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Tools Facilitating Communication for the Deaf[1]

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Abstract

There is a great deal of interest worldwide in serving people with diverse abilities and needs, especially in the field of education. This implies a commitment to inclusion, empowerment and creating opportunities in a range of sectors. The deaf pose a considerable challenge to any proposal for inclusion and social integration, because their difficulty affects communication. The purpose of this study is to contribute to theoretical reflection on the development of communication tools that give the

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deaf access to education. It is based on a review of studies found in databases, on institutional websites and in journals on disciplines such as teaching, psychology and engineering. The various tools that have been created to help members of the deaf community strengthen the social, educational, recreational and work-related aspects of their lives are listed.

Key words

Inclusive education; the deaf, sign language; communicative skill, social integration *(Source: Unesco Thesaurus).*

Herramientas facilitadoras de la comunicación de personas sordas

Resumen

A nivel mundial se ha gestado un grán interés, especialmente en el campo educativo, por atender a la población con capacidades y necesidades diversas; esto implica un compromiso con la integración, la potenciación y generación de oportunidades en diversos sectores. Las personas en condición de sordera representan un gran reto para las propuestas de inclusión y de integración social porque su dificultad repercute en el plano comunicativo. El objetivo de este estudio es aportar a la reflexión teórica respecto al desarrollo de herramientas comunicativas que le permiten a las personas en condición de sordera acceder a la educación, a partir de la revisión de investigaciones que den cuenta de ello en diferentes bases de datos, páginas institucionales y revistas científicas de disciplinas como la pedagogía, la psicología y la ingeniería. Se relacionan las diferentes herramientas creadas con el fin de que la comunidad sorda fortalezca su dimensión social, educativa, de esparcimiento y vida laboral.

Palabras clave

Educación inclusiva; personas sordas; leguaje de señas; competencia comunicativa; integración social (Fuente: Tesauro de la Unesco).

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Ferramentas facilitadoras da comunicação de pessoas surdas

Resumo

No âmbito mundial, tem sido gerado um grande interesse, especialmente no campo educativo, por atender à população com necessidades especiais; isso implica um compromisso com a integração, a potenciação e geração de oportunidades em diversos setores. As pessoas em condição de surdez representam um grande desafio para as propostas de inclusão e de integração social porque sua dificuldade repercute no planejamento educativo. O objetivo deste estudo é contribuir para a reflexão teórica a respeito do desenvolvimento de ferramentas comunicativas que permitam às pessoas em condição de surdez aceder à educação, a partir da revisão de pesquisas que deem conta disso em diferentes bases de dados, páginas institucionais e revistas científicas de disciplinas como a pedagogia, a psicologia e a engenharia. Relacionam-se as diferentes ferramentas criadas com o objetivo de que a comunidade surda fortaleça sua dimensão social, educativa, de espairecimento e vida laboral.

Palavras chave

Educação inclusiva, pessoas surdas, linguagem de sinais, competência comunicativa, integração social (Fonte: Tesauro da Unesco).

Introduction

A person is considered deaf from an audiological perspective when he or she has sensory or structural problems with the ear or the auditory system. This difficulty alters the person's capacity to receive, discriminate, associate and understand sounds in the environment, as well as the sounds that make up an audio-vocal linguistic code. Consequently, acoustic communication or its development is limited when learning to listen begins, even if special devices or hearing aids are used (Quiñonez, Ramírez, Girón & Rey, 2004). Deafness is classified according to total deafness, sensorineural hypoacusis, and transmission or mixed hearing loss (partial mild, moderate, severe or profound). Deafness also includes progressive hearing loss caused by excessive exposure to high-intensity noise (Pooch, Perez, Iglesias, Sais, Rodriguez & Areola, 2005).

There are currently more than 70 million people in the world who live with some type of hearing problem (Dead, 2011). In other words, their hearing is impaired to a degree that restricts their ability to recieve, discriminate, associate and understand sounds, either in the environment or the sounds that constitute an audio-vocal linguistic code (INSOR, 2009). The 2005 Colombian Census reported more than 456,642 people with hearing difficulties; this amounts to 17.3% of the population. Moreover, sensorineural hypoacusis induced by noise in the workplace has led to a significant increase in reports of hearing damage, resulting in a social and public health problem. (Consejo Colombiano de Seguridad, 2008).

