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The Use of Technology in Preschool Education: A Bibliometric Study

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Abstract

This study seeks to construct a bibliometric map of research on the use of technology in preschool education. To examine the structure and evolution of this field, publication co-citation analysis, author co-citation analysis, and word frequency analysis were employed. Descriptive indicators, including the distribution of publications by country, institution, and year, were derived from 1021 documents indexed in the Web of Science (WoS) database. Bibliometric analyses were conducted using the R and RStudio software packages. The findings reveal the prominent and influential role of American universities, scholars, and journals in this research area, a result further corroborated by the outcomes of Bradford's Law analysis. In addition, the terms "technology," "education," "preschool," and "children" emerged as the most frequently used keywords, highlighting the core themes of technology use in preschool education. Notably, since 2014, there has been a marked increase in the number of studies focusing on the use of technology in preschool education, along with a growing number of researchers and institutions contributing to this field. These trends suggest that the use of technology in preschool education is likely to remain a central focus of national and international research agendas and to gain increasing prominence within educational programs in the future.

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Introduction

Early childhood is a critical developmental period in which an individual's neurological development occurs most rapidly, sensitivity to environmental stimuli is at its highest, and fundamental learning patterns are permanently shaped (Shonkoff & Phillips, 2000). Skills acquired during this period directly affect a child's academic performance, social adjustment, and capacity to learn through technology in later years (Hsin et al., 2014). Therefore, the quality of time children spends with technological tools, and the appropriateness of the technological content are of great importance (Christakis & Garrison, 2009).

Technology is recognized as an influential instrument in education that reshapes methods of information acquisition, instructional processes, and pedagogical methodologies (Creswell, 2003). Research examining the integration of technology into educational practices has demonstrated that it enhances children's engagement in learning and fosters their creative thinking abilities (Akpınar, 2005; Arı & Bayhan, 2003; Sivin-Kachala & Bialo, 2000). The preschool education phase requires the most meticulous management of technological integration, as elements such as the developmental suitability of digital instruments utilized during this timeframe, their intended function, the degree of engagement, and pedagogical scaffolding are crucial in shaping educational results (Papadakis, 2020; Stephen & Edwards, 2018).

It is argued that teachers need to continuously improve their pedagogical knowledge, content knowledge, and technological knowledge in order to use technology effectively (Koehler & Mishra, 2009). When teachers struggle to plan technology in a way that is consistent with learning objectives, digital tools can cease to be educational materials and become merely attention-grabbing tools. Similarly, parents' ability to guide their children in the digital environment directly shapes their relationship with screens (Zakaria et al., 2022).

The effects of technology use on learning in preschool education are discussed in terms of both positive and limited aspects (Bransford et al.,, 2000). Studies show that technology use increases cognitive development and learning motivation, and that interactive digital applications, in particular, strengthen conceptual learning (Neumann, 2015). Through technology use, children can become more creative and critical and communicate more easily with each other. Thus, their social skills also develop (Parette, et al., 2000). Research indicates that technology supports early literacy and language skills, with digital storybooks and audio applications being effective in improving vocabulary (Neumann, 2015; Papadakis, 2020). It encourages collaboration and social interaction, with shared tablet tasks or interactive whiteboard activities increasing intra-group communication (Melhuish, 2018). It also enhances creativity, with digital drawing, animation, and content creation tools supporting creative thinking (Bers, 2020). Utilizing technology is only recommended if it can achieve the same developmental impact in the learning activity (Palaiologou, 2014). However, the literature on the use of technology in preschool education also points to some critical limitations and risks (Behnamnia et al., 2020). These include: excessive screen time and the risk of distraction (Straker et al., 2018), exposure to developmentally inappropriate content (Papadakis, 2020), passive use in the absence of teacher guidance reducing the learning value (NAEYC, 2012), and the risks of addiction and social isolation (Putimtseva, 2024). Therefore, technology integration in preschool education should be considered not only in terms of "whether or not it should be used";

Technology use in preschool education is considered a phenomenon that needs to be evaluated in terms of how, for what purpose, how often, with what pedagogical design, and with teacher-parent guidance it is used (Aral & Doğan Keskin, 2018; Tondeur, 2020 ; Ömrüuzun, 2019).

Technology use in preschool education has rapidly developed into an ecosystem that produces scientific knowledge. Accordingly, the aim of this study is to examine research on the use of technology in preschool education through bibliometric methods. Bibliometric analysis is used as an effective method to reveal the global distribution of publications in specific research areas, collaboration networks, thematic shifts, and relationships between key concepts (Van Eck & Waltman, 2010). In this context, the study will analyze the general profile of academic studies on the use of technology in preschool education, and evaluate prominent themes, international collaborations, and research gaps in the field. The findings aim not only to reveal the general structure of studies conducted in this field to date, but also to serve as an important guide for future research.
Accordingly, the research focuses on the following questions:

(1) What are the most influential journals on use of technology in preschool education?
(2) Who are the most influential authors in use of technology in preschool education research?
(3) Which universities and countries contribute the most to use of technology in preschool education research?
(4) What is the citation impact of studies on use of technology in preschool education?
(5) What are the key terms and emerging trends in use of technology in preschool education research?
(6) How do author collaborations form clusters in use of technology in preschool education research?

The findings of this study aim to contribute to the development of approaches to the use of technology in preschool education and to provide valuable information to guide future research in the field.

Method

In this study, publication co-citation analysis, author co-citation analysis, and word frequency analysis were employed to reveal the structure and transformation of the literature on the use of technology in preschool education. Descriptive data, such as the distribution of studies by country, institution, and year, were obtained from the Web of Science (WoS) database. The RStudio program was used to conduct the bibliometric analyses.

Data Collection

In this study, the Web of Science (WoS) database was used to obtain the bibliometric data examined. WoS is regarded as one of the world's leading academic databases due to the breadth and diversity of the publications it indexes (Pranckutė, 2021). In addition to this characteristic, the WoS database provides the distribution of bibliometric data of indexed publications according to countries, scientific fields, journals, and similar categories, and also offers basic statistical information. In this study, the search query used was "USE OF TECHNOLOGY IN PRESCHOOL EDUCATION."

As a result of these searches, we found 1021 articles. BibTeX of these articles were downloaded as Full record in

WoS. Metadata collection consists of three separate “BibTeX” files, because WoS allows downloading up to 500 results in “BibTeX” format at a time. These three “BibTeX” were merged in Latex Bib File Merger.

Data Analysis

Bibliometrics is a quantitative analysis of the bibliographic features of the growing literature (Donthu et al., 2021). It is a quantitative method used to examine the knowledge structure and development of research fields based on the analysis of relevant publications (Jusoh et al., 2021). It is usually used to determine the current status and trends through the analysis of publications (Todeschini & Baccini, 2016). The bibliometric analysis method was used in this research. Bibliometric calculations were made more understandable and readable by showing figures and tables. Descriptive information about the obtained data is given in Table 1.

Table 1. Descriptive Information

Description Results		Results
Main Information About Data	Timespan	1993:2025
	Sources (Journals, Books, etc)	566
	Documents	1021
	Annual Growth Rate %	16,34
	Document Average Age	5,7
	Average citations per doc	11,19
	References	36780
Document Contents	Keywords Plus (ID)	1045
	Author's Keywords (DE)	2803
Authors	Authors	2997
	Authors of single-authored docs	160
Authors Collaboration	Single-authored docs	175
	Co-Authors per Doc	3,33
	International co-authorships %	11,36
Document Types	Article	721
	Article; book chapter	11
	Article; early access	22
	Article; early access; retracted publication	1
	Article; proceedings paper	1
	Article; retracted publication	8
	Editorial material	1
	Editorial material; early access	1
	Proceedings paper	206
	Review	46
	Review; early access	2
	Review; retracted publication	1

The dataset in Table 1 covers the years 1993–2025, and 1021 documents were accessed from 566 different sources, analyzing a total of 1021 publications in the field of technology use in preschool education. The annual growth rate of 16.34% indicates that the field has expanded significantly, particularly in the last decade where digitalization processes have accelerated, and shows a steady increase in literature. The average age of publications is 5.7 years, indicating that the research area is relatively current; the average number of citations per document is 11.19, suggesting that the studies have achieved a moderate level of academic visibility. The presence of 36,780 references demonstrates that the research is based on a comprehensive literature foundation and that the field possesses a bibliographically rich research pool.

The fact that the number of authors is 2997 and the number of single-authored studies is limited to only 175 indicates that the research field predominantly progresses through a collaborative scientific production model. The average number of co-authors per document, at 3.33, supports this finding and reveals that studies are mostly conducted on a team basis. The international co-authorship rate of 11.36% shows that the field is attracting global interest, but international collaborations are still limited in intensity and have potential for expansion. The high diversity of keywords (Keywords Plus (ID): 1045; Author's Keywords (DE): 2803) indicates that research is shaped around multi-dimensional themes such as technological applications, digital tools, learning environments, and child development, thus showing that the field is thematically heterogeneous and open to development. While articles constitute the majority of these publications (n=721), they are followed by proceedings papers (n=206) and reviews (n=46). The number of publications that include book chapters in addition to articles is (n=11). Figure 1 shows annual scientific productivity.

