Glyph Reader App: Multisensory Stimulation Through ICT to Intervene Literacy Disorders in the Classroom

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Abstract. This article shows the experience in the implementation of a tool called Glyph Reader, which is an application that has two interfaces, Web and Mobile and that responds to the need for an educational and interactive resource whose main objective is the Multisensory stimulation for literacy training in a population with cognitive disabilities and/specific learning disorder. The design of the activities that this application has is based on the theoretical model of multisensory stimulation Orton Gillingham, which seeks the development of basic skills for decoding isolated words based on a phonetic - graphic analysis of them. The techniques within this model use the basic concepts of intersensory integration of simultaneous visual-auditory-kinesthetic- tactile differentiation (VAKT), to which the Glyph Reader application takes full advantage, by including graphic phonetic recognition and training activities of syllables/words (exercises with symphons and exercises with combinations of consonants or working syllables), which pass from basic levels to complex levels of decoding, necessary for the development of literacy skills. The study sample for software validation is 250 students from the Eustorgio Salgar educational institution, in the municipality of Puerto Colombia, in the department of Atlántico - Colombia

Keywords: Multisensory stimulation · Phonetic recognition · Technological platform

1 Introduction

Taking into account the needs that exist from the education sector to guarantee the entry to quality education as a fundamental right of persons with disabilities; and with it, the

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deployment for the creation and offer of pedagogical support services for the inclusion of this population, the present project is formulated and implemented which results in the design of the Glyph Reader tool, which seeks to enhance and/or develop literacy competence under a multisensory stimulation approach in population with intellectual disability and/or specific learning problems.

According to the WHO and the World Bank (2011) [1], it is estimated that more than one billion people live with disabilities (around 15% of the world population), and in the specific case of the child population (0–14 years), Statistics reveal that an average of 95 million children (5.1%) present some type of disability, being vulnerable populations, those with low economic income or belonging to ethnic minority groups, who present a significantly higher risk. In the child population, it has been identified that one of the disabilities that have the greatest impact on functionality and school adaptation is Cognitive or Intellectual Disability, with a prevalence of 1% according to the DSM-V Diagnostic and Statistical Manual of Mental Disorders [2], percentage that varies according to age, as well as the level of commitment (intellectual disability of severe functional commitment occurs in 6 of every 1000 people).

Intellectual Disability, is defined by the American Psychiatric Association [2] as the deficit in intellectual functioning (reasoning, problem solving, planning, thinking, academic learning, among others) confirmed through standardized clinical evaluations or intelligence tests; also involving deficits in adaptive functioning that result in the non-achievement of social and cultural standards for personal independence and social responsibility. According to Márquez [3], social and educational intervention implies recognizing that intellectual disability impacts on family and community adaptation in which the child develops, which is why timely school insertion must be taken as a priority goal associated with the improvement in the quality of life, since it tends to reduce barriers to learning, participation, and promote social inclusion.

Along with intellectual disability, other difficulties present in early childhood are related to learning problems in reading and writing. Hallahan, Kauffman and Lloyd [4], point out that the reading disorder (dyslexia) is frequently associated with the disorder of calculus and written expression, being relatively rare to find any of these disorders in the absence of it (the reading one). Reading difficulties are very important to evaluate, since the disparity related to the development of these competences leads to significant implications in the success of other academic areas [22, 23]. They also highlight the fact that skills in this area are considered the most valuable for culture. That is why, in the elementary grades, much of the curriculum focuses on the acquisition of reading ability and in the secondary grades it is the main vehicle for the presentation of information in the contents of different subjects.

In a population without some type of disability, McLoughlin and Lewis [5], point out that, by the third grade, students with reading problems begin to fall behind their classmates in other subjects. Thus, according to Stanovich [6], one of the consequences of this is that these subjects have less access than their peers to sources of information; In this way, while children who have already appropriated reading obtain new information through the use of their ability, those with difficulties continue to fall behind in other areas, differentiating themselves from their peers in the degree of knowledge and information they provide. the work material for the development of your intelligence [24, 25].

One of the strategies to facilitate the social inclusion of people with disabilities and reduce the inequality gap is through technology. According to Aleída Fernández and Yinzú Nairouz "ICT can provide socially rich environments so that people with disabilities can make their disadvantage visible through dialogue and participation in different contexts on and off the Internet." In view of this, the need for actions that seek to know the current situation regarding the availability of enriched projects, tools and inclusive spaces through the use of IT becomes visible [28, 29].

