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Analysis of the impact of ICTs on sign language education

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***Abstract*– In our society, there is currently a constant struggle for equal rights, opportunities, and improvement of the quality of life of people with disabilities. Students with hearing disabilities present communication and learning problems when they attend educational institutions, because they do not have the technological tools that adapt to their needs. In addition, there is a greater technological development motivated by the search for solutions to problems present in educational services. The main objective of this article is to investigate by means of a literary review, the different technological alternatives that exist for people who use sign language as a means of communication and its influence of information technologies for development and learning in an educational field.**

***Keywords*-- Sign language, ICT, Education, Deafness.**

I. Introduction

Sign language is used by people who have some difficulty speaking or hearing and allows them to communicate with others who may or may not have the same difficulties. However, this language is not universal, so each country has its own sign language. Technology offers an endless number of technological tools whose main objective is to facilitate people's lives and increase their efficiency in the development of their activities. Within these technological tools specially designed for people with hearing disabilities, giving them the possibility of integrating into society and not withdraw as years ago, where having a disability was a reason for rejection or lack of efficiency in performing certain activities [1].

Currently, inclusive education is one of the transcendental governmental issues that seeks to achieve an egalitarian education, however, progress is still not considerable, even more so for those students with disabilities who are in the few special basic education centers in the country, based on this, this research focuses on students with hearing disabilities, who have sign language as their only means of communication and interaction with others, however this language is not widespread in our society.

In this way, the integration of assistive technologies in the learning of people with disabilities, has represented a positive contribution, since, through these tools, people with some kind of disability can be incorporated into society, overcoming the barriers that years ago had. That is why currently many scholars of the subject, have devoted much of their studies or research to the creation and innovation of new assistive technologies, with the aim of bringing people with disabilities into society.

RQ1: How would ICTs help in the learning process of hearing-impaired students?

RQ2: How does the use of ICTs promote communication for hearing impaired users and vice versa?

RQ3: In what ways could ICTs enhance performance in sign language education?

II. Theoretical Framework

A. *Sign Language*

[2] Sign language is the natural means of communication of people with oral or hearing impairment, which based on expressions and movements mainly of the upper limbs, allows them to communicate with other people and with each other. People with hearing impairment are born with the full capacity to develop language. However, their hearing limitation prevents them from being able to learn the language or oral language spoken in their environment.

[3] Sign language is a language created by the deaf-mute community, to facilitate the communication of people with hearing or listening disabilities. However, this language is not universal, so some gestures may have a different meaning in a certain country or region.

According to the author [4], sign language is defined as a manifestation of human language that, due to the impossibility of using the oral-auditory way by the speakers, is transmitted through the viso-gestural way.

It is a code that fulfills all the functions that oral languages fulfill in hearing communities. Sign languages are the natural languages of Deaf people. These systems are acquired in a natural way, and they also allow their users to develop their thinking spontaneously and to fulfill the communicative functions of a social conglomerate. [5]

B. *Analysis*

Based on the analysis of the information by means of data collected during an investigation, they represent a key piece for qualitative research since this can be mentioned within a process that is part of a constant cycle in each phase of this investigation and whose purpose is to obtain a validation of

these data within the study obtained in order to establish the sources of the objectives of the investigation. [6]

Content analysis is considered a technique which is used for the study of any type of communication in a direct and systematic way in which messages and contents are quantitatively increased based on categories and subcategories where these data are submitted using statistics. [7]

Regarding the variety of document analysis, this is considered a set of procedures or steps whose purpose is to produce an analytical meta-text which is represented in a transformed form to the textual corpus in which, this is considered in part to the interests of each author regarding a particular topic, which is why these steps are used in case an analysis of all documents obtained and collected by the researchers to obtain an expected result is performed. [8]

According to Kerlinger, "It is seen primarily as a method of observation and measurement. Instead of observing people's behavior directly, or asking them to respond to scales, or even interviewing them, the researcher takes the communications that people have produced and asks about those communications" (p. 543).

C. *ICT impact*

[9], mentions that "the impact of Information and Communication Technologies (ICT) on education is possibly one of the greatest changes in the field of education. Through the Internet and the information and resources it offers, a new window opens in the classroom that allows us to access multiple resources, information and communicate with others, which offers us the possibility of easily accessing personalities with diverse opinions".

[10] consider that, "ICTs that have an impact on education are computers and peripherals, digital information (application programs and programs that display or manage information) and digital communication (electronic messaging, electronic forums for example)."

