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Emerging Themes for Digital Accessibility in Education

Bruna de Brito Prado *, José Alcides Gobbo Junior and Barbara Stolte Bezerra

Graduate Program in Production Engineering, School of Engineering, Campus Bauru, São Paulo State University (UNESP), Bauru 17033-360, Brazil
* Correspondence: bruna.prado@unesp.br

Abstract: The aim of this research is to verify gaps in the research into digital accessibility in education by conducting a systematic review of articles featuring the following terms: "digital accessibility", "education", "educational", and "teaching". It was found that the architectonics and attitudinal dimensions could not be encompassed in the typologies of articles resulting from the systematic review. It was necessary to search for index, indicator, and dimensions to evaluate digital education, including attitudinal dimensions—which refers to stigma and discrimination that people with disabilities face.

Keywords: digital accessibility; teaching; education; educational; dimensions; gaps

1. Introduction

A broadband connection is nowadays as essential as access to electricity and drinking water to guarantee equality in the areas of education, the economy, health, public security, and social issues [1]. Digital technology [2] is a ubiquitous characteristic of modern life, represented by items such as computers, the internet, smartphones, digital televisions, smart technology, and the Internet of Things (IoT). Therefore, ensuring the population's digital accessibility means giving them the right to access cities, to have good health, and to receive good education. Digital accessibility has many dimensions; to be successfully implemented, care must be taken to fulfill the requirements of technological, social, and psychological processes [3].

Digital accessibility is about ensuring that all citizens have access to digital infrastructure and adapting broadband access in public institutions and digital public services (websites, applications, digital services) to everyone's needs by implementing appropriate standards [4].

Moreover, there has been a significant increase in the use of information and communication technology (ICT) in recent decades, and the COVID-19 pandemic has accentuated ICT use in higher education institutions and across the academic community [5]. A great challenge for educators in the use of ICT is being aware of the individual differences between their students, and ensuring that none are left out [6].

This study seeks to identify gaps in the area of digital accessibility linked to education and to identify emerging themes in this area based on the six dimensions of accessibility defined by Sassaki [7]: (1) architectural (the absence of physical barriers); (2) communicational (the absence of barriers in the communication between people); (3) methodological (the absence of barriers in the methods and techniques of leisure, work, education etc.); (4) instrumental (the absence of barriers in instruments, tools, utensils etc.); (5) programmatic (the absence of barriers embedded in public policies, legislation, standards etc.); (6) and attitudinal (the absence of prejudice, stereotypes, stigmas, and discrimination toward people who have disabilities). The main questions this study aims to answer are the following: What gaps remain to be explored around digital accessibility in education? Is there a method or methodology for evaluating digital accessibility in education? If so, what

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has been validated (applied) and for which audience? Is there any possibility of validating this for other audiences?

This study is organized as follows: Section 2 discusses the conceptual foundations of digital accessibility in general; Section 3 discusses materials and methods; Section 4 provides the results; Section 5 presents a discussion; and Section 6 provides the conclusion.

In the conceptual foundations section, we define digital accessibility, standard internet speeds, and types of digital education and items to ensure equity in technological access to education. In the materials and methods section, we define the way the systematic review was carried out, including the inclusion and exclusion criteria and the bibliometric analysis using VOSviewer software 1.6.19 version. In the results section, we present the analyses of selected articles from the systematic review by year of publication, number of citations, country or region of study, theoretical or practical article, journals, adopted methodology, level of education, target audience, context/theme, and gaps. In the discussion, we compare the cited authors with the architectural dimension of Sassaki [7], and in the conclusion, we provide the final considerations of this research.

2. Conceptual Foundations

In an allusion to the concept of accessibility in which the main concern relates to access to the urban public transportation system, digital accessibility in education can be defined nowadays as "ensuring access to devices (computers, notebooks, tablets, etc.), quality internet, and digital skills, through providing training and technical support in the area of information technology, for actors involved in education (students and teachers), in the digital environment, online, synchronously or asynchronously".

Digital accessibility considers the following: exchanges and easy digital interactions; spatial distribution of networked activities (digital environment); ease of access to systems services; the combination of infrastructure and development; consideration of the function, organization, and spatial relations of a digital environment; and participation in the activities developed in the digital environment in a safe, comfortable, autonomous, and independent manner or with appropriate assistance.

Identifying thefunctions of the digital space, defining how to effect displacement and use of this space, and enabling the ability to exchange interpersonal information may be performed with the use of assistive technology or by performing digital displacements between sites, platforms for education, work, or leisure without barriers and by allowing effective participation and realization of activities by all people.

Digital accessibility can be considered as having six dimensions: architectural (the absence of digital architecture barriers); communicational (the absence of barriers to the communication between people in the digital environment); methodological (the absence of barriers relating to the methods and techniques of leisure, work, education, etc. in the digital environment); instrumental (the absence of barriers in relation to instruments, tools, utensils, etc., in the digital environment); programmatic (the absence of barriers embedded in public policies, laws, standards, etc.); attitudinal (the absence of prejudice, stereotypes, stigma, and discrimination in society toward/in relation to people who have difficulties with digital skills).

Another crucial point about digital accessibility is the specification of a minimum internet speed that is suitable for studies. This is currently considered to be at least 25/3 megabits per second (Mbps) (download/upload speed) per inhabitant of a residence, which can be accessed via fixed network, broadband, cable, or fiber optic. A dial-up connection, with speeds between 40 and 60 kilobits per second (Kbps), is too slow and is inappropriate for this kind of activity [1].

Learning through digital media can happen in two ways: synchronous teaching, which occurs in real time and that requires a live internet connection; and asynchronous teaching, which involves online materials and requires an internet connection to obtain or send materials and does not require a continuous connection [1].

Some important requirements that need to be met to ensure equity in technological access for students are the following: high-speed connectivity; enabled devices that enable task completion (excluding cell phones); trainings on distance learning for teachers' professional development; digital literacy training for students, teachers, and families; the provision of technical support for students and teachers by school/university information technology staff; instructional content, such as tutorials; technology supplies (such as books or digital content or refurbished devices); and set implementation costs (monthly internet costs, installation costs, the costs of home computing devices) [1].

