



USABILITY ANALYSIS AS A CRITERION FOR SELECTING MOBILE APPLICATIONS FOR DYSLEXIA CARE

Análisis de usabilidad como criterio para la selección de aplicaciones móviles en la atención de la dislexia

M. Sc. John-Fredy Ordóñez-Martínez 
Universidad de Nariño, Pasto, Colombia. 
jfordonez24a@udenar.edu.co

Ph. D. Cristian-Camilo Ordóñez-Quintero 
Fundación Universitaria de Popayán, Popayán, Colombia. 
camilo.ordonez@docente.fup.edu.co

Ph. D. Hugo-Armando Ordóñez-Erazo 
Universidad del Cauca, Popayán, Colombia. 
hugoordonez@unicauca.edu.co

Received: 26-10-2025

Accepted: 15-03-2026

Available online: 26-03-2026



ABSTRACT

Dyslexia is a specific learning difficulty that affects reading accuracy, fluency, and comprehension, as well as writing skills; thus, it negatively impacts academic performance and educational inclusion. In this context, educational mobile applications have emerged as a technological alternative to support literacy processes by providing interactive environments adaptable to students' needs. The objective of this study was to compare the performance and usability of three mobile applications designed to strengthen literacy skills among students with dyslexia: ABCDinos, Reader Pro, and Galexia. Research was conducted using an iterative methodological approach, which enabled the progressive evaluation of criteria related to accessibility, usability, motivation, and support for the development of reading and writing skills. Results show that these three applications positively contribute to literacy development. ABCDinos stands out for its playful approach, Reader Pro for its level of personalization, and Galexia for the integration of visual and auditory resources. It is concluded that educational mobile applications are a relevant support tool for the inclusion of students with dyslexia in digital learning environments.

Keywords: dyslexia; educational applications; inclusive education; literacy; mobile learning; usability

RESUMEN

La dislexia es una dificultad específica del aprendizaje que afecta la precisión, la fluidez y la comprensión lectora, así como la escritura, lo que impacta negativamente el desempeño académico y la inclusión educativa. En este contexto, las aplicaciones móviles educativas han emergido como una alternativa tecnológica para apoyar procesos de lectoescritura, ya que ofrecen entornos interactivos y adaptables a las necesidades de los estudiantes. El objetivo de este estudio fue evaluar comparativamente la usabilidad y la percepción de soporte para la lectoescritura de tres aplicaciones móviles dirigidas a estudiantes con dislexia: ABCDinos, Reader Pro y Galexia. La investigación se desarrolló bajo un enfoque de estudio de caso con metodología iterativa que permitió evaluar progresivamente criterios de usabilidad, accesibilidad, motivación y potencial de apoyo al desarrollo de habilidades lectoras y escritoras. Los resultados indican que las tres aplicaciones fueron valoradas

positivamente en términos de usabilidad y percibidas como útiles para el apoyo a la lectoescritura: ABCDinos destaca por su carácter lúdico, Reader Pro por su personalización y Galexia por la integración de recursos visuales y auditivos. Se concluye que estas aplicaciones móviles educativas representan una herramienta de apoyo con alto potencial para la inclusión de estudiantes con dislexia en entornos de aprendizaje digital, siempre que su diseño garantice una usabilidad óptima.

Palabras clave: aplicaciones educativas; aprendizaje móvil; dislexia; educación inclusiva; lectoescritura; usabilidad

ANÁLISE DE USABILIDADE COMO CRITÉRIO PARA A SELEÇÃO DE APLICATIVOS MÓVEIS NO ATENDIMENTO À DISLEXIA

RESUMO

A dislexia é uma dificuldade específica de aprendizagem que afeta a precisão, a fluência e a compreensão leitora, bem como a escrita, impactando negativamente o desempenho acadêmico e a inclusão educacional. Nesse contexto, os aplicativos móveis educativos têm surgido como uma alternativa tecnológica para apoiar os processos de leitura e escrita, pois oferecem ambientes interativos e adaptáveis às necessidades dos estudantes. O objetivo deste estudo foi avaliar comparativamente a usabilidade e a percepção de suporte à leitura e à escrita de três aplicativos móveis voltados para estudantes com dislexia: ABCDinos, Reader Pro e Galexia. A pesquisa foi desenvolvida sob uma abordagem de estudo de caso com metodologia iterativa, que permitiu avaliar progressivamente critérios de usabilidade, acessibilidade, motivação e potencial de apoio ao desenvolvimento de habilidades de leitura e escrita. Os resultados indicam que os três aplicativos foram avaliados positivamente em termos de usabilidade e percebidos como úteis para o apoio à leitura e à escrita: o ABCDinos se destaca por seu caráter lúdico, o Reader Pro por sua personalização e o Galexia pela integração de recursos visuais e auditivos. Conclui-se que esses aplicativos móveis educativos representam uma ferramenta de apoio com alto potencial para a inclusão de estudantes com dislexia em ambientes de aprendizagem digital, desde que seu design garanta uma usabilidade ótima

Palavras-chave: aplicativos educativos; aprendizagem móvel; dislexia; educação inclusiva; leitura e escrita; usabilidade.