Very few members of the deaf population have access to the school system. This is due to several reasons. On the one hand, a deaf person is considered, by definition, to be someone with an individual and lasting disability. On the other, there are few possibilities for the deaf to participate in nearby contexts to improve their situation and to lessen their difficulties in adapting to the social environment, given the high cost this represents. The number of students who graduated from college in Colombia was 158,746 in 2006 and 184,330 in 2007. The figure for 2008, from a report by 84% of the universities and institutions of higher education, is 174,756 (INSOR, 2010). Although growth is evident, efforts to include a large number of deaf persons continue to face problems. In fact, 39% of the deaf population has no academic training. A basic primary education is the highest level of schooling achieved among the deaf; this group also accounts for the largest number of dropouts or students who fail to complete their education (DANE, 2010). Only 20% of high school graduates with hearing problems went on to pursue a technical, technological or college education (Ministry of Education, 2010).

These figures demonstrate the need for research to develop educational, social and employment strategies that favor communication and, hence, interaction on the part of those with hearing problems. They also underscore the necessity and importance of furthering scientific and technological development in this area. Children and adults who are hearing impaired have difficulty communicating with people in all walks of life. Oftentimes, this results in the person failing to adapt or being segregated.

Colombia, as a country governed by the rule of law, established the right to equality as one of the pillars in its 1991 constitution (Article 13) and endorses inclusive education. It also enacts general and specific legislation and provisions to minimize discrimination against the disabled population within its borders. The Colombian Education Act (Act 115/ 1994) and its regulatory or application decrees (2082/ 1996 and 366/ 2009 issued by the Ministry of Education -MEN) call for including persons with special educational needs, on an equal basis, through flexible strategies, technological means, experiences, and didactic and teaching support that respond to the particular characteristics of the disabled population. Regulatory Decree 2369/ 1997 underscores the importance of schooling that ensures

participation in equal conditions, by encouraging comprehensive development of the deaf person according to their particular abilities, skills and interests. Nevertheless, the problem of communication makes educational and social inclusion difficult for the deaf and affects any attempt to improve equitable conditions and equal opportunities for this population in compliance with the country's policies on social inclusion. Therefore, the deaf community requires basic communication experiences of an interpersonal nature.

Colombian Sign Language (CSL) is recognized as the language of the deaf community. It is endorsed by the Ministry of Education, the Instituto Nacional para Sordos – INSOR (National Institute for the Deaf), and the Federación Nacional de Sordos de Colombia- FENASCOL (National Federation of the Deaf in Colombia) as the language that enables the deaf in Colombia to articulate their communication and expression needs. Act 324/1996 officially recognizes the visual-gestural and corporal features of Colombian Sign Language as valid for participation in the social, cultural and educational life of the community.

FENASCOL, in its strategic plan for 2011-2014, included research, support for and dissemination of sign language as one of its four strategic vectors. However, extracting a commitment from the community at large, private businesses and schools is still difficult. Optimal, inclusive and participatory instances for the deaf to function independently are lacking, and the deaf continue to be shuffled aside in the family, in schools and in social environments. Society in general does not have a command of CSL, nor do families where a member of the household has a hearing problem. Ninety percent of deaf children have parents who are able to hear. Consequently, they are relatively deprived of linguistic input and the development of a language. They live in an inefficient communicative environment compared to that of youngsters who can hear and those who are the sons or daughters of deaf parents (Myers, 2005). This clearly has repercussions on their social and cognitive development, and on their relationships within the family.

Educational proposals for the deaf are based on the importance of sign language and visual learning, with the presence of interpreters or linguistic models and interaction with others who are hearing impaired. They try to redefine the social construct of deafness, not as a pathology or illness, and encourage integration from a bilingual perspective (Moores, 2010). It has been a constant effort. However, the difficulty in communicating with a hearing person can cause emotional problems for the deaf, since they feel they are being compared to the non-hearing impaired in areas where the deaf are lacking or ignored. Even though a deaf child may be able to perform as well as any other, feelings of insecurity and poor self-esteem abound among deaf youngsters and are formed through the perceptions of others (Villalba, 1996).

What has been stated so far in this article shows the importance of applying communication tools that give the deaf a linguistic resource and enable them to interact further in the areas where they function. The possibility of having access to such tools is crucial. It is estimated that only 10% of the deaf have access communication tools because of the high cost they imply for the government and for families (Instituto de Innovación y Transferencia de Tecnología, 2012). The challenge, at present, is to overcome this gap by developing technological tools that respond to the real needs of the deaf and are easily and readily available to them, their families, schools and institutions.

