Technologies as Resources for Inclusive Education: Subtitled Videos for Hearing Impaired Students Learning

Las tecnologías como recursos para la integración educativa: El video con subtítulos para el aprendizaje del alumnado con discapacidad auditiva

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ABSTRACT

The purpose of this work is to present the use of technologies to support students with hearing disabilities in a Higher Education center in Ecuador. Specifically, the perception of students in relation to the use of video with subtitles for their training, content comprehension and learning is analyzed. The research methodology implemented has been the construction of a mixed methodological design of a descriptive nature. For this, a 22-item questionnaire was elaborated combining the Likert scale with open and close-ended questions. The instrument was applied to a sample of 40 students from the Superior Technology in Administration in a college in Guayaquil. The results revealed the positive perception of students with hearing disabilities regarding the use of video with subtitles and report on the better understanding of theoretical content with the use of this technological tool in students with and without hearing disabilities. Also, there is a greater motivation in the teaching and learning process with the use of this resource among students with hearing disabilities. These results allow us to confirm the benefits of video subtitling, which in turn should encourage high education teachers to implement it in learning environments.

RESUMEN

El propósito de este trabajo es presentar un caso de uso de las tecnologías para apoyar a estudiantes con discapacidad auditiva en un centro de educación superior de Ecuador. En concreto, se analiza la percepción estudiantil respecto a la utilización del video con subtítulos para la formación, la comprensión de contenidos y el aprendizaje. Para la investigación se construyó un diseño metodológico mixto, de corte descriptivo. Para ello, se confeccionó un cuestionario de 22 ítems que combina la escala de Likert con preguntas cerradas y abiertas, y se lo aplicó a una muestra de 40 estudiantes de la Tecnología Superior en Administración de un instituto de Guayaquil. Los resultados revelan la percepción positiva del alumnado con discapacidad auditiva ante el uso del video con subtítulos, e informan sobre la mejor comprensión de contenidos teóricos a partir de la utilización de esta herramienta tecnológica en estudiantes con y sin discapacidad auditiva. También se constata una mayor motivación en el proceso de enseñanza-aprendizaje con el uso de este recurso entre el alumnado con discapacidad auditiva. Estos resultados permiten confirmar las bondades del video subtitulado, lo que debería animar a su implementación en entornos de aprendizaje por parte del profesorado de educación superior.

Introduction

Thanks to the development of the information and communications technology (ICT) and their gradual implementation in educational centers, the working dynamic in the classroom has evolved, as this technology facilitates a much more versatile content presentation and media hosting (Gómez-Trigueros, 2023). Their variety, however, requires of a specialization in their research, development, and use.

Another great advantage of these new technologies is that they provide multiple resources appropriate for the field of inclusive education. Although ICTs per se do

not aim to offer accessibility for people with disabilities, they have been gradually incorporating different elements, applications, and innovations that favor inclusion by offering support —whether technological, in terms of format, services, programs, or artifacts— and favor the functional capabilities of people with disabilities in their daily lives, and also in their learning (Luna, 2013).

In the field of disability, it is important to bear in mind that hearing loss is a sensory limitation which causes different communication disorders. The ICT provides a more accessible visual information —through tablets or PCs— therefore improving the communicative and linguistic competences of users with this type of limitation. Thus, the gap which difficulties their learning is reduced (Carrascosa, 2015).

In higher education, young people with hearing impairment are encouraged to study with peers who do not have this limitation, without any discrimination, which represents a great advance with respect to the long-standing social exclusion of this group. Thus, it fosters the equal opportunity reflected in the higher education policies of recent years.

Among the different resources, the use of subtitled videos stands as an option for the inclusion of people with hearing impairment, due to its versatility, usability, and easy application in classrooms.

The context of the 21st century: The information and knowledge society and the importance of the technology in education

According to Garcés et al. (2016), education needs to redefine learning as a result of the active construction of subjects by people using ICT, as definitely the active training of students is required. The possibility of keep learning and achieve this goal must be a priority in the cultural system and labor relations.

Reforms and innovations in the educational system in Spain such as the most recent ones prevent from considering the benefits, challenges and risks involved in these technologies (Domínguez Alfonso, 2018, p. 2).

The ICT has impressed both teachers and students, who could never imagine that technological resources could bridge the digital gaps in the educational world. The aim is to break down any barrier in the students' process of learning.

