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Development of software to support learning for people with Down Syndrome.

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Abstract
Down syndrome is a common cause of mental impairment that has been the subject of much research, especially in learning and teaching methods. Technological advances, particularly mobile applications, offer new possibilities to improve the education of people with Down syndrome. Studies conducted by Down Spain indicate that visual tools provided by technological devices optimize learning in this group. Based on the observation that people with Down syndrome have better visual than oral learning, it is proposed to develop a mobile application focused on visual aspects such as words, sizes, shapes, orientation and colors. This application seeks to stimulate intellectual development, foster creativity and intelligence, and favor coordination between family and school in the learning process.

Keywords: *Down syndrome, Mobile application, Software.*

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I. INTRODUCTION

Down syndrome has been one of the most analyzed causes of mental deficiency from the field of research, within them have been treated ways of learning and existing teaching methods, all this in order to facilitate the immersion of these people in society; today, technological advances give a number of possibilities for different types of users, not being alien to this people with Down syndrome, as new technologies and the implementation of these in the teaching-learning processes can help counteract many of the needs that people with Down syndrome have.

According to studies conducted by Down Spain, the visual tools offered by technological devices optimize the learning of people with this condition, which enables the integration of people with this intellectual disability in society.

A mobile application will be developed for people with Down syndrome, which aims to stimulate intellectual development, so that the child is more creative, bold, intelligent and happy. Likewise, by involving the family in the learning of their children, it will favor the coordination of the family with the school.

1. Literature review

Within the literature review, the following concepts are found for the interpretation and development of this project, to obtain the software application. First, it must be taken into account that

> Down syndrome is a genetic alteration caused by the presence of an extra chromosome in the baby's cells. Chromosomes are present in most cells of human body tissues. Most people have two copies of all chromosomes. People with Down syndrome have three copies of chromosome 21. This is why it is also known as trisomy 21. [1]

On the other hand, one of the policies at the Colombian level is inclusion, and the Ministry of National Education recognizes it as a

> permanent process that recognizes, values, and responds in a pertinent way to the diversity of characteristics, interests, possibilities, and expectations of girls, boys, adolescents, youth, and adults, whose objective is to promote their development, learning, and participation, with peers of the same age, in a common learning environment, without any discrimination or exclusion, and that guarantees,

> within the framework of human rights, the support and reasonable adjustments required in their educational process, through practices, policies, and cultures that eliminate existing barriers in the educational environment. [2]

Therefore, in Colombia, some corporations and/or people with Down syndrome try to comply with the regulations that govern the above with their resources, but they do not have the necessary technological tools that can help a child in their intellectual development, and it is very difficult for educators to manage to incentivize their interest and attention in studying. It is important to keep in mind that, however, in many cases through the use of appropriate strategies, children with Down syndrome have been able to learn to read and write, and this has led to the elimination of those paradigms that were held before about people who suffered from this syndrome, who were stigmatized and not taken into account in society.

One of the important aspects to consider in the project is that Down syndrome is not a disease, nor does it have degrees, so each person is unique despite having common characteristics, but these individuals have "congenital intellectual disability and the most common human genetic alteration." [1]

Regarding inclusive practice there are many inclusive policies and methods, but the problem lies in how it is implemented in reality, because educating with disability is a challenge for parents, educators and caregivers so Faragher and Clarke propose that the main components are:

a. the willingness of school personnel to incorporate inclusive practices,
b. the identification and provision of appropriate services,
c. identification of supports,
d. the knowledge and experience of teachers to ensure that services are appropriately leveraged. [3]

Based on the above, it is a commitment of all actors to participate in formal educational processes; however, it is also "important to create a stimulating environment that provides opportunities to access the same rights, opportunities and type of experiences as the rest of the community, so that they can actively participate in the family, social, school and work environments." [4, pp. 48, 49]

Currently, educational institutions are involving in their curricula and more specifically in their chairs inclusive strategies, so that students with special conditions can receive their classes in an assertive way. But the following questions arise: What tool to use to keep the student motivated in the learning process? What strategy to use in the teaching process? What is the ideal didactics for students with this condition? This and many other questions arise when it comes to raise assertive teaching and learning strategies; therefore, a research project arises in which support people in this condition and the development of a mobile application that can achieve to awaken their interest at an early age, through game features such as images, levels, times to perform an activity, all this without leaving behind the approach to whom the software is directed.

