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Analysis of speech therapy systems for children with physical disabilities and speech disorders, a systematic review

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Abstract

Today, part of the world's population has an impairment in speaking or being able to communicate normally in their daily lives. In addition, a large percentage of those affected are children. Technology and computers play an important role in these types of problems that many people suffer from. Therefore, the use of speech therapy applications or systems helps the child to reduce treatment time. The research aims to identify the best computer tools and technologies and how they influence the evolution of speech therapy for children with speech disorders or speech problems. For the research, a bibliographic review was conducted in different databases such as IEEE Xplore, Scopus, Google Scholar and ScienceDirect where 49 scientific articles were collected from 2005-2020. Likewise, key words were used to carry out a search corresponding to our topic of study, thanks to which we were able to collect the necessary amount of information to nourish the question posed. Finally, it was demonstrated that the use of mobile applications with a videogame-related subject matter is able to maintain the infant's active practice of speech therapy, reducing its treatment by up to half the time.

Keywords: Speech therapy, mobile applications, speech disorders, systemic review.

Introduction

At present, according to the World Health Organization (WHO) ('OMS | 10 datos sobre la discapacidad', 2017), 15% of the population has a disability that affects physical, intellectual and emotional performance. One of these disabilities is language disorders, which have been affecting thousands of children worldwide, according to the National Institute on Deafness and Other Communication Disorders (NIDCD, 2019) between 7% and 8% of children in the world have this problem. This has become a major problem worldwide and internationally, so many organizations provide free therapy in ONGs and private institutes. These therapies tend to take years to improve patients because they are not constant and in some cases part of the population cannot access these services

because the costs tend to be high due to the length of the treatment. Under this assumption, technology and information technology did not hesitate to provide support to this great problem experienced by thousands of people. Therefore, tools and ways to provide and support the service provided by the organizations were needed. Using applications or learning systems to perform speech therapy helps improve children's learning by reducing treatment time, giving therapists greater reach and constant monitoring of their progress.

Reviewing the definition of (Dom, 2015) Nowadays, mobile applications are no longer just for entertainment, but also for knowledge, and applications capable of providing learning assistance have started to be developed. Also, they are more innovative and dynamic so that the student can learn before, during or after a class session because many of them do not depend on an internet connection.

Learning applications are starting to become more involved in our lives, many of them represented in games that try to improve activities such as memory training. Therefore, results of successful speech therapy learning applications were sought.

As mentioned in the article in (Rocha *et al.*, 2019) The use of learning applications focused on speech therapies is shown to be successful because they are efficient, effective and satisfactory for those who use them, both children and speech therapy specialists. Demonstrating in their data a significant improvement in language skills and oral expressions.

In the same way (Red Universitaria Campusvirtuales. *et al.*, 2012) implemented a robot assistant based on a mobile application in order to carry out activities capable of reinforcing the therapies outside the classroom schedule, this because the application had a system capable of storing the recordings, position of the mouth and the gestures or position of the mouth when performing the practices, thanks to having a webcam. The data collected was sent to a web system that was sent to the therapist so that they could give the corresponding advice to the patients. This system showed very encouraging results and was successfully integrated in some therapy sessions.

The main objective of this research is to analyze the types of computer tools and information technologies used in speech therapies and how they influence their evolution between 2005 and 2020. We took into consideration scientific articles and journals that were collected using different databases and an exhaustive analysis taking into consideration the types of systems, topics and the evolution of the learning therapies of the research project.

Methodology

A. Type of Study

A systematic review is an article of "synthesis of available evidence" where a review of primary studies is carried out with the objective of summarizing the information contained in an article of interest in order to compare it and demonstrate its contributions with those of other similar articles. (Manterola *et al.*, 2013)

B. Research Questions

The proposed research questions are as follows.

RQ1. What would be the best tools and computer technologies for the implementation of speech therapy systems for children with speech disorders or speech problems?

RQ2. What would be the best subject matter to develop an application or system with the objective of complementing speech therapies and how do they influence the development and/or evolution of the therapies?

C. Search Strategies

To answer our research question, a search for published articles was conducted in IEEE Xplore, Scopus, ScienceDirect and Google Academic. A total of 63 scientific articles were collected.

In applying the search for our application, the following keywords were considered:" Speech therapy app"," Speech disorders"," Speech therapy for children with applications"," mobile application for speech disorders" and" speech disorders with apps".