According to Ochoa et al. (2020), technology creates new environments for innovative forms of communication, both human and artificial, and every day they generate new interactions between the user and the machine, in which each one plays a different role from that of the traditional receivers and transmitters of information.

Disability and hearing impairment as barriers in the process of learning

According to the definition provided by the National Center on Birth Defects and Developmental Disabilities of the United States of America (2016), the term *disability* refers to a condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions).

The Convention on the Rights of Persons with Disabilities declares that.

Persons with disabilities include those who have long-term physical, mental, intellectual, or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others. (UN, 2006, Article 1)

In this study, when referring to people with disabilities involves a diverse population with a wide range of needs due to mental or physical impairments or disorders, some observable and some others requiring of a medical and/or psychological study to determine the degree of disability.

According to data provided by the Pan American Health Organization, any person with a high degree of disability has two to four more probabilities to die during a natural disaster or an emergency (PAHO, 2023). This evidences the statement by the Convention on the Rights of Persons with Disabilities declaring that "every person with disabilities has a right to respect for his or her physical and mental integrity on an equal basis with others." (UN, 2006, Article 17).

Among the different types of disability, the following can be described:

- Physical disability: It is the condition or problem that affects the body system or any organ.
- Intellectual disability: It tends to affect the functioning of the intellect of the person, who presents limitations and adaptive behavior. This type of disability usually appears before 18 years of age and requires of a psychoclinical prognosis to be detected.
- Mental disorder: It is the deterioration of mental and behavioral functions at a severe and chronic level. It implies alterations or deficiencies in the neuronal system, which, together with a series of events that the individual cannot handle, trigger a distorted perception of reality.
- Psychosocial disability: It is a limiting condition caused by the social environment and consisting of on a temporary or permanent impairment of the psyche due to lack of timely diagnosis and adequate treatment.
- Multiple disabilities: It involves two or more physical, sensory, intellectual, or mental disabilities.
- Sensory disability: It refers mainly to the visual and hearing disabilities.
- Hearing impairment: A limitation caused by the perception of external sounds.
- Vision impairment: It is a vision impairment, also affecting the structures and functions associated with it. It is an alteration causing subnormal visual acuity, limitation in the field of vision, ocular motility, color or depth, which determines a visual impairment classified according to its degree (Government of Mexico, 2017).

The present research has focused on the hearing impairment. According to Forner (2021), this is defined as the loss or anomaly of an anatomical and/or physiological function of the auditory system resulting in a hearing impairment, which implies a barrier to access oral language. People who live with this complication find it very difficult or impossible to identify sounds, follow a conversation, or even understand an idea.

People who have this type of disability are commonly defined as deaf when the impairment is total or very high, and *hard of hearing* when the hearing loss ranges

from mild to severe —which means they can usually distinguish sounds though with certain difficulty and they can benefit from hearing aids— .

In ancient times it was believed that people with a hearing impairment had less abilities or intellectual capacities, but what was theory back then is nowadays a myth. Neuroscientific research points out that deaf or hearing impaired people have the same degree of intelligence and are able to solve the same types of problems that a person without these impairments (Salazar, 2018).

The causes of hearing impairment may be genetic, or acquired —due, for example, to viral infections and other ear conditions, ototoxic chemicals and medicines, occurrence of encephalitis, meningitis, or tumors— or congenital —caused by the mother's diseases, such rubella, measles, chickenpox, or alcoholism, or birth trauma—.

In their research, González and Martínez (2020) point out that deaf people —like any other human group having their own culture and social context— acquire a particular language of their own through which they can communicate and generate interaction. It is necessary to consider that their language is based on a particular characteristic: it is visual-gestural, and therefore uses gestures, facial expressions, and body language.

Studies such as the one by Ramírez and Rendón (2013, p. 194) illustrate that

> [l]a historia educativa de las personas sordas es una historia de exclusión, frustración, currículos abreviados, bajas expectativas académicas, ingresos tardíos a la escolaridad y al acceso a su lengua natural [la lengua de señas] y desde políticas educativas trazadas en ausencia de estas comunidades, desconociendo sus historias, su ciudadanía, su trabajo, su lengua y sus construcciones identitarias.