Technology provides students with access to information and knowledge, allowing them to better participate in education, and it enables digital citizenship, with the ability to participate in online society, which is a part of modern life [2].

3. Materials and Methods

The research method was a systematic literature review that was based on the methodologies set out in [5,8–11]. The steps were as follows: 1. Search for articles in the database by keywords. 2. Insert the files from the search into VOSviewer and analyze the map results. 3. Narrow the list of articles by reading titles, abstracts, and keywords. 4. Develop a classification system. 5. Define the inclusion and exclusion criteria. 6 Identify the gaps in the literature using Sassaki's [7] dimensions.

Three separate searches were performed in the Scopus (article title, abstract, and keywords) and Web of Science (all fields) databases in February 2023, considering the following strings: "digital accessibility" and "education; "digital accessibility" and "educational"; "digital accessibility" and "teaching". The search did not define a type of paper; this was analyzed after the search with the results and the inclusion and exclusion criteria. New articles published after this month were not included. The number of articles that resulted from each search is shown in Table 1.

Table 1. Results of database searches.

Strings	Scopus	Web of Science	TOTAL
"Digital accessibility" and "Education"	53	42	95
"Digital accessibility" and "Educational"	30	25	55
"Digital accessibility" and "Teaching"	15	14	29
	TOTAL		179

Two databases were used to enable a more comprehensive comparison and scope of verification [12].

The search files found in the databases were inputted to the VOSviewer software (version 1.6.19), which generated maps and lists of keywords, which are analyzed below (Figures 1 and 2 and Table 2). VOSviewer is a software tool that is used for building and visualizing bibliometric networks. These networks can, for example, include individual journals, researchers, or publications, and can be built based on citations, bibliographic coupling, co-citation, or co-authorship relationships.

Figure 1 shows the main keywords related to the theme, such as "digital accessibility", "education", "accessibility", "web accessibility", and "higher education".

The colored map shows that the topic of digital accessibility occurs more frequently between the years 2019 and 2020, with the arrival of the COVID-19 pandemic. A study prepared by the International Association of Accessibility Professionals (IAAP) [13] has identified that COVID-19 has increased the profile and importance of digital channels for organizations, as well as the awareness of, and impact of, accessibility in digital channels.

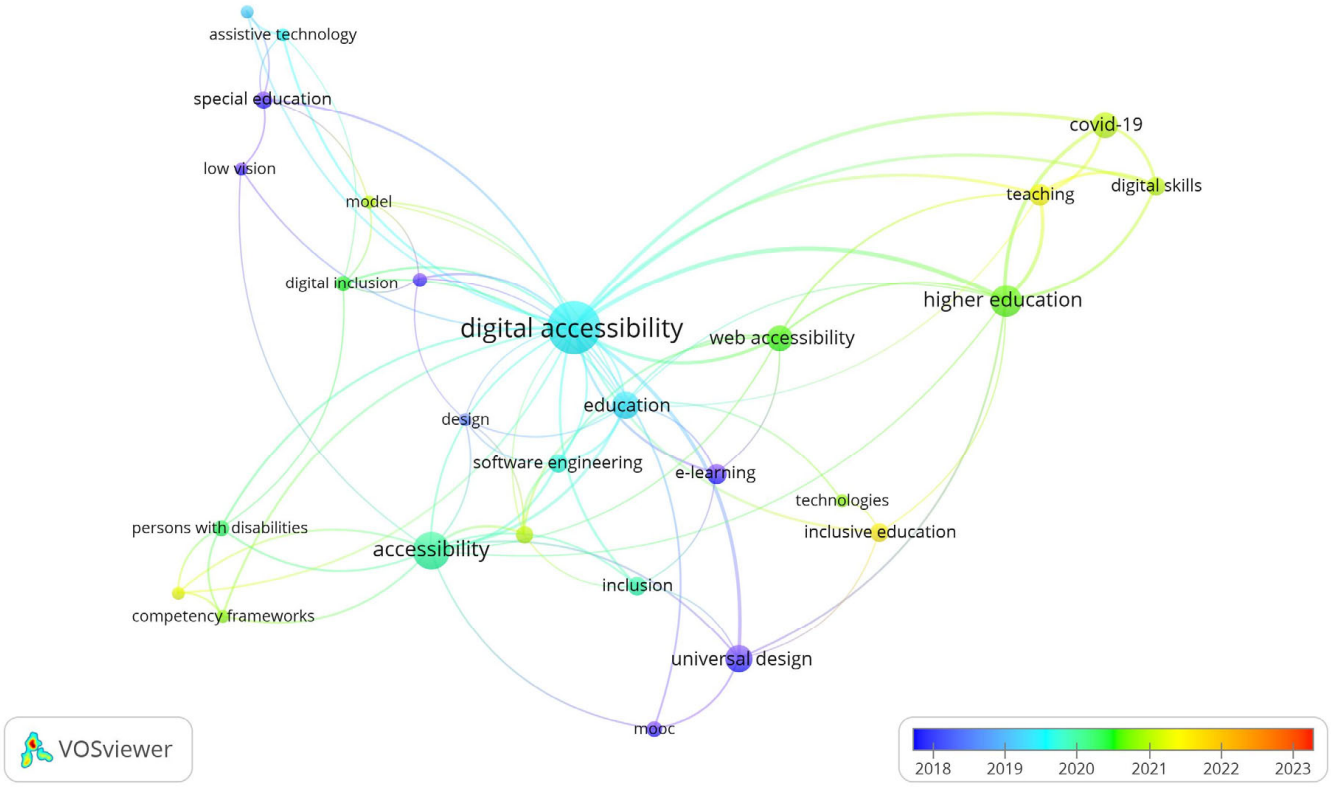

Figure 1. VOSviewer's keyword map.

