Contemporary Educational Technology, 2023, **15**(4), ep480
ISSN: 1309-517X (Online)

OPEN ACCESS

Review Article

Knowledge gaps in education and ICT: A literature review in open access publications

Lizzeth Navarro-Ibarra [1*]
0000-0003-4537-9248

Omar Cuevas-Salazar [1]
0000-0003-0113-0475

Alan Robles-Aguilar [1]
0000-0002-1403-5920

[1] Department of Mathematics, Technological Institute of Sonora, Sonora, MEXICO
[*] Corresponding author: Lizzeth.Navarro@gmail.com

Citation: Navarro-Ibarra, L., Cuevas-Salazar, O., & Robles-Aguilar, A. (2023). Knowledge gaps in education and ICT: A literature review in open access publications. *Contemporary Educational Technology, 15*(4), ep480. https://doi.org/10.30935/cedtech/13770

ARTICLE INFO

Received: 23 Jul 2023

Accepted: 28 Sep 2023

ABSTRACT

The aim of the present study is to find new emerging lines of research in education with the use of information and communication technologies (ICT). To this end, we carried out a meta-analysis selecting an index, which contained scientific articles, and which provided free access to complete documents. The search covered five years, 2017-2021 in which 748 were identified. For the analysis the articles were read in order to identify information and record it. Previously, categories were established such as the date, country, continent, language, level of schooling or demographics of the population of publication and the kind of study and area of research. With respect to the demographics we identified that the aged were the category, which had been studied the least. With reference to years of schooling, pre-school and graduate levels had the fewest articles. That said, we found that the majority of the articles were aimed at education and technology in general. However, it is important to point out that the areas with limited research such as autism, rural area, inclusive education, disabilities, cyberbullying, Indigenous affairs, social exclusion, and down syndrome. These findings show the emerging lines of research to which studies should be expanded with further knowledge.

Keywords: teaching and training, information and communication technologies, level of education, population, research of academic literature

INTRODUCTION

At present, information and communication technologies (ICT) is found in various aspects of daily life, such as at work, in education, communications, socialization and entertainment. Besides, it is included in changes taking place within society. In education, ICT is found in the methods of teaching, the focus of learning, in research and in information exchange (Ratheeswari, 2018).

The educational system has undergone changes with the emergence of ICT; these have become tools for bringing about reforms. ICT has the capability of transforming the existing paradigm in the educational scenario. Meanwhile, ICT has increased the enrollment and access to education by allowing learning, which may take place at any time and from anywhere with no geographic limitations (Singh-Dhillon et al., 2021). ICT operation favors the development of sustainable education, which contributes to the formation of responsible and conscientious students. The implementation of ICT in education should bring about the interiorization of sustainable ethics and development in humanity (González-Zamar et al., 2020).

ICT is used by various kinds of people. In the case of students, it is used to relate to one another, connect to the world, exchange knowledge and information, participate in discussion groups, develop stronger

personalities and improve their social lives. In general, ICT is a platform, which allows students to interact and work collaboratively. On the other hand, ICT also redirects students' attention, which could have consequences in their professional lives (Singh-Dhillon et al., 2021).

The use of ICT in the classroom has generated opportunities for students to learn and apply the skills required for this century. Moreover, teachers may improve their performance by creating pedagogical scenarios in which the content is presented attractively, and which help students learn (Ratheeswari, 2018).

Teacher training in the use of ICT is a continuous process. This should include the knowledge and technical operation of ICT but also the transformation of educational practices, which lead to building scenarios of adaptable learning (Cabero-Almenara & Ortiz, 2018).

The way children and adolescents learn has changed with the use and mastering of ICT, transforming formal or school spaces, non-formal or semi-school spaces, as well as informal or non-school spaces. Learning with, from and through ICTs entails accompanying elements to be valued as cognitive tools (Aparicio-Gómez, 2020).

The COVID-19 pandemic has brough about upheavals not only in the healthcare scenario, but also in the economic, social and educational settings. The situation appears to be more severe in developing countries and diminishes with higher incomes, life-expectancy, education, healthcare and workers. This is why policies of equity and exclusive education are indispensable for assuring the rights to a high-quality education in keeping with the Sustainable Development Objectives of the Organization of the United Nations (Lázaro-Lorente et al., 2020; UN, 2022).