1. INTRODUCTION

Dyslexia is a specific learning disorder primarily characterized by persistent difficulties in reading and writing; for instance, word recognition errors, slow reading speed, spelling difficulties, and limited reading comprehension. These characteristics significantly affect students' academic performance because literacy skills are a transversal foundation for learning in most areas of the school curriculum [1].

From a neurocognitive perspective, studies based on functional neuroimaging have shown that individuals with dyslexia have reduced activation in the left hemisphere's posterior reading system during reading tasks. This alteration is often accompanied by a compensatory increase in activation in anterior regions associated with phonological processes; therefore, it directly impacts the efficiency and automatization of the reading process [2]. These findings reinforce the need to design and implement pedagogical and technological strategies that support the development of literacy in students with dyslexia.

In this context, mobile learning (m-learning) has emerged as a relevant alternative in education, driven by the widespread availability and daily use of mobile devices such as smartphones and tablets. The incorporation of these technologies into teaching and learning processes has enabled the development of educational applications aimed at addressing various needs, including those associated with specific learning difficulties like dyslexia [3].

Mobile devices act as platforms facilitating access to applications distributed through digital stores, which offer a wide variety of educational tools. These applications incorporate interactive and multimedia resources that can foster autonomous and adaptive learning, provided they exhibit adequate levels of usability, accessibility, and pedagogical suitability. For students with dyslexia, usability plays a fundamental role, as an inadequate design can increase cognitive load and hinder the learning process [4].

The main objective of this article is to evaluate the usability of a set of mobile applications aimed at students with dyslexia to identify which ones offer the best conditions in terms of user experience and potential support for literacy. To this end, aspects such as ease of use, interface clarity, navigability, adaptation to user needs, and support for learning processes related to reading and writing are analyzed.

The systematic evaluation of these applications will make it possible to identify strengths and limitations in their design and functionality, and to make comparisons that will help determine which tools are most suitable to support the educational process of students with dyslexia. Hence, the study seeks to provide evidence that serves as a basis for the informed selection of mobile applications in educational contexts, thus promoting the effective use of technology to support the development of literacy skills. This article is organized as follows: Section 2 refers to the background, Section 3 covers the methodology, Section 4 presents the evaluation, Section 5 makes an analysis of results, and the final section presents conclusions and future work.

2. BACKGROUND

Research on the use of mobile applications to support students with dyslexia has increased considerably in the last decade, driven by advances in mobile technologies and the design of user-centered educational tools [5].

From the neurocognitive field, classic studies have established that dyslexia is related to alterations in brain networks responsible for phonological and visual processing of reading, which justify the need for specific technology-supported interventions [6]. In the field of mobile learning, various authors have pointed out that educational applications can facilitate personalized learning and improve the motivation of students with reading difficulties, provided they are designed with appropriate pedagogical and usability principles [7].

According to the systematic review [4], there is a growing number of mobile applications aimed at the detection and intervention of dyslexia; however, a lack of rigorous evaluations focused on usability was noticed. Additionally, an empirical study [8] mentions that mobile applications with simple interfaces, immediate feedback, and multimedia resources can improve phonological awareness, reading accuracy, and engagement in students with dyslexia.

Therefore, from the human-computer interaction perspective, it has been shown that low usability increases cognitive load and limits the effectiveness of educational tools for students with special educational needs [9]. Complementarily, research focused on user experience has concluded that usability is a determining factor for the acceptance and sustained use of educational applications, directly influencing the outcomes [10].

Likewise, studies using standardized instruments, such as the System Usability Scale, have reported that applications with higher levels of usability generate more satisfaction, interaction, and motivation in students with dyslexia [11].

As Özbek and Torppa point out [4], although there is a wide range of applications available, current research shows a deficit of empirical studies that deeply analyze user experience. This gap is especially relevant because poor usability not only increases cognitive load in students with special educational needs but also significantly reduces the effectiveness and acceptance of technological tools [9]. Furthermore, the absence of standardized processes for evaluating usability hinders the identification of truly functional and user-centered applications, which is essential to ensure that technological interventions support, rather than interfere with, the learning process of students with dyslexia.

As underscored in the field of mobile learning [7], the effectiveness of educational applications depends on their design under appropriate pedagogical principles, including long-term validation that demonstrates a significant transfer of acquired skills to the general reading context.

Nevertheless, literature agrees that there is still a research gap in the comparative evaluation of mobile applications for dyslexia from a systematic usability approach, which limits the informed selection of technological tools in inclusive educational contexts [12].