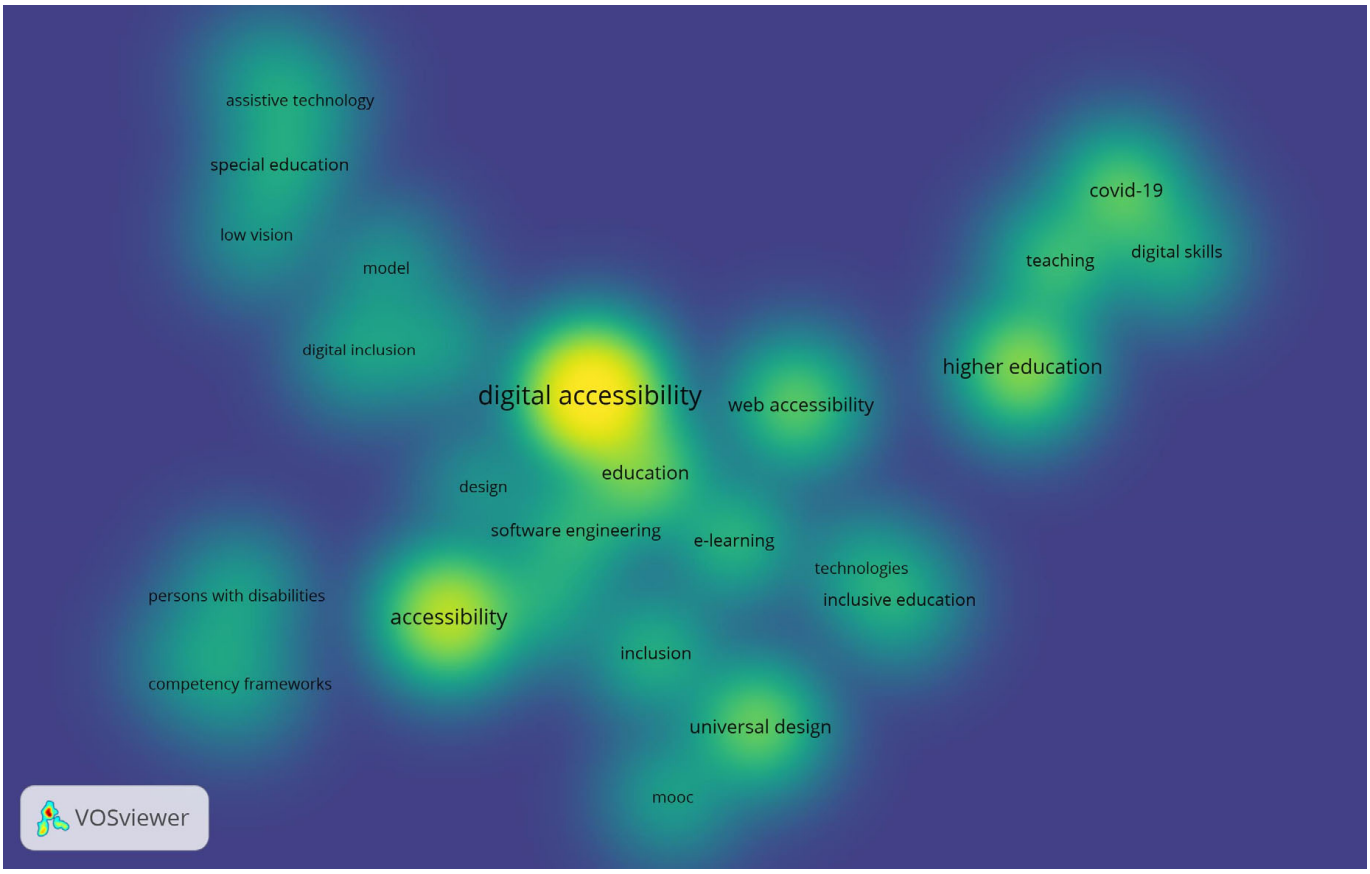

Figure 2. VOSviewer's keyword density map.

Table 2. Keywords, occurrences, and total link strength.

Keyword	Occurrences	Total Link Strength
digital accessibility	73	154
higher education	25	68
accessibility	36	56
education	20	49
teaching	13	46
COVID-19	17	44
digital skills	9	36
web accessibility	18	30
software engineering	10	29
universal design	20	28
gamification	8	25
persons with disabilities	7	19
competency frameworks	5	17
design	5	16
digital inclusion	7	16
inclusion	10	16
inclusive design	5	16
special education	8	15
e-learning	11	13
technology	6	13
assistive technology	5	12
inclusive education	9	12
blindness	5	11
model	5	11
mooc	7	11
low vision	5	8
technologies	5	5

As shown in Figure 1 by color, from 2019 to 2018, the most frequently referred to concepts include the following: "special education," "low vision", "digital inclusion", "design", "e-learning", "universal design", and "mooc." From 2020 to 2021, other keywords appear: "accessibility", "inclusion", "web accessibility", and "higher education". From 2021 onwards, the keywords that occur include "competencies framework", "COVID-19", "digital skills", and "technologies". The most current keywords that appear in Figure 1 are "teaching" and "inclusive education", showing an increasing tendency of articles to talk about inclusion, which relates to accessibility.

The density map, Figure 2, makes the intensity with which the keywords are used in the articles clearer, highlighting "digital accessibility", "accessibility", "higher education", and "universal design".

Table 2 shows the number of occurrences of the 27 most used keywords in the articles resulting from the database search: "digital accessibility" has 73 occurrences; "accessibility" has 36 occurrences; "higher education" has 25 occurrences; "education" and "universal design" are tied, each having 20 occurrences; followed by "web accessibility", having 18; "COVID-19", having 17 occurrences; "teaching", having 13 occurrences; "e-learning", having 11 occurrences; and "inclusion" and "software engineering" tied, with 10 occurrences each.

Regarding the authors, Table 3 and Figure 3 show that the most frequent authors are Fioretti, Rovira, Turro, and Martinez, but with higher incidence of Turro > Martinez > Busqueta > Fioretti > Rovira. We emphasize that these authors were not selected for full reading because these were conference/congress articles, which was one of the exclusion criteria established in the methodology.