In education, the COVID-19 pandemic has brought education on-line, the use of ICT has become a solution for continuing academic curricula. This modality of e-teaching has both favorable and unfavorable aspects. Among the favorable is the flexibility of schedules and spaces, collaborative work with participation in forums or other tools with individual follow-up by teachers. In contrast, among the disadvantages is the social factor, with less interaction among students and with the teacher, the necessary knowledge of the proper use of ICT, students' performance and administration of time for handing in work, and also the teachers' reactions to students' questions and correction of their activities in order to control the learning process (Espino-Díaz et al., 2020).

LITERATURE REVIEW

In a study made by Lei et al. (2021) a strong relationship was found between technological literacy and academic achievements among primary, secondary, high school and university students. The effect of academic achievement was strongest in high school students, followed by primary, secondary and less among university students. Moreover, the effect was greater among women than men. It was greater in applied technological skills than theoretical knowledge. The link is stronger in homework, followed by classwork and exams, among others, and is lowest in grade averages. Finally, the relationship is closer in random controlled experiments than in stratified or convenience samples.

A second level meta-analysis carried out by Martin et al. (2022) examined the impact e-learning had on specific cognitive, affective and behavioral aspects of the students. In this study it was found that e-learning affected cognitive, affective and behavioral results compared to face-to-face learning. Moreover, in higher education the effect is still greater than in basic, mid-level and upper secondary education.

With respect to academic achievement with e-education, Ulum (2022) carried out a study with 27 works developed between 2010 and 2021 in various countries. The results showed that the effect e-education has on academic achievement is mid-level. He also points out that there is no difference in terms of social classes, countries and the focus of e-education and professors.

In a meta-analysis on research in educational technology, Yildiz et al. (2020) found 101 works published between 2015 and 2020 in Turkey. The educational level determined that most are upper level. The works for the most part were aimed at university students, followed by future professors. Furthermore, there were more quantitative studies than qualitative or mixed studies.

In another study carried out in 48 African countries between 2004 and 2014, evaluating the impact ICT permanent education and learning had on inequality in incomes and economic growth. It was found that in

primary education the mobile phone as well as internet contributed to diminishing levels of income inequality. In secondary education ICT indicators have a negative impact on the inequality index. On the other hand, broadband internet had a positive influence on economic growth in primary as well as permanent learning (Tchamyou et al., 2019).

Valverde-Berrocoso et al. (2020) carried out a study on the tendencies of research on e-learning. The analysis was made using the indexed articles on the first three pages of JCR-SSCI specialized in educational technology. 248 articles from 2009 to 2018 were the sample chosen. Among other things, it was found that the massive open online course (MOOC) was the modality present in the majority of the articles analyzed. Most of the research is qualitative, using the case study in MOOC. It was found that the studies are focused on identifying the main problems of e-education. There are also works on professors and future professors' professional development (in which digital competency is verified in both cases). Moreover, research is made on the impact and success of e-learning.

Bozkurt and Zawacki-Richter's (2021) study looked at articles published between 2014 and 2019 in six journals on e-education. The results indicate that the research is aimed at higher level teaching. It was also determined that there is very little research aimed at informal learning using digital resources.

The objective of the present study is to find emergent lines of research in education through the use of ICT, by way of literature review.

METHOD

The objective of the present research requires a literature review. For this we have chosen an index containing scientific articles providing the complete document for our analysis. Other characteristics require free access to the database, that is to say, obtaining the articles free of charge.

Literature reviews enables understanding of a certain area and topic, in addition to showing gaps in knowledge that still need to be explored (Zillmer & Díaz-Medina, 2018). There are two types of reviews, systematic and non-systematic. The present study is a non-systematic review, where its structure has the most commonly used format with the introduction, method, results and discussion sections. This type of reviews is characterized by not defining assumptions and not planning, in addition to not being replicable; the scope is limited by the defined query, search terms and selection criteria; there may be bias in the selection of literature and an evaluation of the results is not carried out (Ferrari, 2015).

The independent index DOAJ (directory of open access journals) contains around 17,500 magazines. These publications are peer-reviewed, and access is free of charge. The indexed journals cover all areas of science, technology, medicine, social science, ats and humanities. Magazines from all over the world in any language are accepted (DOAJ, 2022). For these reasons this index was chosen for the development of this study.

On DOAJ website there are options of searching by journal or by articles. For our study we chose to search by article using the letters "ict" corresponding to "Information Communication Technology" and in all fields (title, abstract, keywords, subject matter, author, orcid, doi, language). For subject matter we selected "education" and also included: education (general), special aspects of education and theory and practice of education. We searched for the five-year period between 2017 and 2021 and found 748 articles.

