

Proceeding Paper

# PreLectO: An App for Cognitive Stimulation through Games in Early Childhood <sup>†</sup>

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**Abstract:** The goal of this work was to develop a mobile application for Android devices, with the objective of stimulating the cognitive skills of children from 0 to 6 years old who are suffering from learning disabilities, while focusing on the most common learning impediments such as reading and writing disorders. This application is based on games specifically designed to meet the needs of this group. For this purpose, we collaborated with professionals from an organization in the area of A Coruña who established the functional requirements of the application and carried out the validation tests. The application monitored the progress of its users, thus allowing the therapists to track them and adapt the training program to each of their individual needs.

**Keywords:** Android; cognitive difficulties; data analysis; learning; mobile application; reading and writing skills; service-learning; stimulation through games



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## 1. Introduction

Reading and writing are fundamental activities in our daily lives. Their acquisition and mastery are essential for the proper development of children and have a great impact on their adult life. But before being able to read and write, generally from the age of six years old, these children must first acquire a series of skills that will enable them to learn to read and write as well as prevent the appearance of future difficulties in this process. These cognitive abilities [1] are, among others, attention, decision making, learning, reasoning, perception, language abilities, or memory. Therefore, early attention provided in the first years of childhood will improve these pre-reading and pre-writing skills in children who are likely to have difficulties in this area.

This work presents the development of an Android mobile application, referred to as an *app*, which aims to help in this preventive intervention during preschool and early childhood education (0–6 years) by stimulating those early skills through games designed by the authors. These games use the ARASAAC pictograms of the Government of Aragon [2] as a vehicle of accessible communication for children with cognitive difficulties. One of the highlights of this *app* is that it allows the professional to follow the child's progress through a statistics module so that they can detect the area of difficulty and enhance the training by focusing on appropriate games.

This work is structured as follows: Section 2 details the materials and methods used; Section 3 shows the results of this work, with a functional *app* verified by the entity and its users; and finally, a discussion is presented in Section 4.

## 2. Materials and Methods

We used the Scrum process [3] in this work, so a total of 9 sprints of 1, 2, 3, or 4 weeks were planned, depending on the tasks to be addressed and the availability of the authors.

The total execution time was 24 weeks. In addition, this software methodology was combined with another work methodology known as service-learning [4], which provides a service to society while students acquire the necessary skills. To this end, we collaborated with a non-profit organization in the area of A Coruña, which serves, among other groups, children with learning difficulties.

Regarding material resources, an HP OMEN 15-ce0xx laptop with an Intel i7-7700HQ 2.8 GHz processor and Windows 10 was used for the development of this work. In addition, 4 mobile phones (two Xiaomi and two Samsung) and 2 tablets (one Samsung and one BQ) were used to test the developed *app* on physical devices. As for software resources, we used the following in this work: Android Studio, the official development environment for Android; IntelliJ, an integrated development environment with a “premium” version available for free through a license provided by the University of A Coruña; Kotlin, an open-source language used by Google for Android *app* development; Android, currently the most widespread open-source operating system on mobile devices; Firebase, a Google cloud platform for project creation and synchronization; Cloud Firestore, a NoSQL database hosted in the cloud; Firebase Authentication, for authentication services; ARASAAC pictograms, for accessible communication; Picasso, an open-source library for Kotlin that allows the downloading of images from a URL and uploading them to the *app* interface in real time; AnyChart, a library for JavaScript and Kotlin that represent statistical data in a wide variety of types of interactive graphics; and finally, LaTeX and Git as text composition and version control software, respectively.

### 3. Results

As a result, we have a functional *app* called PreLectO that allows access to both game and administration modules. Regarding the game module for users, we implemented 9 games (see image on the right side of Figure 1), allowing for the selection of the category to be trained, the number of times the game was to be played, or (if possible) the type of game, always with immediate feedback on game performance. To summarize, the nine games implemented are as follows:

- In the first game, referred to as *Relaciono*, the user selects one of the shown objects whose name begins with the given letter (see the first image on the first row of Figure 1);
- In the second game, referred to as *El intruso*, the user must identify the intruder from among four images, which is the one that does not belong to the semantic field (see the second image on the first row of Figure 1);
- In the third game, referred to as *¿Cuál falta?*, the user must select the letter that completes the given word, with an image provided as support (see the third image on the first row of Figure 1);
- In the fourth game, referred to as *Adivino sonidos*, the user must identify which image corresponds to a given sound (see the fourth image on the first row of Figure 1);
- In the fifth game, referred to as *Palabra correcta*, the user makes associations between uppercase and lowercase letters or words (see the last two images on the first row of Figure 1);
- In the sixth game, referred to as *¡A contar!*, the user practices on counting elements (see the first two images on the second row of Figure 1);
- In the seventh game, referred to as *Veo veo*, the user must use his/her visual recognition skills to find a certain object in a grid of elements (see the third and fourth images on the second row of Figure 1);
- In the eighth game, referred to as *Memorizo los sonidos*, the users work with auditory memory by identifying sound sequences (see the fifth image on the second row of Figure 1);
- Finally, in the ninth game, referred to as *Encuentro fonemas*, the user finds the object whose name includes the given sound (see the last image on the second row of Figure 1).