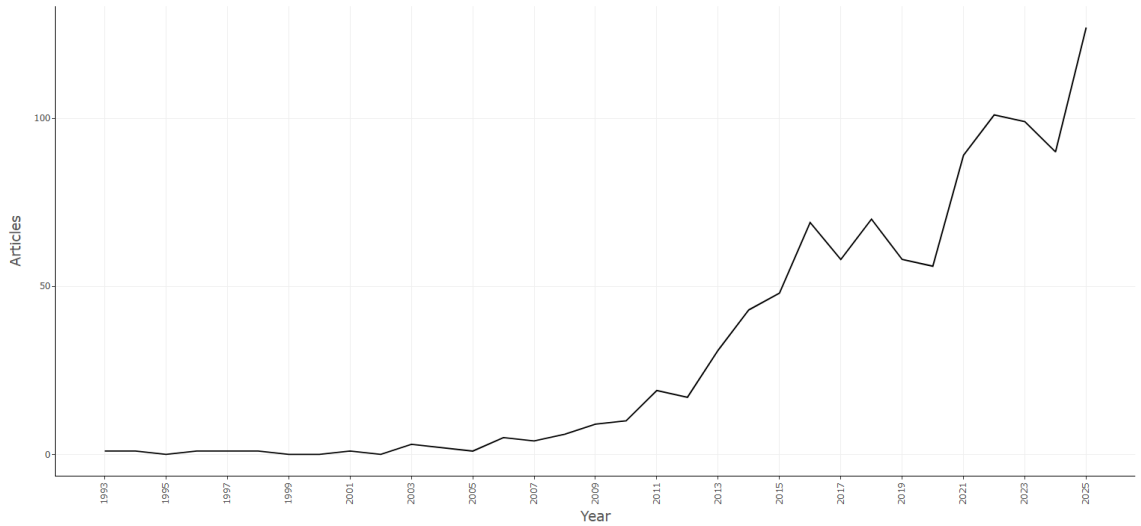


Figure 1. Annual Number of Studies

Author and publication co-citation analyses were performed on these data, and all citations were included in the co-citation analysis. This resulted in scattered and difficult-to-interpret images. For this reason, analyses were limited to publications exceeding a certain threshold value (White & McCain, 1998). There is no definitive judgment in the literature on what this threshold value should be and how many words should be included in the analysis (Özçınar, 2015). In this study, the most frequently cited publications were selected based on the h-index and g-index values. The h-index is calculated according to a researcher's most cited publications and the number

of citations these publications receive from other studies (Sparkes, 2021). The g-index, proposed by Egghe (2006), refers to publications that obtain g^2 or more citations. For instance, if the total number of citations received by the top 10 publications (g) within the selected period exceeds 100, and the total number of citations (g^2) remains below 121 when the eleventh publication is added, the g value for that period is considered to be 10.

The standard citation analysis method is grounded in the idea that citations function as abstract indicators associated with the research topic, process, or theoretical perspective (Small, 1978). Accordingly, the clusters identified through co-citation analysis represent the intellectual and cognitive structure of a particular field of study (McCain, 1990). Cluster analysis can be conducted at the level of publications, authors, or journals. Within this method, the frequency with which two publications, authors, or journals appear together in the reference lists of other publications is considered an indicator of the similarity of their theoretical perspectives, research topics, or methodologies. For instance, if publications A and B are cited together in publications X, Y, and Z, the co-citation frequency of A and B is three. This is interpreted as an indication that the authors of publications X, Y, and Z perceive publications A and B as being similar in certain aspects. One of the objectives of co-citation analysis is to examine changes in the structure of a research field. This method is implemented by dividing the time span of the research field into equal intervals, constructing a co-citation network for each interval, and then integrating these networks. By comparing the standard citation networks developed for successive time periods, it becomes possible to identify points of change and transformation within the field. In the present study, changes in the field were determined through a comparison of the co-citation networks using the RStudio program.

Figure 1 shows that publication production was stagnant and low-intensity during the 1993–2013 period, but the curve showed a significant and sharp increase from 2014 onwards. The increase accelerated particularly after 2020 and continued between 2023–2025, indicating that the field is still in a phase of growth and expansion. The turning points in publication growth coincided with the widespread adoption of technology-focused pedagogical tools (tablets, mobile applications, digital games, etc.) in educational environments; the post-2020 increase may be related to the strong reflection in the literature of the mandatory and intensive use of digital learning tools. Accordingly, the graph shows that the field has not yet reached maturity saturation in terms of publication production, that the volume of research has shown a steady expansion over the years, and that current studies have become dominant in literature.

Results

Annual Citation Count

The annual citation count of academic studies on the use of technology in preschool education is presented in Figure 2. The figure illustrates that the timeframe spanning 1993 to 2004 was characterized by minimal and unstable citation prominence, which was subsequently followed by substantial increases in citations from 2005 to 2010, culminating in the peak average citation score in 2008. Beginning in 2011, average citations transitioned into a comparatively more consistent range, and although variations persisted throughout the 2013–2025 interval, a moderate degree of citation influence was sustained. The early fluctuating structure in citation performance points to the limited scientific visibility of the field in its initial stages; the sudden increases seen after 2005

indicate the reflection of increasing research interest in preschool education technologies on the citation impact. The fact that average citation values continued around a certain equilibrium line in the period after 2013 shows that the literature exhibits an expanding distribution in terms of citations but a non-homogeneous distribution in terms of high impact.

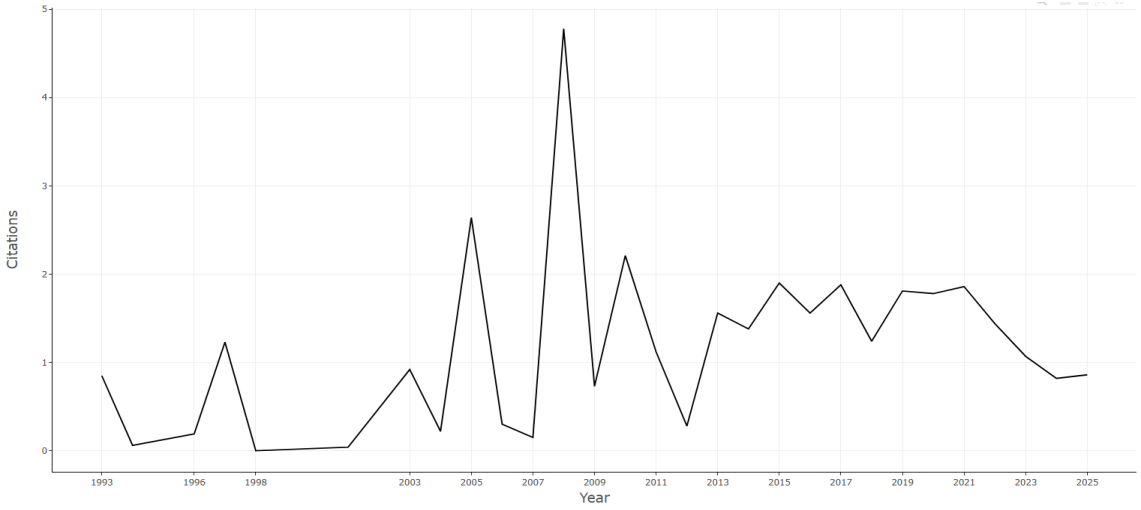


Figure 2. Annual Citation Count

Tre Field Plot

Tre field plot of academic studies on the use of technology in preschool education is presented in Figure 3.

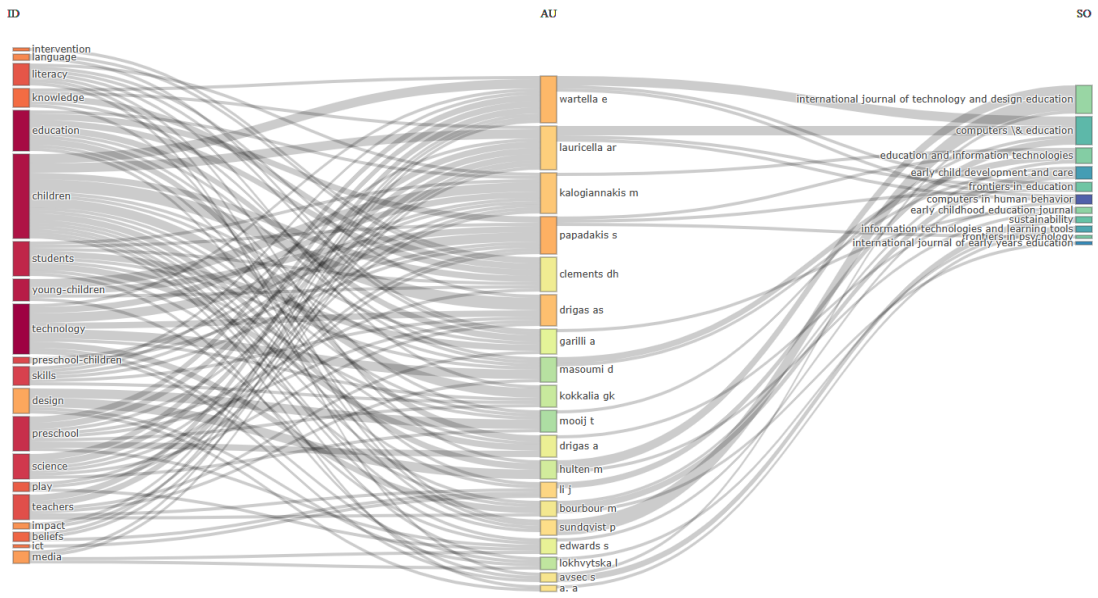


Figure 3. Tre Field Plot

Figure 3 presents a three-domain visualization showing the relationships between keywords (ID), authors (AU), and source journals (SO) in studies on the use of technology in preschool education. In the keywords domain,

concepts such as “intervention,” “literacy,” “knowledge,” “education,” “children,” “students,” “young-children,” “technology,” “preschool-children, skills,” “design,” and “preschool” stand out; these concepts are seen to have multifaceted connections with different authors. In the authors domain, names such as Wartella E, Lauricella AR, Kalogiannakis M, Papadakis S, Dedeş G, Drigas AS, and Garzón J are prominently featured; it is noteworthy that these authors are associated with multiple keywords and source journals. In terms of reference journals, the International Journal of Technology and Design Education, Education and Information Technologies, Computers & Education, British Journal of Educational Technology, Computers in Human Behavior, and Early Childhood Education Journal stand out and are linked to various keywords through different authors.