For the analysis we read the articles in order to identify information and register it. Previously, categories of analysis were established with the year of publication, country, continent, language, educational level and demographic, kind of study and area of research.

With respect to educational level, we used the categories: pre-school, basic, secondary, high school or upper level, higher education, and graduate level. However, there were other categories found and identified as managerial, adults, the elderly and teachers.

The studies were identified as quantitative, qualitative or mixed. The areas of study were defined as they became available during the analysis of the articles.

The statistical analysis was based on frequency and tables of contingency with IBM SPSS (statistical package for social sciences) and for proof of the hypothesis we used MINITAB 17 software.

RESULTS

In the search for articles on DOAJ database from 2017 to 2021 using our criteria for selection, 748 articles were found. Each of the articles was read on-line and the information we obtained was registered. Using IBM SPSS statistics software, we found the frequency and contingency tables. We will now present the analysis carried out, divided by continent, country, language, educational level, demographic and area of study.

With our analysis of the 748 articles, we found that the continents of Asia and Europe make up about 80% of the publications. In third place we found America with 13% and Africa and Oceania both have lower percentages (**Table 1**). We carried out hypothesis testing in order to determine whether there was a difference between the publications of Asia and Europe, accepting the null hypothesis of proportions with a value p=0.080, meaning there is no difference between the publications from the two continents. Hypothesis testing was carried out to determine whether there was a difference between the proportions of publications from America, Africa and Oceania. The difference among the three continents was found to have a value of p<0.001.

Table 1. Articles by continent

Continent	Number	Percentage (%)
Asia	310	41.44
Europe	277	37.03
America	97	12.97
Africa	55	7.35
Oceania	9	1.20
Total	748	100

In **Table 2** we see the distribution of articles by continent and year of publication. Data shows percentages similar to those for 2017 through 2020, while in 2021 the percentage decreased to 17.11%. Hypothesis tests were carried out to determine equality of proportions over the five years, finding equality for all years with a significant level of 0.010. This means that percentage of publications for the years 2017 to 2021 are the same.

Table 2. Articles by continent & year of publication

Year	Asia	Europe	America	Africa	Oceania	Total	Percentage (%)
2017	62	61	21	7	2	153	20.45
2018	50	60	30	9	2	151	20.19
2019	67	55	21	10	0	153	20.45
2020	77	60	15	8	3	163	21.79
2021	54	41	10	21	2	128	17.11
Total	310	277	97	55	9	748	
Percentage (%)	41.44	37.03	12.97	7.35	1.20		

In **Table 3** we see the publications broken down by country in which countries with over ten articles are included. The percentages described are obtained and reported with respect to the total number of articles analyzed. The country with the most articles is Indonesia with 184 (24.60%), followed by Spain with 73 (9.76%). Ukraine has 70 publications representing 9.36%. 74 countries registered ten or fewer publications. These are: Germany, the United Kingdom, France, Yemen, Taiwan, the United States, Poland, Bangladesh, Nepal, Chile, Cuba, Malaysia, Costa Rica, Croatia, Philippines, Portugal, Pakistan, Angola, Slovakia, Greece, Bulgaria, Finland, Ecuador, the Czech Republic, Canada, Slovenia, Rumania, Ireland, Singapore, Denmark, Kenya, Egypt, Australia, Thailand, Saudi Arabia, Vietnam, Venezuela, Sweden, Belgium, Hong Kong, Great Britain, New Zealand, Georgia, Malawi, Syria, Iraq, Ghana, Tanzania, Cyprus, South Korea, Japan, East Timor, Azerbaijan, Morocco, Uganda, China, Fiji, Hungry, Uzbekistan, Holland, Armenia, Switzerland, Ethiopia, Scotland, Honduras, Jamaica, Burkina Faso, England, Zambia, Malta, Peru, Mozambique, New Guinea and Zimbabwe.