[11] mentions that "the impact of ICT, within the knowledge society has brought great changes, regarding form and content, the effect has been massive and multiplying, in such a way that the sense of knowledge has permeated society in general, and one of the great implications and modifications, is education."

III. METHODOLOGY

For the methodology, the collection of data and information regarding the topic to be investigated, and to take into consideration the different points of view put forward by the authors in their research works, a series of points or strategies have been proposed that will allow us to interpret the information collected.

A. *Search strategy and study selection process.*

It was determined to search for research to support and guide the research process. The reviews were conducted to establish empirically the contribution of ICTs in sign language education.

In relation to the search strategy, this involved determining the sources of information where the searches are conducted and the terms and conditions of the search. The sources of information where the search was conducted were electronic libraries, scientific articles, scientific journals. To define the search terms, it was necessary to specify which ICTs would be considered in the review.

Considering the field of study for the research work, we established a search deadline of no more than 6 years and the importance of ICTs in research. If we consider a period longer than 6 years, the impact of information technologies would be lost, since technological advances have increased in recent years.

On the other hand, the authors and their research work that were selected for the analysis and response to the questions formulated selected the different types of published articles, whether theses, research works or books. Related to the topics of communication in sign language using ICTs and learning improvements at different educational levels.

B. *Quality Assessment*

For the quality assessment, the following questions were formulated in the documents or articles found. In the article, how do ICTs improve the learning process with hearing impairment, how can communication be promoted with the use of ICTs in people with hearing impairment and vice versa, and finally, how can ICTs improve educational performance?

IV. ANALYSIS OF RESULTS

As a result, a list of 31 sources of publications was obtained, which were divided into theses, research papers and books. The following table shows the distribution of the documentary sources.

TABLE I
DISTRIBUTION OF DOCUMENTARY SOURCES BY YEAR

Tipo de Publicación	2015	2016	2017	2018	2019	2020
Tesis	4	5	2	2	3	3
Trabajo de Investigaci	2				1	
Libro				1		
Articulo cientifico	3	2				
Revista		2		1		

TABLE II
DISTRIBUTION OF DOCUMENTARY SOURCES BY COUNTRY

Tipo de Publicación	Colombia	Mexico	Chile	Ecuador	Peru
Tesis	6	2		5	3
Trabajo de Investigación	2				1
Libro				1	
Articulo cientifico			1		
Revista		1			

TABLE III
DISTRIBUTION OF DOCUMENTARY SOURCES BY COUNTRY

Tipo de Publicación	Malaysia	Portugal	Jordan	Czech Republic	Panama	España	Bolivia
Tesis						2	1
Trabajo de Investigación							
Libro							
Articulo cientifico	1	1	1	1			
Revista					1	1	

The sources used for the analysis of our research work resulted in the countries of Colombia, Ecuador, Spain, Peru, Mexico, Jordan, Bolivia, Czech Republic, Panama, Malaysia, Portugal, Chile. As can be seen in the case of Colombia, the impact of ICTs in the field of hearing-impaired people is greater than in other countries, suggesting that this country has been developing technologies that seek the social inclusion of people with deafness. Allowing deaf people to participate and communicate through new technologies.

As a result, after reviewing the articles, we obtained the number of 31 articles from 2015 to 2021 that provide information about the research topic. Where a graph was made from these articles found to know the degree of interest in this topic that is of utmost importance for the inclusion of people who have this type of hearing impairment. Next, we will see the graph to see the interest that people have to develop these topics that allow social inclusion in an educational environment.

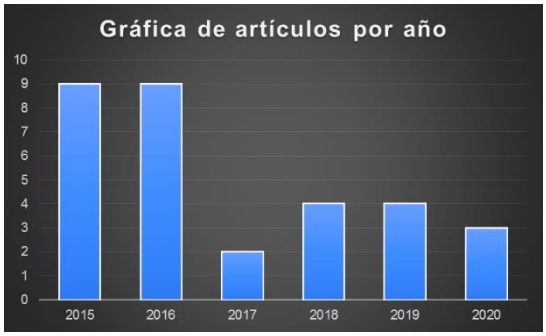

Fig. 1 Graph of articles per year

The comparison of articles found by country has also been carried out...

