highlight this potential mismatch between what we tried to build and what the teachers and students wanted: We started the project with the idea of bringing NLP tools that would help teachers and students to engage with activities in the classroom, but we found out that in the first iterations they needed something simpler, with less automatic processing and more preloaded content. Because of this, special care had to be taken to curate the content of the platform, so that better suited exercises could be created from scratch in the classroom.

The platform and the activities can be adapted to work with students with different levels of command of the language. We are currently working on expanding the content to cater for this. Now that the platform has a wider content base, and many of the more basic features are covered, the teachers are starting to ask for more complex functionalities, so we can start to develop and introduce new tools that require more use of NLP.

6 Conclusions

We presented an ongoing research and extension project that uses NLP tools for aiding English teaching in rural schools. We described several activities that are integrated in the web application: a tool for building crosswords, one for building word searches, a language practice game, a memory game, and a story game. There is also a multiplayer game inspired in the well-known battleship game, dubbed Sea Animals, which lets students practice

¹²<https://www.dgeip.edu.uy/departamentos/lenguas/>

oral skills. More activities are still in development or in a prototype phase and are not included in the platform yet.

As future work we plan to incorporate more NLP in the existing activities, as well as create more activities that can exploit this processing better. For example more games that use plain text (such as stories or articles) as an input, because those are typically the most useful for the teachers working on a particular topic.

We will plan our school visits to receive more structured teacher feedback and a more precise analysis of student interaction with the games. In addition, we have outlined a plan to do a three-visit observation of teachers who are proficient speakers of English to see how they manage the tools. We are also planning to provide access as teachers to a group of teachers willing to work closely with the project in order to understand their needs and how they work with the system.

Current state of the art in many NLP tasks allows us to increase the complexity of some games as a way of improving its mechanics, e.g. the story game could try to solve the chronological graph of events and use this order instead of the narrative one. The BookNLP library¹³ has interesting features that can enrich the story game in different ways. We also have a generator of QA exercises for reading comprehension which is being integrated in the tool, allowed by recent advances in methods for question generation.

We also look for developing more multiplayer games, since those are the most engaging for the students. This vision was also shared by the teachers that answered our survey. In this line, the story game could be extended as a multiplayer game using mechanics inspired in the *Timeline* board game, where two or more players compete putting events in the correct order to win.

Lastly, we also plan to include a model for automatic correction of texts. This would help teachers to reduce the amount of work required to detect common mistakes of Spanish-speaking English students.

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¹³<https://github.com/booknlp/booknlp>

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