Most Local Cited Sources

Most local cited sources of academic studies on the use of technology in preschool education is presented in Table 3.

Table 3. Most Local Cited Sources

Sources	Articles
COMPUT EDUC	953
EARLY CHILD EDUC J	392
COMPUT HUM BEHAV	349
BRIT J EDUC TECHNOL	325
INT J TECHNOL DES ED	302
EARLY CHILD RES Q	300
EDUC INF TECHNOL	286
CHILD DEV	281
PEDIATRICS	276
FRONT PSYCHOL	244

Table 3 shows that when examining the most frequently cited local sources in the field of technology use in preschool education, Computers & Education (n=953) holds a central position in the literature as the most cited source by far. This is followed by Early Childhood Education Journal (n=392), Computers in Human Behavior (n=349), and British Journal of Educational Technology (n=325). International Journal of Technology and Design Education (n=302) and Early Childhood Research Quarterly (n=300) stand out as two strong sources with similar citation densities. In addition, journals such as Education and Information Technologies (n=286), Child Development (n=281), Pediatrics (n=276), and Frontiers in Psychology (n=244) are among other important sources that have achieved high citation visibility in the field of preschool education, learning technologies, child development, and behavioral sciences.

Core Sources by Bradford's Law

Core sources by Bradford’s law of academic studies on the use of technology in preschool education is presented in Table 4.

Table 4. Core Sources by Bradford's Law

SO	Rank	Freq	cumFreq	Zone
Education sciences	1	21	21	Zone 1
International journal of technology and design education	2	21	42	Zone 1
Early childhood education journal	3	20	62	Zone 1
Education and information technologies	4	20	82	Zone 1
Frontiers in psychology	5	13	95	Zone 1
Frontiers in education	6	12	107	Zone 1
Sustainability	7	12	119	Zone 1
Computers \& education	8	11	130	Zone 1
Croatian journal of education-Hrvatski casopis za odgoj i obrazovanje	9	11	141	Zone 1
Information technologies and learning tools	10	11	152	Zone 1

Table 4 shows the core sources identified according to Bradford's Law, representing the most productive and influential publications in the literature on the use of technology in preschool education. Education Sciences and International Journal of Technology and Design are the two journals with the highest frequency, occupying Zone 1 with equal productivity and indicating that the most intensive publication flow in the literature occurs through these sources. These two sources are followed by Early Childhood Education Journal and Education and Information Technologies, which are also located in Zone 1 as key platforms representing the intersection of preschool education and digital learning technologies. Additionally, Frontiers in Psychology and Frontiers in Education are interdisciplinary sources within the core region that increase the visibility of studies related to the educational and developmental dimensions of the field. Journals such as Sustainability, Computers & Education, Croatian Journal of Education, and Information Technologies and Learning Tools complete the distribution within Zone 1 as other core sources that regularly contribute to the literature along the axes of technology, educational design, sustainability, and regional education research.

Sources' Local Impact

Source’s local impact of academic studies on the use of technology in preschool education is presented in Table 5. The table examines the local impact indicators of resources in the field of technology use in preschool education. The h-index is an impact indicator that shows that at least h articles of a resource have been cited at least h times; for example, a value of h=11 for the International Journal of Technology and Design Education indicates that each of its 11 articles has received at least 11 citations. The g-index reflects the total impact of the most cited publications. For example, a g=20 for the International Journal of Technology and Design Education indicates that certain articles of the journal have a high academic impact. The m-index is a normalized metric showing the annual impact rate, obtained by dividing the h-index by the time elapsed since the year the resource started publishing; for example, a value of m=1.2 for Education Sciences shows that it has shown effective growth in a short period of time, considering the starting year of 2021. TC (Total Citations) shows the total number of citations

received by the resource; NP (Number of Publications) shows the total number of publications of the resource covered in the relevant analysis; For example, the Computers & Education resource is represented by TC=899 total citations and NP=11 publications. PY_start defines the first publication year of the resource in the dataset. For example, for the Early Childhood Education Journal, PY_start=2005 is reported.

Table 5. Sources' Local Impact

Source	h_index	g_index	m_index	TC	NP	PY_start
International journal of technology and design education	11	20	0,611	430	21	2008
Early childhood education journal	10	17	0,476	306	20	2005
Computers \& education	8	11	0,421	899	11	2007
Education and information technologies	8	16	0,889	267	20	2017
Frontiers in psychology	7	13	0,7	184	13	2016
Computers in human behavior	6	6	0,545	260	6	2015
Early child development and care	6	8	0,5	77	10	2014
Education sciences	6	10	1,2	125	21	2021
Frontiers in education	6	12	0,857	146	12	2019
Interactive learning environments	5	8	0,5	79	9	2016

Sources' Production over Time

Sources' Production over Time of academic studies on the use of technology in preschool education is presented in Figure 4.

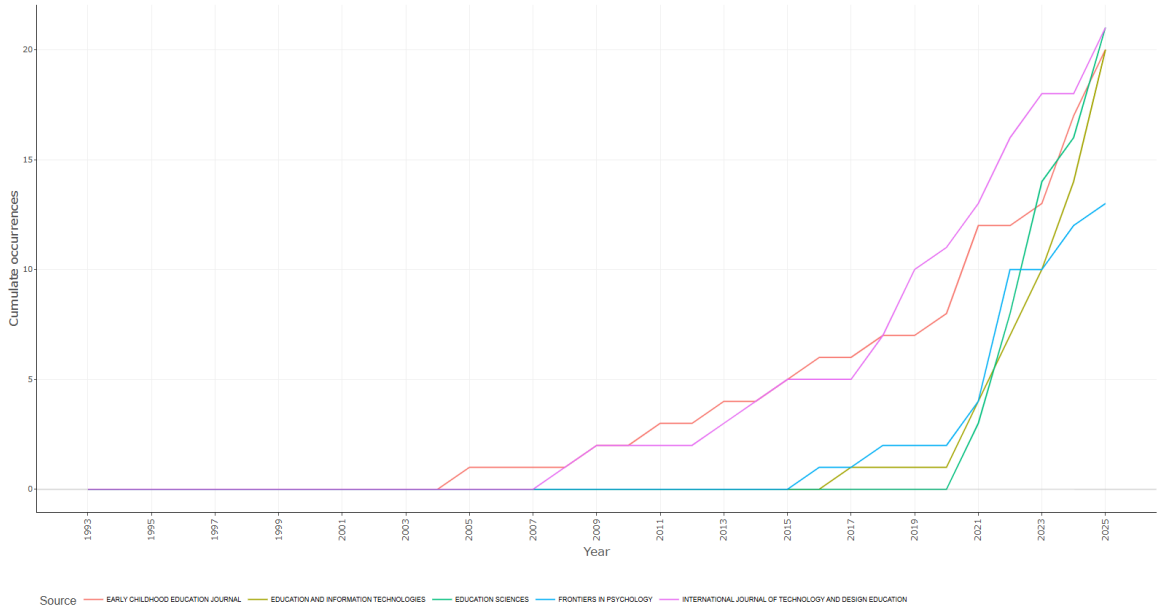


Figure 4. Sources' Production over Time

According to Figure 4, publication output in the field of technology use in preschool education was not seen during the 1993–2004 period, and its first appearance in the literature began in 2005. This beginning occurred in the Early Childhood Education Journal, and the trend of increasing output in the same journal continued in subsequent years. After 2008, the International Journal of Technology and Design Education entered the field and showed an increase in publication volume in the following period. From the mid-2010s onwards, an increase in publication output was observed in journals such as Education and Information Technologies, Frontiers in Psychology, and Computers & Education, and 2021 was reported as the first year in which Education Sciences, International Journal of Technology and Design Education, Early Childhood Education Journal, Education and Information Technologies, and Frontiers in Psychology journals gained momentum in production simultaneously. Between 2023 and 2025, it is described that the publication frequency continued to increase in all the aforementioned journals and contributed to the literature with an expanding volume.

Most Relevant Authors

Most relevant authors of academic studies on the use of technology in preschool education is presented in Table 6.

Table 6. Most Relevant Authors

Author	Articles	Articles Fractionalized
PAPADAKIS S	8	3,67
WARTELLA E	6	1,62
DRIGAS AS	5	2,33
KALOGIANNAKIS M	5	1,50
LAURICELLA AR	5	1,37
LI J	5	2,42
SUNDQVIST P	5	3,17
A. A	4	0,73
AVSEC S	4	2,00
BOURBOUR M	4	2,33

Table 6 analyzes the authors who have produced the most publications in the literature on the use of technology in preschool education, and reports the total number of articles and fractionalized article values under the heading "Most Relevant Authors". In this context, Papadakis S. (n=8; fractionalized=3.67) stands out as the most prolific author in the literature, Wartella E. (n=6; fractionalized=1.62) ranks second, and Drigas A.S. (n=5; fractionalized=2.33) ranks third. Kalogiannakis M. (n=5; fractionalized=1.50) and Lauricella A.R. While Li J. (n=5; fractionalized=1.37) is reported among authors who regularly contribute to the field, Li J. (n=5; fractionalized=2.42) and Sundqvist P. (n=5; fractionalized=3.17) are described as authors with high co-authorship and contributions to team-based production. In addition, A.A. (n=4; fractionalized=0.73), Avsec S. (n=4; fractionalized=2.00) and Bourbour M. (n=4; fractionalized=2.33) are among the most relevant and prolific author groups in literature.

