

Implications Of Internet Of Things (IoT) On The Education For Students With Disabilities: A Systematic Literature Review

Ms. Ruth Nthenya Wambua^a, Dr. Collins Oduor^b

^a rwambua@uonbi.ac.ke

^a Doctoral Student, United States International University, P. O. Box 14634, Nairobi 00800, Kenya

^b Assistant Professor, United States International University, P. O. Box 14634, Nairobi 00800, Kenya

Abstract

The world today has greatly been influenced by the advancements in technology, which has resulted to changes across all sectors of life, which includes the education sector. Moreover, the COVID-19 pandemic as of March 2020 resulted to more ICT integration in most sectors including education, leveraging on emerging technologies like the Internet of Things (IoT), Mircea et al., 2021. IoT refers to the network of interconnected people and devices to the world wide web (www) powered by the internet and is already in use in Education where learning and academic institutions are now incorporating IoT in educational activities, considering the ubiquitous nature of the IoT devices, Kassab et al., 2020a. However, despite the many technological advances, the adoption, and the impact of IoT in education is still in its infancy, Dai et al., 2021.

According to the United Nations sustainable goals of 2015, quality education is both Inclusive and equitable, and promotes lifelong learning. Therefore, regardless of the adopted technologies, quality education should be facilitated to all people within the population, Kayhan et al., 2015a. Considering the world population of 15% that is of people living with disabilities according to World Health Organization, this paper therefore is a systematic review of literature for the period 2010 to 2021, on the implications of Internet of Things (IoTs) on the Education for students with disabilities, to highlight benefits, challenges, adopted scenarios, technologies, as well as gaps and notable areas for further research.

Keywords: Internet of Things (IoT); Education, Educational Technologies; Online Learning; Students with Disabilities; Benefits; Challenges; Policies; Gaps

1. Introduction

Despite being a disruptive technology in most sectors, IoT is among the emerging technologies (Verma et al., 2021) with high rate of adoption considering the promises it gives.

Using the Systematic Literature Review (SLR) method by Kitchenham, 2007, this paper presents a systematic literature review with a goal to present the implications of IoT in education for students with disabilities. This is necessary to provide an update on IoT in education, highlight to what extend it has considered students with disabilities, highlight areas that are lacking and need further research, as well as contribute to the existing knowledge around IoT in education.

The paper is organized in the following sections: background and related work section, which discusses how IoT resonates in academia, its uptake and review of the implication of IoT in education for students with disabilities. Research method section discusses the adopted research methodology, whereas Results section presents the findings of the study. Discussion section gives a detailed evaluation of the implications of IoT in

Education for students with disabilities, limitations of the review section highlight the limitations of the study, and conclusion and further work section concludes the paper.

1.1 Background and Related Work

1.1.1 IoT in Education

Internet of things is an enabler in education. Considering the advancements in technology over the years, most people within any given population are now much technically connected than it was the case before, Al-Fuqaha et al., 2015. This is because most people are owners of smart phones and devices that connect to the internet and to each other, Gómez et al., 2013. Further, with the recent COVID-19 pandemic, there was also an upsurge in adoption of online connection and education. For instance, companies worked from home and would hold their meetings online. Most learning institutions continued with learning and research facilitated by online platforms. Consequently, interactions were majorly through the internet, thanks to IoT.

Education is an integral part of running an impactful government. Therefore, jurisdictions put in policies to support quality and equitable education for its population. IoT in education has resulted to smart education, whereby education is facilitated by smart technologies such as big data, IoT and cloud computing, resulting to a smart learning institution whereby the institution integrates innovative hardware, software, network, and storage concepts to deliver an interactive education environment for all, Hashey & Stahl, 2019. Further, a smart classroom is achieved in that the learning space is made up of electronically interconnected/ interacting devices such as digital screens, projectors and internet connected devices like phones, laptops, and iPads, in addition to making it easier to find and bring experts to the smart classrooms in real time. Coupled with IoT-based learning systems for smart teaching, learning and assessment, such connections create a learning environment that could be remotely accessed, thus providing knowledge anytime and anywhere. Consequently, resulting to improved knowledge dissemination process, better interaction through sharing educational content, flexibility in that knowledge could be remotely accessed, and improved thinking abilities where different learners and institutions collaborate, to list but a few. Therefore, IoT in education works to turn every object (education, institution, classroom, teaching, learning, assessment) into a smart entity (figure 1), Mircea et al., 2021.

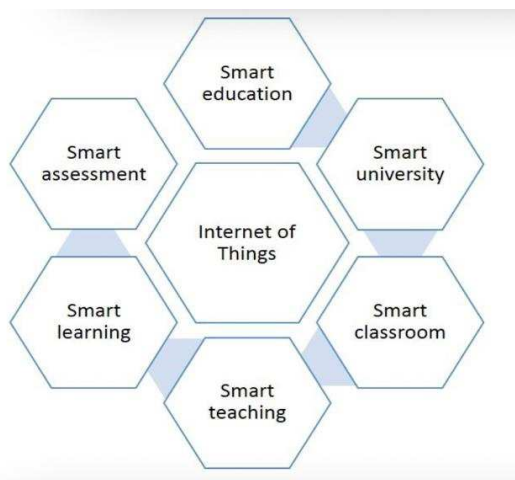


Figure 1: Smart education environment

Following the great advances in technology and online learning, equity among instructors and students with disabilities should be ensured. However, many online courses are still not fully usable by learners with disabilities, Burgstahler, 2021.

1.1.2 IoT in Education for Students with Disabilities

IoT as an Emerging key technology has been adopted in the education sector because of varied reasons. First, it's affordability in that there are increased ways to monitor our environments coupled with affordable smart devices for access, Ashraf & Habaebi, 2015. Secondly, connectivity in that there are varied ways of internet access which could either be fixed broadband, or wireless broadband, resulting to faster networks accessible almost everywhere. Third and not the last, sensors and cloud computing technologies make it easy to obtain specific information from the environment, Weber, 2015.

Therefore, IoT in education has worked to enhance the level of fairness in education delivery in that persons with locomotive challenges could access educational content from wherever they are or within their most convenient and favourable environments. Those with visual disabilities could convert text to audio files, whereas those with hearing challenges could convert audio files to text. Essentially, persons with disabilities are facilitated through IoT to cover the educational materials which cover for assessment, De Jong et al., 2013.

Online learning technologies and pedagogy research continues to address accessibility issues such that components of online courses are accessible by most students including those with disabilities and ensures that instructors routinely use accessible and inclusive online content and practices in their teaching, Irvan et al., 2021a. To add on these, is the existence and adoption of ideal practices and guidelines. For instance, the adoption of the practise of universal design (UD) which guides that the design of products and environments should be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. Moreover, UD-inspired frameworks like the Universal Design for Learning (UDL) are applied to curriculum and pedagogy and are based on the understanding that learners' abilities and response to instruction is variable. Further, the Web Content Accessibility Guidelines (WCAG) adopted on online platforms design, enhances usability and accessibility. Table 1 gives the principles of UD, UDL and WCAG, which when used in combination addresses most aspects of online learning, Burgstahler, 2021.

Table 1: Principles, guidelines, and practices for online learning

Principle	Guidelines and Practices
UD	<ul style="list-style-type: none"> • Equitable use - design for people with diverse abilities • Flexibility in use - design allows for a wide range of preferences and abilities • Simple and intuitive use - design that easy to understand • Perceptible information - design communicates to a user regardless of their conditions or the user's sensory abilities • Tolerance for error - design is tolerant to error (accidental/unintended actions) • Low physical effort - design can be used efficiently, comfortably, and with a minimum of fatigue. • Size and space for approach and use - usable regardless of the user's body size, posture, or mobility
UDL	<ul style="list-style-type: none"> • Engagement - design should stimulate interest and motivation for learning • Representation - design should present information and content in different ways • Action and expression – design should differentiate the ways that students can express what they know
WCAG	<ul style="list-style-type: none"> • Perceivable - users must be able to perceive the content, regardless of the device or configuration they're using • Operable - users must be able to operate the controls, buttons, sliders, menus, etc., regardless of the device they're using • Understandable - users must be able to understand the content and interface • Robust - content must be coded in compliance with relevant coding standards in order to ensure its accurately and meaningfully interpreted by devices, browsers, and assistive technologies

1.2 Related Work

Over the years, systematic literature reviews have been conducted around IoT-related topics, education, and around persons living with disabilities. On one hand, some reviews are generalized and conducted towards a specific group of people with disabilities; for example, Ulloa et al., 2021 highlighted the internet of things solutions that exist for people with disabilities, but with a generalized focus to people with physical and intellectual disabilities. Sánchez-Serrano et al., 2020 presented the impact of the information and communication technologies on students with disabilities and highlighted the scarcity of research studies and the limited dissemination of empirical studies around this area. In both cases, the studies did not highlight the implication of IoT for people with disabilities.