[The educational history of deaf people is one of exclusion, frustration, summarized curricula, low academic expectations, late access to education and their natural language -sign language- and educational policies designed without the guidance and support of the implied community, therefore ignoring their histories, citizenships, efforts, languages, and identities.] Education for the hearing impaired has shifted in recent times from a clinical-therapeutic pedagogical model, focused on the impairment, to a sociological one, focused on the individual's own abilities and on the recognition of sign language as particular to this group. This new approach contributes to facilitate school learning in equal conditions for both hearing impaired and non-impaired students. The following standards are required to achieve this goal:

1. The elaboration of a curriculum adapted to the needs of children, and therefore allowing them to understand and participate of the different situations experienced in the classroom.
2. The use of the sign language, as it facilitates the access to new knowledge, interpersonal relationships, and construction of cultural meanings.
3. The creation of environments which facilitate the learning of both oral and sign language.
4. The strengthening of bilingual and bicultural environments fostering the development of their harmonious character (Rodríguez, 2013).

According to Domínguez (2018), a quality education for the students with hearing impairment must ensure equal access to learning for all students, on equal terms with those not impaired. This means to provide the students with specific hearing needs with the ordinary curriculum, while enabling their comprehension and participation in the classroom. To do this, teachers must encourage the learning of both oral and sign language in this environment, as well as the fostering of friendly relationships among hearing impaired and not hearing-impaired students. Likewise, education professionals must promote the harmonious development of their students' personalities, helping them to thrive in a bicultural environment. This requires of the establishment of a difficult but necessary balance between what is common and shared among the students in terms of their learning and what is unique and specific for the learning of the deaf learner.

According to Burad (2013), the hearing impairment is of an invisible nature, which means that it does not show in the physical characteristics. The individual who has the hearing impairment is visible healthy, which is maybe one of the reasons for the lack of a genuine inclusion process for these people. It is necessary that higher education institutions acknowledge and embrace the diversity and multiculturality of the classroom to provide a quality education for all. It is urgent to promote pedagogical and technological strategies "derivadas de [los diversos] enfoques sociales, económicos, culturales y políticos que posibiliten la aceptación y valoración de la diferencia en el aula" [derived from the different social, economic, cultural, and political approaches which enable the acceptance and appreciation of diversity within the classroom environment] (Paredes, 2018, p. 11).

As emphasized by Gutiérrez (2021), it is a priority within the educational field to inform the community about disability and promote the reconciliation between the two cultures. If children are educated in early stages, the effect will be greater, and the new generation will be totally aware of the existence of hearing impairment. At the same time, the learning and use of sign language must be encouraged to facilitate the inclusion of people with these needs.

Technology vs. hearing impairment

Duque et al. (2016) point out another barrier suffered by people with hearing impairment: the use of ineffective channels for the distribution of content, distorting the pattern of good communication. This is due to different factors such as lack of knowledge or interest to teach in their own language.

The new context in the information and knowledge societies generates determining factors in an hyperconnected community where the access to knowledge becomes the progress cornerstone (Gómez-Trigueros, 2023). It is in this information and knowledge society where science and technology gain indisputable momentum (Rodríguez et al. 2018).

It is important to highlight that students with hearing impairment do not need technological resources to access Office or Windows programs, the internet, or any other type of interactive software (Luna, 2013). However, it is recommended the additional support of hearing aids, implants, sign language gloves, images, subtitled videos, visual alarms, text messages and attached videos, communication boards, as well as to promote the use of sign language and stimulate vocabulary diversity and language social practices.

Computers, mobile phones, and tablets have been a key aid in the educational sphere for students with hearing impairment, as they have increased the accessibility of visual information, encouraged students to do their homework with these resources, improve their communicative and languages competences making possible to accomplish repetitive tasks, and opened a window to inclusion and individual autonomy in learning and information access (Luna, 2013; Carrascosa, 2015).

In relation to the resources to support the students with hearing impairment needs, among other assistive technologies, there are cameras or webcams, phones with video-call applications, and the use of text messages, alarm clocks or alarms with adaptations that, by means of light or vibration signals, call the student's attention. Among such resources, the closed caption refers to a hidden, non-embedded subtitle, or enriched subtitling. It is intended to describe what happens audibly on the screen, such as background music, special sound effects, voice characteristics, acoustic characteristics of objects or characters, etc. The subtitles can be activated individually via on-screen displays or by using the remote control in the classroom.