Most Local Cited Authors

Most local cited authors of academic studies on the use of technology in preschool education is presented in Table 7.

Table 7. Most Local Cited Authors

Author	Local Citations
BLACKWELL CK	52
LAURICELLA AR	52
WARTELLA E	52
CHEN DW	36
COUSE LJ	36
MCPAKE J	17
PLOWMAN L	17
STEPHEN C	17
ROBB M	16
SCHOMBURG R	16

Table 7 shows that when examining the authors with the highest local citation impact in the literature on the use of technology in preschool education, Blackwell C.K. (n=52), Lauricella A.R. (n=52), and Wartella E. (n=52) are reported as the authors with the most local citations, with equal citation frequencies. Chen D.W. (n=36) and Couse L.J. (n=36) represent the second circle of impact with similar citation densities. McPake J. (n=17), Plowman L. (n=17), and Stephen C. (n=17) are described as authors with a certain citation continuum. Robb M. (n=16) and Schomburg R. (n=16) are among the other authors showing measurable local impact in the literature with equal local citation values.

Authors' Production over Time

Authors' production over time of academic studies on the use of technology in preschool education is presented in Table 8. According to the table, when examining the publication output of authors in the literature on the use of technology in preschool education by year, it is reported that A.A. entered the literature with a publication (n=1) in 2014, with a total citation impact of TC=8 and an annual citation impact of TCpY=0.667; that she produced (n=2) publications in 2021, with a total citation impact of TC=3 and an annual citation impact of TCpY=0.600; and that she produced (n=1) publication in 2025, for which she has not yet generated a total or annual citation impact (TC=0; TCpY=0). Avsec S. appeared in the literature with a publication (n=1) in 2019, with a total citation impact of TC=12 and an annual citation impact of TCpY=1.714. It was reported that in 2023, with (n=2) publications, the total citation effect was TC=8 and the annual citation effect was TCpY=2,667; and in 2024, with (n=1) publications, the total citation effect was TC=2 and the annual citation effect was TCpY=1,000. Bourbour M. reported that in 2015, with (n=1) publications, the total citation effect was TC=9 and TCpY=0,818; in 2017, with (n=1) publications, the total citation effect was TC=11 and TCpY=1,222; in 2023,

with (n=1) publications, the total citation effect was TC=17 and TCpY=5,667; and in 2024, with (n=1) publications, the total citation effect was TC=4 and the annual citation effect was TCpY=2,000. It is described that all three authors continued their publishing output in 2023 and 2024, contributing to the literature at different starting years and with limited frequency but regularly.

Table 8. Authors' Production Over Time

Author	year	freq	TC	TCpY
A. A	2014	1	8	0,667
A. A	2021	2	3	0,6
A. A	2025	1	0	0
AVSEC S	2019	1	12	1,714
AVSEC S	2023	2	8	2,667
AVSEC S	2024	1	2	1
BOURBOUR M	2015	1	9	0,818
BOURBOUR M	2017	1	11	1,222
BOURBOUR M	2023	1	17	5,667
BOURBOUR M	2024	1	4	2

Author Productivity through Lotka's Law

Author productivity through Lotka's law of academic studies on the use of technology in preschool education is presented in Table 9.

Table 9. Author Productivity Through Lotka's Law

Documents written	N. of Authors	Proportion of Authors	Theoretical
1	2714	0,906	0,664
2	200	0,067	0,166
3	55	0,018	0,074
4	21	0,007	0,041
5	5	0,002	0,027
6	1	0	0,018
8	1	0	0,01

Table 9 describes author productivity in the literature on the use of technology in preschool education within the framework of Lotka's Law. The total number of authors in the literature is n=2997. Of these authors, n=2714 produced only 1 document, representing a proportion of 0.906 within the author population. N=200 authors produced 2 documents, representing a proportion of 0.067. N=55 authors produced 3 documents, representing a proportion of 0.018. N=21 authors produced 4 documents, representing a proportion of 0.007. N=5 authors produced 5 documents, representing a proportion of 0.002. Additionally, n=1 author produced 6 documents and n=1 author produced 8 documents, with the proportion of these groups reported as . This distribution indicates

that authors contributing only one document are dominant in the literature, and productivity is represented by a relatively limited number of authors at high frequencies.

Authors' Local Impact

Authors' local impact of academic studies on the use of technology in preschool education is presented in Table 10.

Table 10. Authors' Local Impact

Author	h_index	g_index	m_index	TC	NP	PY_start
PAPADAKIS S	6	8	0,667	279	8	2017
WARTELLA E	5	6	0,385	552	6	2013
BOURBOUR M	4	4	0,364	41	4	2015
DRIGAS AS	4	5	0,333	53	5	2014
EDWARDS S	4	4	0,364	96	4	2015
KALOGIANNAKIS M	4	5	0,444	184	5	2017
LAURICELLA AR	4	5	0,308	546	5	2013
MASOUMI D	4	4	0,364	93	4	2015
MOOIJ T	4	4	0,211	39	4	2007
SU J	4	4	1	74	4	2022

Table 10 includes h-index, g-index, m-index, total number of citations (TC), number of publications (NP), and first publication year (PY_start) indicators that assess the local impact of authors in the literature on the use of technology in preschool education. Papadakis S. (h-index=6; g-index=8; m-index=0.667; TC=279; NP=8; PY_start=2017) was reported as the author with the highest local impact in the literature. Wartella E. (h-index=5; g-index=6; TC=552; NP=6; PY_start=2013) and Lauricella A.R. (h-index=4; g-index=5; TC=546; NP=5; PY_start=2013) were similarly described as authors with high total citation volumes. Mooij T. (h-index=4; m-index=0.211; TC=39; NP=4; PY_start=2007) is reported as one of the earliest authors to start production in the dataset, while Su J. (h-index=4; m-index=1.000; TC=74; NP=4; PY_start=2022) is reported as the most recent author to start production and stands out in terms of normalized annual impact.

Most Relevant Affiliations

Most relevant affiliations of academic studies on the use of technology in preschool education is presented in Table 11. The table examines the institutions with the highest publication output in the literature on the use of technology in preschool education. NEAR EAST UNIVERSITY (n=30) ranks first as the most productive institution, followed by UNIVERSITY OF GOTHENBURG (n=25) and UNIVERSITY OF CRETE (n=22). LINKÖPING UNIVERSITY (n=19) and PENNSYLVANIA STATE UNIVERSITY (n=17) are other major universities with high publication volumes in the literature. INSTITUTE OF INFORMATICS AND TELECOMMUNICATIONS (n=16), UNIVERSITY OF HONG KONG (n=16), and UNIVERSITY OF

ZAGREB (n=16) are among the research centers and universities that stand out with an equal number of publications. UNIVERSITY OF NIŠ (n=15) and NORTHWESTERN UNIVERSITY (n=14) are among the top productive institutions.

Table 11. Most Relevant Affiliations

Affiliation	Articles
NEAR EAST UNIV	30
UNIV GOTHENBURG	25
UNIV CRETE	22
LINKOPING UNIV	19
PENN STATE UNIV	17
INST INFORMAT AND TELECOMMUN	16
UNIV HONG KONG	16
UNIV ZAGREB	16
UNIV NIS	15
NORTHWESTERN UNIV	14

Affiliations' Production over Time

Affiliations' production over time of academic studies on the use of technology in preschool education is presented in Figure 5.

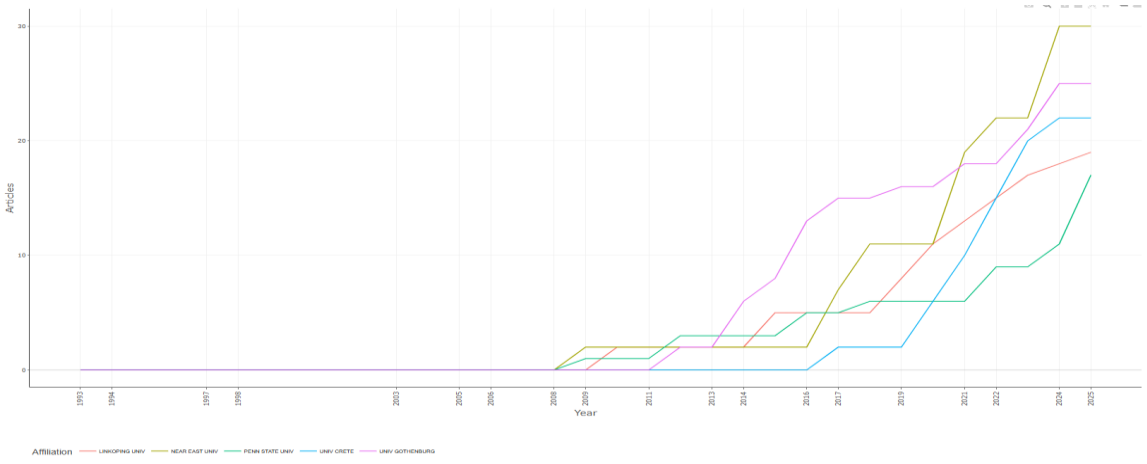


Figure 5. Affiliations' Production Over Time

Figure 5 shows the publication production trends of institutions over time in the literature on the use of technology in preschool education. It is understood that no publications were made in all institutions until 2007, and limited academic production began from 2008 onwards. The period after 2013 stands out as a threshold where institutional contributions to the literature increased. In this context, NEAR EAST UNIVERSITY is the most productive institution (n=30). This is followed by UNIVERSITY OF GOTHENBURG (n=25) and UNIVERSITY OF CRETE (n=22). LINKÖPING UNIVERSITY (n=19) and PENNSYLVANIA STATE UNIVERSITY (n=17) are

other important universities that showed an increase in production volume, especially in the period after 2020. INSTITUTE OF INFORMATICS AND TELECOMMUNICATIONS, UNIVERSITY OF HONG KONG and UNIVERSITY OF ZAGREB contributed to the literature in similar periods and showed a regular increase trend (n=16). NORTHWESTERN UNIVERSITY is among the institutions that have shown an increase in production since 2015 (n=14).