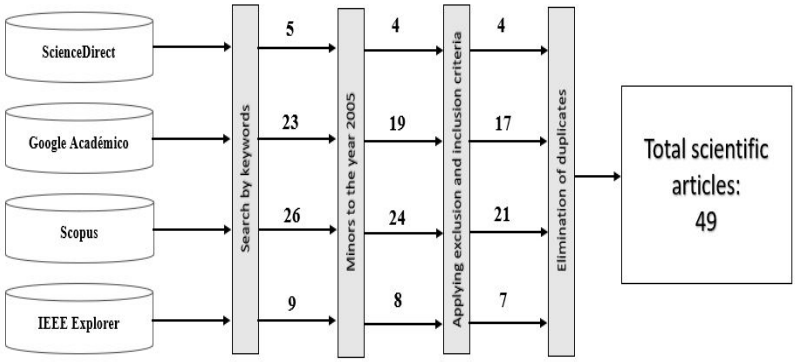

Fig 1. Prisma Diagram Methodology

D. Inclusion and Exclusion Criteria

For the systematic review study, the following inclusion and exclusion criteria were applied in the following table.

Table 1: Inclusion and exclusion criteria

Criteria		
Inclusion	I01	The period of publication of the articles should be between 2005 and 2020.
	I02	The languages included in the search are : Spanish, English and Portuguese.
	I03	The articles must include the keywords or have some relation with them.

Exclusion	E01	Purely computer-related articles on the subject, which did not provide enriching information, were exempted.
	E02	Articles that have very small test samples and do not demonstrate efficient results.

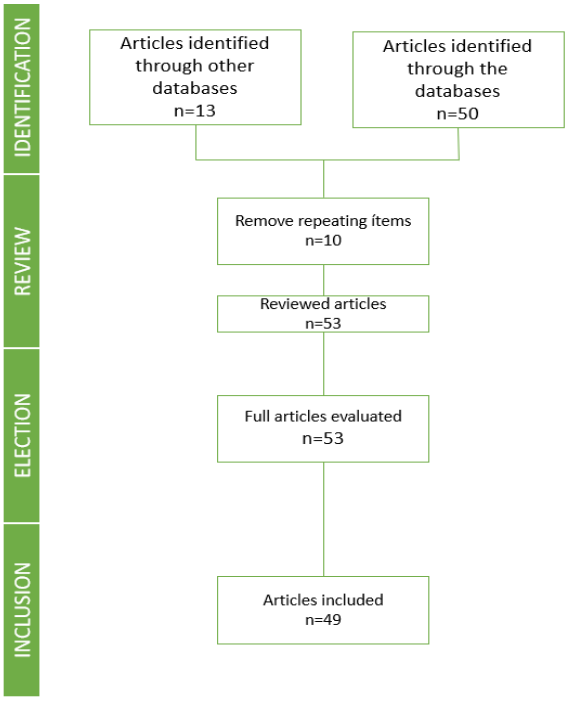

Fig 2. Document inclusion and exclusion flowchart

Results

A total of 63 articles were analyzed, which were collected in different databases already mentioned above, all of which are related to the research topic. That is, speech therapy systems for children with disabilities or speech disorders. After analyzing the articles, they eliminated a total of 14 articles of which 7 did not have information of high relevance to the research, 3 were case studies where there was no application or development test, 2 were articles more than 15 years old and the last one was a thesis. A total of 49 articles were included in the systematic review.

This graph shows the number of articles found by each database.

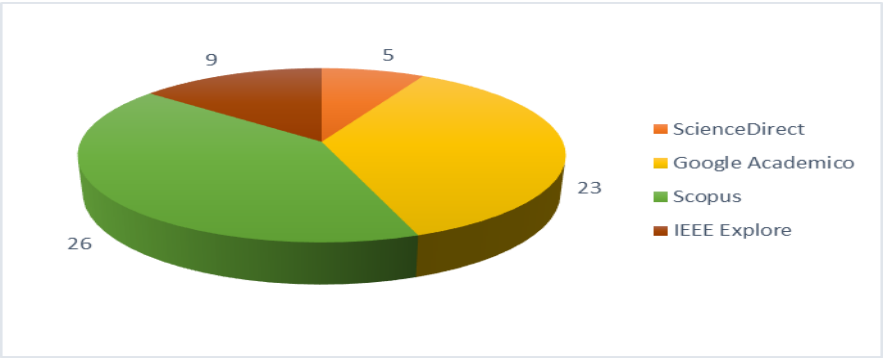

Fig 3. Items by database

This graph shows the number of articles published per year.

