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Analysis of emerging technologies for the social inclusion of people with hearing disabilities: a review of the scientific literature from 2005 - 2020

Henry Melgarejo-Nagata
Facultad de Ingeniería, Universidad Privada del Norte, Lima, Perú, n00108070@upn.pe
Michael Cabanillas-Carbonell
Facultad de Ingeniería, Universidad Privada del Norte, Lima, Perú, mcabanillas@upn.pe

Abstract
Currently, hearing impairment is not alien to our reality. The limitations that these people present are reflected in the development of their communication skills, which prevents its development in the social, work and psychological sphere. There are various methods to help these people, the communication adaptations that aim to develop their social skills. One of the methods to achieve the social integration of these people is by applying ICT. For this reason, the objective of this systematic review of the scientific literature is to determine the criteria that should be taken for the development of an emerging technology for the social inclusion of people with hearing disabilities. For the preparation of this research, a compilation of 61 sources of information in Spanish and English, related to the subject, was made. The selected articles were obtained from the databases Scielo.org, Redalyc.org, Dialnet and IEEE Xplore.
Keywords: Emerging technologies, systematic review, Social inclusion, Hearing disability.

Introduction

Hearing impairment is one of the silent diseases by which part of the population has been affected, which is why the world health organization declared March 3 as the international day of ear and hearing care in search of raise awareness (BBC, 2013). Likewise, the WHO (2019) estimates that more than 5% of the world population suffers from disabling hearing loss, estimating that in the future at least one in ten people will suffer from hearing loss. In Peru, 5.2% of the total population suffers from a disability, of which 532 thousand 209 are cases of people with permanent hearing loss, the equivalent of 1.8% of the inhabitants (INEI, 2012) .

People who lack hearing sensation have a limited ability to communicate with others, which has important effects on the development of their daily lives and in their work

environment, causing most of them to hold lower positions in relation to the strength of their work (WHO, 2019).

Likewise, part of the population with hearing impairment is the victim of different situations that violate their rights. For this we must understand that sign language is a key agent of access to information and participation in all areas of society and life, so that when the use of sign language is deprived or limited, it is being violated their fundamental human rights (Hauland H, Allen C, 2009). Taking into account the above, different cases can be mentioned, such as access to public services that have a high level of difficulty for people with this type of disability due to the lack of sign language interpreters (Peru21, 2015). This not only happens in the aforementioned field, but also in the educational field, where there is no access to higher education or to institutes or universities (Valdez, 2010).

For this reason, it is important not to exempt any dilemma, in order to help these people overcome the social and communication difficulties that may arise. Likewise, one of the ways to achieve this is through the use of information and communication technologies (ICT).

For Rodríguez (2009), it manifests about ICT as the ease of storing, processing and transmitting information through the application of development techniques and devices, which can be accessed remotely from different parts of the world and putting into practice a language global.

Regarding the definition of social inclusion, it responds to equality and respect for differences, the exclusion of brands, and equitable access, to allow the participation of all as important people in society (Vallejo 2012).

ICTs are related to the definition of social inclusion, since they provide digital tools that enable the origin of new teaching, learning and social participation environments, in which individuals can choose a democratic and introspective attitude.

Given the aforementioned, this research is carried out in order to answer the question: What are the criteria that should be chosen for the development of an emerging technology for the social inclusion of people with hearing disabilities?

The objective of the research is to establish the criteria that must be chosen to develop an emerging technology for the social inclusion of people with hearing disabilities.

Methodology

A. Type of Study

This research is based on a systematic review of the scientific literature, for which a search and compilation of various study sources related to the topic "Analysis of emerging technologies for the social inclusion of people with hearing disabilities" was carried out within the time between the years 2005 to 2020.

B. Research Questions

In such a way that it answers the following questions:

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RQ1: What are the criteria to be chosen for the development of an emerging technology for the social inclusion of people with hearing disabilities?
RQ2: To what extent do emerging technologies influence the social inclusion of people with hearing disabilities?