Table 3. Authors, documents, and total link strength.

Author	Documents	Total Link Strength
Turro, mr	9	23
Martinez, ra	7	19
Busqueta, lm	6	18
Fioretti, rms	5	16
Rovira, ms	5	16
Chen, w.	8	0
Chen, wq	8	0

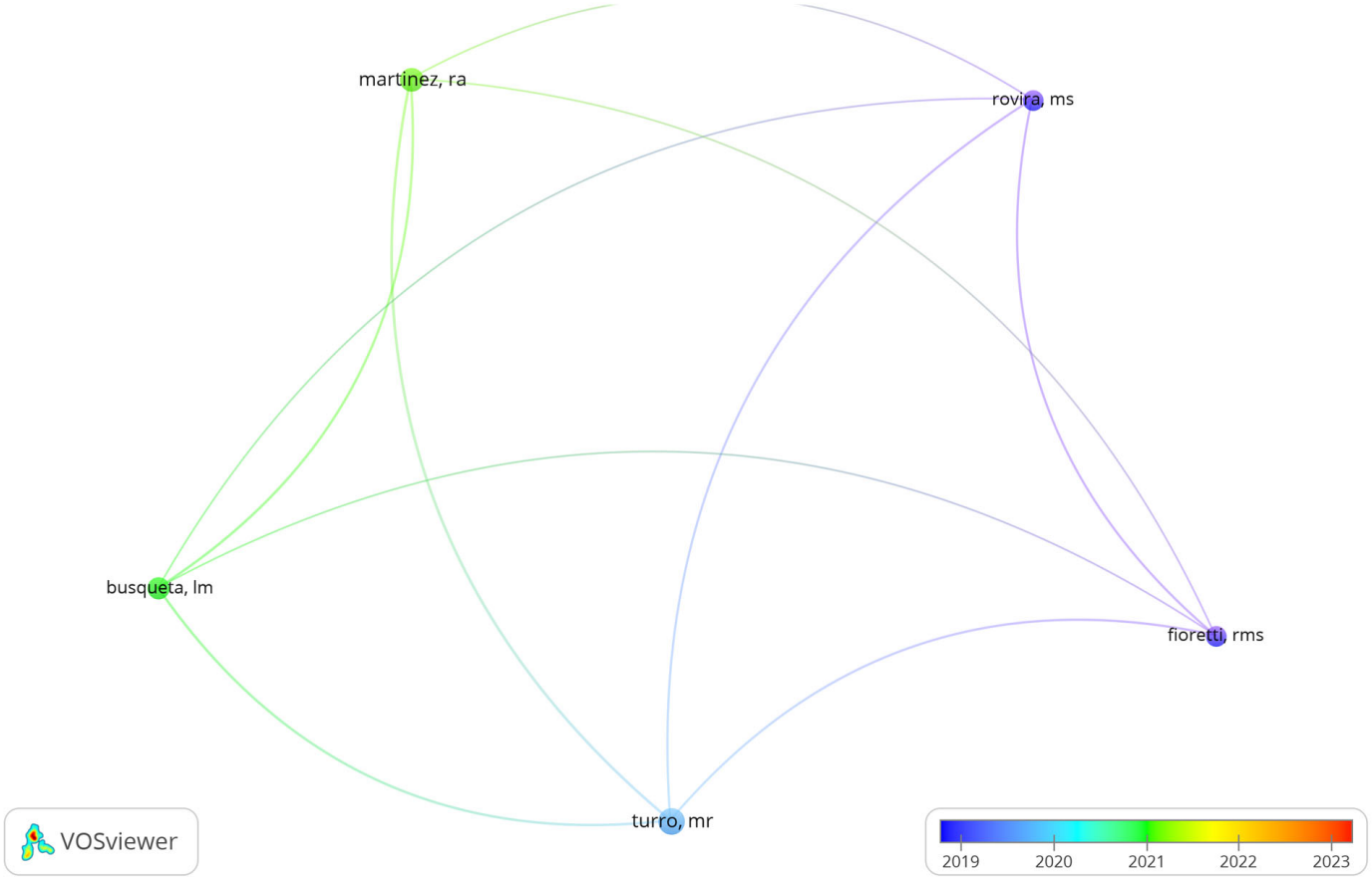

Figure 3. Authors occurrence map.

Duplicate articles were unified when selecting the articles that were included in the sample. The articles' titles, keywords, and abstracts were read in accordance with [10], and some inclusion and exclusion criteria were adopted.

The inclusion criteria were the presence of keywords or content related to the theme of digital accessibility and teaching/education.

The following exclusion criteria were adopted when reading the articles, in accordance with the methodologies of [5,9,10]:

(a) No connection to the topic of digital accessibility and teaching/education;
(b) Article does not have free access;
(c) Article in a language other than English;
(d) Article from the proceedings of congresses or conferences;
(e) Abstracts;
(f) Complete books;
(g) Articles published more than five years ago.

As a result, a total of 179 articles were found and 97 duplicate articles were eliminated, leaving 82 articles. After the first step of the methodology of [11], which defines the access to articles in the databases using pre-established strings, the next step was to read the abstracts [11], title, and keywords [10], which led to selecting 42 articles.

We verified which articles were related to digital accessibility in education and applied the exclusion criteria listed above. A total of 29 articles were discarded, leaving a total of 13 articles that were read in full (Table 4).

Table 4. Article selection.

Criteria	Number of Articles
Total number of articles identified in the database with the strings "digital accessibility" and "education"; "digital accessibility" and "education"; "digital accessibility" and "teaching".	179
Total number of articles eliminated in duplicate	−97
Total number of articles selected after reading the title, abstract, and keywords	42
Total number of articles eliminated after exclusion criteria	−29
Total number of articles read completely	13

4. Results

The articles selected for a complete reading were those by the authors of the following references: [2,4–6,14–22].

Based on the analysis criteria set out in the methodology of [5,11], the articles were analyzed by the following criteria: year of publication; number of citations; country or region of study; theoretical or practical article; journals; adopted methodology; levels of education; target audience; context/theme; and gaps.