Corresponding Author's Countries

Corresponding author's countries of academic studies on the use of technology in preschool education is presented in Table 12.

Table 12. Corresponding Author's Countries

Country	Articles	Articles %	SCP	MCP	MCP %
USA	155	15,2	136	19	12,3
CHINA	117	11,5	97	20	17,1
SPAIN	65	6,4	57	8	12,3
TURKEY	53	5,2	51	2	3,8
SWEDEN	49	4,8	48	1	2
GREECE	47	4,6	42	5	10,6
UKRAINE	45	4,4	44	1	2,2
RUSSIA	38	3,7	36	2	5,3
AUSTRALIA	29	2,8	23	6	20,7
MALAYSIA	28	2,7	25	3	10,7

Table 12 analyzes the international academic contributions and collaboration trends of different countries, showing the leadership and collaboration capacity of these countries in the field of research. Australia has the highest rate of international collaboration and represents the strongest influence in global collaborative publication production (MCP=6, 20.7%). China has the second highest collaboration rate and shows an open production structure for international collaborations (MCP=20, 17.1%). The USA is the country that produces the most international collaborative publications, but its collaboration rate is relatively more limited (MCP=19, 12.3%). Greece and Malaysia are among the countries exhibiting a moderate level of international collaboration intensity (MCP=5, 10.6%; MCP=3, 10.7%). Turkey, Sweden, Ukraine, and Russia are among the countries with low international cooperation values, showing limited global partnership impact in the literature (MCP = 2, 3.8%; MCP = 1, 2.2%; MCP = 1, 2.2%; MCP = 2, 5.3%).

Countries' Scientific Production

Countries' scientific production of academic studies on the use of technology in preschool education is presented in Table 13.

Table 13. Countries' Scientific Production

Country	Freq
USA	534
CHINA	336
SPAIN	189
UKRAINE	172
TURKEY	146
SWEDEN	136
GREECE	122
RUSSIA	118
AUSTRALIA	95
MALAYSIA	68

Table 13 reports the frequency of scientific output by country in the literature on the use of technology in preschool education. The USA (n=534) has the highest publication frequency. China (n=336) follows the USA. Spain (n=189) and Ukraine (n=172) are other countries showing productivity in the literature. Turkey (n=146) is among the countries making high contributions to the literature in this field. Sweden (n=136), Greece (n=122), Russia (n=118), and Australia (n=95) are countries exhibiting consistent scientific output. Malaysia (n=68) represents a measurable publication frequency in the literature.

Countries' Production over Time

Countries' production over time of academic studies on the use of technology in preschool education is presented in Figure 6.

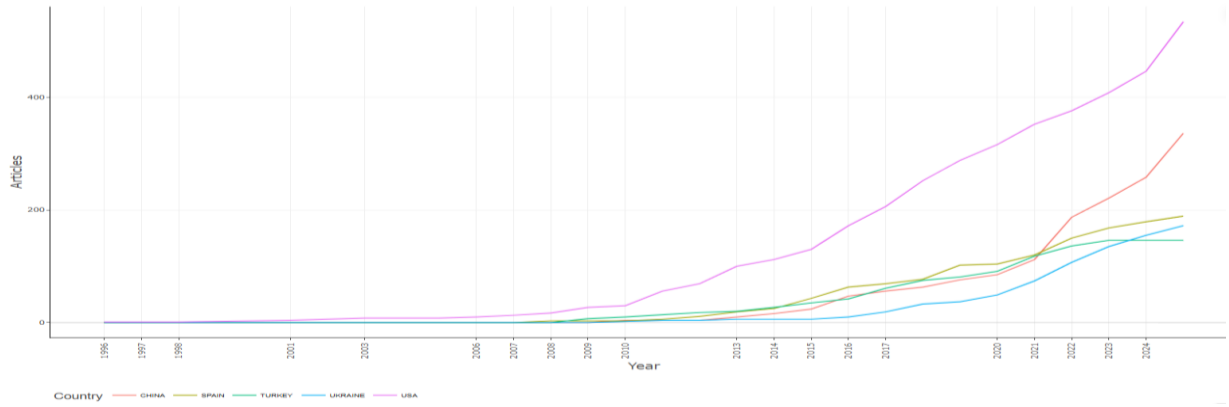


Figure 6. Countries' Production over Time

Figure 6 shows that country-based scientific output in the literature on the use of technology in preschool education between 1996 and 2025 increased rapidly in the period after 2013. Low-volume output began in the 2007–2012 period. After 2013, the upward trend strengthened in all countries. The USA represents the highest cumulative output in the literature. The momentum of publication output increased in Spain after 2016, in China

after 2018, and in Turkey after 2020. Ukraine is also among the countries that expanded their output after 2017.

Most Cited Countries

Most cited countries of academic studies on the use of technology in preschool education are presented in Table 14.

Table 14. Most Cited Countries

Country	TC	Average Article Citations
USA	3945	25,50
CHINA	1009	8,60
GREECE	683	14,50
SPAIN	681	10,50
UNITED KINGDOM	629	57,20
SWEDEN	478	9,80
NETHERLANDS	430	39,10
AUSTRALIA	405	14,00
TURKEY	398	7,50
CANADA	351	20,60

Table 14 examines the total citation performance (TC) and average citation impact per article (AAC) of countries in the literature on the use of technology in preschool education. The USA (TC=3945) has the highest impact in terms of total citation volume. The United Kingdom exhibits the highest performance in terms of citation impact per article (TC=629, AAC=57.20). The Netherlands (TC=430, AAC=39.10) and Canada (TC=351, AAC=20.60) are other countries showing high citation impact. China (TC=1009, AAC=8.60), Spain (TC=681, AAC=10.50), Sweden (TC=478, AAC=9.80), and Turkey (TC=398, AAC=7.50) are visible in terms of total citation volume, but their citation impact per article is relatively limited. Greece (TC=683, AAC=14.50) and Australia (TC=405, AAC=14.00) are countries with a moderate citation impact.

Most Global Cited Documents

Most global cited documents of academic studies on the use of technology in preschool education is presented in Table 15. The table shows the sources with high global citation impact in the technology literature for preschool education. When evaluated separately in terms of Total Citations (TC), Annual Citation Impact (TCpY), and Normalized Citation Impact (NTC), the highest total citation belongs to the study published in CHI (2015) JOURNAL OF TELEMEDICINE AND TELECARE (TC= 282), proving that this study is the most widely reached and most referenced document in the literature. In terms of annual citation impact, the strongest momentum is seen in the study published in BERS (2019) COMPUTERS & EDUCATION (TCpY = 27.43), indicating that despite the relatively recent publication of the document, the rate of citation is at its highest level and the effect continues in the current period. In terms of normalized citation effect, the highest performance is

seen in GORDON (2016) THIRTIETH AAAI CONFERENCE ON ARTIFICIAL INTELLIGENCE (AAAI Conference Proceedings) (NTC = 13.50). When these three indicators are evaluated together, CHI (2015)'s study stands out as the strongest representative of cumulative visibility in the literature, BERS (2019)'s study as the strongest representative of increasing current citation momentum over time, and GORDON (2016)'s studies as the strongest representative of relative citation superiority within the field.

Table 15. Most Global Cited Documents

Paper	DOI	Total Citations	TC per Year	Normalized TC
CHI NC, 2015, J TELEMED TELECARE	10.1177/1357633X14562734	282	25,64	12,35
CLEMENTS DH, 2008, AM EDUC RES J	10.3102/0002831207312908	252	14,00	2,77
COUSE LJ, 2010, J RES TECHNOL EDUC	10.1080/15391523.2010.10782562	248	15,50	6,61
HESS KL, 2008, J AUTISM DEV DISORD	10.1007/s10803-007-0470-5	237	13,17	2,61
GORDON G, 2016, THIRTIETH AAAI CONFERENCE ON ARTIFICIAL INTELLIGENCE	NA	232	23,20	13,50
CLEMENTS DH, 2011, J RES MATH EDUC	NA	223	14,87	12,46
BLACKWELL CK, 2014, COMPUT EDUC	10.1016/j.compedu.2014.04.013	209	17,42	11,66
BUS AG, 2015, DEV REV	10.1016/j.dr.2014.12.004	206	18,73	9,02
KOSTYRKA-ALLCHORNE K, 2017, DEV REV	10.1016/j.dr.2016.12.002	203	22,56	10,80
BERS MU, 2019, COMPUT EDUC	10.1016/j.compedu.2019.04.013	192	27,43	13,27

WordCloud

WordCloud of academic studies on the use of technology in preschool education is presented in Figure 7. When the word cloud in the image is examined, the figure, shows that the conceptual focus of the literature is concentrated around the keywords “technology”, “preschool”, “children”, “education”, “early childhood education” and “educational technology”; in addition, concepts such as “science”, “literacy”, “ICT”, “skills”, “attitudes”, “knowledge”, “intervention”, “design”, “play”, “preschool teachers”, “augmented reality”, “preschool-children”, “young children”, “skills”, “media”, “language” and “ICT literacy” also show relatively high visibility in the field. This distribution shows that technology integration in the preschool period extends not only to tool use but also to multifaceted research axes such as literacy, scientific development, skill acquisition,

teacher roles, learning design, intervention studies and play-based digital experiences.



