

Review

Impact of the Information and Communication Technologies on Students with Disabilities. A Systematic Review 2009–2019

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Abstract: This article provides a bibliographic review of studies undertaken between 2009–2019 regarding the use of Information and Communication Technologies (ICTs) to support the learning of students with disabilities, included in the following databases: Web of Science (WoS), Scopus, ERIC, SciELO, and Google Scholar. Through a descriptive and quantitative methodology, and using bibliometric maps, the most significant data are presented according to their citation and repercussion index. The results show that ICTs are decisive for student with disabilities but there is evidence of a lack of training by teachers. In this regard, findings show that both the quantity of articles published in the different databases and the citations they receive have a medium-low impact index, as well as a low application of them.

Keywords: ICT; disability; indexations; bibliometric; network analysis; scientific journals

1. Introduction

Research on Information and Communication Technologies (ICT) is an emerging and relatively new field of study. A quick search with the terms ICT and disability in Google Scholar revealed 139 results between 1988 and 1998, 3458 from 1998 to 2009, and a startling 16,500 from 2009 to 2019. It is likely that not all of these documents are directly related to the use of ICTs to support the learning of students with disabilities. However, the large number of contributions identified and the advancement of ICT in education make up a promising panorama for the educational success of students. Technology has been referred to by specialized literature from different perspectives. ICTs are valuable tools for people with disability [1]. In a technical point of view, some authors considered that ICTs were composed of “any computer-based tool that people use to work with information, support information and process information needs” [2]. From an institutional perspective the OECD [3] defined ICT as “those devices that capture, transmit and deploy electronic data and information and that support the growth and economic development of manufacturing and service industries”. From the educational perspective, authors such as Luque Parra and Rodríguez Infante [4] understand ICT applied to education as any means, resource, tool, technique, or device that favors and develops information, communication, and knowledge, a definition that entails a markedly practical and applied character, within the educational sphere and system, for which reason it should also be considered as a

didactic support for learning, an element for cooperative work, and also as an element of management and administration.

In relation to the term disability, it has been defined by different researchers, taking into account the International Classification of Functioning, Disability, and Health [5], disability is related to the limitations in normal functioning that a person may encounter for the development of an activity. We cannot talk about disabilities without considering their impact on learning (learning disability). In the case of learning disabilities, the scientific tradition has mainly assumed the consideration that they are due to health problems suffered by people that affect their ability to acquire knowledge and, consequently, to perform effectively in academic contexts [6]. Maestri-banks [7] explains that learning difficulties imply a desire to learn and to be taught things. It is also noted that the term 'learning disability' can be quite confusing as it is not clear if it refers to people who have IQs below 70, people with both intellectual and adaptive disabilities, or people who have been given a learning disability label. The implications of this for services and research are discussed [8]. Taking all this into consideration, this study explores the impact that information and communication technologies have on the learning of people with any type of disability.

In this sense, mobile applications, the Internet, software, and the constant evolution of technologies require integration into the educational world. These can contribute other realities, creating new access spaces, and at the same time contributing to the elimination of the barriers that prevent the approach of all the students. This is because there is a great interest in equality and equity, as evidenced by international agencies and organizations. An example is the UNESCO Weidong Group Fund project "Harnessing ICTs for Education 2030", which will help participating Member States over four years to harness the potential of ICTs to achieve Sustainable Development Objective (SDO) 4 by 2030 through inclusive and equitable quality education. For this and other reasons, the main objective will be to analyze the scientific production on this subject in order to make visible productive variables that can guide further research that improve the quality of life and educational care of students with disabilities. The need to carry out such a study is motivated by different reasons. First of all, our study contributes to increasing the field of knowledge in relation to ICT and disability. Second, the information obtained contributes to a better understanding of the knowledge structure from the scientific field of ICT and disability, analyzing the research articles published in high-impact journals. In this way, by identifying the lines of research and their interconnections, based on the information contained in the analyzed databases, the understanding of this knowledge framework will be enhanced. Finally, the knowledge of the analyzed scientific production will allow one to know the development and evolution of ICT in the field of disability, effectively contributing to the reduction of possible digital gaps due to disability.