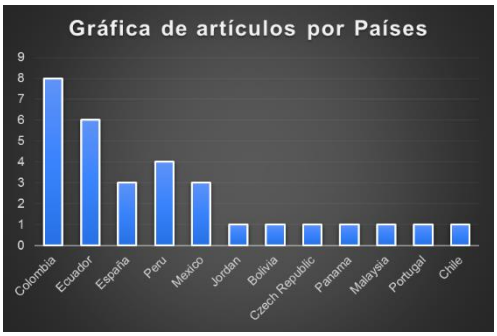

Fig. 2 Graph of articles by country

To have a better appreciation, a percentage graph has also been made.

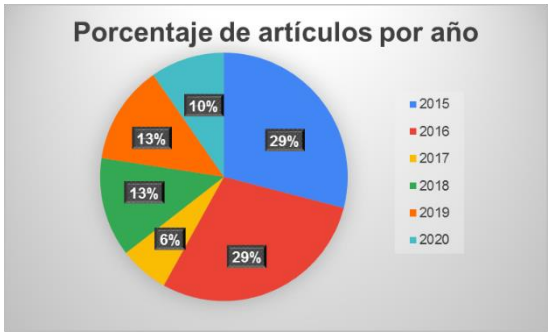

Fig. 3 Percentage of items per year

As can be seen in 2015 and 2016 there was a greater interest in research topics and technologies that allow the social inclusion of people with hearing impairment through technologies that nowadays people use on a daily and everyday basis. To increase the promotion of these technologies, the authorities of each of the countries should provide greater support to the authors who dedicate their studies to allow non-hearing people to have a better quality of life where they participate in the same way as a hearing person. And that they do not feel excluded in an educational or social environment.

For the resolution of the questions, a search was made in the research articles where they talk about the learning process and inclusive communication.

For the development of the first question, a table was developed where the authors mention or relate to learning in non-hearing people.

TABLE IV
FINDINGS FOR THE WORD LEARNING

Título	Hallazgos	P.P.
Desarrollo e implementación de una aplicación móvil que facilite la comunicación de los integrantes de la asociación cultural de sordos de Guayaquil - Asoculsor.[1]	La implementación de la aplicación movil beneficiará directamente a los integrantes de la asociación cultural de sordos de Guayaquil y a toda persona externa que interactúe con ella. Se optimizará los recursos de tiempo y herramienta tecnologica. La automatización del medio comunicativo permitirá al usuario final elaborar frases y controlar sus preferencias linguisticas con mayor facilidad ayudando a su aprendizaje gramatical.	42
Diseño de un sistema de reconocimiento de gestos de la mano basado en visión artificial para estudiantes escolares con discapacidad auditiva en Lima Metropolitana".[2]	En base a la experiencia de los docentes especializados en los alumnos con discapacidad, consideran que si no se tiene los recursos y materiales necesarios resulta un trabajo complejo lograr el aprendizaje total en ellos, sin embargo es la voluntad, actitud y gusto por su trabajo lo que los motiva a tratar de sobrellevar dichas carencias.	11
Sistema inteligente de reconocimiento de lenguaje de señas peruano para mejorar la comunicación entre las personas sordomudas de la Institución Educativa Bautista para sordos Harvest en Chiclayo.[3]	También se presentan en el aspecto educativo, los problemas de comunicación repercuten en el aprendizaje, la educación que reciben las personas sordas en el Perú es muy limitada, considerando que solo existe un colegio con profesores en lengua de señas y un Centro de Educación Básica Alternativa, así como la inexistencia de Instituciones Especiales de Educación Superior.	11
Reconocimiento de gestos estáticos del abecedario de la lengua de señas peruana utilizando cámaras de baja resolución.[4]	Aplicar un modelo de clasificación de reconocimiento de gestos en tiempo real del abecedario de lengua de señas peruana dentro de un sistema de 2 reconocimiento que, utilizando una cámara de baja resolución, permita enseñar a niños sordos y no sordos acerca del idioma español	1
Guante electrónico para traducir de lenguaje de señas a caracteres con voz artificial y conexión inalámbrica a dispositivos móviles para personas con discapacidad auditiva y de lenguaje en la Universidad Técnica de Ambato.[5]	En el ámbito escolar, a los niños con pérdida auditiva no detectada se les acusa de problemas de conducta. Por otra parte en escuelas especiales, la mayoría de docentes poseen dificultades para comunicarse con los estudiantes debido a que no dominan el lenguaje de señas o a su vez no disponen de material didáctico para la enseñanza-aprendizaje de este tipo de idioma.	2