3. METHODOLOGY

This research was framed within a single-case study of an evaluative and exploratory nature, integrating qualitative and quantitative techniques to comprehensively understand the analyzed phenomenon. This design made it possible to examine in depth the usability and perceived support that mobile applications provide to students with dyslexia. In addition, an iterative usability evaluation was incorporated. Progressive adjustments were made based on the feedback obtained during the implementation process. As an initial phase, a pilot test was conducted to verify the feasibility of the methodological design, analyze students' interaction with the applications, and assess their contribution to the strengthening of literacy skills.

For structuring the research process, an iterative approach was adopted due to its user-centered orientation and its capacity to address complex educational issues from a perspective focused on the real needs of students. This approach was integrated with the Iterative Field Research methodological pattern [13]. It emphasizes progressive experimentation in real contexts, continuous feedback, and the iterative refinement of methodological decisions based on empirical evidence obtained in the field.

Hence, iteration was implemented through successive cycles of identification, selection, evaluation, and comparison of mobile applications aimed at strengthening literacy skills in students with indicators of dyslexia. Initially, preliminary analysis criteria were established; subsequently, after the exploratory evaluation of the first applications, these criteria were adjusted and refined based on the findings obtained in terms of usability, accessibility, and pedagogical relevance. This process allowed the consolidation of a more robust comparative analysis. Therefore, iteration was not limited to the review of digital tools but also involved a continuous improvement of the analytical framework and the evaluation parameters used throughout the research.

Based on this integration, the methodology was structured into five sequential and iterative stages: Observation, Hypothesis, Implementation, Evaluation, and Analysis of results.

3.1 Observation

During the observation phase, the educational context was approached directly to identify and understand the difficulties associated with the literacy process in students with possible indicators of dyslexia. Classroom observations and meetings with teachers and students were conducted to identify pedagogical practices, limitations in reading learning, and the participants' level of familiarity with the use of mobile devices. This stage corresponded to the empathize phase of Design Thinking and constituted the basis for the formulation of the research problem.

3.2 Hypothesis

Based on the scientific literature review, which highlights the importance of appropriate pedagogical design and usability in mobile learning tools [7], as well as findings emphasizing the need for simple interfaces and immediate feedback for students with dyslexia [8], the following hypothesis was formulated:

H1. Mobile applications designed for students with dyslexia that demonstrate higher levels of usability and cognitive accessibility, measured through the SUS scale and the Likert scale, will be perceived by students as tools with greater potential to support literacy development and motivation compared to those with lower usability and accessibility.

This hypothesis guides the selection and analysis of mobile applications by establishing criteria centered on user experience, support for the altered brain networks associated with dyslexia [6], and digital pedagogical functionality. The aim is to evaluate their potential to optimize learning outcomes and long-term acceptance, thereby addressing the identified research gap in rigorous usability evaluations [4] and the need for tools that do not increase cognitive load [9].

Results obtained from the search, characterization, and evaluation of mobile applications are presented. This process was conducted to identify the most suitable applications for the research (Figure 1).

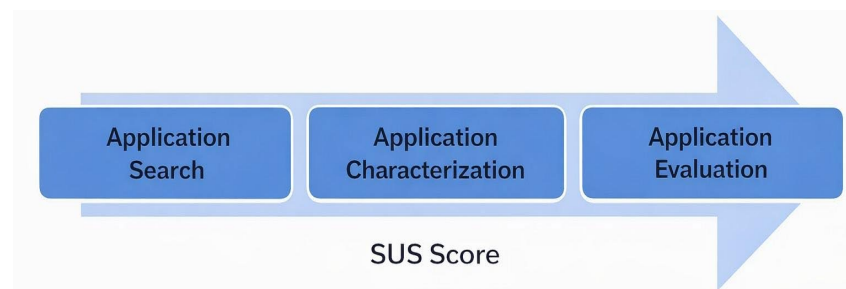


Figure 1. Process of searching and identifying mobile applications for dyslexia.

To identify mobile applications aimed at supporting students with dyslexia in their literacy process, a procedure described in Figure 2 was adopted. It included several steps to achieve the established objective:

Approximately 11 mobile applications were identified as potential tools to support literacy development and contribute to the educational process of students with dyslexia or reading and writing difficulties. This search was conducted in three different stages:

- In mobile application stores (Play Store): This platform was used due to its accessibility and compatibility with the Android operating system.
- In related academic theses: Previous research and academic projects addressing the use of mobile applications for literacy development and support for individuals with dyslexia were reviewed.
- Using web search engines: Search engines such as Google, Yahoo!, and Bing were used to identify mobile applications available in APK format, which might not be directly accessible through official download stores.

This process made it possible to gather diverse and detailed information about the mobile applications available to support students with dyslexia, ensuring an informed and well-founded selection for the research.

Initially, 11 applications were identified through a systematic search in digital stores using keywords related to dyslexia and literacy. Subsequently, inclusion criteria were applied, such as the availability of free access or a functional free version, a recent update date, compatibility with commonly used mobile devices, and an explicit pedagogical focus on supporting reading difficulties. Applications that were outdated, had restricted access, or lacked clear educational objectives were excluded.