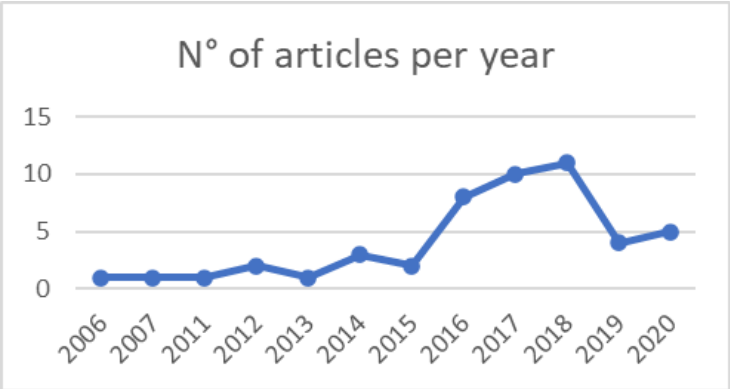

Fig 4. Articles per year

This graph shows the number of articles by country.

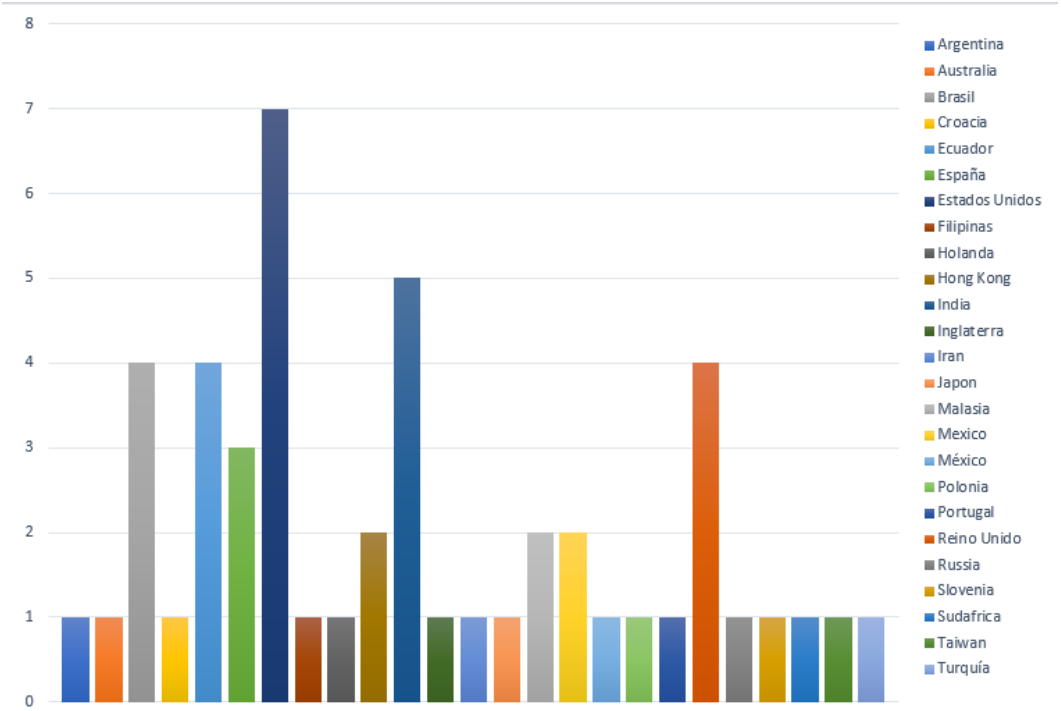

Fig 5. Articles by country

This graph shows the types of systems that were analyzed throughout the research.