The purpose of this study is to reflect on the usability and contribution of communication tools that facilitate social and educational inclusion for the hearing impaired. A document review of scientific publications found in various databases, on institutional websites and in journals on disciplines such as teaching, psy chology and engineering was conducted for that purpose.

Tools that Facilitate Communication for the Deaf

Communication is "interaction of a conversational nature that implies an exchange of verbal and non-verbal information between two or more participants in a face-to-face situation" (Huseman, Lahiff & Hatfield, 1982). This definition suggests communication is sustained under a variety of conditions that involve linguistic factors, such as oral or written statements, plus the other extra-linguistic elements surrounding a communicative act. These extra-linguistic elements include the distance between the persons taking part in the conversation, their behavior, their non-verbal communication and the contexts where conversational acts take place (Martínez, 2002). The deaf acquire sign language (SL) spontaneously, and it how they signify the world. Sign language has its own conventional, grammatical and semantic features; accordingly, it can be analyzed on the basis of its linguistic components, the same as any other language. However, it is not universal. Differences exist between countries and there are even regional variations of sign language.

Interaction in a purely verbal world is a challenge the deaf face every day in a predominantly hearing society that often limits their personal advancement. The development of methods that provide some type of solution for deaf-hearing and hearing-deaf communication has increased; however, each of them explores different tools.

Human tools

These are forms of communication that do not rely on the support of electronic or computer systems. One of them is lip-reading or lip-facial reading, a method used by the deaf to understand spoken words by interpreting the movement of the speaker's mouth and face. However, this tool has constraints, since oral language is conceived to be heard and is visible only in part. There are many variables that prevent messages from being understood through lip-reading, such as insufficient light, the ability of the speaker, the skill of the recipient, the ability to vocalize, and prior knowledge of the vocabulary being used, all of which seriously limit its functionality, effectiveness and accessibility for the deaf (Fernández, 1992). Lip-reading is not common, since it requires training from a young age and is part of the oralist method. It has been used very little and is not considered to be effective, since it only facilitates communication from a hearing person to a deaf person.

Sign language interpreters are used widely. They serve as a communicative bridge between the deaf and the hearing, and vice versa. Their function is relevant within the deaf community, since they are linguistic, social and cultural mediators. Interpreting sign language involves receiving, processing and transmitting communication between communities (Cueva, 2000). Insufficient training and a shortage of qualified SL interpreters for different communicative situations limit their use and restrict independent participation by the deaf community in different areas of activity.

Software

Software is one technological means that allows for greater access to the general population. However, some software proposals are quite complicated and are not well known. The Research Division of ITEC – TELECOM Colombia (1999) created Colombian Sign Language, a tool that consists of 1470 videos of signs, 1400 photographs, 1400 expressions in English, and more than 490 sounds. It also includes a Spanish grammar and lexical analyzer featuring 12,000 words. This analyzer can identify words that are part of the structure of sign language.

Cued speech, a communication system developed by Cornett in 1965 and used with the oralist method, allows deaf or hard-of-hearing children to learn a preexisting language by using cues to read the movements of the mouth. This system is based on a set of hand shapes that are located near the face, so they can be seen simultaneously with the movement

of the lips and can help to clarify the phonemes of the spoken language. Cued speech is not a substitute for auditory training, nor learning or acquiring the sounds of a language, or even sign language. Cued speech is compatible with other methods of communication and training. Its primary purpose is not to create an alternative form of communication, but to facilitate understanding an oral language through hand shapes.

AIUTA is a software product developed by systems engineering students at the Javeriana University in Colombia. It supports the acquisition of Spanish reading-writing skills in hearing impaired children from 8 to 12 years of age. It is divided into three modules: the administration module, which manages the users; the activity module, where new exercises are added; and the work module, which includes the exercises performed with deaf children involved in Logogenia therapy, according to their degree of difficulty (Current News, Universia, 2010).

A Spanish dictionary of sign language is available in Colombia. It is a quick guide for translation into textual language and an alphabetical search tool for sign language in Spanish. (Fundación Hetah, 2013).

Televised Tools

Closed captions are a televised system of communication with subtitles that can be activated to enable the deaf to read the spoken part of what is being televised. The problem with this system is that many people who are hearing impaired do not have bilingual training (knowing how to read and write). In fact, the extent of literacy among the hearing impaired population worldwide and in Latin America is low (Moores & Miller, 2009). Another limiting factor is the speed at which closed captioning appears on the screen, which can prevent the message from being received clearly.