2. Research in ICT and Disability

Back in the 1990s, great hopes were held for the use of various technologies to meet the differentiated needs of those living with various disabilities, for example physical impairments, learning disabilities, speech impairments, and so forth. Adaptive technologies were rapidly becoming loaded with expectations that educational approaches might be greatly enhanced by this swell of innovations in company with advances and accessibility of computer technologies. While the momentum in this direction did not stall, it appeared to idle; so, it is encouraging to realize that a considerable body of literature has accumulated over the last decade or so, which is more differentiated and critically evaluative of achievements.

In this regard, in the pedagogical field, learning with ICT to support people with disabilities has been the subject of research for several decades, but it has been in the last 10 years when it has become an important part to support the learning of students with disabilities. For example, a study carried out by Hegarty [9] in which a review of research topics published from 1998 to 2008 in the "European Journal of Special Needs Education", the medium of a broad spectrum for special education research, concluded that there was almost no research related to ICT and special education; all this in spite of the great demands of ICT with respect to educational transformation.

To address this low presence of research, in the case of Europe, in 2010 the initial results of the project “European Research Agenda for Disability Equality” were published, which encourages the participation of civil society organizations to participate in research with academic institutions, where technology plays a predominant role [10]. In this paper, the authors focused on ICT as a support to learning in different fields (Access to ICT, teaching and learning methods, development and testing of ICT solutions, reviews, assessments, articles on inclusion, social and behavioral development, documents, use of ICT as mediators for interaction, digital games, etc.).

Internationally, scientific studies have been carried out that have already reviewed bibliographically the support of ICTs for students with disabilities, where the computer stood out as a technology used in teaching–learning processes. Authors such as Fitzgerald, Koury, and Mitchem [11] reviewed the literature from 1987 to 1996 on studies related to computer-mediated instruction in the learning of students with mild and moderate disabilities. Pennington [12] reviewed the research between 1997 and 2008 using computer-assisted instruction to teach academic skills to autism students. Other authors analyzed the different teaching methodologies for the inclusion of students, or those that the effectiveness of these tools [11].

A more recent article by Liu, Wu, and Chen [13] reviewed ICT trends in support of students with special educational needs, providing a comprehensive analysis of 26 studies published in indexed journals from 2008 to 2012, focusing on research objectives, methodology used, and results. In these journals, experimental studies predominated, where computer technology prevails over other technologies.

Istenic Startic and Bagon [14] presented the results of a content analysis of all articles published from 1970 to 2011 in seven educational technology journals indexed in Web of Science (WOS). This study highlighted the scarcity of work related to ICT and disability, and that these are published especially in educational technology journals. At the same time, it was highlighted that the issue of the potential of ICT-supported learning for the inclusion process of students with disabilities has not been sufficiently explored. The study concluded that documents on this topic began to appear in 2001 and during the period 1970–2011 only 17 articles were published.

Perelmutter, McGregor, and Gordon’s [15] meta-analysis reviewed assistive technology interventions for adolescents and adults with learning difficulties, concluding that assistive technology interventions may be useful, but must be carefully compared and adapted to the individual. More recently, a bibliometric analysis of the impact of educational research on functional diversity and digital competence [16], conducted on two databases with impact on the scientific community (Web of Science and Scopus), revealed three main trends in relation to the research topics studied: The interaction of technology with students with functional diversity; the relationship of technology with communication in students with functional diversity; and the observation of the relationship between e-inclusion and digital competence.

In addition, Hersh [17] produced a classification framework for inclusive ICT-based learning technologies and ICT-based learning technologies for students with disabilities, covering general learning and assistive technologies. Classification is important as it contributes to structuring and understanding the field, identifying good practices, and facilitating the combination of technologies with learners.

Another area of ICT action in support of disability has revolved around the “professional teachers’ development” to prepare them for the use of ICT and educational inclusion, i.e., to provide to the teachers with skills and competences for their own professional learning and for teaching. Along these lines, studies have been carried out that inform both the development of competences in initial training [18] and permanent training [19] in order to design learning environments that respond to individual needs.

3. Purpose and Research Questions

This investigation responds to the main objective of analyzing the scientific production developed on the use of ICT with students with disabilities. For this purpose, two more specific objectives arise:

1. Quantify bibliometrics in Web of Science, Scopus, Google Scholar, ERIC and SciELO databases, scientific articles published in the 2009–2019 period, with respect to the following variables: Total number of articles published; number of citations received; main citing journals; citation average per year; name, country and institutional affiliation of the most cited authors; and methodological approach of their articles.
2. Analyze the keywords used in the selected articles to identify where research in this field is advancing.