This procedure allowed establishing a set of relevant and technically up-to-date tools for comparative analysis, thus ensuring a broad and diverse sample to strengthen the rigor of the evaluation, as presented in [Table 1](#).



Figure 2. Case study process according to Runeson.

Table 1. Mobile applications identified

Mobile applications	Year of creation	Number of downloads	Version	Operating system	Last update	Rating
Galexia	2016	+100.000	3.0.4	Android 5.0	9 September, 2023	4.2
Aprende a leer con Nok	2015	+100.000	Discontinued	Android	X	3.1
Leo con Grin	2014	+1'000.000	5.7.196	Android 5.0	22 August, 2023	4.2
Palabras Domino Free	2012	+100.000	2.7	Android 4.4	19 March, 2023	3.1
Reader pro	2018	+100.000	1.15.7.3	Android 6.0	11 May, 2022	4.8
Leer 2 Grin y Uipi	2018	+100.000	2.8.116	Android 5.0	22 August, 2023	4.1
ABCDinos	2019	+1'000.000	23.12.00	Android 5.0	26 December, 2023	4.5
Primero Lee	2021	+100.000	2.0.0	Android 4.1	10 April, 2022	4.2
Lesilabra	2021	+100.000	10.6.4	Android 6.0	21 August, 2023	4.0
Preescolar Montessori	2017	+5'000.000	5.4.1	Android 5.1	4 April, 2024	4.0

Usability in mobile applications is defined as the ease with which users achieve their goals. The ISO 9241-11 standard considers attributes such as efficiency, effectiveness, and user satisfaction when interacting with an application.

Accessibility in mobile applications refers to the ease with which any user can use them, regardless of their technical, cognitive, or physical abilities. The WCAG 1.0 guidelines are essential for ensuring that web content is accessible to all users. In this study, usability and accessibility characteristics were considered, including the System Usability Scale (SUS) developed by John Brooke in 1995 [20]. In line with [14], the ISO 9241-11 standard was also incorporated, which breaks down usability into essential components such as user satisfaction, efficiency of interaction, and ease of learning to use the application.

In studies involving mobile applications for dyslexia, evaluating satisfaction, efficiency, and ease of learning through tools such as ISO 9241-11 and SUS is crucial to ensure pedagogical effectiveness and user acceptance. These criteria make it possible to determine whether the application reduces cognitive load, encourages sustained use, and improves user engagement key elements for ensuring that the tool effectively contributes to the development of literacy skills in students with dyslexia.

3.3 Implementation

This phase of the study focused on the implementation and pilot evaluation of a set of mobile applications. Prior to this stage, a rigorous selection of these digital tools was made based on predefined criteria of usability, accessibility, and pedagogical relevance for students with dyslexia. Once selected, the applications were introduced into the school environment, where students interacted with them within the framework of specifically designed literacy activities. This process aligned with the ideation and experimentation stages of the Design Thinking approach, adopting an Iterative Field Research methodology to continuously refine the intervention.

To deepen the evaluation of the mobile applications, the construction of a single case study was proposed, involving fourth-grade students with dyslexia in a specific educational setting. This approach allows for an intensive exploration of a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not clearly evident [15]. Through this design, the aim was to test and evaluate the previously identified mobile applications, obtaining a detailed understanding of how students interact with these tools.

The proposed flexible case study framework [16] was used to guide the construction and implementation of the research, enabling the generation of meaningful results throughout its development. Although the inherent flexibility of this approach is essential for adapting to dynamic contexts, careful planning remains a crucial component to ensure the rigor and success of the research.

It is essential to clearly define the steps required to achieve the objectives of the study. The process carried out in this case study is specified in [Figure 4](#). This approach enabled the development of an appropriate planning process to ensure that the case study was properly implemented in the research [17].

For the case study, the following research question was formulated: How does the usability and performance of educational mobile applications help strengthening literacy skills in students with dyslexia within a real educational context? Based on this question, the necessary instruments were developed to validate it. The study sample consisted of 30 fourth-grade students from the Artemio Mendoza Educational Institution in Pasto, Nariño, Colombia.

Empathy with the study participants was established through direct engagement with the educational context. An exploratory study was adopted to balance students' experiences with mobile applications. A diagnostic questionnaire was applied to detect indicators of dyslexia, such as difficulties in reading, writing, and oral expression. The objective was to compare mobile applications designed to support students with dyslexia in literacy development in order to improve their skills and motivation to learn through the use of ICT.

Students presented reading and writing difficulties associated with problems in the phonological route and phonological coordination. Activities were implemented to improve phonetic and lexical awareness, identify syllables, recognize words in sentences, enhance grammatical structure and writing skills, and promote emotional education and motivation [18].

Consequently, the research sought to evaluate grammatical and written expression; lexical and phonetic awareness; identification of words, syllables, and letters; and correct order in writing.