It is that "Education for children with Down syndrome cannot be carried out in an ordinary way because children and adolescents with this condition require special attention to carry out their teaching and learning process" [5], which is why the need arises to think and develop software that supports the student.

Carrión and others propose that

> in the development of educational software, two fundamental elements should be considered: structure and learning theory. The structure is related to software engineering development models, proposing construction stages such as analysis, design, development, evaluation, and implementation, considering the approach directed towards the production of knowledge by the end user, which in this case is the student. [6]

In fact, the development of educational software on a mobile device is a necessity to innovate in the teaching method currently used for these children, contributing to improving their quality of life and ensuring equal opportunities. All this provides the resource to make effective the participation and equality that they so much need, since often neither parents nor teachers manage to incentivize their interest in studying, and the problem will have repercussions in their adolescent and adult life.

Teaching/Learning (T/L) activities are currently somewhat traditional and include the use of different didactic materials; among which those outlined in Table 1 stand out, which is adapted from [7].

Table 1: Teaching/Learning (T/L) activities

Activities (T/L)	Activities	Duration	Didactic Materials	Stage
Perceptive-Discriminative Method (Association, Selection, Classification, Denomination, and Generalization)	- Grouping of identical elements - Matching and selection of colors, vowels, and/or numbers in different environments	2 hours	Shoes, socks, gloves. Glasses, cups, jars, boxes, tubes, with their lids. Buttons, corks, screws and nuts, coins, clips, paperclips, toothpicks. Corn, lentils, beans, or any type of seeds. Baskets, trays, plates. Any type of container that can be used to put things in or on top of.	Cognition
Repetition of numbers, vowels, colors. Repetition of basic semantic fields.	Songs Repetitions of Semantic Fields	2 hours	Songs Games Blackboard Paper	Language

It is that the use of software applications "generate greater interest in cognitive development therapies so that the work sessions were more interactive and dynamic, managing to capture the child's attention for a longer time and observing the effective retention of learning". [7] the above confirms some inquiries and it is known that people with Down syndrome have a better visual learning than oral, therefore it will be easier for them to learn words, sizes, shapes, orientation, colors, among others, if they are taught graphically. Therefore, it is believed that new technologies, especially mobile applications, can help in teaching and learning.

It is that people with this condition have other types of capabilities, which is why it is necessary to "study carefully what are the peculiarities of learning of children with Down syndrome and the usual way in which these students approach the educational content" [8, p. 10].

The methodology to be used in the development of this project is the descriptive one since it allows collecting, processing and analyzing the variable characteristics that occur in the research. The phases defined for the project can be seen in Figure 1.