Thus, the following research questions were asked to guide this review:

Q1 What is the overall state of research in the field of ICT as a learning support for students with disabilities?

Q2 Which are the countries and journals with the most published articles?

Q3 Which research designs prevails in this research area?

Q4 What are the main and further lines of research on ICT for students with disabilities?

Q5 In what direction are good practices being developed in different countries?

4. Method

4.1. Search Procedures

The research method used was a systematic revision, which consists of a bibliographic search in some of the most used databases, starting from the principles framed in bibliometric studies in the field of education [20], with the use of techniques of descriptive type, quantitative, correlational, and semantic application to the study of keywords with the technique of social network analysis [21] through visual representation with the software VOSviewer. This research was developed according to the criteria proposed by the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses group) developed by Moher et al. [22]. These groups established parameters for systematic literature reviews to increase the dependability and reliability of the data collected.

In order to search for relevant studies, an exhaustive scan was made of the following online databases: Web of Science (WoS), Scopus, Google Scholar, Education Resource Information Center (ERIC), and SciELO, using the following keywords extracted from ERIC search engines: “Information and Communications Technology (ICT)”, “Technology education”, “Disability”, and “students with disabilities”. The quoted descriptors were associated with the Boolean operators “and” and “or”, directing the search to the searched terms. Initially, the following search equation was used: “disabilities” and “ICT” or “students with disabilities” and “technology education”.

4.2. Eligibility Criteria

The studies had to meet the following inclusion criteria: First, (1) published in the last 10 years (January 2009–December 2019). This period was considered because in the last decade the integration of technology in education has had a great influence [23]. (2) Published in English or Spanish. Followed by other inclusion criteria, taking into account the tools included in each of the databases extraction of data from the included studies, such as: (3) Specify search descriptors in the title, keywords, and/or abstract; (4) published in peer-reviewed journals or periodicals; (5) belong to the field of Education and Social Sciences; and (6) address disability at any stage of the education system.

With respect to the exclusion criteria, the documents were deleted on the basis of the following: (1) abstracts, theses, dissertations, books, conference proceedings, and technical reports (due to its accessibility); (2) language; and (3) studies on ICT for students with disabilities outside the educational context.

4.3. Search Procedures

For this purpose, the automated analysis mechanisms included in these databases have been used, whose information has been interpolated to the tables and figures. Data extraction has been carried out through direct consultation of the databases according to the following variables: Year of production; number of citations received; title of the journals with the most publications on ICT and Disability; signatory authors; institutional affiliation of authors; productivity by country; focus of the article (theoretical, quantitative, qualitative, and mixed); distribution of the article by type of disability; distribution of the article by type of technology; relevance of the keywords through their visual representation (VOSviewer).

4.4. Study Selection and Data Extraction

Initially, the search in the database resulted in a total of 1850 documents, distributed in the different databases, in addition to the articles included manually based on the reference list of the articles found, applying the keywords selected in the title and/or abstract.

Once the inclusion criteria selected for this study were applied, 512 documents were extracted (84 from WoS, 90 from Scopus, 28 from SciELO, 123 from ERIC, and 187 from Google Scholar) published in the period 2009–2019 within the Social Sciences and Education area.

A total of 298 duplicate documents were excluded in a first screening. The remaining 214 were then analyzed taking into account the variables mentioned, thus excluding 118 studies, of which 37 by type of document (doctoral theses, books, communications, conference proceedings, and technical reports); 56 not belonging to the educational context; and 25 by language other than Spanish or English. The final result was 96 studies, as reflected in Figure 1, in which, according to the recommendations of the PRISMA declaration, a flow chart has been drawn up showing the selection and inclusion process followed in this study, according to the identification, screening, eligibility, and inclusion actions (Preferred Reporting Items for Systematic reviews and Meta-Analyses) [22].