2 Brief Review of Literature

Doval [7], performs algorithm analysis in the English language. In this work we experiment with a wide range of phonetic algorithms for the English language. The objective of this experiment is to identify different phonetic variables within the framework of the analyzed texts that serve as support for the automatic analysis. Ram [8], analyse the difficulty of detecting voice expressions, based on large voice files. The author performs an exploration based on deep neural networks to be able to analyze the different phonetic spaces and subspaces for the extraction of patterns in the different queries that are required to be performed on the audio that is analyzed.

Kos [9], developed a support platform for multilingual analysis for the detection of different phonetic patterns in speech action. The main objective of this work is to achieve a rapid adaptation of the Slovenian base language to different languages through voice processing. Ghosh [10], focuses its work on the interpretation of the script Devanagari, which is considered as one of the most popular scripts in all of India, for the analysis of the respective patterns and symbols in the application Hidden Markov Models (HMM) has been used for detection Automatic of the different symbols. Cooper [11], studies the formal analysis of the analysis of Dutch English audios, to determine the number of coincidences in the language using neural networks and computational intelligence.

At present, many focused applications have been developed whose purpose is to take advantage of the use of ICT, as support for the improvement of intellectual disability, which are related below:

- Read it easy [12]: This application was developed by the Spanish Confederation of people with intellectual or developing disabilities FEAPS, which aims to support the learning process Reading, aimed primarily at people with intellectual or developmental disabilities or those who have difficulty reading. This project has allowed the adaptation of literary works in an easier to understand format for adaptation to reading and understanding. In the same way this application also has application in the learning of the Spanish language for immigrants to this country.
- Special Words [13]: This application allows you to support children with special educational characteristics in the recognition and learning of words. This process is achieved by matching each of the words with their drawings and sounds. This application includes the use of 96 base words, which can be customized, in the same way children can organize these words and also add others that are related to your daily life as household items, family members, friends among others. The application manages difficulty levels to be able to evaluate the level of learning of users.

- Special Numbers [14]: The main objective of this application is and develop in young people and children with learning difficulties, learning numbers, working mainly in the areas of: Numerical comparison, Ordering and counting. For the development of this application, there was the participation of parents, children, teachers and psychopedagogues, taking into account the way in which children of different ages learn acquires mathematical skills and abilities.
- Series 1 [15]: Focused on children from 3 and a half years, the Series 1 application allows the ordering of objects taking into account their size, color, shape, among other features. This apps are
  It is made up of a set of several boards in which children manage to visualize different objects that they must order in accordance with the request made by the software.
- KIMI [16]: This application was developed by the University of Deusto and the Down Syndrome Foundation of the Basque Country, designed to promote healthy living habits in children and adolescents with intellectual and intellectual disabilities. The application achieves this goal through its central character Kiwi, an alien who arrives on earth and needs to learn the customs of the planet, through interactive and intuitive approaches.
- Drawing [17]: This application was developed by Global Labs, whose objective is the stimulation of space construction in children. Through colorful and entertaining scenarios, children must locate objects that disappear from the stage. The child makes the selection and change of position of the objects from the initial position to the final position, when he manages to position the objects correctly he advances in the application levels.
- Grupolandia [18]: This application was developed by ASDRA and InfinixSoft, which makes use of elements such as: school supplies, fruits, toys to stimulate the classification of different collections of objects.
- Tuli Emotions [19]: This application was developed by IBM Argentina, as a result of the On Demand Community research program of Corporate Citizenship. The end user was ASDRA (Down Syndrome Association of the Argentine Republic), which takes a set of situations from everyday life to stimulate the emotional area of children. In this application children select from a set of faces, which represents the emotion that is described in the scenario shown, when he manages to locate the emotion with the real stage he receives applause and chooses to continue with the next scenario. When the face does not match the selected scenario, it returns to the wrong starting position.

3 Methodology

For the development of the components of the Glyph Reader application, taking into account the levels of scope, it was necessary to know the characteristics at the level of learning and acquisition of the literacy competence, of those who will constitute the sample of users of the initial version of the tool [12, 13]. The importance of having a description of the levels of acquisition of literacy in the population to be involved, as well as coming into contact with teachers and parents or guardians to publicize.