On the other hand, the review by Kassab et al., 2020b was specific to education in that it was about internet of things in education highlighting the noted benefits and challenges. However, just like the previous reviews, the implication of IoT on the education for students with disabilities was not reviewed.

IoT in education has enabled the design of courses and laboratories that allow for prototyping of robotics and other embedded devices that feature advanced technologies of internet connectivity and Real-time operating system (RTOS). Such advances have been made possible by the huge number of connected and embedded devices, Hamblen & van Bekkum, 2013. Further, according to Muthukumar et al., 2021, learning experience was found to be enthralling and with an in-depth understanding of complex concepts and processes, through deploying of advanced control techniques on Industrial IoT hardware. To add on these is that there has been an increase on proposed designs of complex systems and projects that are IoT-based. For instance, Rajkumar et al., 2020 proposed a fire alert system that was IoT-based and had facilitated actuators, that would alert users even when away from home thus helping to protect lives and decreasing damages.

Educational technology continues to advance in tandem with technological advances. Electronic Learning (E-learning) has greatly advanced the education process and has resulted to a new generation of academia keen on modern learning technologies. There is also Mobile learning (M-learning) which is not only an extension

of E-learning, but also an avenue of learning with the benefit of mobility and supports diverse mobile platforms. Lastly, there is Ubiquitous learning (U-learning) which is also a transformation of E-learning and is based on ubiquitous technology where anyone can learn anything at any place. Consequently, a global learning system that utilizes globally available learning resources is possible through application of IoT technology to an E-Learning environment, Said & Albagory, 2017, and by following principles, guidelines, and practices for online learning (Table 1).

According to Bal et al., 2020, special education poses at least two enduring conundrums: Disparities in disability identification and in educational access and outcomes within special education at the intersection of race, class, and gender. Further, Wambua & Oboko, 2015 discuss E-learning for persons with visual disabilities where they note that it's important to factor in technological advances that support education for students with disabilities.

2. Research Method

The study adopted systematic review guidelines by Kitchenham, 2007 as a guiding model in reviewing the implications of IoT on the education for students with disabilities. Microsoft Excel was used as the tool for data collection, recording and analysis.

2.1 Planning the Review

The review plan involved refining the research subject into a set of research questions, identification of the search strategy, search strings, inclusion/exclusion criteria, and the quality assessment criteria to be applied on the extracted studies as detailed below.

2.1.1 Research Questions

With the advancement of IoT in the education sector, and considering quality and inclusive education for all, this study explores the implications of IoT on education for students with disabilities, by trying to answer the following questions:

- Q1:** What are the benefits of IoT on the Education for students with disabilities?
- Q2:** What are the challenges of IoT on the Education for students with disabilities?
- Q3:** What are the adopted scenarios and technologies of IoT on the Education for students with disabilities?
- Q4:** What policies exist to guide IoT on the Education for students with disabilities?
- Q5:** What gaps exist in IoT on the Education for students with disabilities?

2.1.2 Search Strategy

Following the systematic review guideline model by Kitchenham, 2007 and with input from Bai, 2019, a research space was defined that included four electronic databases as outlined below under data sources. The selected publication was in English, as the select language, and the period was from year 2010 to year 2021. Searched items were either journal articles or conference papers, and the search was restricted to the document title. Searched data as guided by the search strings and the inclusion and exclusion criteria was recorded for analysis and informing the study.

2.1.2.1 Data Sources

Considering databases that had a focus to Design Science kind of research and allowed advanced search output of the publication/document title, the following are the databases that informed the study. Further, the selected databases had published content on the subject area of Internet of Things/IoT on education/learning, thus narrowing on databases that had an engineering/Computer Science/Information Systems discipline and the education discipline focus:

- i. IEEE - IEEE is an Electronic Library to Electrical Engineering, Telecommunications, Computer Science; Architecture, Imaging Science & Photographic Technology, Robotics, Biomedical Engineering, Computer Science Information Systems, Software Engineering, Remote Sensing and Artificial Intelligence published content.
- ii. Emerald - This electronic database offers access to Management and library & information services journals, as well as provide access to leading titles in marketing, business disciplines, engineering, and materials science.

- iii. ScienceDirect - An electronic database for peer-reviewed journal articles and book chapters and has about 1.4 million articles on open access.
- iv. EBSCOhost - This electronic database has over 11,000 full text, peer-reviewed journals, over 15,000 abstracted and indexed titles. It offers access to 8 major databases: Academic Search Premier; Business Source Premier; ERIC; Masterfile Premier; Newspaper Source; Health Source: Nursing & Academic; Health Source: Consumer Edition; Medline.

2.1.3 Search Criteria

The search criteria used the Boolean operator 'AND' between the strings which were made up of keywords as informed by the study and the research questions. Example keywords in this study was "Internet of Things:" and Education. Using these keywords and the Boolean operator, the string ("Internet of Things:" AND Education) is formed. Each of the formed search string was applied across the specified databases, each time recording the output for further analysis.

2.1.4 Inclusion and Exclusion Criteria

To inform the study, the following inclusion criteria was adopted:

- i. Databases that published articles within the Information and Technology research areas, in addition to databases that tackled the broad area as defined by the STEM subjects and the education discipline
- ii. The study is a peer-reviewed publication/journal or conference paper
- iii. The study is in English
- iv. The study complies with the defined search strategy and criteria.

On the other hand, the following criteria was used for exclusion:

- i. Databases that did not have a focus to Design Science kind of research
- ii. Databases that did not publish Information Systems and Technology related journals
- iii. Studies that had no focus on Internet of things/IoT and Education
- iv. Studies that did not meet the inclusion criteria.

2.2 Conducting the Review

This section presents the process of conducting the searches, collecting the data and information from the mentioned databases.

2.2.1 Study Search and Selection

2.2.1.1 First-level search

Guided by the search strategy, the mentioned four electronic databases were searched. To start with, a search on the main subject area, in this case "Internet of things" was done to ascertain that the databases published related content. A total of 14,283 articles were noted to have published content on "Internet of things" as summarized in table 1 below, where (#) denotes (Number of).

Table 2: First-level search results (published content with the phrase “Internet of Things”)

		IEEE	Emerald Science Direct	EBSCOhost	Total
# Journal Articles	4,760	117	1,828	7,578	14,283
# Conference Papers	7,982	0	54	22,142	30,124

From the first-level analysis, it was noted that unlike the other databases (Emerald, Science Direct, and EBSCOhost), IEEE database had a better-defined way of retrieving conference papers. The total number of conference papers noted from the IEEE database was 7,982. EBSCOhost output of 22,142 was from conferences/workshops/seminars. Science Direct had a record of 54 from conference abstracts, whereas Emerald database did not have conference papers as an option of search. This was considered to negatively impact further refinement of the study data. Consequently, analysis of conference papers regarding the search strings was dropped for the second-level analysis.

2.2.1.2 Second-level Search

Further refinement was then performed across the databases using Boolean ‘AND’ for all the 83 formed search phrases (Appendix A). The following, table 2 below, show a summary of the second-level search results across the select databases.

Table 3: Second-level search results (from the formed search phrases)

	IEEE	Emerald	Science Direct	EBSCOhost	Total
# Journal Articles	587	32	491	2,050	3,160

2.2.1.3 Third-level Search

During each phrase search, and for each database, all papers that had published content related to the study title “Implications of Internet of Things (IoT) on the Education for students with disabilities” were noted and summarized for later analysis. A total of 49 papers were noted (Appendix B) to have published content related to the research title. Table 3 below is a summary of the number of papers noted per database. The number of papers in the third-level search includes relevant conference papers and these papers were within the first-level search.