Figure 7. WordCloud

Trend Topics

Trend topics of academic studies on the use of technology in preschool education is presented in Figure 8.

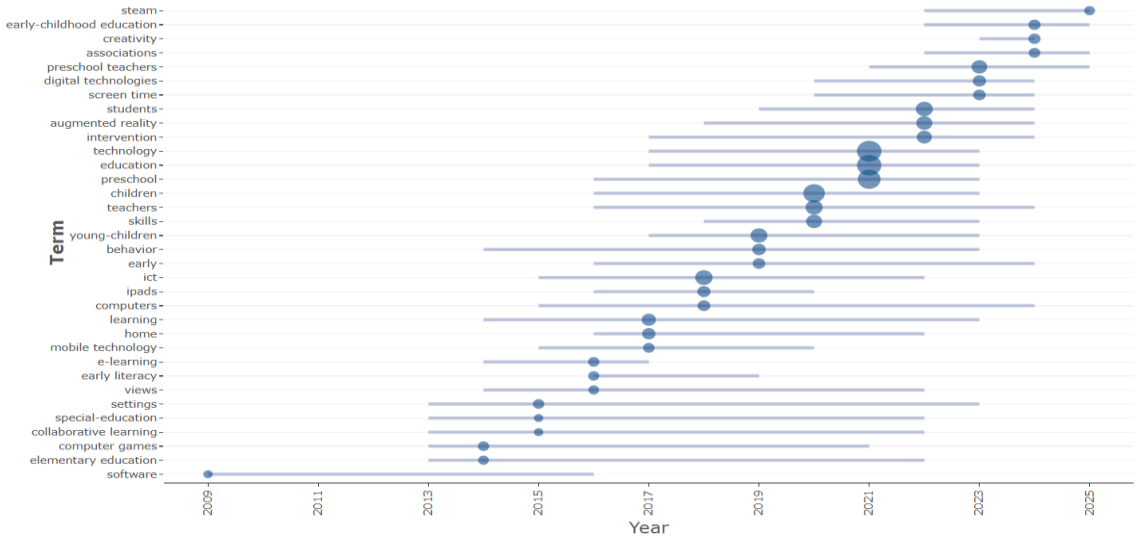


Figure 8. Trend Topics

According to Figure 8, the most frequently used key concepts in preschool education and technology gained visibility with the concept of "software" from 2009 onwards; between 2011–2013, the terms "ICT, iPads", "e-learning" and "early literacy" increased; after 2015, the concepts of "digital technologies", "preschool teachers", "skills" and "intervention" began to be used more frequently; between 2018–2021, the terms "creativity", "young children", "technology", "education" and "children" gained significant intensity; and in the period 2022–2025, the concepts of "STEAM, early childhood education", "creativity, digital technologies", "screen time", "skills, children" and "technology" were mapped as the most current and high-frequency trending terms.

Clustering by Coupling

Clustering by coupling academic studies on the use of technology in preschool education is presented in Figure 9.

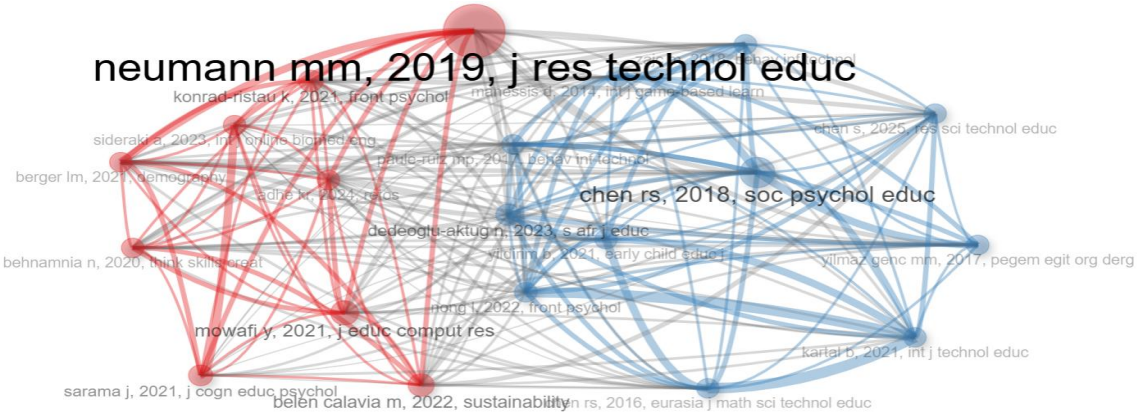


Figure 9. Clustering by Coupling

According to the “Clustering by Coupling” map in Figure 9, documents in the field of technology use in preschool education are grouped into two main clusters. In the red cluster, Neumann (2019) stands out, represented by the highest connection strength in 2019. This cluster shows a concentration of works by authors such as Bers (2025), Konrad (2021), Berger (2021), Ben Am (2020), Mowaf (2021), Hong (2022), Saram (2021), Dedeoğlu-Aktuğ (2023), Mowafi (2021), and Saram between 2020–2023. In the blue cluster, Chen (2018) plays a central role with a study that was positioned with strong connections in 2018. This cluster is depicted on the map as containing the works of authors such as Yılmaz Genç (2017), Belén Calavia (2022), Belen (2022), Kartal (2021) and Cava (2016) between 2016–2022, and there are numerous bibliographic coupling links between the two clusters.

Co-occurrence Network

Co-occurrence network of academic studies on the use of technology in preschool education is presented in Figure 10. The figure illustrates the structure of prominent concepts and their relationships in the literature on the use of technology in preschool education. The figure shows that the keywords “technology”, “education”, “preschool”, and “children” are at the center of the network and have high connection density. The network structure contains clusters represented by different colors; the technology-focused red cluster includes keywords such as “technology”, “teachers”, “classroom”, “attitudes”, “beliefs”, “science”, “mathematics”, and “STEM”, while the education-focused blue cluster includes concepts such as “education”, “preschool”, “students”, “curriculum”, “skills”, “instruction”, and “educational technology”. Finally, the early childhood education-focused green cluster includes keywords such as “early childhood education”, “young children”, “literacy”, “play”, “learning”, “digital technologies”, “ICT”, and “media”. Furthermore, it is observed that concepts such as "augmented reality," "computational thinking," "language," "model," and "intervention" are linked to other keywords at different points in the network. Overall, the network shows that studies on the use of technology in preschool education are concentrated on the axes of technology, education, and early childhood education, and that there are multifaceted

connections between these themes.

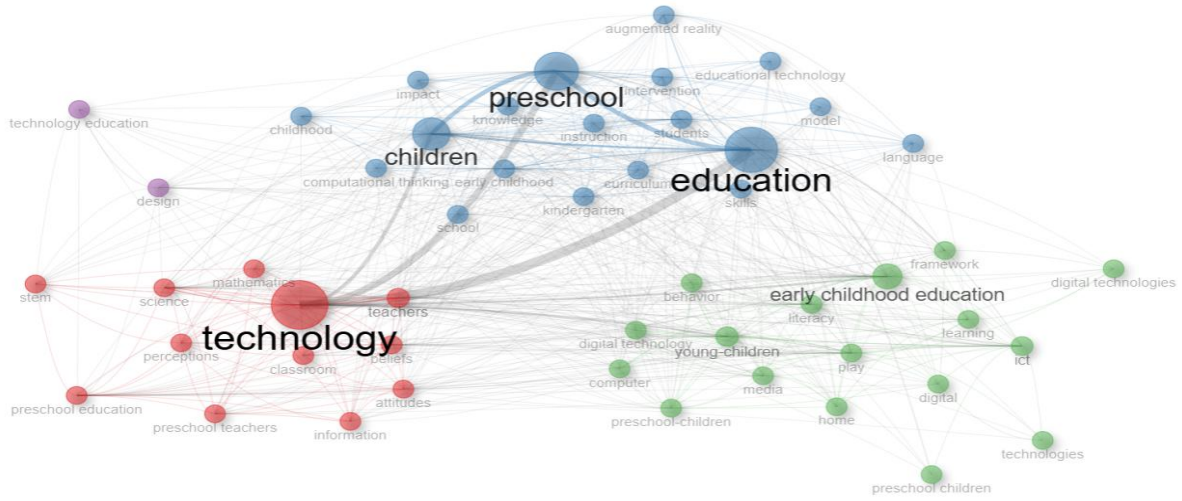


Figure 10. Co-occurrence Network

Collaboration Network

Collaboration network of academic studies on the use of technology in preschool education is presented in Figure 11.