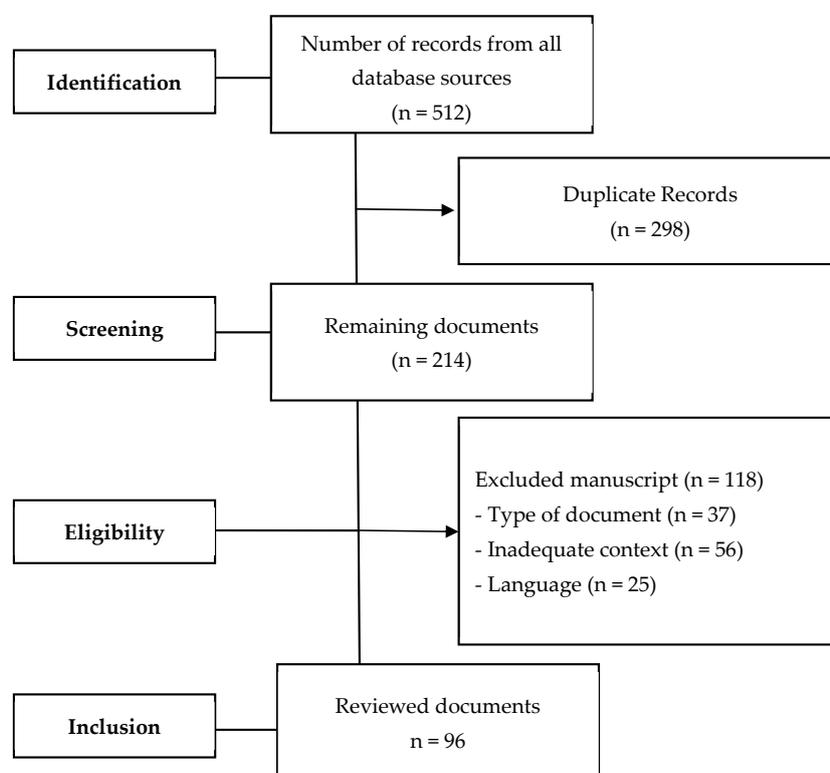


Figure 1. Flow chart of search and selection process.

5. Results

The scope of this study is wide. In order to enable a better understanding of the results found, they will be presented in two phases. The first will be linked to the first specific objective of this research, namely the bibliometric quantification of the identified scientific output. The second phase, focused on keyword analysis, sets out the graphs in both databases and their subsequent analysis, in order to identify the areas of study and research.

5.1. Phase I. Productivity, Quotes, Countries and Organization, Methodological Approach, Research Topics

This section shows the quantitative data differently when analyzing the five databases. It highlights the consolidation of articles on the topic of research in Google Scholar and ERIC databases, with respect to Scopus, WoS, and SciELO (Figure 2).

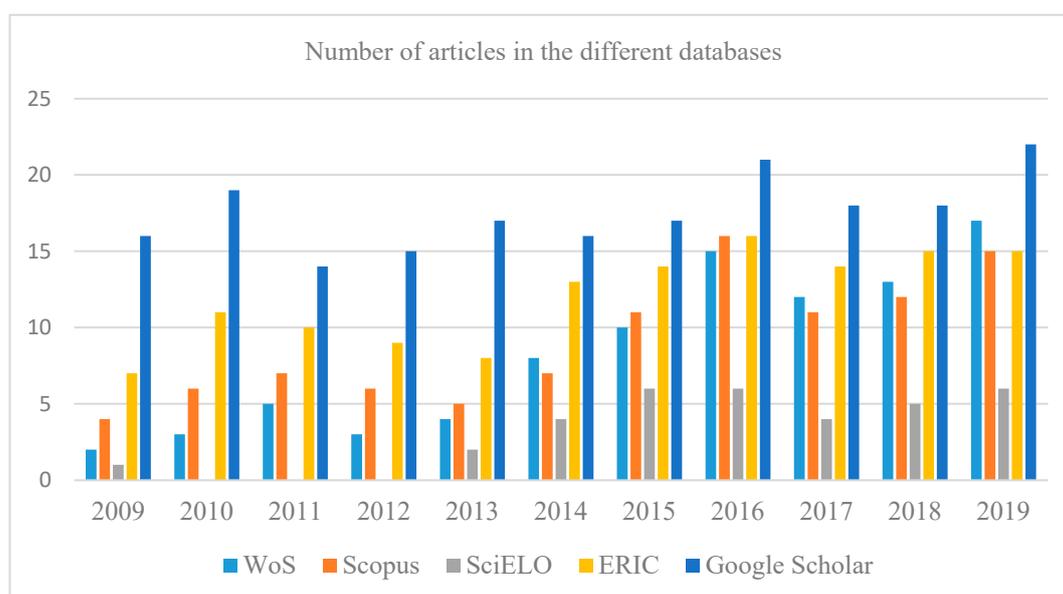


Figure 2. Number of articles in the different databases.