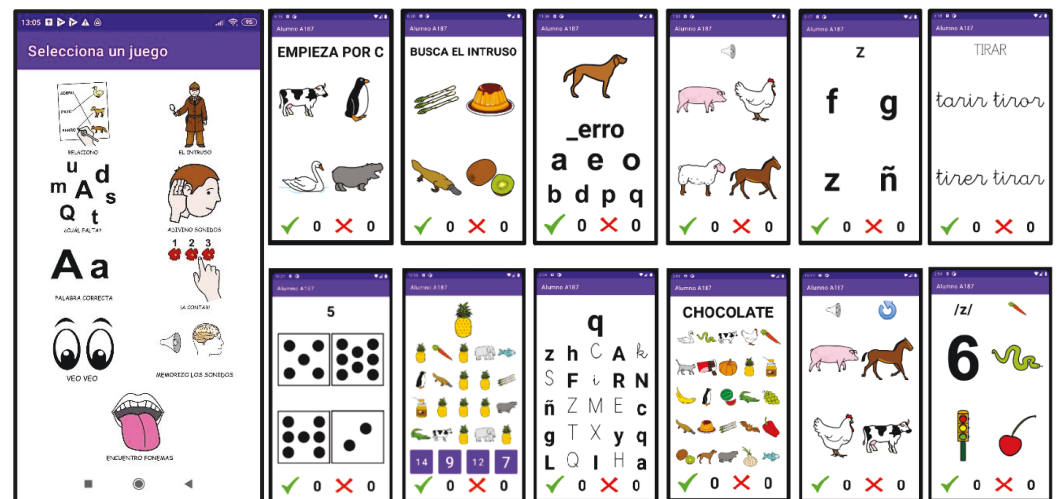


Figure 1. Game module menu (left) and some images of the games on the two rows (right).

For the administration module, we developed a user management system and another one for recording results during the sessions. These results can then be visualized by the specialists on graphs such as the one shown in Figure 2. On these graphs, we can see statistics such as the time required to achieve a successful outcome, or the percentage of successes, which will allow a time analysis of the child’s progress according to the skills that were being worked in each game or in a set of games, subsequently recommending a therapy adapted to each scenario.

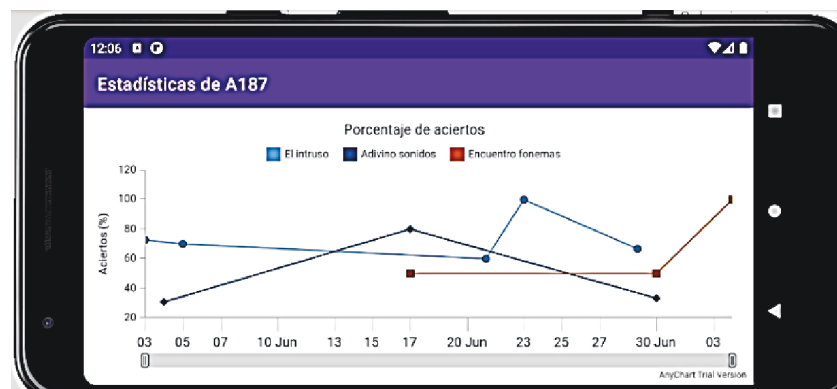


Figure 2. Example of an image of statistical results to track the child’s progress.

Throughout this development, two acceptance tests were performed by the entity—one at the end of the 5th sprint and another at the end of the 7th sprint in our Scrum methodology. Both tests were satisfactorily passed and some changes were incorporated into the app as a result. So far, only one 6-year-old user has tested our app; the child adequately responded to the therapy performed after using it.

#### 4. Discussion

As a result of this work, a functional mobile application that responds to the needs of children with reading and writing disorders is now available. This was made possible by following the indications of both required functionalities and modifications after two validation tests were carried out by a social entity in the area of A Coruña on different versions of the application.

PreLectO allows the training and monitoring of the child’s progress, which is essential for therapies used by professionals in these types of entities. In addition, stimulation through games specifically designed for young children attracts the attention of the child who, in this way, learns by playing.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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