Table 3. Articles by country & year of publication

Country	2017	2018	2019	2020	2021	Total	Percentage (%)
Indonesia	31	29	46	42	36	184	24.60
Spain	14	15	22	15	7	73	9.76
Ukraine	18	14	14	13	11	70	9.36
Russia	6	3	3	9	3	24	3.21
Brazil	6	4	7	4	3	24	3.21
Nigeria	2	2	4	2	6	16	2.14

Table 3 (continued). Articles by country & year of publication

Country	2017	2018	2019	2020	2021	Total	Percentage (%)
Turkey	7	1	4	3	0	15	2.01
Italy	1	1	4	4	4	14	1.87
Norway	5	4	0	2	2	13	1.74
Colombia	1	5	4	3	0	13	1.74
Iran	2	2	2	4	2	12	1.60
Argentina	2	3	4	2	0	11	1.47
Serbia	2	7	0	1	1	11	1.47
India	2	2	2	5	0	11	1.47
Mexico	1	6	2	0	2	11	1.47
South Africa	1	3	2	2	3	11	1.47

With respect to the language of the publication of these articles, English is most prevalent with 60.00%, followed by Spanish with 12.00% and Indonesian with 9.00%. In **Table 4** we see the languages with an incidence of over 1.00% identified. Among the languages represented with less than 1.00% we see Norwegian, Polish, Serbian, Italian, Malaysian, Basque, Chinese, Thai, Arabic, German, Croatian, and Rumanian.

Table 4. Articles by language

Language	Number	Percentage (%)	Language	Number	Percentage (%)
English	468	62.6	Ukrainian	26	3.5
Spanish	87	11.6	Russian	22	2.9
Indonesian	69	9.2	Farsi	10	1.3
Portuguese	27	3.6	French	8	1.1

In **Table 5** we see the languages of publication of the articles by year. The information in **Table 5** is for the languages, which represent a percentage higher than 1.00%. The English language has the greatest presence with 468 articles, 62.57%., followed by Spanish and Indonesian both with 87 (11.63%) and 69 (9.22%) of publications, respectively.

Table 5. Articles by language & year of publication

Year	English	Spanish	Indonesian	Portuguese	Ukrainian	Russian	Farsi	French
2017	83	20	19	6	9	6	2	1
2018	77	29	12	6	11	3	2	3
2019	98	16	14	9	5	4	2	1
2020	111	14	12	5	0	7	4	2
2021	99	8	12	1	1	2	0	1
Total	468	87	69	27	26	22	10	8
Percentage (%)	62.57	11.63	9.22	3.61	3.48	2.94	1.34	1.07

The educational level to which the research is aimed was another category, which was registered. In **Table 6** the findings of educational level may be seen in which the percentage we see is with respect to the total number of articles analyzed (748). Within this total we have 134 studies making up various educational levels, representing 17.90%. We also see 53 articles aimed at managerial levels, adults, the elderly and teachers making up 7.00% of the 748. With respect to educational level, the greatest percentage is for higher education with 42.11%, while mid-level basic covers 14.57%. The primary and high school levels present similar percentages, in third place. Both graduate and pre-school levels have the fewest.

Table 6. Articles by educational levels

Education level	Number	Percentage (%)	Education level	Number	Percentage (%)
Pre-school	17	2.27	Highschool	52	6.95
Primary	54	7.22	Higher education	315	42.11
Secondary	109	14.57	Graduate studies	14	1.87

In the analysis of the articles, categories other than educational level were seen and thus we made the division of demographics. In **Table 7** we describe the demographic categories found and the percentage presented with respect to the total number of articles in this paper. The largest percentage of studies (2.67%) is aimed at adults, while the elderly are the group with the lowest percentage (0.53%).

Table 7. Articles by demographics

Demographic	Number	Percentage (%)	Demographic	Number	Percentage (%)
Managerial	16	2.14	Elderly	4	0.53
Adults	20	2.67	Teachers	13	1.74

The distribution of articles by year of publication and educational level is seen in **Table 8**. It is in graduate studies, where we see fewer articles published between 2017 and 2021, while the incidence fluctuates for the other levels. Hypothesis tests were run related to the educational levels in order to determine equality among the years 2017 through 2021. The findings showed there is equality of proportions among the various years for primary, secondary, high school and higher education. In other words, the productivity of publications is the same from pre-school through higher education. It was found that pre-school and graduate studies were the level with the least research.

Table 8. Articles by educational level & year of publication

Year	Pre-school	Primary	Secondary	High school	Higher education	Graduate
2017	1	10	14	9	58	5
2018	3	12	18	14	68	1
2019	4	10	27	13	67	4
2020	5	11	28	7	67	2
2021	4	11	22	9	55	2
Total	17	54	109	52	315	14
Percentage (%)	2.27	7.22	14.57	6.95	42.11	1.87

In **Table 9** articles are related by educational level and country, showing only those countries with more than ten publications. The country with the most articles is Indonesia (154), followed by Spain (56) and Ukraine (49). Next we find Russia and Brazil with 15 publications each. The countries mentioned in **Table 8**, it may be seen that higher education is the level with the most articles followed by secondary education.