Título	Hallazgos	P.P.
El aula inclusiva y las TICs como apoyo para personas con discapacidad visual y auditiva en las universidades en la zona 5.[6]	Se considera a las personas con discapacidades en las escuelas, colegios, universidades y en centros de trabajos, además la tecnología de la información y comunicación está involucrada en la enseñanza-aprendizaje de los estudiantes, a través del cual los docentes no los excluyan y pueda trabajar con todos sus educando. Por lo tanto, es necesario que todas las universidades tengan un aula inclusiva para personas con discapacidad visual y auditiva, utilizando las Tic's que son muy necesarias para su mejor desenvolvimiento en su aprendizaje.	2
Sistema de referenciación funcional para población con discapacidad visual para la utilización del sistema integrado de transporte público.[7]	Para cumplir con este propósito, y garantizar la educación de todos los niños y jóvenes colombianos, el Ministerio de Educación Nacional ha creado un Plan Decenal (2006 2016) que garantiza la dotación de equipos, programas y docentes formados para la atención a la población con necesidades educativas especiales. Para ello sugiere la gestión y asignación de recursos de inversión con el fin de garantizar su ingreso y permanencia, desde la primera infancia hasta el nivel superior. De esta manera se busca minimizar las barreras en el aprendizaje y promover el acceso y la participación de las personas discapacitadas. Así, personas con caracteristicas especiales tiene la oportunidad de aprender a utilizar el medio más apropiado de acuerdo con sus necesidades y tiene la oportunidad de ser alfabetizado	155
Estrategia pedagógica mediada por TIC para el fortalecimiento de la competencia comunicativa en lengua de Señas Colombiana que permita la Inclusión de estudiantes sordos del colegio Jorge Eliécer Gaitán IED.[8]	El aprendizaje significativo es el proceso a través del cual una nueva información de forma no arbitraria y sustantiva se incorpora a la estructura cognitiva del que aprende, es decir lo informativo adquiere un proceso lógico en el momento del aprendizaje	39
Dispositivo intercomunicador para personas sordociegas.[9]	El acceso a la comunicación es un factor preponderante en el éxito de procesos de aprendizaje a todo nivel. Los problemas de conducta y cognitivos que se derivan de esta condición frecuentemente están asociados a la carencia de habilidades comunicativas, las cuales se pueden dar por sistemas de comunicación propios, estándar o últimamente por la inclusión de tecnología	31
Modelo de aprendizaje asistida por computadora para la enseñanza en la comunicación de personas con discapacidad auditiva.[10]	Las tecnologías de la información y de la comunicación (TIC) resultan grandes aliados del educador para favorecer el proceso de enseñanza- aprendizaje ya que estas herramientas posibilitan promover una mejor calidad de vida educativa y facilitar el aprendizaje. Una nueva estrategia de enseñanza que apoye básicamente en el proceso de enseñanza-aprendizaje de niños con problemas de discapacidad auditiva aportando con conceptos de método científico reflejado en el modelo de enseñanza.	4
La inclusión de las TIC en la educación de personas con discapacidad.[11]	Las TIC son una importante fuente de recursos para el aprendizaje de los estudiantes con discapacidad, permiten la consolidación de La inclusión de las TIC en la educación de personas con discapacidad 20 un modelo educativo que equipara las oportunidades de aprendizaje, se ha tenido mucho cuidado de que, en las experiencias presentadas la tecnología no se convierta en el fin sino en el medio para lograr objetivos pedagógicos, por tanto las experiencias están vinculadas a un currículo, a una planificación donde se expresan aquellos aprendizajes que se quieren lograr con cada uno de los estudiantes; de esta manera las tecnologías se convierten en un recurso para superar las barreras de acceso a la información y producen un impacto positivo en la educación de las personas con discapacidad	20

RQ1: How would ICTs help in the learning process of hearing-impaired students?

It has been proven that ICTs promote the learning process with different tools that different authors propose in their research work. All this for the development of didactic topics. It has been noted that people with hearing impairment have skills to recognize images or illustrations and have greater ease when interacting in a system when its content is related to images and video.

The institutions do not have the necessary resources or materials to carry out a class, which results in a complex work to achieve learning in people with hearing impairment, for this reason it is recommended the use of ICTs to propose a solution to the lack of resources. And in this way facilitate the teacher and students with disabilities can also participate and interact in class.

On the other hand, there is also greater support with regard to primary and secondary education. But it has also been found that ICTs can be used to support a university entrance exam since currently the issue of inclusive education is reflected in a higher percentage than in previous years where it is sought that people with disabilities have the same opportunities as others.