These 96 articles have been distributed heterogeneously among the different quartiles of the selected databases. The largest number of articles on this subject was published among 2016–2019. Likewise, the increase in the number of citations of articles in databases since 2014 is significant. In spite of this, its incidence continues to be very low, due to few articles reaching more than 10 citations (Figure 3).

Among the countries that have been most active in recent years, the United Kingdom stands out first with 25 publications on ICT and Disability, followed by the United States (23 publications), Spain (22 publications), Sweden (20 publications), Australia (15 publications), and Italy (10 publications). This shows that the Universities with the greatest production of articles in this field are European. Among the three universities with the greatest impact, Illinois State University (USA), Complutense University of Madrid (Spain), and Linköping University (Sweden) are in first place. The role of European universities is very noteworthy as they represent more than 50% of European scientific production on ICT and Disability.

The methodological approach of the articles is a value that provides us with a general perspective of how research and reflection on ICT and disability studies are being tackled so far. Thus, the results obtained show that until now the bulk of the research has focused on theoretical articles of reflection and essay, with a percentage greater than 30%, more than empirical (Figure 4).

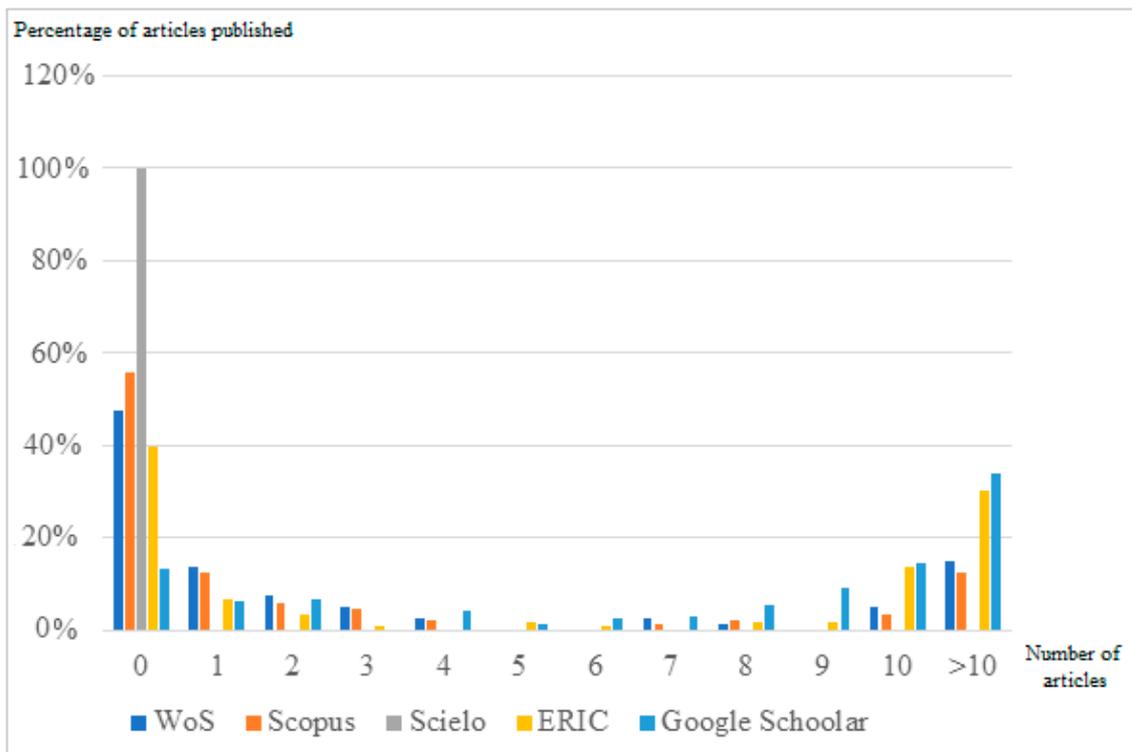


Figure 3. Articles cited per year.