Table 9. Articles by educational level & country

Country	Pre-school	Primary	Secondary	High school	Higher education	Graduate	Total
Indonesia	6	18	43	35	51	1	154
Spain	2	6	7	2	38	1	56
Ukraine	2	3	4	2	36	2	49
Russia		2	1	1	11		15
Brazil		1	1	1	11	1	15
Nigeria			6		8		14
Turkey			3		9		12
Norway	1	1	3	1	5		11
Mexico		1		2	6	2	11

In **Table 10** we see the distribution of research by country of publications identified in the present study. The countries making up **Table 10** all had at least two articles. Ukraine with eight articles had the most, followed by Indonesia, Iran and India with four articles each.

Table 10. Articles by demographics & country

Country	Managerial	Adults	Elderly	Teachers	Total
Ukraine	2	3	1	2	8
Indonesia	4				4
Iran	2	2			4
India		4			4
Spain	2	1			3
Russia	1			2	3
Norway			2		2
Cuba	1			1	2
Greece	1	1			2
Czech Republic		1	1		2
South Africa		1		1	2
Thailand	2				2

The kind of study used to analyze the articles were either qualitative, quantitative or mixed. In **Table 11**, we see that qualitative studies predominated with 51.60%, followed by quantitative with 32.22% and finally mixed with 16.18%.

Table 11. Articles by kind of study

Kind of study	Number	Percentage (%)
Qualitative	386	51.60
Quantitative	241	32.22
Mixed	121	16.18
Total	748	100

In **Table 12** we show the grouping of articles by kind of study and year of publication. In the first four years of the study (2017-2020) the number of articles is similar. It is only in 2021 that we see a decrease. However, in the five years covered by our research, qualitative studies are the most prevalent each year with their total representing 51.60%. Nevertheless, we see a decrease in the last four years of the study. Quantitative and mixed studies show no significant differences, some with a value of p=0.050 with respect to publications carried out in the five years covered by our study.

Table 12. Articles by kind of study & year of publication

Year	Qualitative	Quantitative	Mixed	Total	Percentage (%)
2017	87	45	21	153	20.45
2018	91	36	24	151	20.19
2019	77	53	23	153	20.45
2020	75	58	30	163	21.79
2021	56	49	23	128	17.11
Total	386	241	121	748	
Percentage (%)	51.60	32.22	16.18		

In **Table 13** we see the information for the countries with eleven or more articles, classified according to the kind of study. In the distribution by country, we can see differences among those with more qualitative or quantitative studies. For example, Indonesia, Ukraine and Brazil, among others show more qualitative than quantitative studies. In contrast, in Nigeria, Turkey and Iran, among others, we see more quantitative than qualitative studies.

Table 13. Articles by kind of study & country

Country	Qualitative	Quantitative	Mixed	Total	Percentage (%)
Indonesia	93	58	33	184	24.60
Spain	30	30	13	73	9.76
Ukraine	43	13	14	70	9.36
Brazil	20	2	2	24	3.21
Russia	13	8	3	24	3.21
Nigeria	5	10	1	16	2.14
Turkey	5	7	3	15	2.01
Italy	9	5		14	1.87
Norway	8	5		13	1.74
Colombia	6	3	4	13	1.74
Iran	3	5	4	12	1.60
Argentina	9	2		11	1.47
Serbia	6	4	1	11	1.47
India	3	7	1	11	1.47
Mexico	5	4	2	11	1.47
South Africa	9	1	1	11	1.47

In the classification of studies by educational levels, the number of quantitative studies is the greatest only in high school education (**Table 14**). In contrast, for pre-school, primary, secondary, higher education and graduate studies, there are more qualitative studies. It is important to point out that at the graduate level, there are no quantitative studies.

Table 14. Articles by kind of study & educational level

Educational level	Qualitative	Quantitative	Mixed
Preschool	12	3	2
Primary	35	14	5
Secondary	47	45	17
High school	18	22	12
Higher education	148	104	63
Graduate	8		4
Total	268		103
Percentage of total	51.6		16.2

The classification by areas was carried out as they occurred during our analysis of the articles. In **Table 15** the articles are placed by areas, according to findings of our studies. The areas in **Table 15** only include those with at least two publications. The education category includes research on didactics. Research on education without specifying a specific area represents 36.90% and those aimed at technology 24.70%. In third place, we see the area of languages (17.20%), followed by science (10.00%) and mathematics (4.80%). For the area of reading only two studies were found. The areas of social science, community problems, autism, civil education, inclusive education, disabilities, Indigenous affairs, gifted students, music, social exclusion and down syndrome had only one publication each.