For the second question in the same way, another table was presented where the authors make mention of communication.

TABLE V
FINDINGS FOR THE WORD COMMUNICATION

Título	Hallazgos	P.P.
Desarrollo e implementación de una aplicación móvil que facilite la comunicación de los integrantes de la asociación cultural de sordos de Guayaquil - Asoculsor.[1]	La aplicación móvil desarrollada ayudará a mejorar la comunicación de las personas sordas con las personas oyentes a través de un medio tecnológico accesible y disponible como celulares inteligentes y tabletas.	42
Diseño de un sistema de reconocimiento de gestos de la mano basado en visión artificial para estudiantes escolares con discapacidad auditiva en Lima Metropolitana".[2]	Desarrollar nuevas tecnologías enfocadas en ésta problemática, como son los sistemas de reconocimiento gestual permitirán contribuir en el proceso de comunicación entre una persona no oyente con su entorno social.	15
Sistema inteligente de reconocimiento de lenguaje de señas peruano para mejorar la comunicación entre las personas sordomudas de la Institución Educativa Bautista para sordos Harvest en Chiclayo.[3]	Teniendo en cuenta este factor desfavorable, se propone implementar un sistema inteligente de reconocimiento de lenguaje de señas peruano, con el fin de disminuir la barrera de comunicación existente, así como contribuir a mejorar las relaciones interpersonales entre una persona con discapacidad auditiva y un oyente, el cual permitirá su inclusión en diferentes sectores como el educativo, social y laboral	13
Reconocimiento de gestos estáticos del abecedario de la lengua de señas peruana utilizando cámaras de baja resolución.[4]	Se propone un aplicativo móvil cuyo objetivo es eliminar las barreras de la comunicación de las personas sordas ante las diversas situaciones que enfrentan con la sociedad hablante; es por ello que se integran herramientas de la computación visual, sintetizadores de voz para lograr realizar una herramienta de ayuda para la comunicación de personas sordas con las personas oyentes.	7
Guante Electrónico para Traducir de Lenguaje de Señas a Caracteres con Voz Artificial y Conexión Inalámbrica a Dispositivos Móviles para Personas con Discapacidad Auditiva y de Lenguaje en la Universidad Técnica de Ambato.[5]	Aplicar un modelo de clasificación de reconocimiento de gestos en tiempo real del abecedario de lengua de señas peruana dentro de un sistema de 2 reconocimiento que, utilizando una cámara de baja resolución, permita enseñar a niños sordos y no sordos acerca del idioma español	1
El aula inclusiva y las TICs como apoyo para personas con discapacidad visual y auditiva en las universidades en la zona 5.[6]	El proyecto es de gran utilidad debido a que se trata de un sistema eficaz y fiable de asistencia para personas con discapacidad auditiva y de lenguaje, que permite mejorar su comunicación, desenvolvimiento e inclusión en diferentes sectores como el educativo, social y laboral.	4
Sistema de referenciación funcional para población con discapacidad visual para la utilización del sistema integrado de transporte público.[7]	Estas herramientas utilizadas en las Tic's son de mucha importancia en el proceso educativo de los estudiantes universitarios con sordera, para que de esta forma sea incluidas en todas las actividades que se vayan a realizar dentro del aula y no sea una excepción.	12
Estrategia pedagógica mediada por TIC para el fortalecimiento de la competencia comunicativa en lengua de Señas Colombiana que permita la Inclusión de estudiantes sordos del colegio Jorge Eliécer Gaitán IED.[8]	La persona con discapacidad sensorial auditiva posee dificultades propias en sus competencias comunicativas, por ende, en sus procesos de inclusión con los oyentes, por tal motivo es necesario diseñar una estrategia pedagógica mediada por un RED (Recurso Educativo Digital), para fortalecer estas competencias y lograr que el aprendizaje y comprensión de la Lengua de Señas Colombiana Básicas (LSC) sea incluyente.	4
Dispositivo intercomunicador para personas sordociegas.[9]	El dispositivo de comunicación bidireccional ayuda a la comunicación de cualquier persona sin ningún conocimiento en lenguaje de señas braille o similar y permite que una persona con discapacidad logre expresarse sin ni siquiera conocer o haber interactuado antes con la otra persona.	79
Modelo de aprendizaje asistida por computadora para la enseñanza en la comunicación de personas con discapacidad auditiva.[10]	La necesidad y las posibilidades que ofrece este modelo de aprendizaje apoyaran a los procesos de enseñanza y comunicación ya que esto es un aporte al conocimiento porque muchas personas no toma en cuenta la vida social o desarrollo personal social y cultural también en el ámbito laboral y una buena comunicación ante la sociedad	9
La inclusión de las TIC en la educación de personas con discapacidad.[11]	Dentro de cada espacio curricular se diseñaron proyectos con actividades que incluyeron diversos recursos TIC, a fin de promover en los estudiantes el aprendizaje, el conocimiento, el juego, el pensamiento, la comunicación, la creación y el trabajo colaborativo	97