A questionnaire based on the Likert scale and the ten usability statements of the System Usability Scale (SUS) was applied to evaluate and compare applications [19]. Each student answered the questionnaire three times, once for each mobile application. As shown in [Table 2](#), a five-point scale was employed to indicate the level of agreement with each statement, where 1 = strongly disagree and 5 = strongly agree.

Table 2. Likert scale metrics

Rating	Likert Item
1	Strongly Disagree
2	Disagree
3	Neutral and/or Indifferent
4	Agree
5	Strongly Agree

For research and data collection, these steps were followed:

- The researcher explained the initial access and use of the applications to the students.
- The applications were implemented in order from lowest to highest SUS score: Galexia, Reader Pro, and ABCDinos.
- The level of identification of words, syllables, and letters was observed during the activities.
- The researcher supervised the students' progress in each activity.
- The objective of the study was presented: to compare mobile applications that support students with dyslexia in literacy development.
- The exclusively academic use of the collected data and its confidentiality were explained.
- The evaluation was conducted according to the usability scale questions ([Table 3](#)).
- The 11 mobile applications analyzed were recommended to students as an educational incentive.

4. EVALUATION

Finally, in the evaluation phase, a comprehensive assessment of the analyzed mobile applications was conducted in order to determine which of them offers the best usability conditions to support literacy development in students with dyslexia. This evaluation was based on empirical evidence obtained during the implementation and analysis phases, as well as on the perceptions and experiences reported by students.

As a result, the most suitable application for use in inclusive educational contexts was identified, providing clear criteria for the informed selection of technological tools aimed at supporting students with dyslexia.

4.1 Evaluation of Mobile Applications

For the evaluation, the System Usability Scale (SUS) was used. This instrument employs alternating positive and negative statements to generate a score that reflects the user's perception of the usability of an application [14].

The data collection instrument used the Likert scale to evaluate the ten identified statements, as shown in Table 3. This scale allowed a score from 1 to 5 to be assigned to each statement, thus facilitating the calculation of final scores for each mobile application evaluated. For the SUS evaluation, the formula created by John Brooke was applied; therefore, the following equations were used:

$$\left(\sum_{i=1}^{10} \text{impares} - 1\right) = X \quad (1)$$

$$\left(\sum_{i=1}^{10} \text{pares} - 5\right) = Y \quad (2)$$

$$(X + Y) * 2.5 \quad (3)$$

Table 3. SUS usability and explanation.

Usability Item	What it Seeks / What it Measures
1. I think that I would like to use this system frequently.	Measures the intention of recurrent use and the perception of long-term usefulness.
2. I find the system unnecessarily complex.	Measures the perception of complexity and difficulty in use.
3. I think the system was easy to use.	Measures the overall perception of ease of use.
4. I think that I would need the support of a technical person to be able to use this system.	Measures the perceived need for external support and the user's autonomy.
5. I find the various functions in this system were well integrated.	Measures the perception of cohesion and smooth functioning among the system's features.
6. I think there was too much inconsistency in this system.	Measures the perception of lack of uniformity and predictability in the design or behavior.
7. I think that most people would learn to use this system very quickly.	Measures the perceived ease of learning for new users.
8. I find the system very cumbersome to use.	Measures the perception of friction or difficulty in interaction, affecting efficiency.
9. I feel very confident using the system.	Measures the user's confidence and sense of security when interacting with the system.
10. I had to learn a lot of things before I could get going with this system.	Measures the perception of a steep learning curve and the effort required to use the system.

This evaluation system provides users with a usability score for the identified mobile applications. It has been widely used in other studies, continuously improving the evaluation of usability in mobile and web-based content [14].

Evaluation results determined that the applications were suitable for the research, as most of the scores exceeded the recommendations established by the creators of the scale, with the exception of one application that obtained a score below 68.

Results shown in Figure 3 indicate that the highest-rated applications in terms of usability and accessibility were Galexia (85.0), Reader Pro (92.5), and ABCDinos (95.0). These scores significantly exceed the recommended threshold established by Brooke's scale, indicating an excellent user experience.

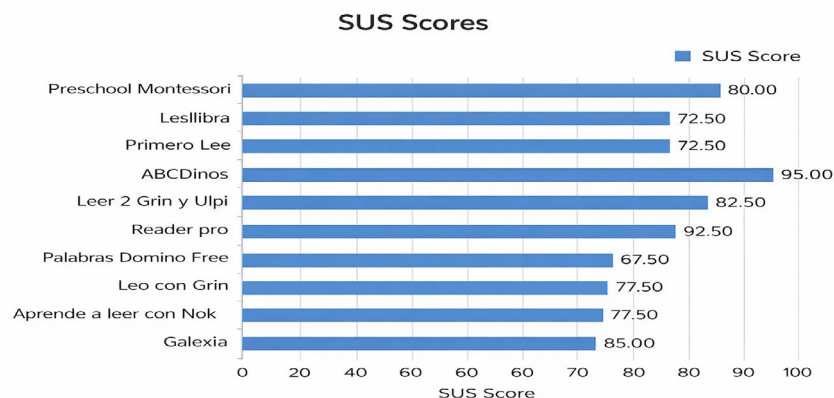


Figure 3. Characterization scores of mobile applications.