C. Search Strategies

To search for articles relevant to the subject, the databases of ProQuest, ScienceDirect and IEEE Xplore (Institute of Electrical and Electronic Engineers) were used, which are non-profit, and have a wide collection of articles, lectures disseminated from various parts of the world, which are used by teachers, students, professionals, among others, for research of a different nature such as scientific, technical and medical, which can be downloaded or read online in operation, as well as virtual libraries that operate in a effective and efficient. In addition, articles from other repositories were added such as: Google Academic, Uniminuto, ResearchGate and the CEU Institutional Repository.

During the article search process, the English and Spanish languages that are related to the issue raised were taken into account, thus applying the use of search for keywords such as "hearing impairment", "hearing problems", "hearing", "auditory", "Hearing problems", "hearing handicap", "deaf", "emerging technologies", "ICT", "app", "software".

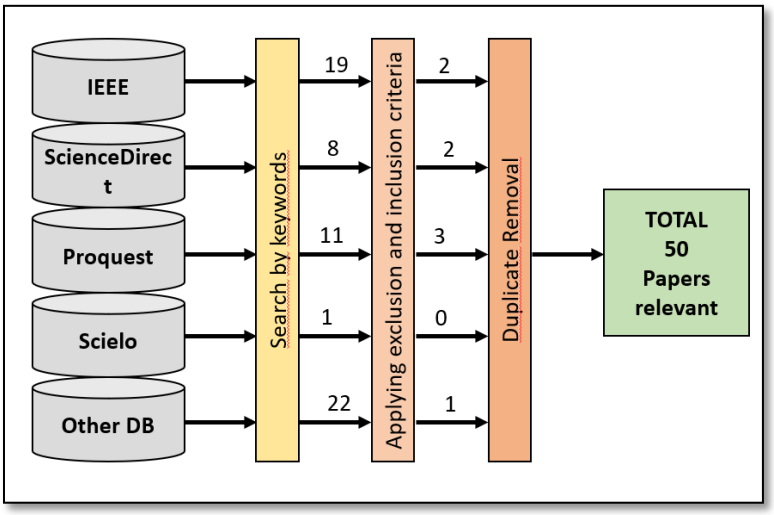

Fig 1. Prisma Diagram Methodology

D. Inclusion and Exclusion Criteria

61 articles were obtained, discarding articles from years other than the range proposed for this research, and articles that did not belong to the category of systematic reviews were also not included.

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Table I: Inclusion and exclusion criteria

Criteria		
Inclusion	I01	Articles related to emerging technologies for the social inclusion of people with hearing disabilities
	I02	Articles within the established date range
	I03	Articles belonging to the category of systematic reviews.
Exclusion	E01	Articles not related to to emerging technologies for the social inclusion of people with hearing disabilities
	E02	Articles outside the established date range
	E03	Articles that did not belong to the category of systematic reviews.

Results

Using the databases mentioned above, it was possible to collect 11 research articles in ProQuest, 19 in IEEE Xplore, 8 in ScienceDirect and 23 in other repositories, adding a total of 61 articles, which are related to the present investigation. And to which, certain selection filters were applied to discard repeated articles, research with another study method (Thesis) and articles that do not comprise the specified period (Over 15 years). Eliminating, 3 repeated articles, 6 theses that are outside the allotted time and 2 theses. At the end of the review of the articles, 50 investigations were obtained, which were included for the systematic review of the scientific literature (See Figure 2). The results will be detailed in the next paragraphs.