Nowadays there is a wide range of tools for teaching the hearing impaired. As transmitters of knowledge, teachers have the duty to research for a variety of playful activities that encourage students to learn. In this sense, it is crucial to foster curiosity, facilitate learning, and leverage both the interests and abilities of each student. Among the most conducive activities to stimulate learning in people with hearing impairment, the following can be highlighted:

- Accompanying signs and verbal images introducing the sound of each word, in order to facilitate their comprehension in the communication process with other people.
- Stimulating language use, as having a hearing impairment does not imply having any impediment to speak. It is necessary to reinforce this aspect and minimize both expression and speaking barriers.
- Conducting integration games to stimulate the activity of students with hearing loss, so they can follow the instructions and participate in the classroom dynamics.
- Improving the visual and tactile channels through the manipulation of objects: painting, drawing, modelling with plasticine, crafting, puppet shows, etc., among other handcrafted ideas (Mi Aula Integrada, 2022).

Besides, thanks to the society of information and knowledge, there are new ways to create learning experiences in the classroom by preparing students for the technological context while they acquire new contents, competences, and skills.

For all these reasons, and in line with the references and studies reviewed, this research aimed to analyze the perception of the students from the university high school Instituto Superior Universitario Bolivariano de Tecnología de Guayaquil (Ecuador) on the use of interactive technology for the teaching and learning process for students with hearing impairment. From this central objective, this work proposes the refutation of the following hypotheses:

- H_1: Students with hearing impairment learn the curriculum contents more easily using technology.
- H_2: The use of subtitled videos improves the students' comprehension, having or not a hearing impairment.

Methodology and materials

Research design

The study uses a descriptive approach and blended methodology (Sánchez et al., 2018). An exploratory research design based in the questionnaire form as data collection instrument was used for its design (Gómez-Trigueros et al., 2021).

The process of the study was configured throughout different stages. In the first place, a theoretical review on the process of learning of people with hearing impairment mediated by technology was conducted by reviewing the existent research on the use of video subtitling for the development of learning, the conceptualization of disability and its implementation. Secondly, the design and subsequent validation of the instruments was performed with the collaboration of professors from national and international universities who had previous experience in both classroom didactics and technology implementation (Table 1). Thirdly, and after the suggestions and evaluations of these experts, the research team conducted the items review: for example, modifications in the questions to provide a better comprehension of the posed questions and to unify some of the items. Fourthly, the information was collected through the questionnaire, and finally analyzed.

Table 1. Data from the experts validating the instrument.

Research center	Category	Specialty	Years of expertise	Sex
Universidad de Alicante (Spain)	Tenured Professor	History of Education	6	Women
Universidad de Valencia (Spain)	Tenured Professor	General and Specific Didactics	8	Men
Universidad de Valencia (Spain)	Hired PhD	General and Specific Didactics	7	Men
Universidad de Alicante (Spain)	Hired PhD	General and Specific Didactics	17	Women
Universidad de Valencia (Spain)	Hired PhD	General and Specific Didactics	10	Men
Universidad de Alicante (Spain)	Associated hired PhD	Educational Research and Innovation	5	Women
Universidad de Alicante (Spain)		General and Specific Didactics	1	Woman
Universidad Bolivariana del Ecuador (Ecuador)	Tenured Professor	Education sciences	25	Women

Authors' own elaboration (2023).

Background and participants

The research was conducted during the whole academic course 2022-2023, in the learning contexts of the high school center Instituto Superior Universitario Bolivariano de Tecnología de Guayaquil. The study sample was selected following a non-probabilistic, targeted,

intentional technique (Argibay, 2009): it was formed by 40 participants, training students at the Advanced Technology in Administration career. The sample is considered significant with respect to the total population and includes 23 women (57.5%), 15 men (37.5%), and 2 students who preferred not to say (5%). Age data cover three stages (Table 2).

Table 2. Demographic characteristics of participants.

Sex		Age			Total
		18-21 years	22-24 years	25 years or more	
Men	Total number	13	1	1	15
	% within age group	41.9%	33.3%	16.7%	37.5%
Women	Total number	16	2	5	23
	% within age group	51.6%	66.7%	83.3%	57.5%
Prefers not to say	Total number	2	0	0	2
	% within age group	6.5%	0%	0%	5%
Total	Total number	31	3	6	40
	% within age group	100%	100%	100%	100%

Authors' own elaboration (2023).