4.1. Year of Publication

In regard to the year of publication, most of the articles read (38.46%) were published in 2022, followed by 2021 and 2020, which each accounted for 23.08% of the articles. The year 2023 had only one article, as did 2019. Table 5 shows the frequency of the publication years of the selected articles.

Table 5. Frequency of the publication years of the selected articles.

Year	Frequency	Frequency %
2023 *	1	7.69
2022	5	38.46
2021	3	23.08
2020	3	23.08
2019	1	7.69
Total	13	100

* Until February 2023.

Figure 4 shows the peak of publications in 2022 and the lows in 2019 and 2023 (it is important to note that this paper was written in February 2023).

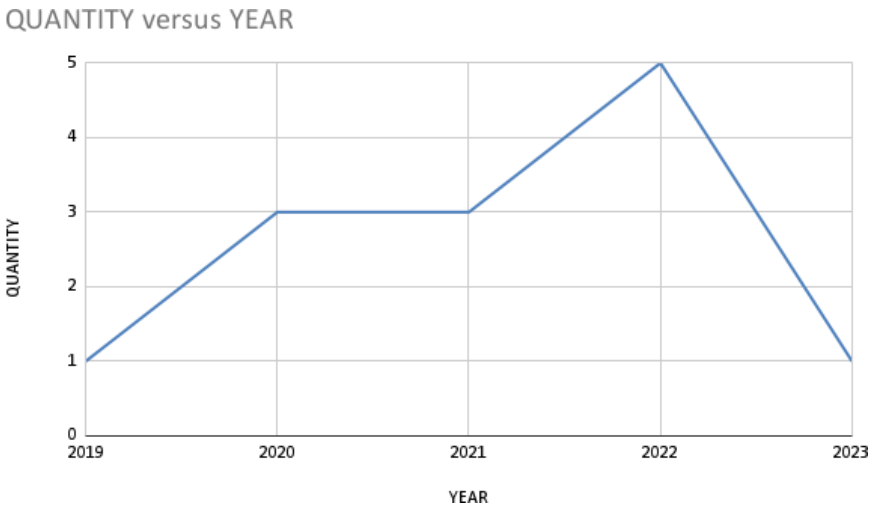

Figure 4. Selected articles by number of publications per year.

4.2. Number of Citations

The number of citations of the selected articles is significant: [5] is the most cited, with eight citations, followed by seven citations for [6,19]. Among the selected articles, four do not yet have a citation record: [14–16,21]. See Figure 5.

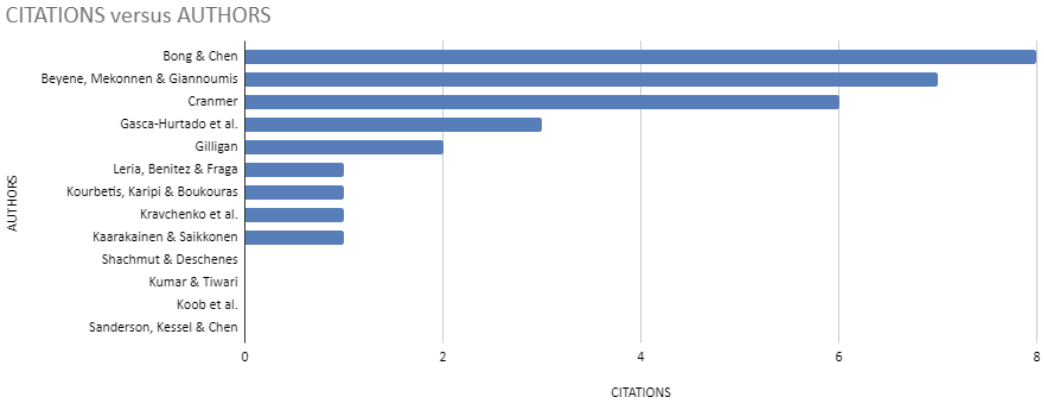

Figure 5. Number of citations, per author, for the selected articles [2,4–6,14–22].

Summing the citations of the selected articles by year, Figure 6 shows a trend line of increasing citations every year.

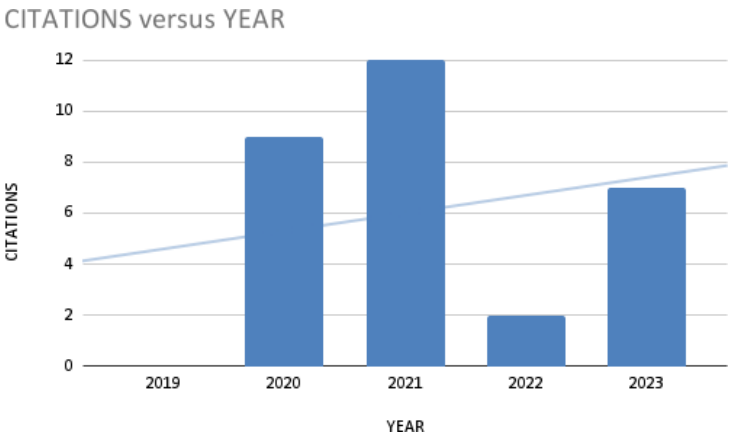

Figure 6. Sum of citations per year for the selected articles.

Figure 7 presents a scatter plot showing that the articles from 2021, 2023, and 2020 are the most cited.