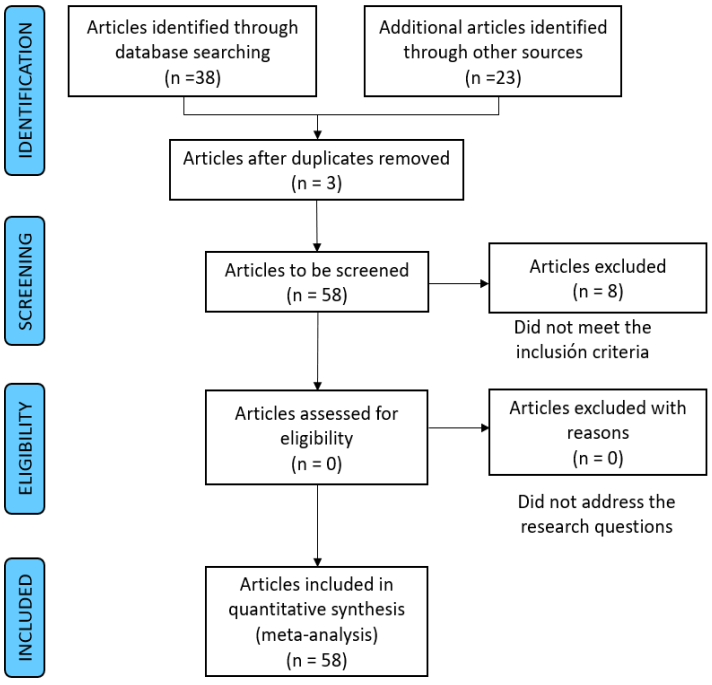

Fig 2. Document inclusion and exclusion flowchart.

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By applying a quantitative analysis to the publications and their origin of publication, it is evident that the issue of the application of Information and Communication Technologies (ICT) to support the social inclusion of people with hearing disabilities, is of global interest. In such away, It is observed that Colombia tops the list with 9 articles, then the United States with 6 articles, followed by India with 5, followed by 3 from Mexico as well as Chile, Brazil and Spain and the rest of the countries have one or two articles scientists as we can see in Figure 3.

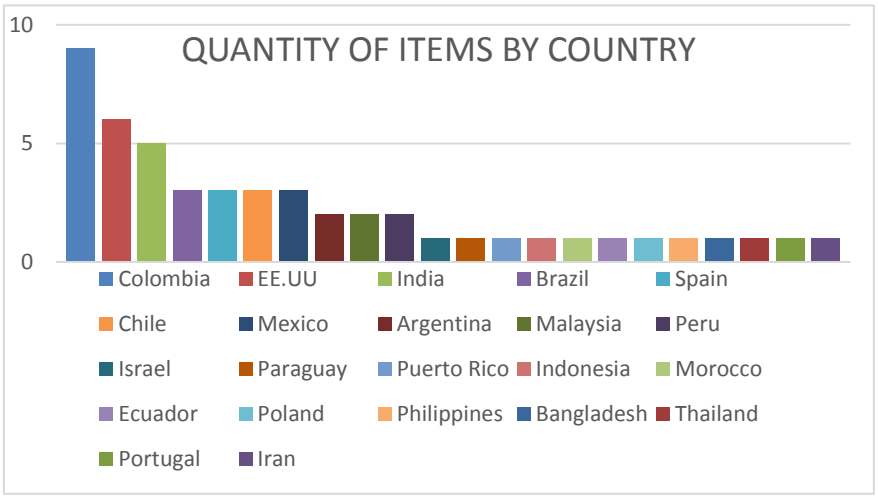

Figure 3: Articles by each country.

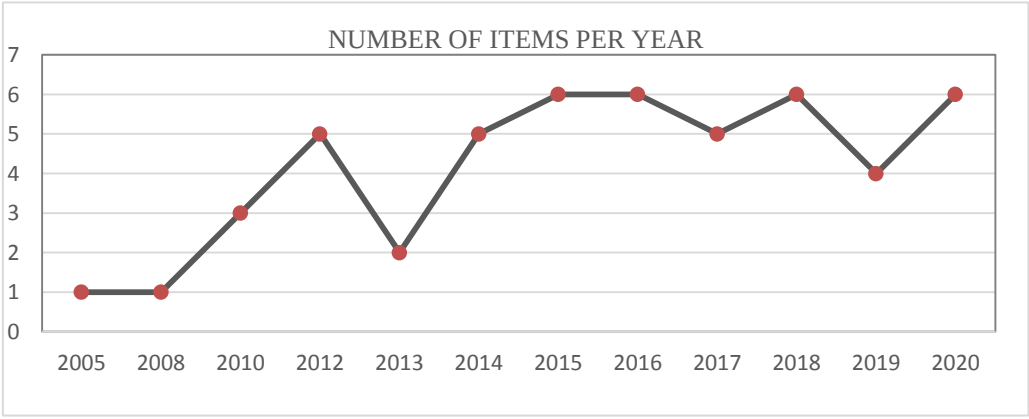

Figure 4: Articles published in from 2005 to 2020.