Evaluating tools

This research adopted a cross-sectional, methodological, quantitative design of a descriptive and inferential nature. Firstly, by administering a questionnaire adapted to the study objectives and designed *ad hoc* based on the one by Gómez (2020), which content was validated by experts of public Spanish and international universities. Researchers were asked to evaluate the importance and functionality of each question by using a five-point scale in which 1 meant "Totally disagree" and 5 "Totally agree". They were also encouraged to provide suggestions for each question.

Subsequently and from the experts' comments, some items were remodeled and a new one was added. The questionnaire included 22 items combining the Likert scale (items 5 and 7-13) of closed questions (items 4, 14, and 16-21) and open questions (items 15 and 22). The instrument was organized according to these study dimensions:

- D_1: Value of the video proposed (items 4-5)
- D_2: Value of the video resource for the teaching-learning process (items 7-10)
- D_3: Value of the video with subtitles for content-learning (items 11-13)
- D_4: Value of the didactic content of the video (items 6 and 14-22).

Besides, the first part (items 1-3) included aspects related to the sociodemographic characteristics of the sample.

With the aim of checking the reliability of the questionnaire, the Cronbach's alpha coefficient was calculated (Raykov & Marcoulides, 2017). The result obtained ($\alpha = 0.831$) proves the existence of a high and adequate internal consistency for the proposed study. Values over 0,70 are considered good Cronbach's alpha values, and when the values is close to 1, it is considered very good (Fraenkel et al., 2006).

The instrument was administered through a link hosted on the free application Google Forms. Participants received the questionnaire in their personal and/or institutional email and they were informed about the objective of the research and confidentiality of the answers. The number of responses obtained was 40 responses ($n = 40$).

Results and discussion

Descriptive data analysis

This section compiles the statistical analyses carried out from the punctuation and the answers provided in the questionnaire. The first stage is the descriptive analysis (mean [M] and standard deviation [SD]) of the participants' punctuations in the studied dimensions. Secondly, Pearson correlation coefficient parametric measurement is conducted to determine a possible correlation between content comprehension and the educational value of the subtitled video resource. In addition, the Cronbach's Alpha test established a high level of reliability for the instrument ($\alpha = 0.831$) (Table 3). The IBM SPSS Statistics 26 software was used to conduct these statistical techniques.

The descriptive, statistical results (M and SD) of the items with Likert scale are relevant. In the first place, the appreciation of the proposed video (item 5) is positive or very positive, with a standard deviation just below 0.6 (SD = 0.504), proving that there is consensus. Secondly, it is observable that students consider positive the use of videos with subtitles as classroom resources, as illustrated by the answers to items in D_2. Thus, when they are questioned about their degree of satisfaction with the teaching-learning process using the video (item 8), the response option is "Agree" (M = 4.2; SD = 0.744). Something similar occurs with item 9, "Do you consider this video to be educational?", in which the majority of replies were option 4, "Agree" (M = 4.43; SD = 0.572); and with item 10, How would you qualify the information watched on the video?", for which the average response was also 4 (M = 4.45; SD = 0.597).

In relation to item 7, "How did you understand the video related to the Global Citizenship Education (GCED)?", students for the most part selected option 3, "Neither agree nor disagree", though it should not create confusion, as the answer is closer to value 4, "Agree" (M = 3.99; SD = 0.939).

In the D_3, related to the value of the video with subtitles to learn the contents, the sample answers are positive in item 11, "Do you consider that study content is better understood with the subtitled video or using a video without subtitles?" and item 12, "I consider that including a video with subtitles to work in class or at home helps me to learn more easily" (M ≥ 4.60).

A noteworthy element is item 13, "Watching the subtitled video was distracting and did not help learning at all", which is a reversed item. In it, the answer choice had value 2, "Disagree". Once again, this illustrates the sample positive perception of the teaching and learning resource which is the subtitled video.

Table 3. Descriptive statistics (M, SD) of research questionnaire.