Table 4: Third-level search results (published content related to the study title)

	IEEE	Emerald	Science Direct	EBSCOhost	Total
Number of papers	18	9	10	12	49

2.2.2 Data Extraction and Synthesis

Following the study search and selection, data extraction process ensued and was done by reading the full text

of the selected studies. A predefined extraction form (Appendix C) was utilized to record the full details of the 49 selected papers to determine that the papers were addressing the study research questions. Like the selection process, the data extraction process was also supported by Microsoft excel tool. To note is that the numbering of the papers from Paper 1 to Paper 49 is consistent for referencing.

2.2.2.1 First-level synthesis

For all the selected papers, their contributions to the study were noted. This was done guided by the study keywords, in this case benefits, challenges, technology, policies, and gaps. Table 4 and graph 1 below shows the summary of the number of papers where the keywords were well highlighted and discussed.

Table 5: First-level synthesis (number of papers with the noted keywords)

	Benefits	Challenges	Technology	Policies	Gaps
Number of papers	10	10	39	2	7

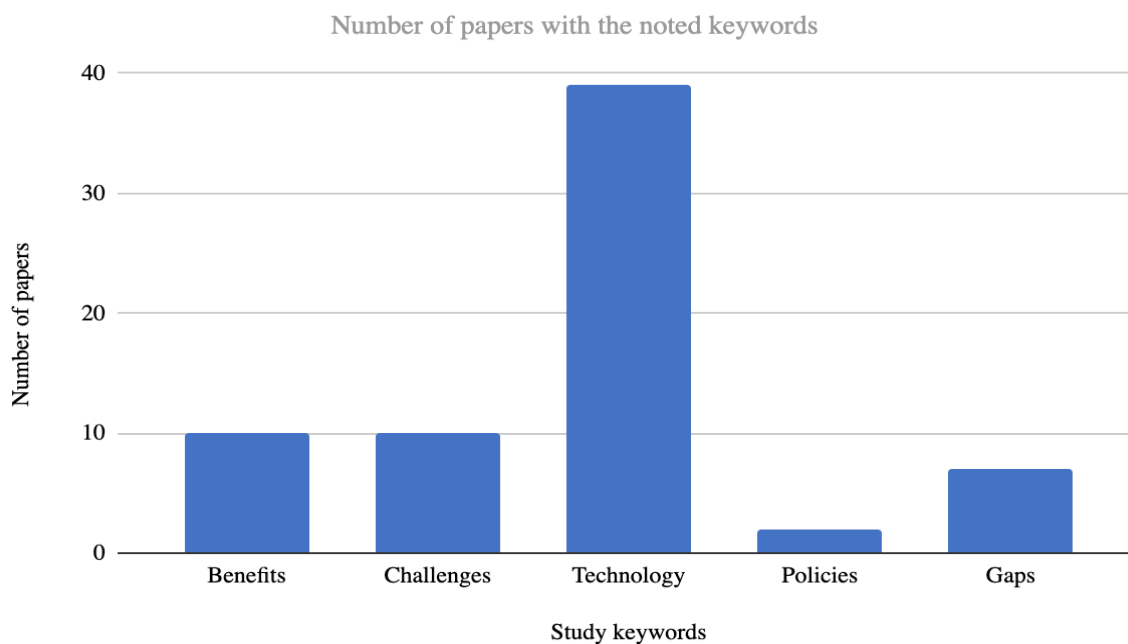


Figure 2: First-level data extraction and synthesis output (number of papers with the noted keywords)

2.2.2.2 Second-level Synthesis

Further synthesis was done to establish to what extend the papers addressed the study title “Implications of Internet of Things (IoT) on the Education for students with disabilities”. This was done by noting all the papers that considered students with disabilities. Table 5 and graph 2 is a summary of the papers that considered students with disabilities.

Table 6: Second-level synthesis (number of papers that considered students with disabilities)

	Considered students with disabilities
Number of papers	17

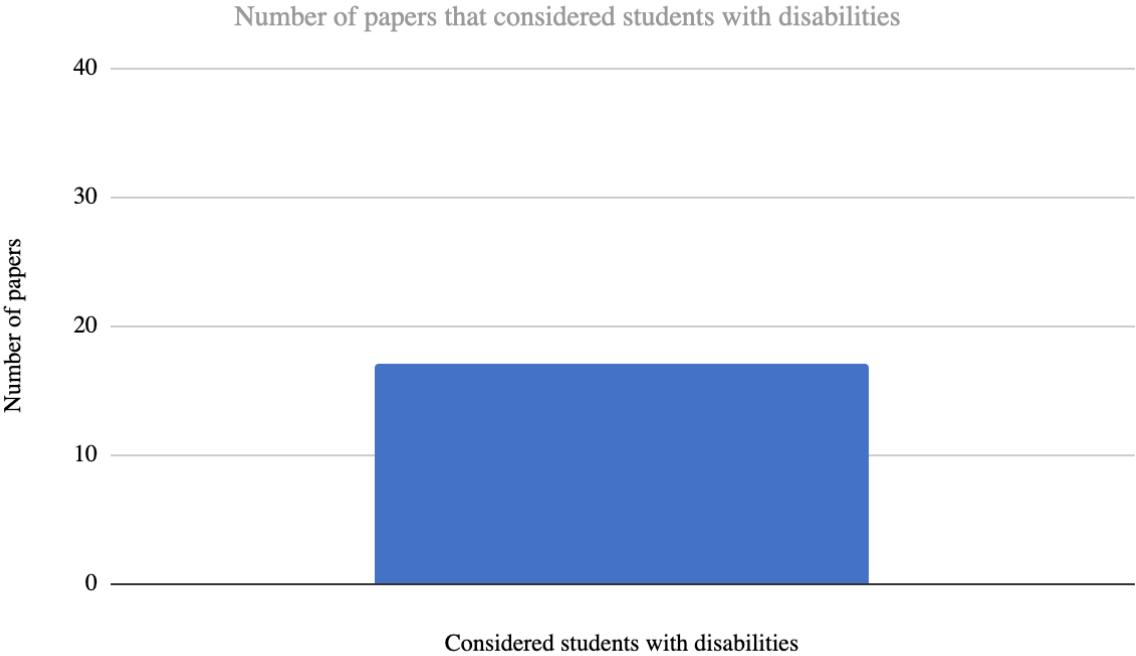


Figure 3: Second-level data extraction and synthesis output (number of papers that considered students with disabilities)

2.2.2.3 Third-level Synthesis

Guided by the study title, further refinement of first and second-level synthesis was done to determine the number of papers that had mentioned the study keywords and at the same time had considered students with disabilities. The output of the synthesis is as summarised on table 6 and graph 3 below, where Benefits is “B”, Challenges is “C”, Technology is “T”, Policies is “P”, Gaps is “G”, and considers students with disabilities is “SwD”.

Table 7: Third-level synthesis (number of papers with the noted keywords and considers students with disabilities)

	B	C	T	G	SwD
Number of Papers	1	5	11	2	3

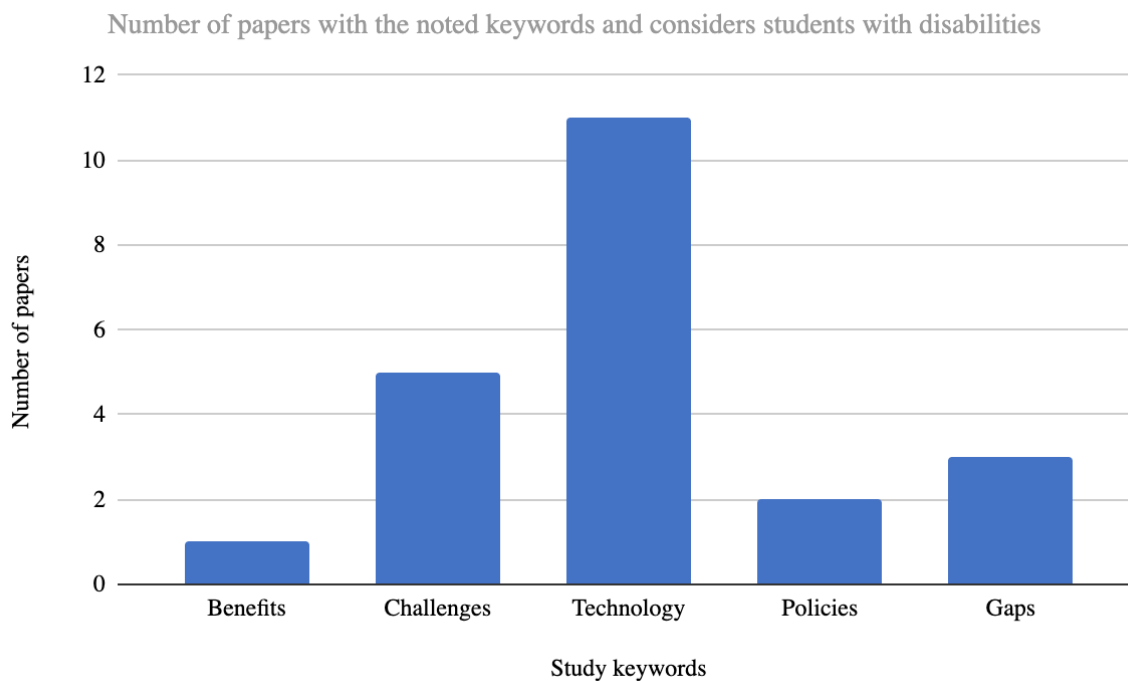


Figure 4: Third-level data extraction and synthesis output (number of papers with the noted keywords and considers students with disabilities)