RQ2: How does the use of ICTs promote the communication of hearing-impaired users and vice versa?

The use of ICTs plays an important role in the social inclusion of hearing-impaired people as visualized in the review of research articles; non-hearing people can communicate through technology. But the technology to be used should be easily accessible and available to everyone so that hearing people are also interested in participating in these activities. As in the case of early childhood and secondary education, where students should awaken their interest in participating in activities using ICTs, either by proposing didactic games or by developing activities in which everyone participates. In

classroom environments, the role of teachers is very important to encourage the use of ICTs and thus eliminate the barrier that prevents communication. The new didactic possibilities and methodologies for teaching and communication are present and the technologies provide a way of doing things increasing the interest of students to learn.

These improvements in education through ICTs cannot be developed or transmitted without the support of the teacher and the family. At that age students are in an early formative stage, so it is important for students to have high quality learning, this helps children to prepare to learn and succeed in and out of school, a correct learning has a positive impact on school readiness and is reflected in the learning outcomes and academic performance of students from preschool to high school. Thus, a problem for learning is the existing communication barrier with non-hearing people, which is why training and time dedicated to the use of these new technologies is crucial to improve interpersonal relationships between a hearing-impaired person and a hearing person.

Another point to consider is the importance of training teachers to learn and apply the use of ICTs in a correct and easy to explain way, in order to transmit to students, the benefits of using technologies and the advantages they offer us, providing another approach to their use.

By making technologies easily accessible to all users, the communication process of hearing and non-hearing people is increased. Overcoming the difficulties within a process of inclusion and improving their communication for their next social stage, either in university or work life. While it is true that these technologies and proposals have not been fully reflected in the work environment, making use of ICTs more frequently can help to generate more research projects so that people suffering from this disability can be included in a future workspace.

RQ3: In what ways could ICTs raise the performance of sign language education?

Sign language is important in the lives of people with hearing impairment, that is why it is necessary to emphasize the correct use of this language, so that they can have a proper learning of this language, just as verbal language has rules, in the same way sign language. However, basic education schools have not implemented the learning of sign and verbal communication due to the lack of support services for such education.

The use of ICTs through new teaching methodologies influences the performance in the education of people with deafness, generating new ways of acquiring knowledge through interactive activities where non-hearing people generate new knowledge from interactions with other students in the class, allowing the student to develop personally, and motivating them to continue learning. As emphasized, study techniques through the use of ICTs is an attractive way to learn and teach students. Achieving their attention and capture in a faster way.

On the other hand, study groups in education also influence the academic performance of a person, since at the time of teaching one also learns. Without the use of ICTs this would be difficult or time consuming for the hearing impaired to participate. For this reason, the use of technological resources should be promoted to bridge this communication gap.

Similarly, the use of ICTs not only facilitates students to improve their learning ability but can be taken as a complement to the education given by teachers, as they have a profound impact on children with hearing impairment, since the form and way the information reaches children with deafness should be legible and clear. So the training that a teacher receives for teaching through the use of technologies is essential for the student to also improve their performance in the educational environment.

IV. Conclusions

The contributions of ICTs in the education of people with hearing impairment have been decreasing over the years, according to the graph of articles by year (Figure 1), there was a greater interest in implementing new technologies in the years 2015 and 2016, although each time the technologies are increasing and evolving with the passage of time, it reflects the low interest in applying them to narrow the gap between hearing and non-hearing people.

The use of ICTs generates an impact that achieves inclusion in education that must go hand in hand with the interest of the educational community, since the changes generated by the integration of technology in education are constantly advancing and require the preparation of teachers.

From the results obtained in the literature review it is concluded that thanks to the contributions of ICTs in the education of people with hearing impairment, it is of great motivation to students who benefit from these resources, generating a better academic climate and making an education based on dynamics that make use of the various tools that can improve the quality of students.

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