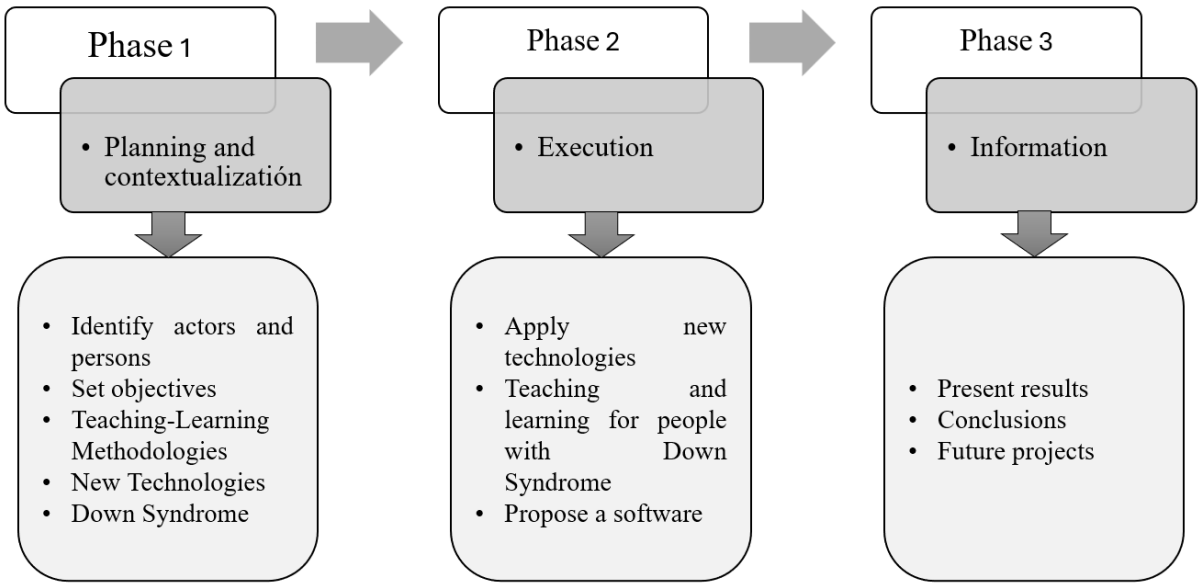

Figure 1: Methodology used in the project

The methodology to be used in the execution stage for the development of the application is the Agile Methodology for the Design of Multimedia Applications for Mobile Devices, also called MADAMDM, this methodology is divided into 5 phases which are represented in Figure 2.

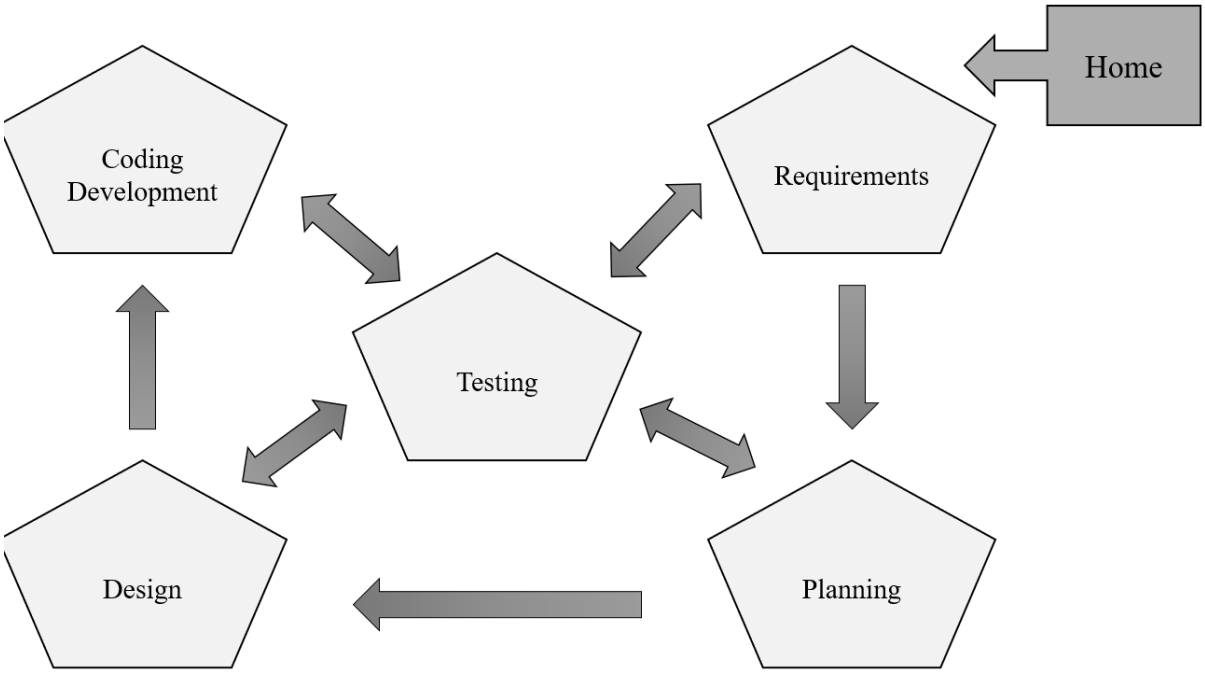

Figure 2: Development Methodology

As can be seen in Figure 2, this methodology allows testing to continue in each of the phases of the software development life cycle, this allows the development of a more complete software prototype and minimizes failures.

Applying this methodology allows to collect information, with the purpose of gathering information to develop the educational software. At this stage a focus group was implemented that includes people such as parents, caregivers, teachers and psychologists. The most relevant information can be found in Table 2, which shows the modules that make up the application.