2.2.2.4 Fourth-level Synthesis

Further, table 7 and graph 4 compares the number of papers that discusses the keywords as noted in the first-level synthesis with the number of papers that mentions the keywords and at the same time considers students with disabilities as noted in the third-level synthesis.

Table 8: Fourth-level synthesis (compares first and third-level synthesis)

	Benefits	Challenges	Technology	Policies	Gaps
First-level synthesis	10	10	39	2	7
Third-level synthesis	5	5	11	2	3

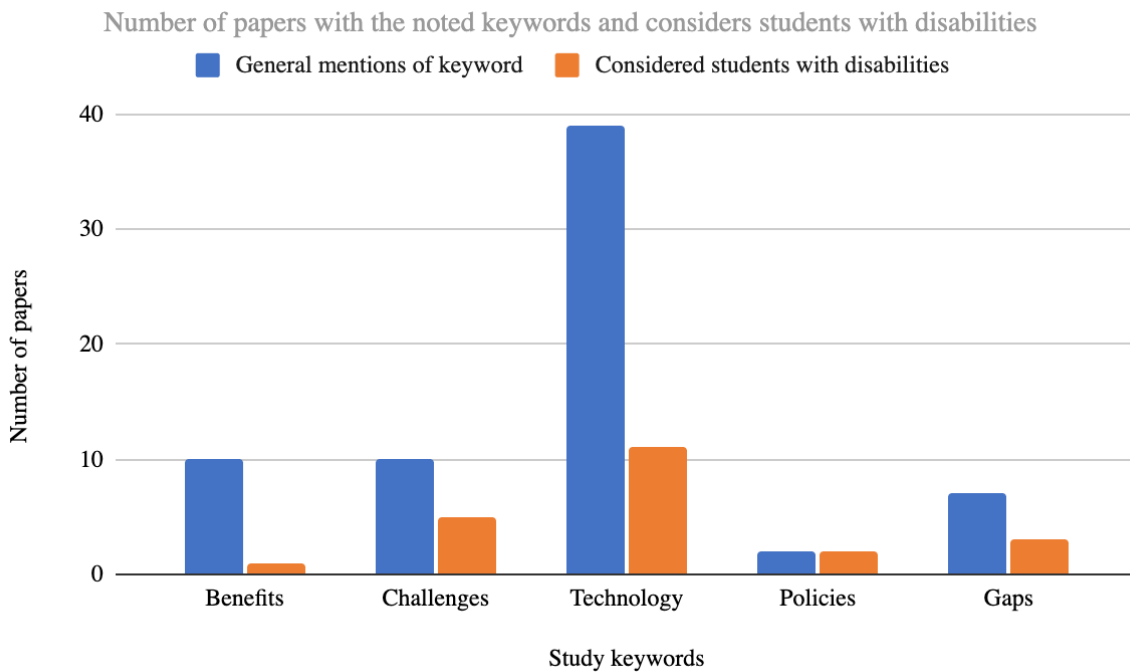


Figure 5: Fourth-level data extraction and synthesis output (compares first and third-level synthesis)

The extracted and synthesized data informed the results findings as discussed in the next paper section.

3. Results Findings

Q1: What are the Benefits of IoT on the Education for Students with Disabilities?

According to Mircea et al., 2021, adoption of IoT in education is beneficial in that it results to a positive influence on excellence in teaching, on additional resources, on intra and extra university connectivity and excellence in learning.

Considering students with disabilities, the use of wireless assistive technology and IoT exposes the students to more accessible learning environments, as well as the benefit from the use of pedagogical agent (or virtual assistants), Bright, 2021a.

Q2: What are the Challenges of IoT on the Education for Students with Disabilities?

Education for students with disabilities has its own share of challenges such as teacher training and support whereby responsible educators feel unprepared and inadequately resourced to teach students with disabilities. To add on this is the perception of assistive technology whereby educators' perceptions of assistive technology are tied to their knowledge of its use and ultimately influence their integration of technology to teaching. Further, affordability concerns are a great challenge in that students with disabilities may not be able to access appropriate learning devices, Bright, 2021a.

On the other hand, general technological challenges are a threat to IoT on the education for students with disabilities, as well as any other set of students. For instance, limited memory, bandwidth, and energy would limit the technological demands of IoT on education. In addition, a case whereby there is a lot of data to be communicated across students who possess insufficient resources would lead to communication overhead. Moreover, fairness in an education setup will remain to pose a challenge in that it's not easy to ensure an equitable distribution of student resources at all times. Lastly and not the last, the heterogeneous hardware that encompass the IoT landscape results to varied outputs regardless of the students' scale.

Q3: What are the Adopted Scenarios and Technologies of IoT on the Education for Students with Disabilities?

For effectiveness, methods of IoT teaching should include a practical component as well as incorporate hardware and software designs that would significantly reduce the teaching workload and improve data management, J. Wang, 2015. On the other hand, the education for students with disabilities is made easier with the help of assistive technologies as well as having fellow well-abled students and tutors as support system. For instance, a Learning Management System (LMS) should have content accessible by persons with varied disabilities, like text-based learning content for students with visual impairments, and visual-based content like use of pictures, diagrams, and videos with subtitles for students with hearing loss, Irvan et al., 2021b.

Generally, there is variety of developed IoT applications and services for people with disabilities that use varied embedded sensors, external devices, and actuators. The following table (table 6) is a summary of IoT applications and services for different disability types, and it outlines the main sensors, actuators, gateways, and communication technologies as used in literature, Antoni'c, 2021. Notably, is that many solutions use Raspberry Pi or Arduino as microprocessor or hardware, to serve as gateways, in combination with mobile devices for server data transmission and for user interaction. On the other hand, for efficient power

consumption, Bluetooth and WiFi are the commonly used wireless communication techniques, Mahmoud & Mohamad, 2016.

Table 9: Summary of IoT services for people with disabilities

Disability Type	IoT Service	IoT Device	Gateway	Communication Type
Mobility/physical	Indoor thermal comfort	Thermal sensor	Arduino	WiFi
	Home mobile healthcare	WBAN, body sensors	Mobile phone	ZigBee, Bluetooth
	Fall detection	Shoe sensor	Raspberry Pi	LoRa, LPWAN, WiFi
	Hand rehabilitation and telemonitoring; Smart wheelchair	Smart toy; smart wheelchair	Arduino + Mobile phone	Bluetooth
Vision	Dynamic Bluetooth beacons; Cognitive navigation	BLE beacons	RFduino + Raspberry Pi; Mobile phone	BLE
	Assistive walking	Smart walker	Arduino + Mobile phone	ESP8266
	Shopping aid	RFID+NFC tags	Mobile phone	RFID, NFC
Hearing	Real time communication; Wireless alerts	Different sensors	Raspberry Pi + Mobile phone	WiFi, Bluetooth, GSM
	Monitoring baby incidents	Smart bracelet	Mobile phone	WiFi
	Sign language recognition	Smart glove	Raspberry Pi + Mobile phone	WiFi
Other	IoT-aware aal system	Different sensors	Raspberry Pi + Mobile phone	BLE, WiFi, Ethernet
	Bluetooth skin resistance sensors	Skin resistance sensor	Mobile phone	BLE

In the education setup, the internet of things includes four core technologies namely RFID technology, sensor technology, intelligent technology, and nano technology, embodied in classroom teaching, extracurricular learning, and educational management, N. Wang & Wang, 2018.