Dimension	Item	M	SD
D_1	Item 5. How would you qualify the video related to the Global Citizenship Education (GCED)?	4.55	0.504
D_2	Item 7. How did you understand the video related to the Global Citizenship Education (GCED)?	3.99	0.939
	Item 8. The teaching-learning process in the video was satisfying.	4.20	0.744
	Item 9. Do you consider this video to be educational?	4.43	0.572
	Item 10. How would you qualify the information watched on the video?	4.45	0.597
D_3	Item 11. Do you consider that study content is better understood with the subtitled video or using a video without subtitles?	4.60	0.911
	Item 12. I consider that including a video with subtitles to work in class or at home helps me to learn more easily.	4.65	0.597
	Item 13. Watching the subtitled video was distracting and did not help learning at all.	2.20	1.400

Authors' own elaboration (2023).

Cross-tabulation analysis

A cross-tabulation table was elaborated to confirm the students' perception in relation to the technological resource "video with subtitles" to learn disciplinary contents (Table 4). This table comprises the responses provided by the students, organized by their characteristics according to questionnaire item 3: "The student has some disability or any hearing, visual, or other difficulty". This item has a dichotomous answer ("Yes"/"No") on their disability.

Table 4. Educational value of the subtitled video resource in relation to the students' characteristics.

		Item 3. The student has some disability or any other hearing or visual difficulty.	
		Yes	No
Item 11. Do you consider that study content is better understood with the subtitled video or using a video without subtitles?	Neither agree nor disagree	0	4
	Agree	8	8
	Totally agree	2	18
Item 12. I consider that including a video with subtitles to work in class or at home helps me to learn more easily.	Neither agree nor disagree	0	2
	Agree	7	7
	Totally agree	3	21

Authors' own elaboration (2023).

In order to assess the students' appreciation and perception, items 11 and 12, part of the D_3 (value of the subtitled video for content learning) were analyzed.

Here there is an increased frequency of response for options "Agree" and "Totally agree", both on the part of participants with and without disabilities. Options 2 ("Di-sagree") or 1 ("Strongly disagree") are not selected. These results reveal the positive reception of the subtitled video to teach didactic content, both among students with disabilities and those who do not have a certified disability.

With respect to D_4, related to the understanding of the didactic content, items 16, 17, and 18 were analyzed (Table 5).

Table 5. Frequency and percentage analysis of responses to questionnaire items 16, 17, and 18.

	Item 16			Item 17			Item 18		
r	f	%	r	f	%	r	f	%
Change	19	47.5	1985	3	7.5	A general meeting for Global Citizenship Education	24	6
Built	7	17.5	1995	2	5	There was no meeting	1	2.5
Fair	3	7.5	2019	35	87.5	Agreed to help without meeting	1	2.5
Equitable	11	27.5				None of the previous is right	14	35
Total	40	100		40	100	Total	40	100

Note: *r* = response; *f* = frequency.
Authors' own elaboration (2023).

In relation to item 16, "What is the objective presented by the Association Québécoise des Organismes de Coopération Internationale (AQOCI)?", 47.5% of the interviewees answered "Change", which was the right choice. 27.5% (*f* = 11) answered "Equitable", and 17.5% (*f* = 7), "Built". Only 7.5% (*f* = 3) answered "Fair", which was a wrong answer. Therefore, it can be concluded that most students understood the purpose of the video.

Something similar occurs with item 17, "In which year was adopted the context for the Global Citizenship Education (GCED)?". 87.5% of the students chose "2019", the correct answer. This indicates that most of students (*f* = 35) paid attention to the subtitled video and understood its content. The rest of participants —12.5% (*f* = 5)— chose the wrong answer.

With respect to item 18, "What was adopted in 2019 by the Association Québécoise des Organismes de Coopération Internationale (AQOCI)?" the answers show a good comprehension of the didactic content: 60% of participants (*f* = 24) chose the right answer, "A General Meeting for Global Citizenship Education". In this case, 40% provided a wrong answer (*f* = 16).

In general, and in view of the analysis of D_4, it can be concluded that the content comprehension achieved with the subtitled video was largely positive among the student participants, who expanded their curricular knowledge and improved, therefore, their learning.

Conclusions

In the current context of the knowledge and information societies, the use of technology is seen as a powerful tool for the inclusion and integration of all students in the community. The new educational paradigm of the 21st century is based on the principle of promoting a personalized learning that addresses diversity in the classroom and adapts to the students' needs (Granados et al., 2021).