Table 2: Module and components that make up the application

Module	Components
User module	- Implement a system of user profiles to store the individual progress of each child. - Offer different levels of difficulty adaptable to the user and his progress.
Color Module	- Present a palette of basic and advanced colors. - Allow color selection by touching or clicking. - Provide color identification exercises on everyday objects. - Provide auditory and visual feedback on correctly selecting a color.
Letters module	- Show the complete alphabet with the option to listen to the pronunciation of each letter in Spanish. - Include letter-picture association exercises. - Offer simple word formation games. - Allow letter writing practice through guided strokes on the screen.
Household objects module	- Present different spaces in a house such as: kitchen, bathroom, bedroom, living room, among others. - Show common objects in each room with their names. - Include activities to identify and classify objects by room. - Offer memory games with household objects.
Colombia departments and their capitals module	- Display an interactive map of Colombia divided by departments. - Allow the selection of each department to see its name and capital. - Include department-capital association games. - Provide basic information about each department and capital in visual and auditory form.
Instructions and rewards module	- Provide clear and simple instructions for each activity, with the option of repetition in reading and listening. - Include a system of rewards and achievements to motivate learning. These can be medals, trophies or coins. - Implement parental controls to manage usage time and access to content.
Reporting module	- Implement a user progress tracking system. - Generate performance reports for parents and educators. - Allow export of progress data for analysis.
Content module	- Allow remote updating of educational content. - Implement a system to add new modules or interactive activities so that the application grows in content.

These functional requirements provide a solid basis for developing an effective and attractive educational application for children with Down syndrome. It is important to consider the target audience, therefore, the following aspects should be taken into account:

a. User interface:
- Design an intuitive interface with large buttons and contrasting colors.
- Use clear and representative icons for each section of the game.
- Implement simple gestures for navigation (taps, swipes).
- Provide visual and auditory feedback for each interaction.

b. Accessibility:
- Include interface customization options (text size, contrast).
- Implement compatibility with assistive technologies (screen readers).
- Offer input alternatives for users with different motor skills.

c. Multilingualism:
- Provide the option to switch between Spanish and other relevant languages.
- Ensure that all content is correctly translated and localized.

d. Security and privacy:
- Implement a secure user data storage system.
- Comply with child data protection regulations.

Based on this information, the design was carried out iteratively applying the concept of Quintero et al. by means of "modular programming, by type of user and by stepwise refinement so that there are successive levels of specificity until finally reaching the detail that makes each of the modules operational" [9].

For the design of the application, it was taken into account that "children's interactions with tablets and smartphones are increasingly common, already forming part of their repertoire of games and toys." [10, p. 31]

II. RESULT AND DISCUSSION

As mentioned above, the design of this software arises from the interest in improving the teaching and learning processes in students with Down syndrome and help them to have an adequate educational inclusion.

Figure 3 shows that children with this condition are explorers and this is a way of learning, therefore the use of ICTs is a consolidated fact in the school and social development of all people, for this reason it is necessary to offer technological tools that can improve the educational response to facilitate access and use of new technologies such as different mobile devices, This is confirmed by Sereño who indicates that the use of "these resources has had a strong impact on academic work, both inside and outside the institutions, which is the place where many of the actions that will later be carried out in the classroom are determined" [11].

Figure 3: Children with Down Syndrome exploring their environment

However, it is very important to take into account what Castro et al. say, because
In order for there to be a real impact of ICT in the configuration of new ways of teaching and learning, an integrating vision of educational policies, the organization of the institution, material resources and

actors involved is required, which are part of the development of a clearly defined and shared educational project. [12]

The above is relevant because all actors must be involved and committed to this, as long as at all times we talk about inclusion.

As mentioned above, the application is to reinforce learning with people in this condition, therefore, the following navigation map was taken into account for the application, which is presented in Figure 4, which graphically represents how a child can navigate or move within the software.