Q4: What Policies Exist to Guide IoT on the Education for Students with Disabilities?

Among the United Nations global goals is the goal on quality education, whereby one of the targets is to eliminate all discrimination in education by the year 2030 by ensuring equal access to education and vocational training for the vulnerable, including persons with disabilities. Considering the involved countries, whose practices may vary based on existing education policies, there may be varied attainment levels. For instance, Turkey has the Disabled law 5378 prepared by Higher Education Council to regulate the education of students with disabilities, and its constantly being reviewed for effectiveness, Kayhan et al., 2015b. Further, Teather & Hillman, 2017 noted that despite the Australian government legislation purporting an inclusive education for all students, there was still underestimated numbers of students with disabilities in Australian schools resulting in poor educational outcomes and work-readiness. Therefore, adequate policies on the education for students with disabilities are yet to be well enforced in most jurisdictions for effectiveness.

On the other hand, IoT on the education for students with disabilities is coming along well despite the challenges on adoption and guiding policies. Internet of things as a technology poses security concerns considering that its basis is on data which in most cases is specific to an entity and not for the public. There is

surely need for a clear regulatory framework, policies, and measures to guard and govern collected data. Existing international standards such as for the use of UHF RFID having been addressed is a step in the right direction. However, appropriate laws on a regulatory level are still missing and should be addressed, Weber, 2015.

Q5: What Gaps Exist in IoT on the Education for Students with Disabilities?

Connectivity and access to technology may vary depending on federal agencies, state entities and localities whereby there may exist divergent governing rules, resulting to a gap on attainment levels of inclusive education across jurisdictions. Moreover, the information journey of students with disabilities through accessible learning materials continues to vary in that the existence of inaccessible formats such as Portable Document Format (PDF) is a challenge to one category of disability and not another, Nganji, 2018.

The adoption of accessibility and inclusivity guidelines and practises is among the ways of addressing most challenges and noted gaps, Burgstahler, 2021. However, designing for cases with multiple disabilities is difficult, Nganji & Brayshaw, 2017.

4. Discussion

According to Habib et al., 2021, the advancement of the Internet of things (IoT) fortifies the development of intelligent systems for diverse information management even within the education domain.

On the education for students with disabilities, wireless technology, IoT, and broadband access are among vehicles to broaden participation of students with disabilities in education and address challenges experienced in classrooms and beyond. It's important for disability advocates, educational technology developers, education scholars and practitioners to work together to ensure that education for students with disabilities is factored in with the adoption of IoT and other technologies in education. For instance, researchers should not only be familiar with principles and guidelines around inclusive education, but also include individuals with disabilities and accessibility professionals in their research teams. Moreover, IT designers should possess basic accessibility principles and standards-compliant coding practices to ensure disability compliant platforms, Burgstahler, 2021.

From this study results findings, IoT on the education for students with disabilities is not only beneficial to the individual, but to the society at large. Moreover, ways to mitigate the noted challenges should be highlighted and adopted to leverage on the benefits of IoT in education and to ensure quality and inclusive education. Further, dedicated policies and legislations to guide and govern education for students with disabilities, as well as regulatory mechanisms to address evolving IoT security risks will go a long way, Brass & Sowell, 2021.

5. Limitation of Review

The study majorly considered journal articles. It could have been more comprehensive if all types of scientific contributions were considered. Moreover, this study was limited to English as the publishing language assuming any other contributions that might have been published in another language.

6. Conclusion and Further Work

Quality education is both Inclusive and equitable and promotes lifelong learning which aims to support the integration of every individual into the education process, Kayhan et al., 2015b. Therefore, education should be accessible to all persons within any population and designed online learning platforms should also be accessible by all learners including students with disabilities.

Even with the noted advancements in facilitating learning, especially technology-aided learning, there remains a gap in ensuring seamless access and fairness to persons with disabilities. For instance, according to Antoni´c, 2021, device standardization and interoperability, privacy protection, increased data security, and a commitment to accessibility by all parties within the IoT ecosystem, are a challenge for a wider usage of these services for people with disabilities.

Conclusively, the implications of Internet of things on the education for students with disabilities should be extensively researched, highlighted, and addressed. Hence the need for evidence-based research on the education for students with disabilities. Further, intervention measures like teachers to only employ technology-mediated lessons if they are inclusive of different learning styles and needs, localities to employ mobile-friendly learning through apps and texts, states to develop funding for expanded broadband services for public spaces, and federal agencies to relax rules around connectivity and access to technology, could be among impactful ways of supporting the education for students with disabilities amid IoT integration, Bright, 2021b.

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Appendix

Appendix A. Search Phrases

#	Search Phrases
1	"Internet of Things:"
2	"Internet of Things:" AND Education
3	"Internet of Things:" AND Education AND "disability:"
4	"Internet of Things:" AND learning AND "disability:"
5	"Internet of Things:" AND Learning
6	"Internet of Things:" AND "Learning technologies:"
7	"Internet of Things:" AND Technology*
8	"Internet of Things:" AND perspective*
9	"Internet of Things:" AND "learning perspective*:"
10	"Internet of Things:" AND Student*
11	"Internet of Things:" AND Disability
12	"Internet of Things:" AND Student AND disability
13	"Internet of Things:" AND "Students with disability:"
14	"Internet of Things:" AND "Adopted scenarios:"
15	"Internet of Things:" AND STEM
16	"Internet of Things:" AND "Information systems:"
17	"Internet of Things:" AND "Information systems and Technology:"
18	"IoT:" AND Learning
19	"IoT:" AND "Learning technolog*:"
20	"IoT:" AND Technolog*
21	"IoT:" AND perspective*
22	"IoT:" AND "learning perspective*:"
23	"IoT:" AND Student*
24	"IoT:" AND Disability
25	"IoT:" AND "Student* with disability:"
26	"IoT:" AND "Adopted scenarios"
27	"IoT:" AND Data Science
28	"IoT:" AND STEM
29	"IoT:" AND "Information system*:"
30	"IoT:" AND "Information systems and Technology:"

#	Search Phrases
31	"Digital learning:" AND Disability AND Gaps
32	"Online learning:" AND Disability AND Gaps
33	"Digital learning:" AND "Students with disabilities:"
34	"Online learning:" AND "Students with disabilities:"
35	"Internet of Things:" AND "Digital learning:"
36	"Internet of Things:" AND "Online learning:"
37	"Internet of Things:" AND "scenarios:"
38	"Students with disability:" AND Education
39	"Students with disability:" AND Learning
40	"Students with disability:" AND Technology
41	"Students with disability:" AND Setting
42	"Students with disability:" AND Gaps
43	"Disability setting:" AND Disability
44	"Disability setting:" AND Education
45	"Disability setting:" AND Learning
46	"Disability setting:" AND Technology
47	"Disability setting:" AND Gaps
48	"Learning for students:" AND Disability
49	"Education for students:" AND Disability
50	"Education for students with disability:" AND Gaps
51	"Education for students with disability:" AND Technology
52	"Education for students with disability:" AND Setting
53	"Internet of Things:" AND Pedagogy
54	"Internet of things:" AND "Educational technology:"
55	"Internet of things:" AND "Online learning:"
56	"Internet of Things in Education:" AND Student*
57	"Internet of Things:" AND Education AND Student*
58	"IoT:" AND "Online learning:"
59	"IoT:" AND Pedagogy
60	"IoT:" AND "Educational technology:"
61	"IoT:" AND "Education:"
62	"Internet of Things:" AND "Education:" AND "Disability:" AND Policy
63	"Internet of Things:" AND "Education:" AND "Disability:" AND Policies