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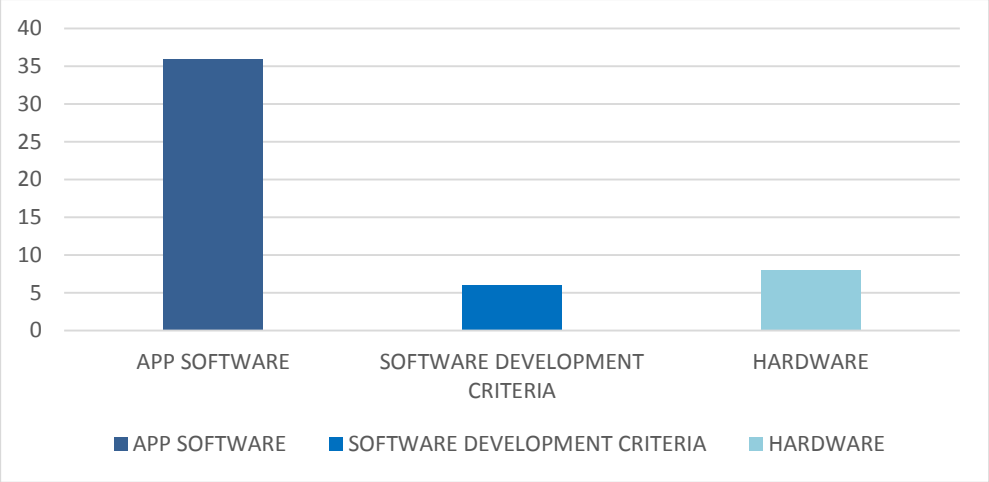

In this figure (See Figure 5), we can see the number of publications by study topic, in which the application software has the highest number of articles with 36, followed by the hardware with 8 articles and finally the criteria for development of a software with 6 articles.

In addition, a distribution was made regarding the skills in which the posts emphasize. Table II shows the results obtained, 19 studies focused on developing the cognitive ability and learning of people with hearing disabilities, through the teaching of sign language, the fingerprint alphabet, among others. Second, there is the ability to communicate with 18 items, through the application of hearing aids, prosthetic audio prototype, among others. Finally, there are 13 articles with the objective of developing social skills for the inclusion of deaf people, through the development of APIs focused on the translation of sign language, or the recognition of words, among others.

TABLE II: ITEMS BY SKILL TO DEVELOP

ABILITY	AMOUNT
COGNITIVE	19
SOCIAL	13
COMMUNICATION	18

Likewise, the articles were classified according to the type of application (mobile, web, desktop, hardware). Table III shows the results found. The most common type of application is the computer supported with 20 articles, followed by the web with 12 articles, the mobile ones that are applications with 10, and finally the hardware with 8 articles in which we find prototypes, prosthetic audio devices, among others.