Navigation Map of the Application

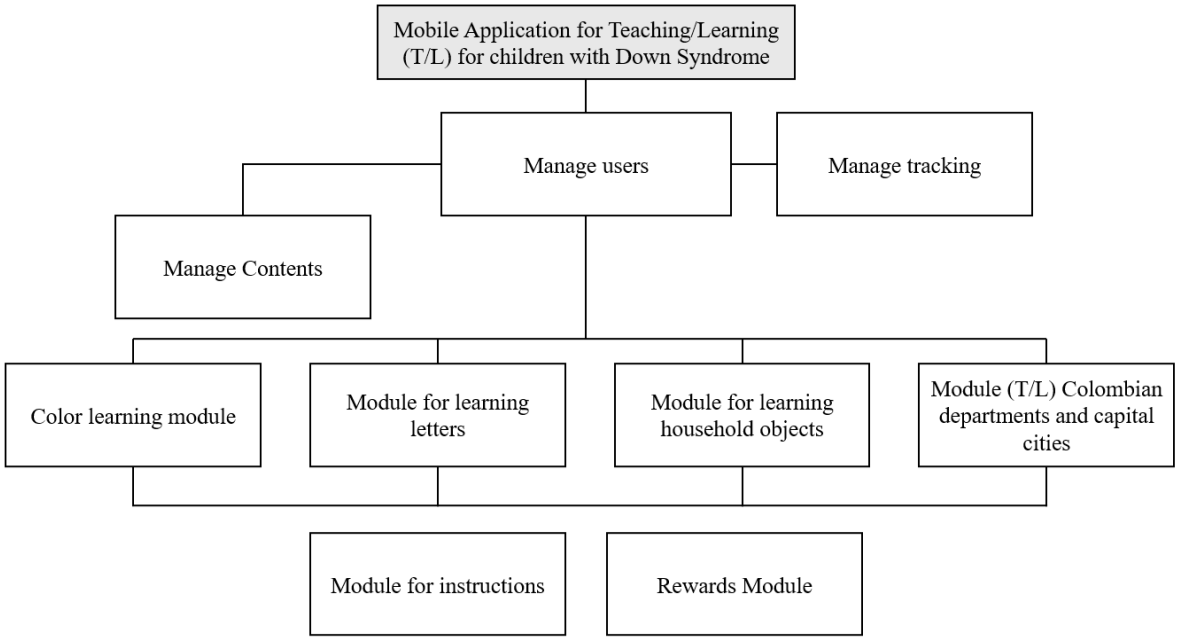

Figure 4: Navigation Map of the Application

The development of this software is a need to innovate in the way of teaching these children, contributing to improve the quality of life and ensuring equal opportunities, all this providing the resource to be effective that participation and equality that they need so much, as often neither parents nor teachers are able to encourage the interest of these by the study and the problem will affect their adolescent and adult life.

This type of application motivates the child with this condition to improve in several aspects Felix et al. indicate that

> Pedagogical experiences in special education related to the use of new technologies can represent a positive aspect in terms of integration and self-esteem of people with DS, which in many cases is damaged, affecting their relationships. But with the use of attractive devices, they are able to achieve certain goals on their own, achieving a feeling of equality and with a better predisposition towards themselves and others. [13]

Figure 5 shows a girl with Down Syndrome who, because she is a minor, her face is not shown. But with the constant use of the application, she is able to identify colors and make a drawing in the developed software.

Figure 5: Girl with Down's Syndrome using the application

In the literature review, other similar software's were found in which the application was validated, and, in their results, they presented that,

> the use of educational software significantly improved the children's attention. The subjects with attention deficit problems, dyscalculia and dysgraphia, decreased their errors by approximately 30%. This shows that the computational tool favors learning in this type of special disabilities. [14]

Therefore, it is important to continue with the validation phase to obtain statistical data and possible improvements to the software application. On the other hand, it is important to mention that the work would not have been possible without the enthusiasm and dedication of Ricardo Martinez and Seimi Sanchez, two students of the Technology in Data Systematization of the Politécnico Colombiano Jaime Isaza Cadavid.

III. CONCLUSION

Mobile applications represent a promising tool to improve learning in people with Down syndrome, taking advantage of their predisposition to visual learning and the increasing accessibility of technology.

The integration of the family in the learning process through technological tools can strengthen the coordination between home and school, thus enhancing the integral development of the child with Down syndrome.

Although mobile applications show potential to improve learning in people with Down syndrome, further research and development of measurement tools are needed to validate the effectiveness of these learning strategies in the long term.

Some research has been done and it is known that people with Down syndrome have a better visual learning than oral, so it will be easier to learn words, sizes, shapes, orientation, colors, among others, so the application was focused on these aspects and is considered as a graphic learning. Therefore, it is deduced that new technologies, especially mobile applications, can help in teaching and learning, however, for future work, an instrument should be used to measure whether this learning strategy is valid.

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