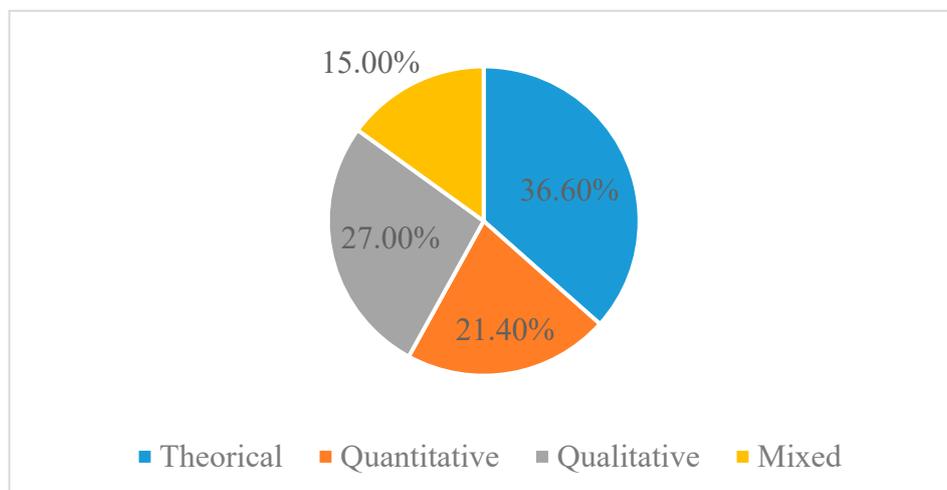


Figure 4. Methodological approach of the articles.

A noteworthy point is the low number of citations of those articles indexed in the main databases, WOS and Scopus, compared to others with lesser prestige, such as Google Scholar. The accessibility can be a possible explanation of this finding, being more accessible and viewable articles from this database. Therefore, we can verify that the articles with more citations in the respective databases analyzed have an eminently theoretical focus (Table 1), which denotes that research on ICT and Disability has not yet been fully explored, focusing more the efforts made in the field of dissemination than in the scientific-academic.

Table 1. Most cited articles.

Author (s)	Journal	Year	Methodology	Instrument	Cites				
					1	2	3	4	5
Fernández-López, A., Rodríguez-Fortiz, M.J., Rodríguez-Almendros, M.L., and Martínez-Segura, M.J.	Computers & Education	2013	Mixed	Q, O	101	140	-	52	310
Berezna, S., Ayres, K.M., Mechling, L.C., and Alexander, J.L.	Journal of Developmental and Physical Disabilities	2012	Qualitative	O	67	73	-	67	149
Kennedy, M.J. and Deshler, D.D.	Learning Disability Quarterly	2010	Theory	-	43	-	-	61	129
Mintz, J., Sucursal, C., Marzo, C. and Lerman, S.	Computers & Education	2012	Qualitative	I, O	38	41	-	41	104
Kagohara, D.M.	Journal of Behavioral Education	2011	Mixed	Q, O	35	45	-	73	93
Campigotto, R., McEwen, R., and Epp, C.D.	Computers & Education	2013	Mixed	I, O	29	41	-	30	108
Istemic Starcic, A., and Bagon, S.	British Journal of Educational Technology	2014	Theory	-	15	22	-	8	56
Lidstrom, H., and Hemmingsson, H.	Scandinavian Journal of Occupational	2014	Theory	-	12	20	-	6	43

Note: 1: WoS; 2: Scopus; 3: SciELO; 4: ERIC; 5: Google Scholar. Q: Questionnaires, O: Observations, I: Interviews.

The impact of the authors with the most citations in the different databases is also remains very low, mainly in the high-impact databases. In other words, the impact is still very limited in this field (Table 2).

Table 2. Most Cited Authors.

Authors	WoS	Scopus	SciELO	ERIC	Google Scholar
Hemmingsson, H.	136	764	-	77	1013
Lidstrom, H.	92	113	-	41	289
Istemic Starctic, A.	80	165	-	15	363
Bagon, S.	17	24	-	8	156
Elhore, A.	17	5	-	1	40
El Kafi, J.	13	13	-	1	119
Benmarrakch, F.	12	17	-	1	45

The journals with the highest citation index are published mostly in English institutions, represented mainly by the journal “Computers & Education” one of the most productive in the study of ICT and disability. It is followed by “Education and Information Review” and “British Journal of Educational Technology”.