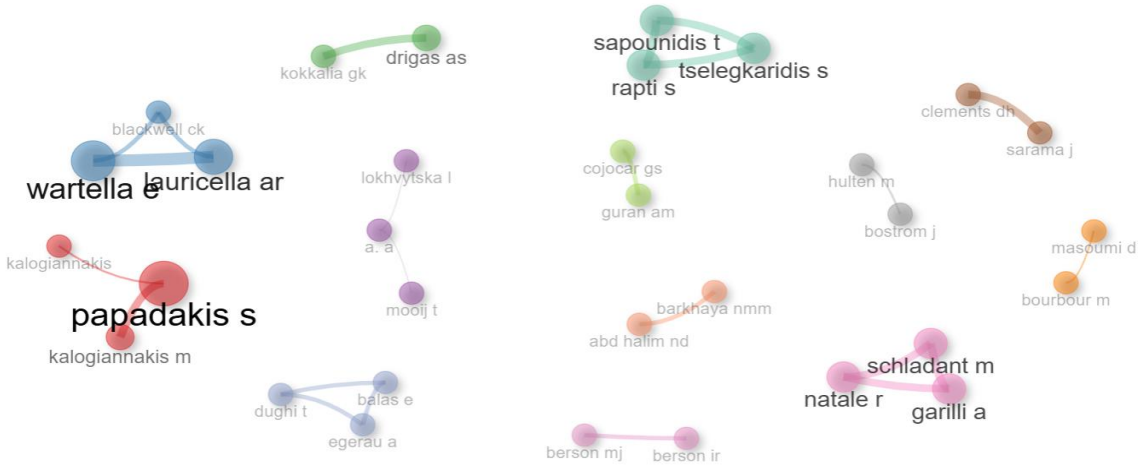


Figure 11. Collaboration Network

Figure 11 presents a collaborative network regarding the use of technology in preschool education. The network structure shows the authors involved in the studies as nodes; the connections between the nodes reflect co-authorship relationships. Some authors, such as Papadakis S., Wartella E., and Lauricella A.R., are represented by more prominent nodes compared to others. Clusters shown in different colors within the network reveal various co-authorship groups among the authors. Other authors in the network are represented by a more limited number of connections, generally indicating collaborative work in pairs or small groups.

Co-citation Network

Co-citation network of academic studies on the use of technology in preschool education is presented in Figure 12.

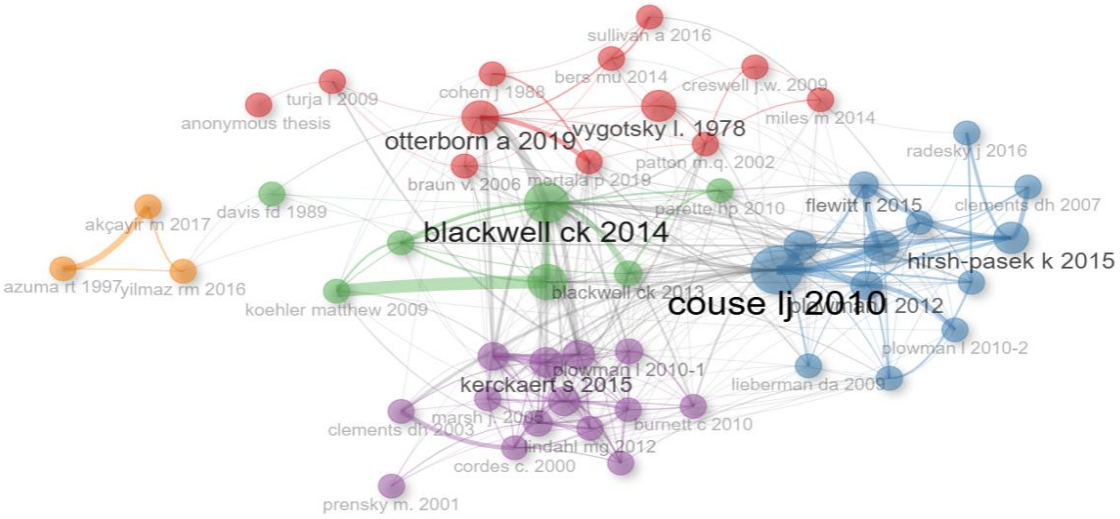


Figure 12. Co-Citation

Figure 12 presents the collaborative citation network of academic studies in the field of technology use in preschool education. In the figure, cited studies are shown as nodes, and collaborative citation relationships between studies are shown as links; different colors represent clusters of collaborative citations. Studies such as Blackwell (2014), Couse (2010), Hirsch-Pasek (2015), Kerckaert S(2015), Ottoborn (2019), and Vygotsky (1978) are central to the network and establish strong collaborative citation relationships with other studies.

Factorial Analysis

Factorial analysis of academic studies on the use of technology in preschool education is presented in Figure 13.

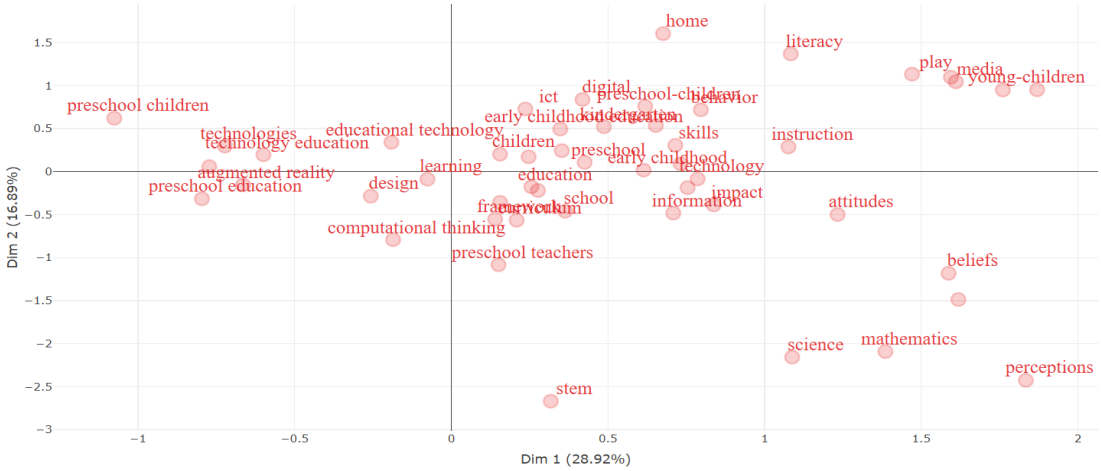


Figure 13. Factorial Analysis

Figure 13 shows that in the two-dimensional distribution obtained from the factorial analysis, the first dimension explains 28.92% of the total variance, while the second dimension explains 16.89%. In the graph, keywords such as “education”, “technology”, “early childhood”, “children”, and “preschool” are centrally located, while the concepts “digital”, “ict”, “media”, “play”, “literacy”, and “young-children” are positively positioned in the first dimension. The keywords “beliefs”, “attitudes”, “perceptions”, “mathematics”, and “science” are positively positioned in the first dimension and negatively positioned in the second. The concept of “STEM” has a prominent negative position in the second dimension, while the keywords “home” and “literacy” are noteworthy for their positive positions. In addition, it is observed that concepts such as “educational technology”, “technology education”, “augmented reality”, “computational thinking”, “design”, and “learning” are distributed in the middle and left regions of the graph, while the keywords “preschool teachers”, “framework”, “school”, and “curriculum” are located closer to the center. Overall, it is seen that the keywords are concentrated on different axes on the factor plane and exhibit multidimensional distribution.

Thematic Evolution

Thematic evolution of academic studies on the use of technology in preschool education is presented in Figure 14.

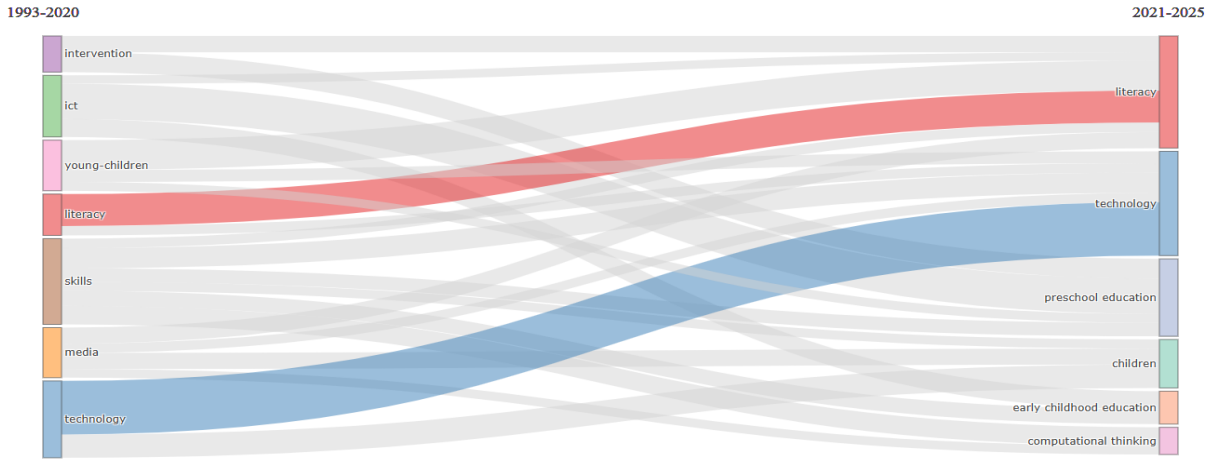


Figure 14. Thematic Evolution

Figure 14 illustrates the thematic evolution of technology use in preschool education between the periods 1993–2020 and 2021–2025. During the 1993–2020 period, the themes of “technology”, “media”, “skills”, “literacy”, “young-children”, “ICT”, and “intervention” were prominent; these themes are seen to connect predominantly to the themes of “technology”, “literacy”, “preschool education”, “children”, “early childhood education”, and “computational thinking” in the 2021–2025 period. It is noteworthy that the themes of “technology” and “literacy” show continuity in both periods, while themes such as “skills”, “media”, and “ICT”, which were present in the previous period, are related to different themes in the subsequent period; and new themes such as “computational thinking” and “early childhood education” emerged in the 2021–2025 period. This thematic flow visually reveals the distribution and continuity of relationships between key concepts within two defined time intervals.