#	Search Phrases
64	"Internet of Things:" AND "Education:" AND "Disability:" AND Technology
65	"Internet of Things:" AND "Education:" AND "Disability:" AND Technologies
66	"Internet of Things:" AND "pedagogy:" AND "students with disabilities:" AND "Processing components:"
67	"Internet of Things:" AND "pedagogy:" AND "Disability:"
68	"Internet of Things:" AND "Education:" AND "Disability:" AND Benefits
69	"Internet of Things:" AND "Education:" AND "Disability:" AND Challenges
70	"Internet of Things:" AND "Education:" AND "Disability:" AND "scenarios:"
71	"Internet of Things:" AND "Education:" AND "Disability:" AND "technolog*:"
72	"Internet of Things:" AND "Education:" AND "Disability:" AND "adopted scenarios:"
73	"IoT:" AND "Education:" AND "Disability:" AND Policy
74	"IoT:" AND "Education:" AND "Disability:" AND Policies
75	"IoT:" AND "Education:" AND "Disability:" AND Technology
76	"IoT:" AND "Education:" AND "Disability:" AND Technologies
77	"IoT:" AND "pedagogy:" AND "Disability:" AND "Processing components:"
78	"IoT:" AND "pedagogy:" AND "Disability:"
79	"IoT:" AND "Education:" AND "Disability:" AND Benefits
80	"IoT:" AND "Education:" AND "Disability:" AND Challenges
81	"IoT:" AND "Education:" AND "Disability:" AND "Adopted scenarios:"
82	"IoT:" AND "Education:" AND "Disability:" AND "Adopted technolog*:"
83	"IoT:" AND "Education:" AND "Disability:" AND Scenarios

Appendix B. Papers that Published Content Related to the Research Title

#	Item Type	Publication Year	Author	Title	Database
1	Conference Paper	2021	Burgstahler, Sheryl	Designing Online Learning to be Accessible to Students with Disabilities	IEEE
2	Conference Paper	2021	Irvan, Muchamad; Damayanto, Angga; Jauhari, Muhammad Nurrohman; Aqilah, Thalsa Syahda	The Effectiveness Factors of Online Learning Through Learning Management System for Students with Disabilities	IEEE
3	Conference Paper	2021	Habib, Kaiser; Kai, Elson Ee Teng; Saad, Mohamad Hanif Md; Hussain, Aini; Ayob, Afida; Ahmad, Ammar Syafiq Sabaahul	Internet of Things (IoT) Enhanced Educational Toolkit for Teaching & Learning of Science, Technology, Engineering and Mathematics (STEM)	IEEE
4	Conference Paper	2019	Fidai, Aamir; Kwon, Hyunkyung; Buettner, Gabrielle; Capraro, Robert M.; Capraro, Mary Margaret; Jarvis, Cynthia; Benzor, Madison; Verma, Saaransh	Internet of Things (IoT) Instructional Devices in STEM Classrooms: Past, Present and Future Directions	IEEE
5	Conference Paper	2019	Kim, Jee-Eun; Bessho, Masahiro; Sakamura, Ken	Towards a Smartwatch Application to Assist Students with Disabilities in an IoT-enabled Campus	IEEE
6	Conference Paper	2021	Antonic, Martina	IoT Technologies Offer New Potentials for People with Disabilities	IEEE
7	Journal Article	2021	Xiao, Ruijian; Liu, Xingeng	Analysis of the Architecture of the Mental Health Education System for College Students Based on the Internet of Things and Privacy Security	IEEE
8	Conference Paper	2018	Spyrou, Evangelos; Vretos, Nicholas; Pomazanskyi, Andrew; Asteriadis, Stylianos; Leligou, Helen C.	Exploiting IoT Technologies for Personalized Learning	IEEE
9	Journal Article	2021	Verma, Anil; Singh, Aman; Anand, Divya; Aljahdali, Hani Moateq; Alsubhi, Khalid; Khan, Baseem	IoT Inspired Intelligent Monitoring and Reporting Framework for Education 4.0	IEEE
10	Journal Article	2020	Ding, Yu; Li, Yuhang; Cheng, Lei	Application of Internet of Things and Virtual Reality Technology in College Physical Education	IEEE
11	Journal Article	2021	Xiao, Ruijian; Liu, Xingeng	Analysis of the Architecture of the Mental Health Education System for College Students Based on the Internet of Things and Privacy Security	IEEE
12	Journal Article	2021	Dai, Zhicheng; Zhang, Qianqian; Zhu, Xiaoliang; Zhao, Liang	A Comparative Study of Chinese and Foreign Research on the Internet of Things in Education: Bibliometric Analysis and Visualization	IEEE
13	Journal Article	2021	Mircea, Marinela; Stoica, Marian; Ghilic-Micu, Bogdan	Investigating the Impact of the Internet of Things in Higher Education Environment	IEEE
14	Conference Paper	2015	Wang, Jingli	The design of teaching management system in universities based on biometrics identification and the Internet of Things technology	IEEE
15	Journal Article	2021	Muthukumar, N.; Srinivasan, Seshadhri; Subathra, B.; Ramkumar, K.	Teaching Industrial Internet-of-Things-Based Model-Predictive Controller	IEEE
16	Journal Article	2013	Hamblen, James O.; van Bekkum, Gijsbert M. E.	An Embedded Systems Laboratory to Support Rapid Prototyping of Robotics and the Internet of Things	IEEE
17	Conference Paper	2020	Rajkumar, Anusha Devi; Sakaew, Sirirat; Yensook, Thammaphon; Aphiratsakun, Narong	Fire Alert System & Application Based on Internet of Things for STEM Education	IEEE
18	Conference Paper	2018	Papulovskaya, N.V.; Tarasov, A. D.; Artemasov, D. A.	Future Engineers: Education for the Internet of Things	IEEE

#	Item Type	Publication Year	Author	Title	Database
19	Journal Article	2012	Domingo, Mari Carmen	An overview of the Internet of Things for people with disabilities	ScienceDirect
20	Journal Article	2014	Bjekić, Dragana; Obradović, Svetlana; Vučetić, Milica; Bojović, Milevica	E-teacher in Inclusive e-education for Students with Specific Learning Disabilities	ScienceDirect
21	Journal Article	2015	Waiyakoon, Suwit; Khlaisang, Jintavee; Koraneekij, Prakob	Development of an Instructional Learning Object Design Model for Tablets Using Game-based Learning with Scaffolding to Enhance Mathematical Concepts for Mathematic Learning Disability Students	ScienceDirect
22	Journal Article	2019	Fekete, Christine; Tough, Hannah; Brinkhof, Martin W.G.; Siegrist, Johannes	Does well-being suffer when control in productive activities is low? A dyadic longitudinal analysis in the disability setting	ScienceDirect
23	Journal Article	2016	Lersilp, Theeratorn	Assistive Technology and Educational Services for Undergraduate Students with Disabilities at Universities in the Northern Thailand	ScienceDirect
24	Journal Article	2012	Izzo, Margaretha Vreeburg	Universal Design for Learning: Enhancing Achievement of Students with Disabilities	ScienceDirect
25	Journal Article	2015	Kayhan, Nilay; Sen, Mumin; Akcamete, Gonul	Opinions of University Students with Disabilities on Current Regulations and Adaptations at Higher Education Institutions	ScienceDirect
26	Journal Article	2021	Muhsen, Ibrahim N.; Rasheed, Omar W.; Habib, Eiad A.; Alsaad, Rakan K.; Maghrabi, Mohannad K.; Rahman, Md A.; Sicker, Douglas; Wood, William A.; Beg, Muhammad S.; Sung, Anthony D.; Hashmi, Shahrukh K.	Current status and future perspectives on the Internet of Things in oncology	ScienceDirect
27	Journal Article	2013	Gómez, Jorge; Huete, Juan F.; Hoyos, Oscar; Perez, Luis; Grigori, Daniela	Interaction System based on Internet of Things as Support for Education	ScienceDirect
28	Journal Article	2021	Ashima, Reem; Haleem, Abid; Javaid, Mohd; Rab, Shanay	Understanding the role and capabilities of Internet of Things-enabled Additive Manufacturing through its application areas	ScienceDirect
29	Journal Article	2021	Bright, Dara	An integrative review of the potential of wireless assistive technologies and internet of things (IoT) to improve accessibility to education for students with disabilities	EBSCOhost
30	Journal Article	2021	Mkrttchian, Vardan; Gamidullaeva, Leyla; Finogeev, Alexey; Chernyshenko, Serge; Chernyshenko, Vsevolod; Amirov, Danis; Potapova, Irina	Big Data and Internet of Things (IoT) Technologies' Influence on Higher Education: Current State and Future Prospects	EBSCOhost
31	Journal Article	2021	Bal, Aydin; Waitoller, Federico R.; Mawene, Dian; Gorham, Aja	Culture, context, and disability: A systematic literature review of cultural-historical activity theory-based studies on the teaching and learning of students with disabilities	EBSCOhost
32	Journal Article	2018		Research and Practice on Innovative Methods of Ideological and Political Education for College Students Based on Internet of Things + Technologies*	EBSCOhost
33	Journal Article	2013	Henderson, Kirsty; Gibson, Chris; Gibb, Forbes	The impact of tablet computers on students with disabilities in a Higher Education setting	EBSCOhost