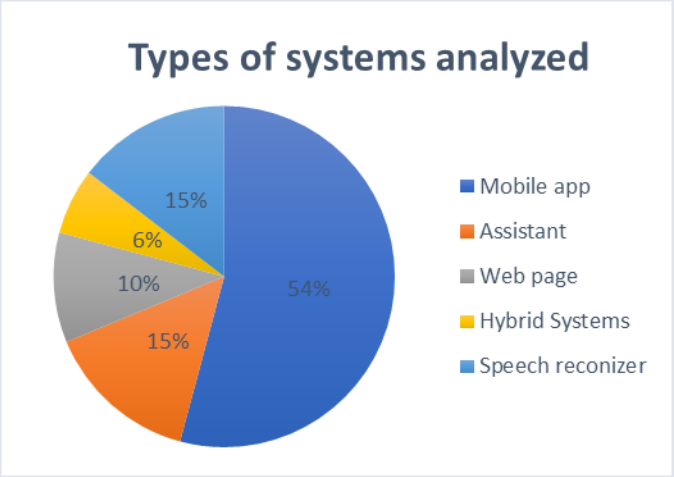

Fig 6. Types of systems analyzed

This graph shows the types of studies that were performed in the articles reviewed.

The following tables show articles divided by subject matter, which were distributed in two areas, "Mobile applications and speech recognition technologies to improve speech therapies " which had 21 articles related to mobile development applications focused on video games, along with face-to-face and face-to-face therapies "Learning and practice system" with 28 articles where independent applications are related to face-to-face therapies, web pages and easy recognition systems, voice, among others.

Table 2: Division of article by theme

	Thematic
applications and speech recognition technologies to improve speech	Educational videogames to stimulate constant practice in children
	Video games to complement specialist-supervised speech therapies
Learning and practice system	Websites and speech learning assistants
	Mobile and web applications developed by specialists
	Analysis of practice systems and improvement of current speech learning applications and robots.

The following table will show the division of the articles under the theme of mobile applications to reinforce and improve speech therapies and learning and practice systems.

Table 3: Classification of articles according to theme

Themes	References	Results
Educational videogames to stimulate constant practice in children	(Pamplona and Ysunza, 2020); (Jamis *et al.*, 2019); (Redrovan-Reyes *et al.*, 2019); (Rocha *et al.*, 2019); (Lorusso *et al.*, 2018); (Ng *et al.*, 2018); (Ahmed *et al.*, 2018); (Shenoy *et al.*, 2017); (Cercel Constantin, 2015); (Sazak, Yıldırım and Kerrigan, no date)	The following scientific articles were based on the development of an educational video game which aims to provide learning techniques for speech improvement through simple games that in turn serve as didactic practices for the patient.

These results show us the analysis of a secondary complement to face-to-face therapies using applications and video games.

Table 4. Classification of pro-thematic articles on video games as a complement supervised by specialists

Themes	References	Results
Video games to complement specialist-supervised speech therapies	(Marshalkin, Obukhova and Chernov, 2020); (Khalil *et al.*, 2020); (Du and Salen Tekinbas, 2020); (Estrada-Cota *et al.*, 2019); (Mart, 2019); (Gačnik *et al.*, 2018); (Hair *et al.*, 2018); (Nayar, 2017); (Rodrigues *et al.*, 2014); (Félix, Mena and Camacho, 2014); (Drapeau, Huynh and Nech, no date)	We were able to find scientific articles where an application was developed to complement the therapy of a patient, using video games. In addition, an expert therapist who evaluates the patient's current condition and suggests an application for a complementary therapy practice recommends these applications.

This table shows the types of web pages used for speech learning.

Table 5. Classification of articles by topic of websites and speech learning assistants

Themes	References	Results
Websites and speech learning assistants	(Arévalo Illescas and Martínez Gutiérrez, 2017);(Vijayalakshmi and Priya, 2017); (Sebastián and Lima, 2016); (Folksman *et al.*, 2013); (Red Universitaria	We were able to find a support system that complements a patient's therapy by means of speech exercises, vocalization, among

	Campusvirtuales. *et al.*, 2012); (Pentiuc *et al.*, 2010); (Tan *et al.*, 2007)	others. In addition, these systems are monitored by an expert therapist in charge of speech therapy.

The following table shows the second thematic segmentation based on mobile and web applications developed by specialists.

Tabla 6. Mobile and web applications of an educational nature developed by specialists

Themes	References	Results
Mobile and web applications developed by specialists	(Ferreira *et al.*, 2020); (Dudy *et al.*, 2018); (Sivaram, Kumar and Kumar, 2018); (Orehovački *et al.*, 2017); (Lavaissiéri and Melo, 2017); (Udayashankara and Havalgi, 2016); (Tommy and Minoi, 2016); (Grajzer, 2016); (Rybarczyk and Gonçalves, 2016); (Robles-Bykbaev *et al.*, 2015); (Awad and Piechocki, 2014)	The information collected provides us with data based on an independent system whose purpose is to provide assistance based on voice modulation practices, gestures, among others, to patients with speech disorders. However, they are autonomous systems that by themselves seek to achieve the goal of improving the speech condition.