Table 15. Articles by areas

Area	Number	Percentage (%)	Demographic	Number	Percentage (%)
Education	276	36.9	Journalism	2	.3
Technology	185	24.7	Games	2	.3
Languages	129	17.2	Sports	2	.3
Science	75	10	Culture	2	.3
Mathematics	36	4.8	Cyberbullying	2	.3
Art	9	1.2	Agriculture	2	.3
Rural areas	5	.7	Civics	2	.3
Business administration	4	.5	Reading	2	.3
Job market	2	.3			

In **Table 16** we find the articles ordered by area and year of publication. In the information we included areas relevant to the matter at hand, although they had only one study. Among the least studied areas are autism, rural areas, inclusive education, disabilities, cyberbullying, Indigenous affairs, social exclusion and down syndrome.

Table 16. Articles by areas & year of publication

Year	Education	Technology	Languages	Science	Mathematics	Autism	Rural areas	Inclusive education	Disabilities	Cyberbullying	Indigenous affairs	Social exclusion	Down syndrome
2017	54	48	16	16	5	1	1	1	0	0	0	0	0
2018	53	33	33	16	5	0	1	0	1	1	0	0	0
2019	52	36	31	18	9	0	2	0	0	0	1	0	0
2020	60	44	30	13	9	0	1	0	0	0	0	0	0
2021	57	24	19	12	8	0	0	0	0	0	0	1	1
Total	276	185	129	75	36	1	5	1	1	1	1	1	1

The data shows similar numbers of papers through the years for each area, except for technology and languages. There is a decrease of 50% between 2017 and 2021 in articles on technology while for the area of languages, the number of studies also decreased between 2018 and 2021.

The articles in areas with little research have been carried out in various countries (**Table 17**). The country, which stands out is Spain with four studies on rural areas, cyberbullying and down syndrome, in all. India also has two articles on rural areas. However, the rest of the countries have only one article in these areas.

Table 17. Articles by areas & countries

Country	Education	Technology	Languages	Science	Mathematics	Autism	Rural areas	Inclusive education	Disabilities	Cyberbullying	Indigenous affairs	Social exclusion	Down syndrome
Indonesia	47	27	57	32	16			1					
Spain	34	21	5	5	1	1	2						1
Ukraine	21	17	16	2	9								
Russia	14	4	4	2									
Brazil	6	6	2	9	1								
Nigeria	7	5	1	1		1							
Turkey	7	3	3		1								
Italy	7	2	1	1	1								
Norway	3	7	1	1									
Colombia	6	3	2	2									
Iran	5	4	1	1	1								
Argentina	4	5	1	1									
Serbia	5	1	3										
India	3	3	1			2							
Mexico	5	2	1	1	1							1	
South Africa	4	3	2		1								
Germany	4	6											
Cuba	4	1		2					1				
Malaysia	1	2	2	3							1		
Poland	7		1										
Philippines	4	5											
Greece	3	2		1									
Ecuador	5	2	1										
Czech Republic	1	4											
Canada	1									1			
Saharan Africa	1					1							

In **Table 18** we see studies by area and educational level. The areas of education, technology, languages and science have the greatest number of articles at the level of higher education. In second place we find education, technology and languages for secondary level. Pre-school has no articles on science and mathematics and only one study on languages. Graduate studies have no articles on mathematics or languages either. The areas with fewer than 1.00% of the research are found at the primary and secondary levels. High school, higher education and graduate studies have only one article each. For pre-school there were no studies in these areas.

Table 18. Articles by areas & educational levels

Education level	Education	Technology	Languages	Science	Mathematics	Autism	Rural areas	Inclusive education	Disabilities	Cyberbullying	Indigenous affairs	Social exclusion	Down syndrome
Pre-school	10	5	1										
Primary	18	16	6	3	5			1		1			1
Secondary	27	30	23	12	11	2					1		
High school	11	5	13	18	3		1						
Higher education	128	76	61	29	9							1	
Graduate	7	3	1	1					1				
Total	201	135	105	63	28	2	1	1	1	1	1	1	1
Percentage of total	36.9	24.7	17.2	10	4.8	.7	.3	.1	.1	.1	.1	.1	.1

The areas of study in the category of demographics identified are shown in **Table 19**. The area of technology shows the most studies, followed by education and languages. The areas with the fewest publications are adults, the elderly and teachers.