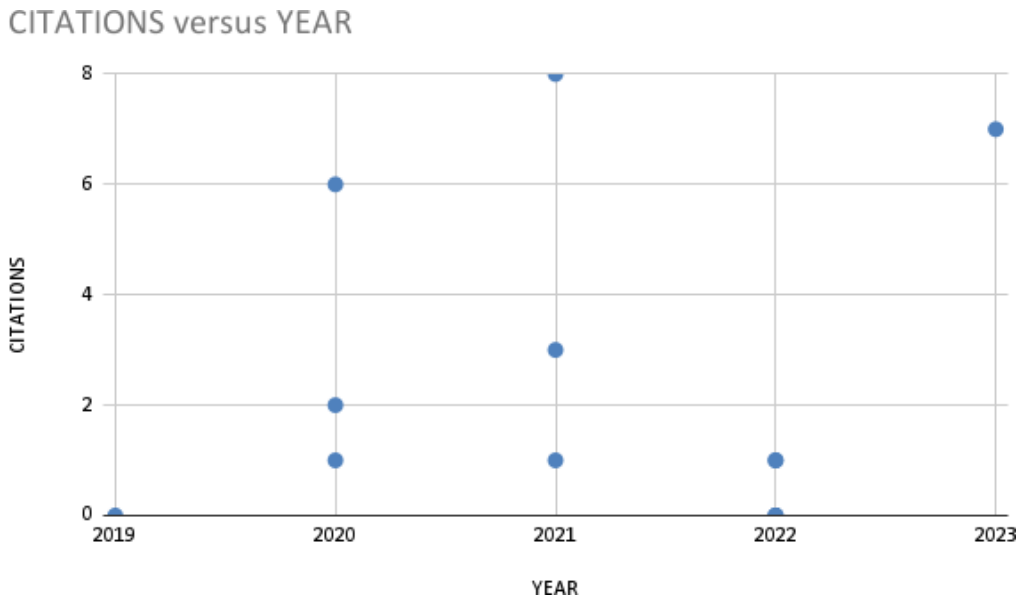

Figure 7. Scatter plot of citations per year for the selected articles.

4.3. Country or Region of Study

In regard to the countries/regions of the selected studies, most of them (more than 61%) are from developed countries, followed by underdeveloped countries, with 23%, and those with no location, which account for a little more than 15% of the articles. It is important to note that developed countries have more access to technologies and better-quality internet. See Table 6.

Table 6. Countries of publication of the selected articles.

Category	Frequency	Frequency (%)
Developed country	8	61.54
Underdeveloped country	3	23.08
Not listed	2	15.38
Total	13	100

4.4. Article Typology (Theoretical/Practical)

More than 69% of the selected articles are practical, with the rest of them being theoretical. See Table 7.

Table 7. Article typology (theoretical/practical) for the selected articles.

Category	Frequency	Frequency (%)
Theoretical	4	30.77
Practical	9	69.23
Total	13	100%

4.5. Journals

As shown in Table 8, the breakdown of the share of articles published in various journals is as follows: 15.38% of the selected articles were published in each of the following journals: the International Journal of Inclusive Education; Universal Access in the Information Society; and Lecture Notes in Computer Science (including the subseries Lecture

Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). Other journals each accounted for 7.69% of the selected articles.

Table 8. Number of publications per journal for the selected articles.

Journals	Frequency	Frequency (%)
International Journal of Inclusive Education	2	15.38
Universal Access in the Information Society	2	15.38
Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	2	15.38
Journal of Postsecondary Education and Disability	1	7.69
British Journal of Educational Technology	1	7.69
IEEE Revista Iberoamericana De Tecnologías Del Aprendizaje—IEEE Rita	1	7.69
Education and Information Technologies	1	7.69
International Journal of Computer Science and Network Security	1	7.69
Information Technology and Libraries	1	7.69
Academia (Greece)	1	7.69
Total	13	100

The subject matter of these journals ranges from education to technology, universal accessibility, computer science, disability, and inclusive education.

4.6. Methodological Approach Applied in the Selected Articles

Looking at the methods applied in the articles, see Table 9, more than 38% involved testing tools or assistive technologies, as well as comparing existing tools or analyzing guides; a little more than 23% applied semi-structured interviews (i.e., interviews with a flexible structure, which can be adapted according to the needs of the researcher at the time of the research); followed by systematic reviews (15.38% of the articles) and surveys (7.69% of the articles).

Table 9. Methodological approach adopted by the selected articles.

Category	Frequency	Frequency (%)
Semi-structured interview	3	23.08
Survey	1	7.69
Systematic review	2	15.38
Testing Tr description of tools or guides	5	38.46
Website analysis	2	15.38
Total	13	100

It is interesting to note that among the articles selected, a large number test a new methodology, which demonstrates the creativity regarding, and thirst for, new methods among current researchers.

4.7. Levels of Education

The levels of education on which the selected articles focused were as follows: 61.54% focused on higher education; 15.38% did not specify the level of education; and 7.69% in the USA focused on K-12, which includes primary and secondary education. See Table 10.

Table 10. Level of education studied in the selected articles.

Category	Frequency	Frequency (%)
Higher education	8	61.54
K-12 (USA)	1	7.69
Secondary	1	7.69
Elementary and secondary	1	7.69
Not listed	2	15.38
Total	13	100

4.8. Target Audience of Selected Articles from Systematic Review

The target audience of selected articles from systematic review was verified by reference to the appearance of the terms shown in Table 11: 23.81% of the studies related to people with disabilities, followed by students, with 19.05%, and those with hearing impairment (14.29%). Less common target groups were those with disability, which could be students, children ("child"), or higher education applicants.

Table 11. Target audience of selected articles from systematic review (occurrence of terms) of the selected articles.

Term	Frequency	Frequency (%)
Student	4	19.05
Faculty	2	9.52
Technicians	2	9.52
Person with disability	5	23.81
Disability	1	4.76
Child	1	4.76
Higher education applicants	1	4.76
Visual impairment	2	9.52
Hearing impairment	3	14.29
Total	21	100

It is interesting to note how frequently the terms accessibility and digital accessibility are linked to disabled persons, given that digital accessibility should apply to everyone, just like accessibility.

4.9. Context/Theme

Although the emerging themes of the analyzed studies vary, these themes all fall within the same extensive categories—digital accessibility, inclusion, and disabilities—which break down into specific sub-themes according to the study method and case study.

A word cloud was created in the Google Docs extension Word Cloud Generator. It was necessary to separate the most important words from each context/theme dealt with by the articles, and to remove accents from the words, because these interfere with the map result. See Figure 8.