TABLE III: ITEMS BY TYPE OF APPLICATION

TYPE OF APPLICATION	AMOUNT	REFERENCES
HARDWARE	8	Sarji.D (2008) Gonzalez.A., & Silvestre.N. (2014) Hernandez.C, Pulido.J , Arias.J , Villegas.S , Talledo.W., & Barrientos.A (2015) Tobar.A (2017), Rodríguez.M , Nambiar.R, Karia.D., & Hirafuji.D. (2018)
DESK	20	Quiñonez.J., Dolores.M., Vargas.M., Rojano.R., & Garcia.R. (2010) Barreto. A., Margarita.S , Tang.P , & Fakhteh.S (2012) , Betancur, D , Velez.M. , Pena.A., Gomez.M., & Palacio.A (2013) , Agudelo.P , Morena.Y., & Rodriguez.A (2014) , Calle.E , Falco.P., & Krutz.D (2015) , Hernandez.R ,Romero.M. ,& Urrego.S (2016) , Nagori. P, Pedrosa.B ,Cobo.E.,& Nagori.N. (2017) , Sabaresh.G , Karthi.A ., Dabran.L., & Singher.E. (2018) , Masrur.S., & Imamul.A. (2019) , Marceles.K, Villalba.K. , Chanchi.G. , Caiza.J., Berenice.S , Sampayo.B., Castillo.G , Marcos.D , Nacimiento.L, Neto.N , Escudeiro.P , Galasso.B., Esdras.D., Kumula.S., Nascimento.M., & Silva.L. (2020)
MOVILE	10	Dent. K (2012) Wong.Y., Mat.N., & Nor Azan .M (2013), Bushell.E (2014), Kappor.C., Parteek. K , Rizky.Y Sindey.C , Vernal.S. & Yuniar.R., (2016) , , Caiza.J , Villalba.K , Mary.C, & Samonte.M. (2019) , Mack.K , Bragg.D , Ringel.M , Bos.M., Albi.I., Hernandez.A , Marteen.W ,& Mondoy.I (2020)
WEB	12	Roberts.V., & Vera.R. (2005) Domogola.E (2010) , Duque.C , & Merino.C (2012) , Saenz.F ,Chacon.E. ,Romero.C. , Peluso.L , Viera.A , Chacon.E , & Romero.C (2014) , Rincon.M , Aguirre.A , Carmona.M. , & Saida.M (2015) , Jimenez.E (2016) , Espinoza.V , Rosas.R., Sauvalle.I. , Velazco.R , Rosas.I , & Dominguez.A (2017) , Narathip.T , Itai.D ,& Eytan.S (2018) ,Navarrete.G (2019)

Discussions

In this chapter of this systematic review of the scientific literature, the results previously carried out are presented, answering the proposed questions:

RQ1: What are the criteria to be chosen for the development of an emerging technology for the social inclusion of people with hearing disabilities?

According to table III, the investigations were distributed by types of application considering whether they are for computer, mobile, web or hardware (prototypes) in which we evaluate which one has the greatest amount of use. Considering that 40% are desktop software, 24% are web applications, 20% are mobile apps and 16% are hardware, which facilitates the understanding about the type of application that can be proposed to develop it and that I collaborated in the inclusion of this people.

According to table II, you can see the skills that the articles focus on. 38% of these allow the development of cognitive learning ability, 36% focus on the progress of communication techniques and 26% seek to achieve optimal social development. Through adaptive software or hardware application.

According to figure V, the research articles on software, hardware and application software criteria, related to our topic in question, use technology for the inclusion of people with hearing disabilities and points out that 72% they are application software, 16% are hardware, and 12% are software development criteria. This result indicates that there is a greater amount of application software implemented and others still under development, which facilitates the understanding of learning sign language in a virtual way, the improvement of speech and the capacity for socialization.

RQ2: To what extent do emerging technologies influence the social inclusion of people with hearing disabilities?

According to table II, you can see the skills that the articles focus on. 38% of these allow the development of cognitive learning ability, 36% focus on the progress of communication techniques and 26% seek to achieve optimal social development. Through adaptive software or hardware application.

Conclusions

In conclusion, after conducting an exhaustive analysis of all the articles, it is possible to show that suffering from this type of disability entails a life with many challenges, due to the limitations it presents, both in the workplace and in the social field, and not only in these cases. If not also in the academic environment. And to help break the barrier of limitations, it is investigated how with the use of technology, we can develop an inclusion plan.

The articles were distributed to extract the best techniques and methods that can help us develop software that allows a person with hearing impairment to achieve optimal communication in different environments (Social, work, academic), allowing a significant improvement in their quality of life.

Obtaining as a result that the development of a mobile application is one of the most viable options to achieve optimal social inclusion.

Finally, the creation of new information and communication technologies that help social incorporation of people with disabilities is encouraged.

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