Specifically, digital resources are presented as key elements in the field of teacher training, whose technological abilities impact their students. The idea is in line with the necessity of elaborating a pedagogical design that includes the ICTs in the educational sphere to facilitate the teaching-learning process (Gómez-Trigueros, 2023). Therefore, it is necessary to design and create didactic materials that contain elements to include all students. These materials must be capable of transmitting content and informing students through screens that feature descriptions, images, and subtitles that reflect the disciplinary content narrated (Luna, 2013).

The present study is based on the assumption that it is valuable to implement the adequate technologies as classroom resources. Specifically, this research confirms the value of subtitled videos for improving the students' comprehension of content, whether they are hearing impaired or not. The idea is supported by previous studies which highlight that the use of subtitles accompanying the images facilitates the learning and participation of students with hearing impairment. (Díaz, 2018).

From the answers provided by the sample of participants, the two initial research hypotheses are confirmed (H_1 and H_2). In relation to the first hypothesis, the values obtained through the questionnaire in the analyzed dimensions analyzed prove that the subtitled video resource facilitates a better comprehension of curricular content on the part of students with hearing impairment. These results are aligned with the findings of previous researches considering the innovation of technology as an effective tool in relation to the "apropiación de conceptos y contenidos, la promoción y fortalecimiento de habilidades y actitudes pertinentes y necesarias para el logro de los aprendizajes en los estudiantes" [acquisition of contents and concepts and the promotion and strengthening of skills and attitudes relevant and necessary for students to achieve learning] (Román et al., 2011, p. 29). Likewise, as shown by the results obtained in this work, the inclusion of subtitled videos generates attention processes that minimize the learning gap between students, since they serve as support materials for a better comprehension of the discipline ahead.

It must be emphasized the positive considerations that this technological learning resource (questionnaire D_3) receives on the part of the students with hearing impairment, as most of them affirm to understand contents better with the aid of the video and consider appropriate the use of this educational tool for the classroom and at home. These perceptions of students with hearing impairment towards the use of digital resources is also observed in other studies such as the one by Pérez (2003), which highlights that these tools help teachers to organize their educational activity by providing highly organized, structured, and complete material, adapted to the characteristics of every student.

The evidence supports the hypothesis that the use of technologies benefits hearing-impaired students in their learning process. By using technological resources tailored to their needs —such as real-time subtitles, transcriptions, or assistive listening devices—, students can access content more effectively. These tools allow them to receive visual or textual information, thereby compensating for their difficulty in processing information just by

hearing. As a result, their ability to learn and understand curricular content improves significantly.

Furthermore, the second hypothesis posed that the use of the subtitled video improved the understanding of contents for both hearing-impaired and hearing students. Results show that most students chose the right answer for items associated with the understanding of disciplinary content (D_4). This reinforces the idea that the use of subtitles in videos may improve the students' comprehension, providing the both the hearing-impaired and non-hearing impaired with visual and textual support. These findings emphasize the necessity of implementing accessible strategies and technological resources in the educational sphere to foster inclusion and effective learning for all students. Subtitles provide additional visual ais which facilitates the understanding of contents. This benefits all students allowing them to follow the narrative more easily, grasp details better, and reinforcing their information retention.

This research work shows some limitations, such as the reduced sample size of participants ($n = 40$) and the context where the questionnaire was administered. In future studies, it would be interesting to have a larger sample which allows for more complex statistics. Likewise, it is necessary to promote longitudinal studies which analyze the implications of implementing digital tool such as subtitled videos, throughout different academic years.

Despite these limitations, this study confirms the need for an inclusive education adapted to the individual needs of students and which fosters their learning and development in a respectful and collaborative environment. It is in this context where technologies play a key role bringing, as pointed out by Luna (2013), a window of opportunity to achieve personalized learning in a diverse world.

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Conflict of interest statement

The authors have no conflicts of interest to declare.

Authors Contribution Statement

Kevin Josué Monar Ibarra participated in the research, methodology, analysis, and conclusions, as well as in the writing of the original manuscript, its review and editing. Erika Elizabeth Abril Arzube contributed to the research, conceptualization, analysis, and conclusions, as well as in the writing of the original manuscript, its review and editing. Isabel María Gómez-Trigueros participated in the research, guiding of focus groups, statistical analysis, and conclusions, as well as in the writing of the original manuscript, its review and editing.