The most prominent words are "digital", accounting for almost 22% of all occurrences; "accessibility" (a little over 14%), "teaching" and "higher" and "educational" (almost 10%); "assistive", "inclusion", "information", and "technology" (a little over 7%); and "competence" (4.88%). See Table 12.

Figure 8. Context/theme word cloud.

Table 12. Context/theme of the selected articles.

Word	Frequency	Frequency %
Digital	9	21.95
Accessibility	6	14.63
Education	4	9.76
Educational	4	9.76
Higher	4	9.76
Assistive	3	7.32
Inclusion	3	7.32
Information	3	7.32
Technology	3	7.32
Competence	2	4.88
Total	41	100

The searched keywords are part of the contexts and/or themes of the selected articles. The other themes are complementary to, or other biases of, research related to accessibility, focusing on assistive technology, disabilities, competencies, inclusion, and the educational area.

To summarize, most of the analyzed articles were published in 2022. The most cited article has eight citations, and the second most cited article has seven citations. More than 60% of the selected articles are from developed countries. Almost 70% are practical. The journals in which the articles were published focus on the areas of inclusive education, universal design, or computer science. More than 38% of the articles apply tests, guides, or descriptions of tools, with a focus on higher education, primarily. About 61% predominantly target people with disabilities and/or students. In regard to context, almost 22% of the articles use the word digital and just over 14% use the word accessibility.

4.10. Gaps

Here, we present the classification of the VOSviewer keywords in Sassaki's accessibility dimensions [7] (Table 13). For simplicity, we use acronyms for the dimensions: D_{Arq}—architectural dimension; D_{Com}—communication dimension; D_{Met}—methodological dimension; D_{Inst}—instrumental dimension; D_{Prog}—programmatic dimension; and D_{Atit}—attitudinal dimension.

Table 13. VOSviewer keywords versus Sassaki's [7] accessibility dimensions.

VOSviewer Keywords (Number of Occurrences)	Accessibility Dimensions of Sassaki [7]					
	D_{Arq}	**D_{Com}**	**D_{Met}**	**D_{Inst}**	**D_{Prog}**	**D_{Atit}**
"Digital accessibility" (73)		X	X	X	X	X
"Accessibility" (36)	X	X	X	X	X	X
"Higher education" (25)		X	X	X	X	X
"Education" (20)		X	X	X	X	X
"Universal design" (20)	X	X	X	X	X	X
"Web accessibility" (18)		X	X	X	X	
"COVID-19" (17)	X	X	X	X	X	X
"Teaching" (13)		X	X	X	X	X
"E-learning" (11)		X	X	X	X	X
"Inclusion" (10)	X	X	X	X	X	X
"Software engineering" (10)		X	X	X		
"Digital skills" (9)		X	X	X		X
"Inclusive education" (9)	X	X	X	X	X	X
"Gamification" (8)		X	X	X		X
"Special education" (8)	X	X	X	X	X	X
"Person with disabilities" (7)	X	X	X	X	X	X
"Digital inclusion" (7)		X	X	X	X	X
"Mooc" (7)		X	X	X	X	X
"Technology" (6)	X	X	X	X	X	X
"Competency framework" (5)		X	X	X	X	
"Design" (5)	X	X	X	X	X	X
"Inclusive design" (5)	X	X	X	X	X	X
"Assistive technology" (5)	X	X	X	X	X	X
"Blindness" (5)	X	X	X	X	X	X
"Model" (5)		X	X	X	X	
"Low vision" (5)	X	X	X	X	X	X
"Technologies" (5)	X	X	X	X	X	X
TOTAL	51.85%	100%	100%	99.29%	88.88%	85.19%

5. Discussion

In the discussion of the systematic review, we relate the meaning of each term in Sassaki's [7] dimensions to the selected articles.

The term "digital accessibility" refers to the communication dimension, as it relates to being in the digital environment; the methodological dimension because it delimits methods and techniques within the areas of leisure, work, education, etc.; the instrumental dimension, as it relates to enabling the use of instruments and tools for digital access; the programmatic dimension, as it relates to having laws and standards on digital accessibility; and the attitudinal dimension, due to the difficulties that people with disabilities face when using technology and the prejudice they experience in this regard. The term "digital accessibility" does not refer to physical issues relating to the architectural dimension. Reference [5] presents a list of recommendations on aspects of legislation and standards (programmatic dimension), and theoretical and practical elements (methodological dimension) to be used in digital accessibility trainings. Future studies based on this research could be applied in trainings and evaluated to validate the methodological approach.

The term "accessibility" is the most generic and general, relating to all dimensions since these dimensions are derived from the same term. "Universal design" also encom-

passes all of the dimensions because it addresses issues that are universal, that is, used for all. However, other terms, such as "inclusion", "inclusive education", "special education", "person with disabilities", "technology", "technologies", "design", "inclusive design", "assistive technology", "blindness", and "low vision", also cover following dimensions: architectural, communicational, methodological, instrumental, and attitudinal. Some studies approach these themes like the authors of [15], who conduct research with people with diverse types of disabilities to test information literacy platforms and check attitudes (the attitudinal dimension) toward them. Education study [4] presents the access possibilities, and the other studies test whether people with disabilities can easily access the information on websites (communicational dimension) of universities in Ukraine.

Digital technologies that support inclusion could guide schools to use digital technologies and provide training for teachers and children on using digital technologies (communication dimension). Future studies based on [19] could test the use of technology with a larger sample of students, as it was tested with only seven children, and to identify the main difficulties faced by those who do not accept the use of technology in the classroom. Regarding inclusive education, the sample does not consider student dropout (the methodological dimension). The studies provide no information about social status and school success prior to the level studied. This study examining whether the difference in usage habits depends on user preferences or a lack of digital communication skills related to a specific language and to learning difficulties [22]. Future studies based on [22] could seek to answer the following question: how did the experience change the perception of the target audience from this study of digital accessibility work?