5. RESULTS

The objective was to evaluate the usability of the selected mobile applications for students with dyslexia, with particular emphasis on user interface. An initial diagnostic test was conducted with 30 fourth-grade students from the Artemio Mendoza Educational Institution, using the questionnaire designed to identify potential literacy and dyslexia-related difficulties.

Twenty percent (6 students) showed indicators of dyslexia by obtaining a total score lower than 30 points on the questionnaire by showing difficulties in the evaluated aspects, as illustrated in Figure 4.

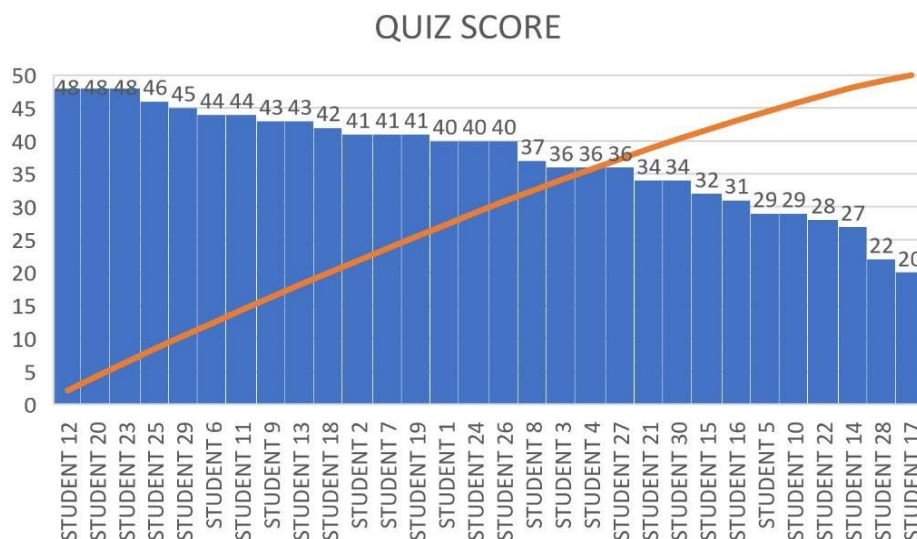


Figure 4. Scores obtained from fourth-grade students at IEAM.

Six students with scores equal to or lower than 29 points on the questionnaire were identified. They were evenly distributed between girls and boys aged 9 to 12 years, as shown in Table 4. During the first session, objectives and advantages of using mobile applications were explained, thus generating great interest and attention among the students.

Table 4. Identification of students with the lowest scores in the dyslexia questionnaire

Students	Age	Gender	Questionnaire Score
Student 5	9	Female	29
Student 10	9	Female	29
Student 14	10	Male	27
Student 17	12	Female	20
Student 22	10	Male	28
Student 28	11	Male	22

In subsequent sessions, activities were conducted with groups of two students, implementing tasks focused on completing words and practicing pronunciation and syllable segmentation according to phonetics. Each session lasted approximately one hour and did not require an internet connection. Then, the Brooke usability test was applied. The researcher explained the 10 usability statements, and students responded using the Likert scale.

As detailed in Figure 5, Galexia obtained an overall score of 82.5 in usability and accessibility, indicating a high level of acceptance according to the criteria of the SUS. This result suggests that the application provides a clear, understandable, and functional interface for the participating students. Likewise, the obtained ratings show that users perceive the tool as accessible and appropriate for activities related to literacy development, particularly in contexts where difficulties in this process are present.

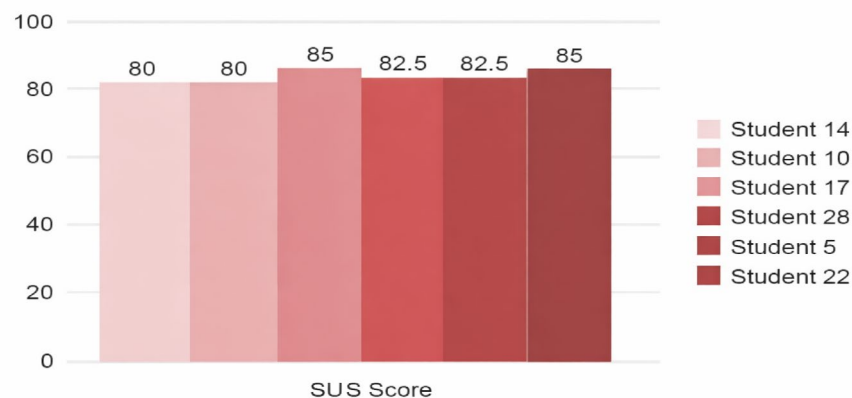


Figure 5. Results obtained from the Galexia application.