Table 19. Articles by areas & demographics

Demographic	Technology	Education	Languages	Job market	Rural areas	Agriculture	Sciences	Art	Social	Games	Music	Total
Managerial	13	2	1									16
Adults	2	6	3	2	2	2	1	1			1	20
Elderly	2		1							1		4
Teachers	4	8							1			13

DISCUSSION & CONCLUSIONS

The objective of the present study was to determine the emergent lines of research in education using ICT. To this end we carried out an analysis of scientific articles published between 2017 and 2021. The reviewed articles were open access. In the results we obtained the distribution of the publications for the pre-established categories.

We found Asia to be the continent with the most studies, followed by Europe. The predominance of Asia over the other continents was seen for all five years of the study. The number of articles for each year was similar.

It was found that Indonesia was the country with the most articles, more than double those of the country that followed. The countries following Indonesia, Spain and Ukraine together had over 50.00% of the publications in Europe, proving how knowledge generation nuclei are formed within continents.

It was found that English was the predominant language in the articles that made up our study. While Indonesia is the country with the most studies, these are written both in English and Indonesian. Thus, Indonesian was in third place, following Spanish.

The articles we analyzed were aimed at different educational levels. It was found that higher education is, where the majority of the articles are aimed, coinciding in this with Bozkurt and Zawacki-Richter (2021), Granic (2022), Valverde-Berrocoso et al. (2020), and Yildiz et al. (2020). Secondary education is in second place coinciding with Valverde-Berrocoso et al. (2020). Once again, Indonesia is the country with the most articles aimed at the level of higher education, followed by Spain and Ukraine. In these three countries secondary education is the second most prevalent target of publications.

Over the course of our research, besides registering the educational levels of the articles, we also identified the demographics that were the targets of the articles. The categories were divided into managerial, adults, the elderly and teachers, which all together amounted to 7.00%. The dearth of studies aimed at these demographics opens the first emergent line of research for future studies.

With respect to the kinds of studies, our findings are similar to those of de Valverde-Berrocoso et al. (2020) in which there were more qualitative than quantitative studies and mixed studies were the least used. This distribution was seen over the five years covered by our research. Similarly, the counties with the largest number of publications coincide with the proportion of the kinds of studies. In all educational levels qualitative studies prevail over quantitative except in studies on the high school level in which quantitative outnumber qualitative studies.

In reference to the areas the studies are aimed at, it was found that, as expected, most of the articles are aimed at education and technology in general. However, it is important to point out the areas with scarce research such as autism, rural areas, inclusive education, disabilities, cyberbullying, indigenous affairs, social exclusion and down syndrome. In the area of reading only two articles were found, although the Programmed for international student assessment (Schleicher, 2019) indicated low levels of achievement for students in this area. Studies should be directed at these areas in order to broaden the level of knowledge, establishing emergent lines of research. In addition, systematic review studies were sought that corroborate the amount of research by area, detecting a lack of articles in this regard, which establishes a gap in knowledge.

With reference to the demographics we identified, education and technology are the predominant areas. However, the elderly stands out as the demographic with the fewest research articles. Therefore, this demographic category is the area in which more studies are required.

Finally, we found no studies aimed at technology in the process of teaching/learning of trades. While in each country the kinds of trades vary, it is a window of opportunity for developing future studies.

The limitations of the study include the analysis period from 2017 to 2021. In addition, the search was carried out only in the independent index DOAJ. Another limitation is that the reviewed publications are open access articles.

Author contributions: All authors were involved in concept, design, collection of data, interpretation, writing, and critically revising the article. All authors approved the final version of the article.

Funding: This article was financed by the Program to Promote & Support Research Projects PROFAPI 2023.

Ethics declaration: The authors stated that the study did not require ethics committee approval since it is a review of existing literature.