#	Item Type	Publication Year	Author	Title	Database
34	Journal Article	2020	Stančin, Kristian; Hoić-Božić, Nataša; Skočić Mihic, Sanja	Using Digital Game-Based Learning for Students with Intellectual Disabilities – A Systematic Literature Review	EBSCOhost
35	Journal Article	2020	Siegrist, Johannes; Tough, Hannah; Brinkhof, Martin W. G.; Fekete, Christine; SwiSCI study group	Failed reciprocity in social exchange and wellbeing: evidence from a longitudinal dyadic study in the disability setting	EBSCOhost
36	Journal Article	2020	Matni, Nagib; Moraes, Jean; Oliveira, Helder; Rosário, Denis; Cerqueira, Eduardo	LoRaWAN Gateway Placement Model for Dynamic Internet of Things Scenarios	EBSCOhost
37	Journal Article	2014	Hashey, Andrew I.; Stahl, Skip	Making Online Learning Accessible for Students With Disabilities	EBSCOhost
38	Journal Article	2014	Smith, Sean J.; Basham, James D.	Designing Online Learning Opportunities for Students with Disabilities	EBSCOhost
39	Journal Article	2021	Thakkar, Ankit; Lohiya, Ritika	A Review on Machine Learning and Deep Learning Perspectives of IDS for IoT: Recent Updates, Security Issues, and Challenges	EBSCOhost
40	Journal Article	2021	Liu, Jinhua; Wang, Caiping; Xiao, Xianchun	Internet of Things (IoT) Technology for the Development of Intelligent Decision Support Education Platform	EBSCOhost
41	Journal Article	2021	Leong, Yee Rock; Tajudeen, Farzana Parveen; Yeong, Wai Chung	Bibliometric and content analysis of the internet of things research: a social science perspective	Emerald
42	Journal Article	2016	Del Giudice, Manlio	Discovering the Internet of Things (IoT): technology and business process management, inside and outside the innovative firms	Emerald
43	Journal Article	2017	Nganji, Julius T.; Brayshaw, Mike	Disability-aware adaptive and personalised learning for students with multiple disabilities	Emerald
44	Journal Article	2018	Nganji, Julius T.	Supporting the information journey of students with disabilities through accessible learning materials	Emerald
45	Journal Article	2017	Teather, Susan; Hillman, Wendy	The invisible students with disabilities in the Australian education system	Emerald
46	Journal Article	2021	Goumagias, Nikolaos; Whalley, Jason; Dilaver, Ozge; Cunningham, James	Making sense of the internet of things: a critical review of internet of things definitions between 2005 and 2019	Emerald
47	Journal Article	2018	Liang, Xueling; Chen, Yong	Libraries in Internet of Things (IoT) era	Emerald
48	Journal Article	2017	Makori, Elisha Ondieki	Promoting innovation and application of internet of things in academic and research information organizations	Emerald
49	Journal Article	2020		Internet of Things (IoT) to the rescue: How IoT could improve supply chain risk management	Emerald

Appendix C. Data Extraction and Synthesis Form

(Refer to Appendix B for Item Type, Publication Year, Author, and Database)

Data Synthesis to determine that the 49 papers were addressing the research questions: Benefits(B), Challenges(C), Technology(T), Policies(P), Gaps(G), Considered students with disabilities (SwD)							
				Contribution to study (1 denotes "YES" and 0 denotes "NO")			
#	Title	Focus of Paper	B	C	T	P	G SwD
1	Designing Online Learning to be Accessible to Students with Disabilities	This paper shares the design and results of an exploratory study that focused on improving the accessibility of online tools and pedagogy	0	0	1	0	0 1
2	The Effectiveness Factors of Online Learning Through Learning Management System for Students with Disabilities	The purpose of this article is to investigate the performance of special needs students with visual and hearing impairments when participating in online learning via LMS and identify the supporting factors and capacities that can be used to improve the quality of their learning.	0	0	1	0	0 1
3	Internet of Things (IoT) Enhanced Educational Toolkit for Teaching & Learning of Science, Technology, Engineering and Mathematics (STEM)	The purpose of this study is to develop a smart toolkit in association with a Teaching and Learning (T&L) module to expose STEM knowledge to the students.	0	0	1	0	0 0
4	Internet of Things (IoT) Instructional Devices in STEM Classrooms: Past, Present and Future Directions	The focus of this paper is on the function of IoTs and the process of providing educators with the technology, instructional tools, and materials necessary to implement IoT devices within the classroom.	0	0	1	0	1 0
5	Towards a Smartwatch Application to Assist Students with Disabilities in an IoT-enabled Campus	In this paper, we present our first prototype application that helps SWDs achieve daily life tasks inside a building such as monitoring environmental conditions and controlling in-building devices. We then report the initial results from a preliminary test with two students with motor impairments and discuss the opportunities and challenges for further improvements.	0	0	1	0	0 1
6	IoT Technologies Offer New Potentials for People with Disabilities	In this paper we briefly outline disabilities and investigate existing IoT applications and systems which provide a basis for identifying relevant IoT devices, as well as open challenges that need to be addressed that IoT system can be used by people with disabilities.	1	1	1	0	0 1
7	Analysis of the Architecture of the Mental Health Education System for College Students Based on the Internet of Things and Privacy Security	In order to strengthen the research on the mental health education model under the network environment, this paper proposes the architecture of the college student mental health education system based on the privacy and security of the Internet of Things.	0	0	1	0	0 0
8	Exploiting IoT Technologies for Personalized Learning	This paper presents the IoT ready platform of the MaTHiSiS H2020 EU project.	0	0	1	0	0 0
9	IoT Inspired Intelligent Monitoring and Reporting Framework for Education 4.0	This research presents a novel monitoring and irregularity detection framework for educational institutions.	0	0	1	0	0 0
10	Application of Internet of Things and Virtual Reality Technology in College Physical Education	Aiming at the problems of single teaching methods and insufficient long-distance teaching ability in the current physical education teaching process of colleges and universities, based on virtual reality technology, this paper designs and proposes a college physical education virtual reality system consisting of the Internet of Things, cloud platform and mobile client.	0	0	1	0	0 0
11	Analysis of the Architecture of the Mental Health Education System for College Students Based on the Internet of Things and Privacy Security	This paper proposes the architecture of the college student mental health education system based on the privacy and security of the Internet of Things.	0	1	0	0	0 0

#	Title	Focus of Paper	B	C	T	P	G	SwD
12	A Comparative Study of Chinese and Foreign Research on the Internet of Things in Education: Bibliometric Analysis and Visualization	In this study, a total of 2257 articles, including (1) 1243 domestic articles from 2005 to 2021; (2) 1014 foreign articles from 2005 to 2021, were collected for comparative analysis between China and foreign countries using the visualization software CiteSpace.	0	0	1	0	1	0
13	Investigating the Impact of the Internet of Things in Higher Education Environment	This article is aimed at describing a smart education environment and the extent to which the IOT is conducive. The paper also identifies and describes the most important benefits and challenges related to the adoption of the IoT in higher education.	1	1	1	0	0	0
14	The design of teaching management system in universities based on biometrics identification and the Internet of Things technology	In this paper, we present a teaching management system in universities and colleges based on integrated biometrics identification and the internet of thing technology.	0	0	1	0	0	0
15	Teaching Industrial Internet-of-Things-Based Model-Predictive Controller	This article explores how the Industrial Internet of Things (IIoT) could be leveraged to enhance the teaching/learning experience of advanced control techniques [e.g., model-predictive control (MPC)] for complex systems (nonlinear and multivariable) for undergraduate students.	0	0	1	0	0	0
16	An Embedded Systems Laboratory to Support Rapid Prototyping of Robotics and the Internet of Things	This paper describes a new approach for a course and laboratory designed to allow students to develop low-cost prototypes of robotic and other embedded devices that feature Internet connectivity, I/O, networking, a real-time operating system (RTOS), and object-oriented C/C++.	0	0	1	0	0	0
17	Fire Alert System & Application Based on Internet of Things for STEM Education	In this paper, a methodology of fire alert system based on Internet of Things for STEM educational purposes is proposed to create awareness among users regarding fire emergencies in their threshold despite the user's absence.	0	0	1	0	0	0
18	Future Engineers: Education for the Internet of Things	This paper describes an Internet of Things (IoT) course creation experience, where open educational resources were combined with academic practical seminars.	0	0	1	0	0	0
19	An overview of the Internet of Things for people with disabilities	In this paper, an overview of the Internet of Things for people with disabilities is provided.	0	1		0	0	1
20	E-teacher in Inclusive e-education for Students with Specific Learning Disabilities	This paper considered roles of e-teacher which are useful in e-education of students with disabilities.	0	0	1	0	0	1
21	Development of an Instructional Learning Object Design Model for Tablets Using Game-based Learning with Scaffolding to Enhance Mathematical Concepts for Mathematic Learning Disability Students	This study aimed to develop an instructional Learning Object design model for tablet using game-based learning with scaffolding approach to enhance mathematical concept for learning disability students.	0	0	1	0	0	0
22	Does well-being suffer when control in productive activities is low? A dyadic longitudinal analysis in the disability setting	this study investigated the relationship between control in productive activities (paid work, housework, caregiving) and well-being in persons with a physical disability and their caregiving partners from a dyadic perspective, exploring not only the effect of own control on well-being, but also the effect of the partners' control on well-being.	0	1	0	0	1	0
23	Assistive Technology and Educational Services for Undergraduate Students with Disabilities at Universities in the Northern Thailand	This study examined the provision, usage, and needs of assistive technology and educational services for students with disabilities in higher education.	1	0	1	0	0	1