It is interesting to observe how the term "COVID-19" influences all dimensions: architectural, because the pandemic led to the imposition of physical barriers and boundaries; communicational, because the pandemic prevented people from having physical contact, while virtual contact became more common/intense; methodological, because the pandemic led to the creation of new methods and techniques for leisure, work, and education; instructional, because the pandemic led to the creation of new instruments and tools for connection; programmatic, as the pandemic involved decrees regarding the opening and closing of different places, or required the use of masks in certain places; and finally, attitudinal, because during the pandemic there was prejudice not against disabled people alone but against all people in general, especially those with cold-like symptoms, because there was a belief that everyone could be a threat to an individual's health.

"Higher education" relates to the communication dimension, thinking of education in the digital environment, as well as to the methodological dimension (due to teaching methods). It relates to the instrumental dimension, as regards making teaching possible in the digital environment by means of digital instruments and tools, and to the programmatic dimension, as regards having laws and rules about access to higher education, as well as those which determine how vacancies and guidelines are offered for this level of education. Higher education also relates to the attitudinal dimension, as regards there being prejudice toward and discrimination against people with disabilities in this level of education. The term "education" relates to the same dimensions as "higher education", for the same reasons as "teaching" and "e-learning". In study [16], the authors suggest that future research applies the methodology in other colleges and institutions as samples as well (methodological dimension). The term "digital inclusion" relates to all of the dimensions except for the architectural dimension, as well as the term "digital platform", and the term "mooc", which is a massive course which is also delivered digitally.

"Web accessibility" does not involve physical architectural barriers because the web is a digital environment, nor attitudinal barriers because there are no interpersonal relationships. However, it relates to all of the other dimensions: communication in a digital way; methodological, with methods and tools for any area of leisure, work, or education; instrumental, as regards providing instruments and tools for digital access to websites; and programmatic, as regards Web Content Accessibility Guidelines (WCAG). We suggest that future studies based on the study [14] analyze websites (communicational dimension) from

universities other than those in India and consider more indicators for evaluations and also consider conducting evaluations using software.

The term "software engineering" relates to the communication dimension, as it has to do with software; to the methodological dimension, as it relates to creation methods; and the instrumental dimension, as software is composed of instruments and tools.

Teaching by "gamification" is conducted online, so it does not relate to the architectural dimension. Study [20] proposed the following areas of future research: (1) the development of a module for managing user profiles (photo, institution to which they belong, password change, account creation, etc.); (2) functionality design for privacy management of gamified environments; and (3) the implementation of quality attributes for access control, error messages and navigability elements during the creation process and design strategy, and the validation of the methodological framework (which relates to the methodological dimension) for the design of case studies and experiments.

The word "model" also relates to digital models, and for this reason it does not relate to the architectural dimension. Similarly, it does not relate to the attitudinal dimension, because there is no interpersonal relationship, which is the same for "competency framework". To complement [2], more research could be carried out to identify if there are other competence frameworks (which relates to the programmatic dimension) on accessibility besides the ones mentioned by the authors (the European Framework for Educators' Digital Competence (DigCompEdu) and UNESCO's ICT Competence Framework) to complement the comparisons between the frameworks mentioned and other existing ones. The tool (instrumental dimension) is interesting, but the article only describes the items that make up the tool: the tool does not seem to have been tested with students with hearing impairment or who are hard of hearing. This could be conducted in upcoming studies based on [18].

The association between the keywords that resulted from the VOSviewer analysis and Sassaki's dimensions [7] shows that the most frequent gaps that can become future studies based on the selected articles from systematic review in digital accessibility are related to the architectural dimension: that is, comparing architectural accessibility with digital accessibility, followed by the attitudinal dimension, which relates to prejudice and discrimination in relation to people with disabilities. Some keywords are not related to the programmatic dimension due to the fact that there is no legislation on the matter, or to the instrumental dimension due to the lack of an instrument or tool to assess this dimension.

6. Final Considerations

The articles selected for systematic review cover a diverse set of emerging themes within the field of education. Even though the theme focuses on education, it would be possible to narrow the field of study further. Multidisciplinary studies cover issues from people with disabilities, such as website analysis, gamification of education, cognitive disabilities, the creation of websites focused on education, the analysis of digital skills related to the level of education, devices to overcome a lack of digital accessibility or digital skills, as well as technology as an ally in breaking down the digital divide.

We do not really evaluate digital teaching itself, in answer to the research questions presented in the introduction; rather, the evaluations are of websites or tools that are already dictated at the national or regional level.

It is important to note that most of the articles eliminated in this research are articles from congress annals and not from journals, as the exclusion criteria defined that congress articles would not be read and so they were not analyzed in this research. These articles may date from the beginning of the COVID-19 pandemic and may be in the process of being published in journals.

Another issue observed in the systematic review is the question of the language in which the articles are written. For the review to have an international reach, it would be interesting if they were written in English, and several of the result of search were found in Spanish or Portuguese.

We conclude that, after defining the term digital accessibility, conducting a systematic review, carrying out a bibliometric analysis, presenting an analysis of the selected articles, and comparing the authors cited, we found that none of the selected studies consider digital accessibility on education area with a methodological applied.

Then, we found, through the systematic review, and bibliometric analyses of the selected articles some gaps for further research: to find indexes, indicators, or dimensions in an area other than the educational area to be adapted to a tool for digital education. The studies selected for the systematic review were classified by Sassaki's dimensions [7]: over 38% were classified under the methodological dimension, over 30% under the instrumental dimension, 23% under the communication dimension, and just over 15% under the programmatic dimension. No studies were classified under the architectural and attitudinal dimensions, corroborating the keyword analysis (Table 14). Future research can add the architectural, attitudinal, or other dimensions not cited here, or even indexes and indicators specific to the field of education.

Table 14. Frequency of accessibility dimensions in the selected articles.

Accessibility Dimensions (Sassaki, 2009)	Selected Articles	Frequency (%)
D_{Arq}	-	0
D_{Com}	[4,14,19]	23
D_{Met}	[5,6,16,20,22]	38.46
D_{Inst}	[15,17,18,21]	30.77
D_{Prog}	[2,5]	15.38
D_{Atit}	-	0

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