Declaration of interest: The authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

REFERENCES

Aparicio-Gómez, O. Y. (2020). The education of desire and the use of ICT. In M. Bosch (Ed.), *Desire and human flourishing. Positive education*. Springer. https://doi.org/10.1007/978-3-030-47001-2_22

Bozkurt, A., & Zawacki-Richter, O. (2021). Trends and patterns in distance education (2014-2019): A synthesis of scholarly publications and a visualization of the intellectual landscape. *International Review of Research in Open and Distributed Learning, 22*(2), 19-45. https://doi.org/10.19173/irrodl.v22i2.5381

Cabero-Almenara, J., & Ortiz, R. (2018). La formación del profesorado en TIC: Aportaciones desde diferentes modelos de formación [Teacher training in ICT: Contributions from different training models]. *Revista Caribeña de Investigación Educativa* [*Caribbean Journal of Educational Research*]*, 2*(2), 61-76. https://doi.org/10.32541/recie.2018.v2i2.pp61-76

DOAJ. (2022). *Directory of open access journals*. https://doaj.org/

Espino-Díaz, L., Fernandez-Caminero, G., Hernandez-Lloret, C. M., Gonzalez-Gonzalez, H., & Alvarez-Castillo, J. L. (2020). Analyzing the impact of COVID-19 on professionals. Toward a paradigm shift: ICT and neuroeducation as a binomial of action. *Sustainability, 12*(14), 5646. https://doi.org/10.3390/su12145646

Ferrari, R. (2015). Writing narrative style literature reviews. *Medical Writing, 24*(4), 230-235. https://doi.org/10.1179/2047480615Z.000000000329

González-Zamar, M. D., Abad-Segura, E., López-Meneses, E., & Gómez-Galán, J. (2020). Managing ICT for sustainable education: Research analysis in the context of higher education. *Sustainability, 12*(19), 8254. https://doi.org/10.3390/su12198254

Granic, A. (2022). Educational technology adoption: A systematic review. *Education and Information Technologies, 27*, 9725-9744. https://doi.org/10.1007/s10639-022-10951-7

Lázaro-Lorente, L. M., Ancheta-Arrabal, A., & Pulido-Montes, C. (2020). The right to education and ICT during COVID-19: An international perspective. *Sustainability, 12*(21), 9091. https://doi.org/10.3390/su12219091

Lei, H., Xiong, Y., Chiu, M. M., Zhang, J., & Cai, Z. (2021). The relationship between ICT literacy and academic achievement among students: A meta-analysis. *Children and Youth Services Review, 127*, 106123. https://doi.org/10.1016/j.childyouth.2021.106123

Martin, F., Sun, T., Westine, C. D., & Ritzhaupt, A. D. (2022). Examining research on the impact of distance and online Learning: A second-order meta-analysis study. *Educational Research Review, 36*, 100438. https://doi.org/10.1016/j.edurev.2022.100438

Ratheeswari, K. (2018). Information communication technology in education. *Journal of Applied and Advanced Research, 3*(1), 45-47. https://doi.org/10.21839/jaar.2018.v3iS1.169

Schleicher, A. (2019). *PISA 2018: Insights and Interpretations.* OECD.

Singh-Dhillon, S., Singh, M., & Kumar, R. (2021). Paradigm shift in education through ICT. *The Journal of Oriental Research Madras, XCII-LXV*, 31-41.

Tchamyou, V. S., Asongu, S. A., & Odhiambo, N. M. (2019). The role of ICT in modulating the effect of education and lifelong Learning on income inequality and economic growth in Africa. *African Development Review, 31*(3), 261-274. https://doi.org/10.1111/1467-8268.12388

Ulum, H. (2022). The effects of online education on academic success: A meta-analysis study. *Education and Information Technologies, 27*, 429-450. https://doi.org/10.1007/s10639-021-10740-8

UN (2022). *United Nations. Sustainable development goals.* https://www.un.org/sustainabledevelopment/es/

Valverde-Berrocoso, J., Garrido-Arroyo, M. C., Burgos-Videla, C., & Morales-Cevallos, M. B. (2020). Trends in educational research about e-learning: A systematic literature review (2009-2018). *Sustainability, 12*(12), 5153. https://doi.org/10.3390/su12125153

Yildiz, E. P., Cengel, M., & Alkan, A. (2020). Current trends in education technologies research worldwide: Meta-analysis of studies between 2015-2020. *World Journal on Educational Technology: Current Issues, 12*(3), 192-206. https://doi.org/10.18844/prosoc.v7i1.4867

Zillmer, J. G. V. & Díaz-Medina, B. A. (2018). Revisión narrativa: Elementos que la constituyen y sus potencialidades [Narrative review: Elements that constitute it and their potential]. *Journal Nursing and Health*, *8*(1), e188101. https://doi.org/10.15210/jonah.v8i1.13654