Televised interpretation in sign language is another appropriate alternative for the deaf community. It uses the same communication system, but is available only for a few programs and at times that are not convenient. Moreover, it appears in a small box that makes it difficult to understand the message being televised.

Cochlear Implants

A cochlear implant is an electronic medical device that converts sound into electrical signals that stimulate the hearing nerve. According to Weir (1990), the electrical signals are processed by the different parts of the implant, which consists of an external set-up (microphone, processor and transmitter) and an internal implant (receiver-stimulator and electrodes). Cost-benefit studies done in Colombia show a cochlear implant generates economic benefits for the patient and produces health utilities in terms of a gain in decibels and in language discrimination (Peñaranda, Mendieta, Perdomo, Aparicio, Marían & García, 2012). Yet, interventions of this type are not available to all who are hearing impaired; there is a lack of clarity in the health systems about their condition and these devices are considered costly. On the other hand, some professionals who work with the deaf regard cochlear implants as an oralist approach that generates unrealistic expectations among families who postpone learning sign language and, therefore, delay school enrollment, because they hope their children will be able to learn to communicate orally after undergoing surgery that enables them to hear. Furthermore, some who use these implants say the cost of maintaining them (i.e., the batteries) is high.

Recognition Systems

Recognition systems are designed to help the deaf communicate at a scientific and technological level. They are based on methods such as neural networks, genetic algorithms, statistical techniques, voice synthesizers, image recognition techniques and tools like accelerometers and movement detection cameras. A statistical method to recognize words that are subsequently recreated through signs,

using computerized animation, was developed to enable the deaf and hard-of-hearing to testify in court. The translation of oral language into Spanish sign language was achieved through finite-state transductors that make it possible to recognize certain pre-configured words (Gallo, San Segundo, Lucas, Barra, D'Haro & Fernández, 2009).

The CyberGlove is another recognition system. It interprets 26 signs in Chinese Sign Language using 18 sensors and a 3-D tracking system based on neural networks to recognize stance, orientation of the palm, its position and course of movement. This simulation-based motion system is sold and used in multiple applications (Jiangquin, Wen, Yibo, Wei & Bo, 1998 and Swee, Ariff, Sh-hussain & Seng, 2007).

Along the same line, the system developed by Swee, Ariff & Seng teaches a method for recognizing Malay Sign Language (MSL) using two instrumented gloves that allow the deaf and mute to communicate with the hearing (Kim, Jang, & Bien, 1996).

The Stanford University Center for the Study of Language and Information introduced TeleSign in 1992, a system that featured an instrumented glove on each participant's dominant hand to empower telephone communication between two hearing-impaired individuals by reconstructing and visualizing a virtual hand projected on the computer screens of each of the participants in the conversation. The prototype measured the position and movement of the fingers, and the entire orientation of the hand and each of its fingers. Using these data, it was possible to reconstruct and imitate a virtual hand that ultimately was displayed on a computer screen, thereby enabling communication between remote individuals with hearing and speech impairments (Chapin, Kramer, Haas, Leifer & Macken, 1992).

Another project, similar to TeleSign, illustrates an image recognition technique based on chains of electromagnetic sensors. This development is comprised of an instrumented glove with six magnetic sensors and a table with three electromagnets. A three-dimensional image of a hand is constructed with the signals and intensity of the magnetic field, based on vector and vector algebra projection systems. The ISDN telephone protocol is used, through which the image can be sent anywhere in the world (Dogramadzi, Allen, Bell, &Rowland, 1999).

SoftCasstec, a Mexican company, developed a software product called SIRO. It translates electric signals from a pair of instrumented gloves, enabling hearing-impaired persons to communicate orally. This product learns and recognizes the signs entered into it and the equivalent word. (Instituto de Inovación y Transferencia de Technología, 2009).

The sign language translator is another project that has been developed. It uses an instrumented helmet, a camera and an image recognition system to identify forty different words in the United States Sign Language, including verbs, nouns, adjectives and pronouns, with 97.8% certainty. The major drawback is that it has to be used in a controlled environment. However, the authors proposed including a new system of sensors, comprised of a glove with six accelerometers, which would send the necessary data for ASL recognition. (McGuire R., Hernández Rebollar, Starner, Henderson, Brashear, & Ross, 2004). Sandjaja & Marcos (2009) developed a system to recognize 5000 numbers in Philippine Sign Language (PSL). The process involved analyzing and parameterizing 5000 videos of FSL to find distinctive parameters that would allow them to recognize new videos in the future.