#	Title	Focus of Paper	B	C	T	P	G	SwD
24	Universal Design for Learning: Enhancing Achievement of Students with Disabilities	This paper defines universal design for learning, presents examples of how universally designed technology hardware and software applications promote increased learning, and provides examples of how professors integrate UDL and technology into college settings to enhance learning outcomes of all students, including those with disabilities.	1	0	1	0	0	1
25	Opinions of University Students with Disabilities on Current Regulations and Adaptations at Higher Education Institutions	Based on in-depth qualitative research method, this study analysed and evaluated the views of students with disabilities on the current regulations, arrangements and adaptations regarding their education process, social and academic needs.	0	0	0	1	0	1
26	Current status and future perspectives on the Internet of Things in oncology	In this review, we highlighted the current applications of IoT in the medical literature, along with the challenges and opportunities.	1	1	1	0	0	0
27	Interaction System based on Internet of Things as Support for Education	In this paper we focus on the education field, where Internet of Things can be used to create more significant learning spaces.	1	0	1	0	0	0
28	Understanding the role and capabilities of Internet of Things-enabled Additive Manufacturing through its application areas	The purpose of this paper is to highlight the importance of the effective utilisation of internet-based technologies in Additive Manufacturing (AM) through its practical implications in various areas.	0	0	1	0	0	0
29	An integrative review of the potential of wireless assistive technologies and internet of things (IoT) to improve accessibility to education for students with disabilities	This research paper seeks to examine the challenges and opportunities for wireless technologies and the Internet of Things (IoT) to improve access to education for students with disabilities (SwDs).	1	1	1	0	1	1
30	Big Data and Internet of Things (IoT) Technologies' Influence on Higher Education: Current State and Future Prospects	The article is devoted to overview, discussion, and investigation of application in higher education of two modern information technologies: big data and internet of things.	0	0	1	0	0	0
31	Culture, context, and disability: A systematic literature review of cultural-historical activity theory-based studies on the teaching and learning of students with disabilities	The systematic review of literature sought to understand the extent to which researchers study the teaching and learning of students with disabilities utilizing CHAT.	1	0	1	0	0	1
32	Research and Practice on Innovative Methods of Ideological and Political Education for College Students Based on Internet of Things + Technologies*	This paper deeply analyzes the current situation of ideological and political education of college students in China under the background of Internet of Things and finds that the application of technologies of the Internet of Things in education is mainly embodied in three aspects: classroom teaching, extracurricular learning, and educational management.	0	0	1	0	0	0
33	The impact of tablet computers on students with disabilities in a Higher Education setting	This study evaluated the impact of iPads on students with disabilities in a Higher Education (HE) setting with a focus on an assessment of their physical characteristics and functionality; their utility as communication devices; and the use of iPads to engage with university services.	0	1	0	0	0	1
34	Using Digital Game-Based Learning for Students with Intellectual Disabilities – A Systematic Literature Review	The purpose of this systematic literature review is to explore the area of digital Game Based Learning (GBL) for students with intellectual disabilities as a tool that enables positive impact on learning and mastering specific skills in order to make recommendations for future research.	0	0	1	0	1	1
35	Failed reciprocity in social exchange and wellbeing: evidence from a longitudinal dyadic study in the disability setting	We explore the effects of failed reciprocity on wellbeing and the impact of the partners' perception of reciprocity on wellbeing in persons with a physical disability and their partners.	0	1	0	0	0	1
36	LoRaWAN Gateway Placement Model for Dynamic Internet of Things Scenarios	In this article, we introduced a LoRaWAN gateway placement model for dynamic IoT applications called DPLACE.	1	0	1	0	0	0
37	Making Online Learning Accessible for Students with Disabilities	Making Online Learning Accessible for Students with Disabilities	1		0	0	0	0

#	Title	Focus of Paper	B	C	T	P	G	SwD
38	Designing Online Learning Opportunities for Students with Disabilities	Designing Online Learning Opportunities for Students with Disabilities	0	0	1	0	0	0
39	A Review on Machine Learning and Deep Learning Perspectives of IDS for IoT: Recent Updates, Security Issues, and Challenges	In this paper, a comprehensive survey on Intrusion Detection System (IDS) for IoT is presented for years 2015–2019. The paper also discusses security issues and challenges in IoT.	0	0	1	0	0	0
40	Internet of Things (IoT) Technology for the Development of Intelligent Decision Support Education Platform	A smart classroom architecture based on IoT technology is designed, which connects with traditional network facilities through the IoT gateway.	0	0	1	0	0	0
41	Bibliometric and content analysis of the internet of things research: a social science perspective	The aim is to reveal contemporary research trends and patterns in Internet of Things (IoT) so that social scientists who are new to the discipline may be steered towards rightful directions when examining this phenomenon.	0	0	1	0	0	0
42	Discovering the Internet of Things (IoT): technology and business process management, inside and outside the innovative firms	Its primary research goal has been to investigate both the impact and the role of the IoT on the business process management in terms of promotion of knowledge flow, innovation, and competitiveness.	0	0	1	0	0	0
43	Disability-aware adaptive and personalised learning for students with multiple disabilities	The purpose of this paper is to address how virtual learning environments (VLEs) can be designed to include the needs of learners with multiple disabilities.	0	0	1	0	0	1
44	Supporting the information journey of students with disabilities through accessible learning materials	This paper aims to suggest how the information journey of students with disabilities could be facilitated, by first revealing the existence of inaccessible formats such as Portable Document Format (PDF) and then suggesting the inclusion of alternative formats of accessible learning materials, thus improving retrieval.	0	0	0	0	1	1
45	The invisible students with disabilities in the Australian education system	There has been very little empirical research for the need to identify the importance of an inclusive territory of commonality for “invisible” students with disabilities in Australian education testing, such as the National Assessment Program-Literacy and Numeracy (NAPLAN). The paper aims to discuss this issue.	0	0	0	1	0	1
46	Making sense of the internet of things: a critical review of internet of things definitions between 2005 and 2019	This paper aims to study the evolution of definitions of internet of things (IoT) through time, critically assess the knowledge these definitions contain and facilitate sensemaking by providing those unfamiliar with IoT with a theoretical definition and an extended framework.	0	0	1	0	0	0
47	Libraries in Internet of Things (IoT) era	The purpose of this paper is to report on the current state of research on applications of IoT in libraries, describe challenges that IoT applications face in libraries and discuss directions of adopting IoT in libraries in the future.	0	1	0	0	0	0
48	Promoting innovation and application of internet of things in academic and research information organizations	The purpose of the study was to investigate factors promoting innovation and application of internet of things in academic and research information organizations.	0	0	1	0	0	0
49	Internet of Things (IoT) to the rescue: How IoT could improve supply chain risk management	This paper aims to review the latest management developments across the globe and pinpoint practical implications from cutting-edge research and case studies.	0	0	1	0	1	0
Total number of papers			10	10	39	2	7	17