This table shows the segmentation of practice systems and enhancements for learning applications and robots.

Tabla 7. Analysis of practice systems and improvement of current applications in speech learning robots.

Themes	References	Results
Analysis of practice systems and improvement of current speech learning applications and robots.	(Heyman, 2018); (Furlong *et al.*, 2018); (Stark and Warburton, 2018); (Javadi, Ghazvini and Dianat, 2017); (Checa-Moreno and Quevedo-Blasco, 2017); (Nasiri, Shirmohammadi and Rashed, 2017); (Yang *et al.*, 2016); (Alvarado,	The following scientific articles show an analysis of different systems and applications that are based on speech therapy for patients with these disorders. It was concluded that in most cases they should be complementary and worked in parallel with a therapy expert. In addition, the

	Coelho and Dougherty, 2016); (Foong *et al.*, 2012); (Fernandes, 2011)	quality of these systems was evaluated, showing a correct functioning and significant sections for the patient's learning.

Discussions

Different scientific articles were analyzed according to our central theme, which aims to know which are the best information technology tools for the development of speech therapies for children with speech disorders or speech problems and how therapies evolve. Criteria were also identified for these articles to help answer our question, which are: types of systems, development theme, usefulness results.

RQ1. What would be the best tools and computer technologies for the implementation of speech therapy systems for children with speech disorders or speech problems?

Figure 5 shows that most of the articles related to our topic come from North America, Brazil, Japan, and India. This result indicates that there is a greater awareness of digital tools as complements to speech therapies and that they are not as widely available in Spanish.

According to Figure 6, 54% of the applications are developed on mobile devices because they are more dynamic. Likewise, they can be designed in a friendly way and with different themes, which makes them more acceptable to them.

Table 5 and 6 shows us mobile or web applications made with specialists in order to give a control or to help a number of people who can't receive speech therapies for different reasons, so these are used as complements or forms of practice through gestures, pronunciation and repetition with the aim of improving speech.

Likewise, Table 7 shows that the use of voice recognition in the use of therapies in the practice tools as well as the use of web pages or some other device to monitor the progress of patients.

RQ2. What would be the best subject matter to develop an application or system with the objective of complementing speech therapies and how do they influence the development and/or evolution of the therapies?

According to Table 2, there are a total of 21 articles where video games are discussed as a complement to speech therapies, and a total of 28 articles where independent systems or support pages for people with low resources can be accessed free of charge.

Table 3 and 4 highlights the use of applications with video games because children are easily distracted or lose interest in things easily, which makes therapies more lasting or tedious and, in most cases, they end up abandoning them. So, video games make them more interested and can increase the practice from home or in appointments with specialists.

85% of the articles studied are about application software to help during the therapy process for children with speech disabilities or speech disorders, of these, more than 90% achieved their goal, demonstrating that the use of applications both independently and / or as additional speech therapies achieves greater effectiveness of therapies, the duration of treatment is reduced considerably as well as capture their attention thus achieving greater frequency in the practices that will generate a greater development in speech.

Most of the articles collected were developed systems that were intended to complement speech therapies as well as to give access to these therapies to as many people as possible, either because they were not available in their languages or because they did not have access to specific devices to make use of these applications.

Conclusions

Children with speech disorders or problems present difficulties in the development of therapies, as mentioned above, these therapies are of long duration due to the fact that most of them are only performed in person, have high costs and tend to be abandoned due to lack of interest on the part of the children.

In this systematic review, different articles on speech therapy systems were analyzed. Several articles demonstrated that the development and implementation of a system as an adjunct to therapies has a great utility and improvement in therapies.

This study found that mobile applications and video games make children have a greater interest in them and perform them more consistently either in therapeutic centers or at home individually. Likewise, it was possible to reduce the treatment duration from 3 years to almost half the time.

Therefore, therapy schools and parents should be encouraged to use these applications to improve the treatment of children with speech disorders or problems because they have proven to be efficient and achieve their objectives throughout the studies.

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