With regard to the most researched areas, that which refers to “ICT and Intellectual Disability” (25.58%) is highest, followed by those that refer to “ICT and Hearing Disability” (18.60%) or “ICT and

Physical Disability” (18.02%) (Figure 5). Likewise, we can highlight in this review the existence of articles that have addressed “teacher training” in “ICT as support for disability”.

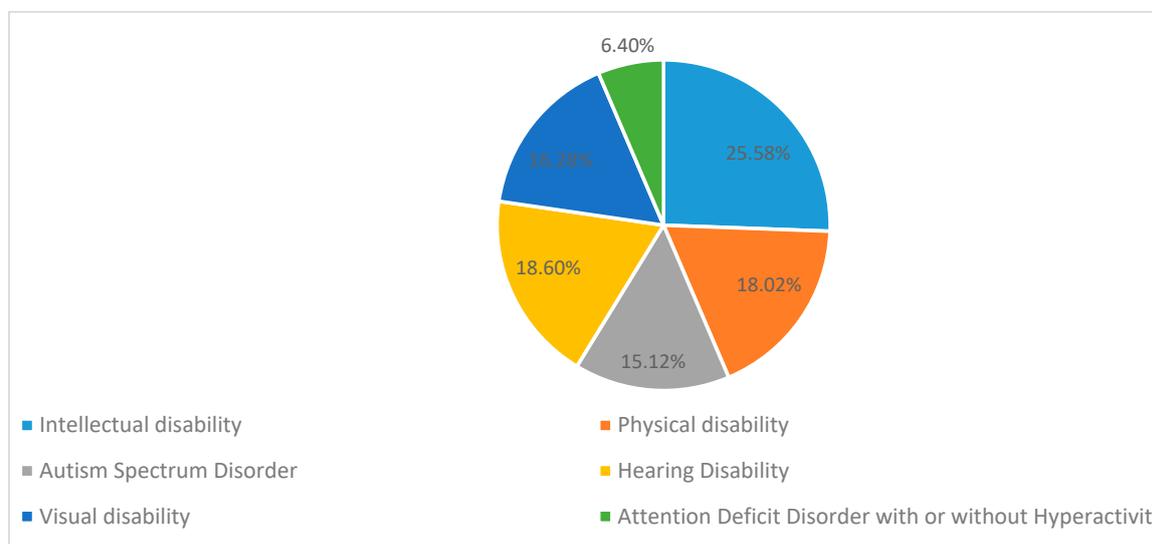


Figure 5. Distribution of articles by type of disability.

The use of technologies has opened up new opportunities in people’s lives, including students with disabilities. It is therefore necessary to classify the distribution according to the type of tool and ICT supports most used to work with students with disabilities. Firstly, there are studies that use computers (38.93%), followed by Smartphones or Tablets (29.77%), video consoles (16.79%), and finally, there are those that use other tools (television, music systems, video cameras, digital blackboards, etc.) (14.50%).

With regard to the distribution of the type of ICT resource most used by students with disabilities, in general, we can highlight that those using Web 2.0. or Internet resources (28.94%) stand out, with a special mention that those using E-Learning, social networks, or virtual platforms are included here; closely followed by those studies that use educational software (computer program) (24.96%) or virtual reality software (17.45%). To a lesser extent, there are those who use technology for accessibility (16.17%), followed by others not specified (13.19%).

5.2. Phase II. Co-Occurrence of Keywords

In the second phase, and in order to identify possible trends and directions in the research, the analysis of the relations established between the key words was carried out by means of their graphical representation. Once the file was loaded, the field “Key-Words Plus (KW+)” was chosen as the basis for obtaining the network of words, which are the key words automatically extracted from the documents.

Thus, as mentioned above, by analyzing the selected databases, a total of 96 documents corresponding to the complete period 2009–2019 were collected, of which a total of 56 KW+ were obtained with a frequency of ≥ 3 . After analyzing the homogeneity of the KW+, thematic groupings have been generated according to the degree of similarity of the KW+. In this case, three clusters have been formed. In addition, the weight of each descriptor within the network can be observed due to the size of the node that represents it and the links, that is, the relations that each node exchanges by means of a straight line. The labels and size of the circles reflect the weight of the KW+ (Figure 6).