Countries' Collaboration World Map

Countries' collaboration world map of academic studies on the use of technology in preschool education is presented in Figure 15.

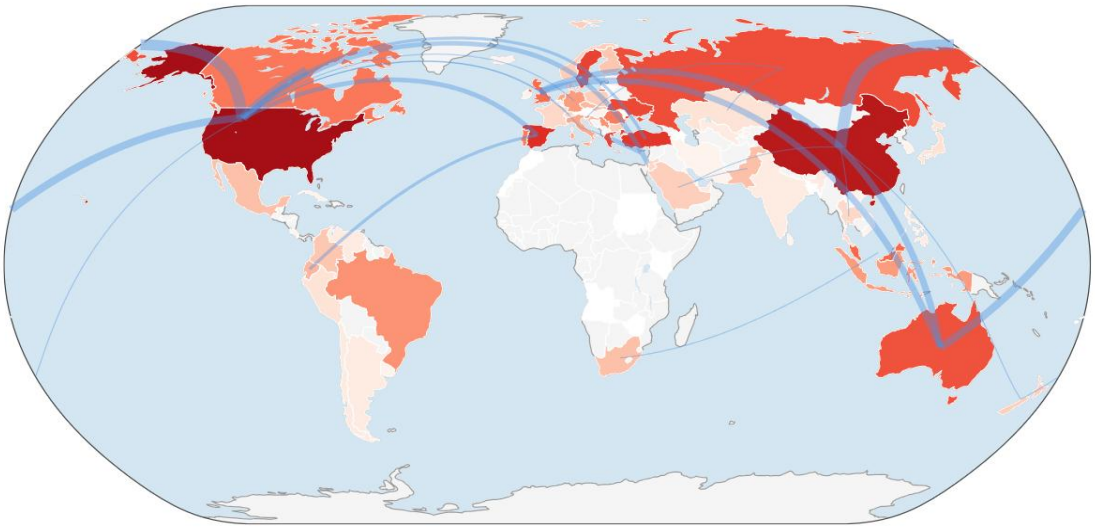


Figure 15. Countries' Collaboration World Map

Figure 15 shows a world map illustrating international cooperation in the use of technology in preschool education. Countries are colored in shades of red, with darker red representing higher levels of interaction or importance within the network. Connections between countries are shown with blue slanted lines, and the thickness of the lines reflects the volume of interaction. Countries such as the United States, China, and Australia are heavily colored, indicating their central positions in the international cooperation network. Overall, the map reveals the global interactions between countries and the intensity levels of these interactions.

Discussion and Conclusion

In this research, a bibliometric analysis was conducted on scientific studies published in the field of technology use in preschool education. The Web of Science database was searched using the keyword “use of technology in preschool education.” within the scope of the bibliometric analysis, a total of 1,021 studies published between 1993 and 2025 were identified. The distribution of the included studies by publication year and their citation frequencies were examined. Furthermore, the sources and authors within the dataset that received the highest number of citations in the field were identified and analyzed.

Publication output of studies using technology in preschool education has sharply increased since 2014. The highest average citation value was reached in 2008. The International Journal of Technology and Design Education, Education. Education Sciences is the most widely published journal. The Computers & Education Journal is the most cited journal. According to Bradford's Law, there are 10 journals clustered in the first region. Similarly, Asriadi et al. (2025) stated in their study that research intensified after 2010. Ramadhani et al. (2024)

identified the International Journal of Technology and Design Education as the journal with the most publication output. They found that the Computers & Education Journal is the most cited journal (Perdima et al., 2022; Çınar et al. 2024; Duman & Arıcı 2023). The recent increase can be attributed to the increasing integration of digital technologies (tablets, educational software, mobile applications) into educational environments. A study by Hu and Yelland (2019) confirms these findings, showing that the use of artificial intelligence and technology integration in early childhood education is rapidly increasing and enabling data-driven learning and personalization of instruction. Furthermore, the impact of the COVID-19 pandemic on educational research may also be a factor (Su et al., 2022; Bozkurt et al., 2022).

PAPADAKIS S. is the most prolific author on the subject. BLACKWELL C.K. is the most cited author. BOURBOUR M., KALOGIANNAKIS M., LAURICELLA AR, and EDWARDS S. are other prominent authors. BLACKWELL C.K., LAURICELLA AR, and WARTELLA E. are among the most cited authors locally. In terms of publication output over the years, A. A., AVSEC S., and BOURBOUR M. have been significant figures. The total number of authors in the literature, according to Lotka's Law, is 2997. This confirms that the field has a broad author base, but the citation effect is concentrated more among a limited number of highly visible authors. In parallel with these findings, the prominent authors in the study by Ramadhani et al. (2024) are: COURTNEY K. BLACKWELL, ALEXIS R. LAURICELLA & ELLEN WARTELLA. Contrary to the research findings, Çetinkıran (2022) found P. Mishra and M.J. Koehler to be the most cited authors in her study.

The university with the most publications is NEAR EAST University. This is followed by the UNIVERSITY OF GOTHENBURG and the UNIVERSITY OF CRETE. In general, it is observed that the trend of increasing publication production of institutions has strengthened in the post-2020 period, and geographical and institutional diversity in the literature has expanded. Similarly, Ramadhani et al. (2024) found Illinois State University and the University of Gothenburg to be the universities with the most publications. Karabekmez and Yıldız (2025) found National Taiwan University to be the university with the most publications.

In terms of country-based scientific output, the USA has the highest number of publications. This is followed by China, Spain, and Turkey. The USA also has the highest number of articles with responsible authors, national articles, international articles, and citations. Similar findings exist in other studies (Granic & Marangunic, 2019; Eren, 2025; Bui et al., 2024; Ali et al., 2025). The United Kingdom leads in the average number of citations per article. Australia has the highest rate of international collaboration. This finding reveals that countries with strong academic and digital infrastructure dominate the literature in technology-based preschool research. However, the rapidly increasing contributions of China, Spain, and Turkey after 2013 are an important and positive development, showing that geographical diversity in the literature has expanded over time.

Chi (2015) article, "A Systematic Review of Telehealth Tools and Interventions to Support Family Caregivers," published in J Telemed Telecare, became the most cited article worldwide. Gordon (2016) research, "Affective Personalization of a Social Robot Tutor for Children's Second Language Skills," had the highest local citation rate. Hursen (2021) identified Bus (1995) study as the most cited publication. In another study, Eren (2025) determined that the most cited authors were, in order, "Bers, M.U.", "Kazakoff, E.R.", and "Sullivan, A." Bers

M.U. developed a coding robot (KIBO robot kit) that can be programmed with wooden blocks without a keyboard or screen for children aged 4-7.

The most frequently used keywords by authors are “technology”, “preschool”, “children”, and “education”. These keywords are followed by the terms “education”, “early childhood education”, and “educational technology”. The frequently used keyword “software” has entered the literature. Recently, the concepts “steam”, “early childhood education”, “creativity”, and “digital technologies” have been mapped as high-frequency trending terms. When examining the prominent concepts and the relationships between them, it is seen that the keywords “technology”, “education”, “preschool”, and “children” are at the center of the network and have high link density. The factorial analysis revealed a two-dimensional distribution. In the graph, keywords such as “education”, “technology”, “early childhood”, “children”, and “preschool” are positioned in the center. Looking at the thematic evolution, it is seen that the themes of “technology”, “media”, “skills”, and “literacy” were prominent in the initial studies; It is observed that these themes later linked predominantly to the themes of “technology”, “literacy”, and “preschool education”. Recently, it is noteworthy that new themes such as “computational thinking” and “early childhood education” have emerged. Similar to these findings, in Hursen (2021) research, the terms pre-school, early childhood education, pre-school education, early childhood, and in Sulistyaningtyas (2025) research, the terms “early childhood education,” “technology,” “digital media,” and “children” stand out. Papadopoulou et al. (2023) research confirms that this development is occurring with the increasing adoption of technology in early childhood education and the growing availability of child-friendly digital devices. The thematic evolution shows that the field is moving towards more innovative research agendas associated with cognitive and creative skills. This is supported by research (Sullivan & Bers, 2018) indicating that teaching children coding and programming can develop critical thinking and problem-solving skills from an early age. It also provides strong empirical evidence that early childhood education is an increasingly complex and dynamic field, constantly adapting to new social and technological realities (Hernández-Torrano & Ibrayeva, 2020).

According to the Clustering by Coupling map, the works are grouped into two main clusters. In the red cluster, Neumann (2019) stands out; while in the blue cluster, Chen (2018) plays a central role. The collaboration network shows that some authors, such as Papadakis S., Wartella E., and Lauricella A.R., are represented by more prominent nodes compared to others. When examining co-citations, Blackwell (2014), Couse (2010), Hirsch-Pasek (2015), and Ottoborn (2019) are seen to have strong co-citation relationships with other studies. Hursen 2021 identified Clements, DH, and Barnett, WS as the authors with the highest number of co-citations in the field.

Recommendations

In our research, although the WoS (Web of Science) database was used as a source of great scientific importance, it should not be forgotten that other national and international databases such as Scopus, Dimensions, Dergipark and TR Index can also be used. We hope that the findings presented in this study will be useful to other researchers. We also hope that our research will encourage more studies in this field and contribute to the literature on the subject.

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