Three other mobile devices were created to facilitate communication between the deaf and non-hearing impaired people (2013). The first is called Visual Sound Station. It captures indoors sounds and portrays them in visual form. The device has two micro-electromechanical microphones that distinguish specific sounds such as fire alarms, doorbells, a telephone ringing or a baby crying. These sounds are represented in width and visualized in direction, giving the hearing-impaired person a depiction of what is happening in that particular realm of sound.

Visual Sound Glasses are a device designed to show the direction outdoor sound is coming from. They are eye glasses that listen for the boom of sirens and horns, among other sounds. Light-emitting diodes indicate the direction of the sound.

The third device permits written communication between the hearing impaired and people without limitations. It uses a keyboard and a pair of screens that show the written text, and the words in the text are emitted in verbal expressions.

This translation system features an animated interpreter called Iris who translates a text written in Spanish into sign language. It is used by entering a phrase in Spanish in the text box, then clicking the translation button or enter. Iris will translate the text into sign language immediately. This application searches for signs by analyzing the phrase in its grammatical structure, emphasizing the origin country and spelling out the word if an equivalent is not found. There currently are 2,949 signs available for Colombia (Fundación Hetah, 2013).

The focus, at present, is on carry out the work of sign language recognition, interpretation and learning systems through imitation in real time. Hopefully, technology will advance to the point in research on neural networks where the sensitivity, explicitness and precision required for successful recognition of different sign languages in different countries can be achieved. This is the case with the creation of an automated real-time human computer interaction tool designed to recognize and interpret sign language gesture for human robot interaction (Shekhar, Akshat & Deepak, 2012).

Final Thoughts

The history of exclusion endured by the hearing impaired continues to this day, despite policy decisions and an interest in forsaking ideas that associate deafness with illness for thinking that values diversity (Ladd, 2003; Hauser *et al*., 2010). Sign language is still the primary communication tool learned by the deaf community. Together with learning to read and write a language, it is crucial to furthering their quality of life and their prospects for integrating into the hearing society. Proposals for creating technological tools to facilitate communication are increasingly prevalent and rely on the scientific development of two-way communication (deaf-hearing and hearing-deaf), with the tools developed previously, especially sign language and language reading-writing. In this sense, strengthening these two processes in teaching continues to be fundamental. It requires efforts that range from motivating families, teachers and the hearing in general to learn sign language as a more humane form of communication to strengthening reading comprehension. Both are still quite limited in the deaf community (Herrera-Fernández, 2014).

This review of existing methods and tools to facilitate communication for the deaf community shows the target audience has difficulty accessing them. One problem is the limited purchasing power of families and state institutions to obtain them. Another is the limited amount of information on these tools that is circulated within institutions and to the general public. This is the case with software that has been developed on a more continuous basis, but is used very little. There is also the problem of scant interest or even unawareness among professionals, families, society in general and the hearing impaired, which also poses a constraint to accessing communication tools. Perhaps this is because they regard the m as being of little use, costly or difficult to acquire. The devices categorized in this article as human tools are a case in point.

Sign language interpreters and linguistic models are one teaching aid used at schools in Colombia to accommodate deaf students. However, these interpreters or models have no higher education, since there is no technological or college training available to perform this work properly. Moreover, as noted earlier in this article, not many people are interested in the job. As for families, there are no

clear statistics in Colombia on their desire for their deaf children to learn to speak. Nevertheless, this seems to be the reason for seeking out cochlear implants as a communication tools. It also maybe why not all members of a deaf person's immediate family support group commonly learn sign language.

While interpersonal, face-to-face communication is still the fundamental core of the deaf person's scenario for communicating, it also is evident that many studies underscore the importance of developing computer and electronic systems to overcome the problems pointed out in this article. The majority of these projects are intended to implement recognition systems based on sign language. Different resources of this type that could be used in educational situations are described, but there is very little empirical evidence on their use and impact. The articles that were reviewed contain no clear reference as to how much these devices are used, who benefits from them, or what institutions promote, use and support their development, nor do they refer to how their use benefits individuals, families, and educational or social communities.

It is important to bear in mind that sign language is different in each country. Therefore, in conjunction with these developments, it is essential to generate an interdisciplinary and transdisciplinary interest among professionals and efforts at the state and institutional level in the different countries to participate actively, to oversee and to promote the recourses that are necessary for these tools to respond to the particular needs of a diverse society. Only then can those isolated projects fulfill their intention to achieve education that harbors no discrimination of any kind and favors interaction, communication and free participation that leads to a better quality of life for the hearing impaired.

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