We can point out that there is evidence of an important increase in publications in this field over the last few years, mainly from 2014 onwards, although 2016 and 2019 are the years with the highest number of publications. As a result, we can see that the impact in recent years is increasing. Despite this, there are few journals on disability that collect the most cited articles. One possible reason may be determined by the high impact of journals according to international evaluation platforms (Impact Factor). Another possible explanation may be due to the greater visibility of these journals in the international context through the repositories and databases declared by the journals themselves.

The little development of this field of research indexes negatively in teacher training, causing a low involvement of teachers in the classroom.

With respect to RQ2, the universities and countries that so far are having the greatest scientific repercussion on this line of research are the European ones (United Kingdom, Spain, and Sweden) followed by the American ones. Thus, the most outstanding journals are those of Anglo-Saxon origin, with “Computers & Education”, “Education and Information Review”, and “British Journal of Educational Technology” standing out in their production.

Regarding RQ3, the results obtained show that until now the bulk of the research has focused on theoretical articles of reflection and essay (empirical studies), followed by those of a qualitative nature. Thus, the methodological approach of the articles published in the different databases presents a theoretical approach, which makes it difficult to carry out a critique from more empirical postulates. These aspects are consistent with other similar studies that decode that there are little empirical studies that explores the opportunities that ICT may offer to people with disabilities [1]. We can mention that there are no significant differences in relation to the methodology used and the countries of origin, although North Americans tend to use a more theoretical approach, while Europeans are more inclined towards mixed methodologies.

As for RQ4, the main lines of research within the domain of ICT and disability through the analysis of thematic relational nodes show the existence of three main trends: (1) The interaction of educational technology with the use of software and the computer; (2) the relationship of technology with students with disabilities, their educational needs, and the learning environment; and (3) the correspondence established between students with disabilities, their participation, and the involvement of the teacher. In addition, we can point out that most studies are aimed at students with intellectual disabilities and the use of computers as a technological resource.

In this regard, the use of ICTs should not only be aimed at improving the teaching–learning process of students with disabilities, but also at satisfying their emotional and social needs. Although, an increasing trend has been identified deepening the actual possibilities of ICT for improving the teaching and learning processes of students with disabilities, in line with the research developed by Williams, Jamali, and Nicholas [24]. It is important to take into account in future work aspects related to the training of teachers, since it is through them and their involvement in the classroom that these aspects can be worked on. The preparation and development of ICT skills in teachers for students with disabilities should be encouraged, with the aim of promoting the inclusion of people with disabilities in the technological environment [25].

Finally, related to RQ5, it has been observed that among the practices developed are those that refer to the use of multimedia mobile devices (mobile phones, Ipod Touch, Tablet). It is also detected that there are no significant differences between the different countries, as both Europeans and North Americans recommend using mobile phones in the classroom, as they consider that these tools favor the development of social skills, their autonomy, and the improvement of activities for daily life, both inside and outside the school [26,27], improving student motivation [28]. The experiences of people with disabilities using information and communication technologies (ICT) promote their social and personal skills, which will improve the inclusion of these people in their daily life [25,29]. In addition, we can highlight that both in New Zealand and Spain, there are studies that recommend the use of other multimedia devices, such as Ipod Touch or Tablet, as useful tools for students with disabilities to access leisure material, while developing their cognitive skills, communication, and

acquisition of new knowledge [30,31]. In recent years, the use of other tools with students with disabilities in the educational field such as virtual reality is appearing, especially with students with autism, since it improves social interactions, the acquisition of skills, and the participation of students in the classroom [32].

However, this study shows us how the use of ICT can have negative consequences, especially for teachers, due to the lack of training in the use of these tools (González Amarilla and Pérez Vargas, 2019) [33].

Regarding the limitations of this study, we found the following: The effectiveness of specific technological tools was not compared or contrasted for students with disabilities. The limitation resulted partly from the scarcity of research studies and the limited dissemination of empirical studies over the last decade in this area. Also, there have been taken into account only two languages, English and Spanish. Additional key words such as “assistive technology and disability”, “assistive technology”, “augmentative and alternative communication”, or “technology and learning needs” could have been used. The selection of articles that include these terms is a limitation by not covering specific technologies for each of the disabilities, which we propose to do in future research.

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