This type of iterative development allowed the feedback of the research and development process in its early stages, so that from the beginning data and information can

be obtained that enable improvements to the tool designed and guarantee the success of the final product.

The characterization of the population is carried out in the facilities of the San Juan Bosco Educational Institution, which is of an official nature and is located in the municipality of Sabanagrande - Atlántico. The Institution was chosen as the basis for the development of the project, in the initial phase of characterization, since it has an included population that presents cognitive disability, in addition, it reports high rates of low academic performance and also presents a history of low performance on the Knowledge tests [14, 15]. At present, the Institution has an approximate population of 1500 students, which are distributed in the levels of Preschool, Basic Primary, Basic Secondary and Academic Average.

3.1 Population and Sampling

The population under study are students between the ages of 7 and 14, who have difficulties in learning to read or write or who have a diagnosis of cognitive impairment of the level of mild commitment.

Likewise, the choice of the sample is given by expert criteria, of a non-probabilistic type, because it is made up of elements of a population that are chosen at random [16, 17]. Therefore, the following phases were developed, within the framework of the methodology:

1. Awareness raising of the project to the community of Managers and Teachers.
2. Information Request for students who meet the inclusion characteristics.
3. Meeting with parents and students who will be part of the study.
4. Informed consent signatures.
5. Request for information on personal data and academic performance.
6. Diligence of the characterization instrument by the teacher community (group director).
7. Tabulation of data and interpretation of results.
8. Results and preliminary report.

3.2 Instruments

To obtain general information of the level in which the students are, in addition to consulting notes of the first period for the subjects of mathematics and Spanish, the Questionnaire for the Assessment of Learning Problems (CEPA) was applied, which the director of grade for each student reported [26, 27]. CEPA is "an instrument designed to be used by the teacher himself in the classroom. Its objective is to provide an instrument for the evaluation of the learning difficulties that students have in different areas, within the context of their own course. This facilitates the detection of children who are more likely to have learning difficulties and their timely referral for a diagnosis" [18, 19].

CEPA comprises 39 items that are grouped into 8 frequent areas of learning difficulties, is designed to evaluate processes Cognitive and language. The evaluation areas are as follows [20, 21]:

- Receipt of information: Includes 4 items and has as purpose to evaluate the child's ability to understand and retain oral information.
- Oral language expression: Evaluates the use of expressive language.
- Attention concentration and memory: Estimate the capacity of the child to attend in class the concepts given by the teacher. Its concentration and working memory.
- Reading: Evaluate confusion when reading letters and words, their type of reading and comprehension.
- Writing: The achievements in copying, dictation, calligraphy and spelling are evaluated.
- Mathematics: Measures knowledge of ordinal numbers, cardinal, the ability to perform arithmetic operations and the understanding its meaning.
- Global Evaluation: It is the appreciation of the intellectual capacity of the child, according to the teacher's criteria.

Based on each component, the teacher must give a score for each statement, which is expressed as follows:

0. Strongly Disagree
1. Partially Disagree
2. Partially agree
3. Totally agree

4 Applications Features

Glyph Reader is an application based on multisensory analysis that allows the strengthening of reading and writing skills in children between the ages of 7 and 13, through a guided interface of three types of activities: Drawing, Writing and Choosing (Figs. 1 and 2).

Fig. 1. Principal screen of Glyph Reader

Fig. 2. Selection roles in Glyph Reader

When the user selects the draw option, it allows him to make strokes freely so that he can draw on the screen in accordance with the phoneme he has heard. By means of the write option, the syllable that you wish to reinforce can be redrawn based on the audio that is supplied by the software (Figs. 3 and 4).

Fig. 3. Writting in Glyph Reader

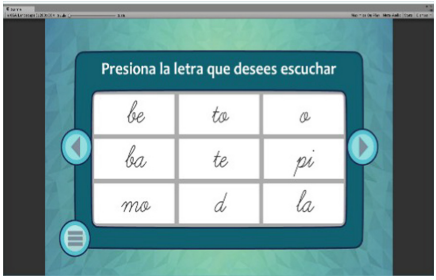

Fig. 4. Chossing in Glyph Reader

In the option you choose, given an audio supplied by the system the user must select the correct writing option. All these types of exercises strengthen the listening and writing skills of children with cognitive and intellectual disabilities to improve reading-writing skills.