Reader Pro, on the other hand, achieved an overall usability score of 88.3, placing it at a very high level of acceptance on the SUS scale, as shown in Figure 6. Students highlighted its variety of activities and ease of use, especially in exercises associated with word identification and letter comparison. These results reflect a positive user experience and suggest that the application has design features that may facilitate its integration as a digital support resource in literacy development processes.

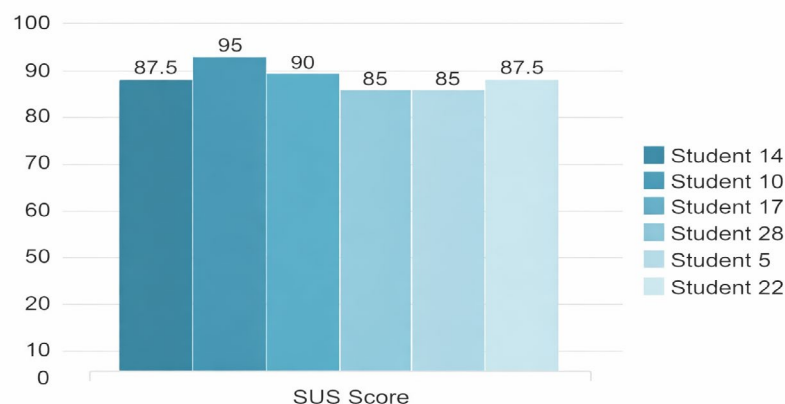


Figure 6. Results obtained from the Reader Pro application.

As shown in [Figure 7](#), ABCDinos has pleasantly surprised users with an extraordinarily high overall usability score of 91.25, standing out as an application rated “better than imaginable” according to the scale proposed by Brooke. Students praised its usability, interface, and variety of activities, and were positively impressed by its vibrant colors and the presence of engaging characters. In summary, ABCDinos far exceeded expectations, thus positioning as a highly effective tool for improving literacy skills.

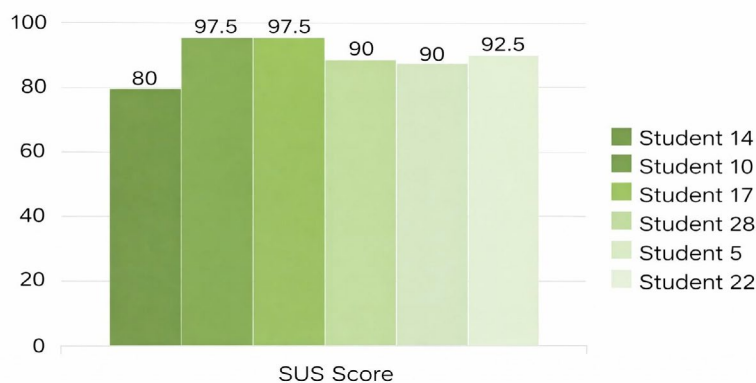


Figure 7. Results obtained from the ABCDinos application.

After the analysis, the order of the applications according to their usability scores was determined as follows: ABCDinos obtained the highest score, followed by Reader Pro, and Galexia in third place, as detailed in [Figure 8](#).

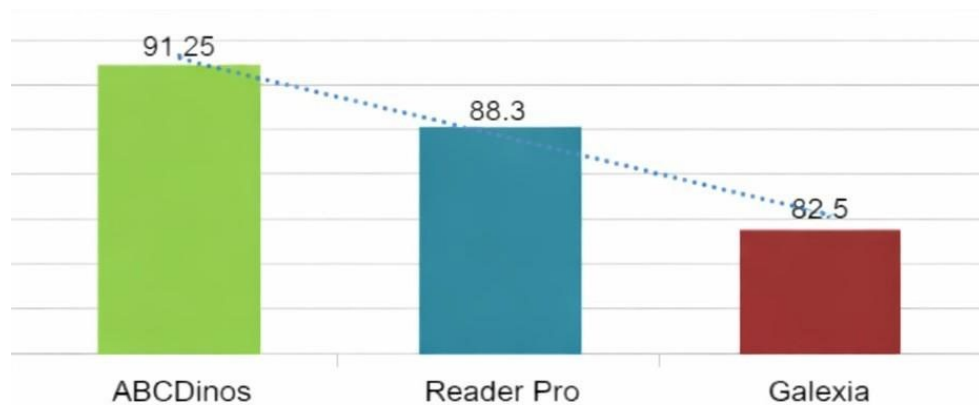


Figure 8. Final results of the study.

Study results indicated that ABCDinos was the application most highly rated by students, standing out for its ability to maintain high motivation, clarity in its activities, and accessibility. Reader Pro ranked second due to its variety of activities and its ability to adapt to each student's learning pace. Galexia, although entertaining, was affected by long waiting times, which influenced its final position in the analysis.