5 Results

Once the students who meet the inclusion criteria (age between 7 and 14 years old, poor performance in literacy tasks, identify a diagnosis of mild cognitive impairment or difficulty in reading or writing learning) have been identified and whose Parents or guardians sign the informed consent, an initial group of 59 participants is obtained, from which the following information is obtained (Table 1):

Table 1. Age table

Age	Frequency	Percentage
7	1	1,7%
8	13	22,0%
9	14	23,7%
10	15	25,4%
11	7	11,9%
12	7	11,9%
13	2	3,4%
Grand total	59	100%

Of the children who will be part of the research, it is found that the highest percentage is in ages ranging from 8 to 12 years, children who are behind in relation to their peers and who, according to the assessment of their teachers, present problems in the correct writing of words and syllables, incurring errors that are not admissible for their age and level of education. A homogeneous distribution of boys and girls is determined (Tables 2 and 3).

Table 2. Sex table

Sex	Frequency	Percentage
Male	29	49,2%
Female	30	50,8%
Grand total	59	100%

As shown in the Table 4, there is a greater participation of third grade students. This occurs, because in those grades the SABER tests are presented, since there is special interest on the part of the directive and teaching community to know what happens to those children who are behind in their reading-writing process despite their age and level. Likewise, it is desired to see the effectiveness of the tool in third grade children, since short-term strategies can be implemented to enhance their reading skills. On the other hand, there are children from the Acceleration and Compass programs, which include students with learning difficulties due to external variables (lack of stimulation or support at home, etc.) and/or diagnoses of cognitive disability or problems of learning.

As can be seen in the Table 4, of the 59 students belonging to the study sample, the majority (59%), that is; 35 students present a basic academic performance and 23 students (39%) a low performance. Only 1 student shows high performance according to their grades.

Table 3. Grade table

Age	Frequency	Percentage
1° B	5	8,5%
3° A	10	16,9%
3° B	13	22,0%
3° C	13	22,0%
3° D	4	6,8%
4° A	3	5,1%
5° A	2	3,4%
5° B	4	6,8%
Acceleration	2	3,4%
Compass	3	5,1%
Grand total	59	100%

Table 4. Math performance table

Math performance	Frequency	Percentage
High performance	1	1,7%
Low performance	23	39,0%
Basic performance	35	59,3%
Grand total	59	100%

Table 5. Spanish performance table

Spanish performance	Frequency	Percentage
Low performance	17	28.8%
Basic performance	42	71.2%
Grand total	59	100%

With regard to the basic Spanish subject, the students who are part of the study have a basic or low performance. As teachers were requested and as expected, students who will present problems such as confusing letters, literacy problems, difficulties in separating words, among others; They are students who have poor performance in basic subjects such as mathematics and Spanish. After the use of the software, the following improvements could be identified in the students (Tables 5, 6 and 7).

Table 7. Spanish performance table after software implemented

Spanish performance	Frequency	Percentage
Low performance	27	45,7%
Basic performance	32	54,3%
Grand total	59	100%

Table 6. Math performance Table after software implemented

Math performance	Frequency	Percentage
High performance	24	40,67%
Basic performance	35	59,3%
Grand total	59	100%

6 Conclusions

In the development of the characterization process significant advances are achieved, among which the following stand out:

1. It is possible to establish commitments on the part of the educational Institution in development of the project, as well as of the educational community and parents.
2. It is possible to present the demo version of the application to teachers, parents and students, so that they give their feedback on the tool, so that with their contributions they can go to work and improving the design and development of it.
3. It is observed in the responses to the CEPA questionnaire that teachers report difficulties in reading in children selected at the level of syllable reading, word reading and reading sentences and also consider that children have a low level of development of their processes of learning, regarding what is expected for their age and level of education.

For the purpose of giving greater impact to the final investigation, a second part of the characterization will continue, including the application of an intelligence scale (Weschler Intelligence Scale - WISC-IV) and the ENI- reading and writing subtests. 2 (Child Neuropsychological Evaluation 2), instruments that will be provided by the Psychobiology Laboratory of the Faculty of Psychology of the University of Costa CUC.

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