6. DISCUSSION

Conducting a comparative study of mobile applications designed for dyslexia, such as the one proposed, presents considerable methodological strengths. By addressing the gap identified [12] regarding the lack of systematic comparative evaluations, this type of research goes beyond individual case studies. One of its main advantages is the ability to establish objective criteria to differentiate the effectiveness, usability, and accessibility of various tools. This provides educators and parents with a solid empirical basis for making informed decisions, rather than relying on assumptions or marketing claims. Furthermore, identifying design features (interfaces, feedback mechanisms, multimedia elements) associated with high usability in this study may guide future improvements and application development, in line with what Mohamad [8] suggested regarding the potential impact on phonological awareness and reading accuracy.

However, this approach also entails inherent weaknesses and disadvantages. The main methodological limitation of a comparative study lies in the difficulty of controlling all external variables that may influence the effectiveness of the applications. Factors such as variability in students' initial cognitive abilities, the context of use at home or school, and consistency in implementation by teachers may introduce noise into the results. From a practical perspective, another disadvantage is the significant investment of time and resources required to select, configure, and monitor multiple applications in an equitable manner, as well as the potential heterogeneity in the quality of applications available on the market. Additionally, comparisons may fail to capture important nuances, as one application may be superior in one aspect (phonological awareness) but inferior in another (motivation), making it difficult to draw a simplified overall conclusion.

Moreover, this implementation also faces considerable challenges and disadvantages. A key drawback is the risk that poor usability may increase cognitive load and limit the effectiveness of the tools [9], which is counterproductive for students with dyslexia. The variability in pedagogical quality and the lack of rigorous empirical evidence for many applications available on the market represent a

significant obstacle [4]. In addition, there are access barriers such as the availability of devices, internet connectivity, and adequate teacher training to effectively integrate these technologies. Overreliance on technology without appropriate pedagogical supervision may also lead to superficial learning or the neglect of other essential social and cognitive skills.

Results presented in [Figure 3](#) allow us to infer that the applications feature intuitive interfaces, simple navigation, and clearly structured activities, aspects that facilitate students' understanding and use. Likewise, the inclusion of visual elements may enhance accessibility for children with dyslexia, as it could be associated with a reduction in cognitive load and a higher level of autonomy in learning. The evaluation conducted by experts, including the advisor and teachers from the educational institution, supports the validity of these results, considering that the applications downloaded in their free versions from the Play Store offer relevant resources for strengthening literacy skills through games and educational activities adapted to the needs of this population.

7. CONCLUSIONS AND FUTURE WORK

Making a detailed characterization of mobile applications is essential in studies such as this one because it facilitates research and provides a wide range of options for their implementation with students. In addition, designing the case study prior to the sessions is crucial, as it guides the research process and enables effective planning of the project as a whole.

The ABCDinos application was identified as optimal in terms of usability and user perception for primary school students due to its attractive graphics and its game-like interface. Students perceived the application as entertaining and similar to a video game, which became a key factor during the pilot test. Exploring the application allowed them to actively construct knowledge and facilitated the identification of letters in different typefaces.

On the other hand, applications that present slow tasks or activities that take a long time to complete may become tedious for primary school students. This can lead to a loss of attention, reduced concentration, or boredom, which negatively affects the learning process. In contrast, the applications that capture students' attention more effectively are those that offer quick actions and continuous activities that maintain an appropriate learning pace without becoming excessively long.

The proper characterization and selection of mobile applications are fundamental for optimizing learning in educational environments. It is essential to consider both the user experience and the specific features that facilitate students' active and motivated participation, thereby ensuring effective and meaningful learning.

Support from teachers and professionals in computer science and education is essential to achieve an adequate characterization of mobile applications. Such support allows the study to be conducted more effectively and to produce meaningful results in a shorter period of time. Collaboration between educators and technology experts ensures that the applications selected and evaluated meet both pedagogical and technological objectives, providing an enriched learning experience for students.

For future studies of this kind, it is essential to have access to more devices in order to conduct pilot testing. In this case, the sessions were carried out using only two mobile devices belonging to the researcher. Conducting the study in an institution equipped with devices such as tablets would allow the participation of all students and facilitate a more comprehensive and global analysis.

Furthermore, the use of John Brooke's usability metrics is crucial in studies focused on usability, as they provide well-established parameters for effective evaluation. These metrics make it possible to measure the effectiveness, efficiency, and satisfaction of mobile applications from the user's perspective, which is essential to ensure that the technological tools implemented truly benefit the learning process.

Therefore, a combination of adequate resources, interdisciplinary collaboration, and the use of robust evaluation metrics is key to conducting effective studies and obtaining valuable results that significantly improve the integration of technology in the educational field.

AUTHORS' CONTRIBUTION

John-Fredy Ordóñez-Martínez: Conceptualization, Investigation, Methodology, Writing-Original Draft.

Cristian-Camilo Ordóñez-Quintero: Investigation, Methodology, Supervision, Writing-Review & Editing

Hugo-Armando Ordoñez-Erazo: Formal Analysis, Conceptualization, Investigation, Methodology, Supervision, Validation, Writing-Original Draft, Writing-Review & Editing.

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