

Interactive and Digital Learning in The Third Decade of The Millenia: A Bibliometrics Analysis with Future Research

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Abstract. *This paper explored a trend analysis related to interactive and digital learning from 1977 until July 2023. This research aimed to determine (1) the publication trends of interactive and digital learning; (2) the most prolific authors, themes, and topics; (3) the most institutions, countries, and highly cited documents of interactive and digital learning; (4) the essential keywords and themes involved in interactive and digital learning and (5) the pattern of co-authorship and topics from co-occurrence analyses of author keywords. The data were obtained through the Scopus database with the keywords “interactive learning” OR “digital learning.” The search resulted in 1161 documents. The data were exported and analyzed using tools such as BiblioMagica, BiblioMagika@Split, Microsoft Excel, VOSviewer, and Biblioshiny. The results showed that most publications were in 2021 and 2022. The most significant contributors with the most research documents were Lee, J. S. (14 publications), The Education University of Hong Kong by Institution (8.93%), English by Language (97.07%), United States by Country (21.19%), e-learning by trend topics with 217 frequencies. This study found the article “Seriously considering play: designing interactive learning environments based on the blending of microworlds, simulations and games” written by Rieber L. P. as the most cited publication. Moreover, five themes emerged based on the results of network visualization mapping, interactive and digital learning: (1) digital learning and technology, (2) technology in education, (3) adult learning and education, (4) learning technology and tools and (5) adapting education in the digital era. This study recommended a systematic literature review on popular topics such as e-learning and learning systems for further studies.*

Keywords: *bibliometric, future research, digital learning, interactive learning*

1. Introduction

Interactive learning refers to an educational approach that actively engages learners in the learning process through participation, collaboration, and hands-on activities (Yang, 2023; Sitthiworachart, Joy, & Ponce, 2023; Lin, Chen, & Liu, 2017). It goes beyond passive listening or reading, encouraging students to actively interact with the learning materials, their peers, and the instructor. Rieber (1996) explained that the goal is to enhance engagement, motivation, and knowledge retention by creating an immersive and dynamic learning environment. Institutions around the world have witnessed a transformative shift in the field of education, particularly in the realm of interactive and digital learning (Alenezi, 2023).

According to Reichert-Schlaß et al. (2023), digital learning, also known as e-learning or online learning, refers to the use of digital technologies and the internet to deliver educational content and facilitate learning experiences. It encompasses a wide range of digital tools, platforms, and resources that support teaching and learning in virtual or blended environments. Digital learning offers numerous benefits, including flexibility in time and location, personalized learning experiences, and access to a vast array of educational materials (Vaicondam, Sikandar, Irum, Khan, & Qureshi, 2022). It enables learners to engage with multimedia content, interactive simulations, virtual

laboratories, and collaborative online spaces. Digital learning can involve self-paced online courses, live virtual classrooms, video lectures, educational apps, and educational games (Lee & Pinar, 2022; Yusof, Yin, Norwani, Ahmad, & Ismail, 2022; Chinchua, Kantathanawat, & Tuntiwongwanich, 2022; Sprenger & Schwaninger, 2021).

The third decade of the millennium refers to the period between the years 2020 and 2029. Each decade represents ten years, and the third decade is counted from the beginning of the millennium, which started in the year 2000. Therefore, the third decade of the millennium began on January 1, 2020, and will end on December 31, 2029. The COVID-19 pandemic, which struck during the third decade of the millennium, profoundly impacted the education field by accelerating the integration of digital and interactive learning approaches as educational institutions swiftly adapted to remote instruction, technological advancements, and innovative pedagogical strategies (Guzzo, Boffo, Ferri, Gagliardi, & Grifoni, 2022; Seyffer, Hochmuth, & Frey, 2022). Furthermore, this study explored the evolution of research topics. We aimed to answer the following five questions:

- RQ1: What are the publication trends in the field of interactive and digital learning, and how have they changed over time?
- RQ2: What are the most influential institutions in the field of interactive and digital learning, and how have they contributed to the development of the field?
- RQ3: What are the most active countries in the field of interactive and digital learning, and how does this vary across different regions and periods?
- RQ4: What are the most highly cited documents in the field of interactive and digital learning, and what are the key themes and topics that they address?
- RQ5: What are the most common keywords and themes in the literature on interactive and digital learning, and how have they evolved?

2. Method

This study is guided by the following five steps:

- 1) Selecting the database (Scopus) and defining the search terms. We use Scopus as a data source due to its unparalleled advantages. With its comprehensive coverage of diverse academic disciplines, Scopus offers access to a vast collection of reputable and high-quality publications, ensuring researchers can rely on credible information. Scopus provides detailed citation information, empowering scholars to track and analyze the impact of research papers and aiding in assessing the influence and relevance of studies. Its advanced search with research metrics, offering h-index, citation counts, and journal impact factors. Scopus often provides direct access to full-text articles, enhancing researchers' convenience in accessing complete papers.
- 2) Conducting and cleaning data using bibliomagika and biblioMagika@split
- 3) Join the data into biblioMagika@Split, Open Refine, and VOSviewer
- 4) Performing the bibliometric network analysis
- 5) Performing the conceptual structure, thematic, and trend topics.

The selection of the documents gathered for this study was constructed based on the research protocol guided as per Figure 1. The data was extracted from the Scopus database as of 7 July 2023. The following combination of keywords was used: “interactive learning” OR “digital learning” to identify all the target publications. The following was conducted: TITLE (“interactive learning” OR “digital learning”). We

excluded 2024 for the publication year and then were limited to document-type conference papers, articles, book chapters, reviews, and editorials. We also limit to source type journals, conference proceedings, book and book series, and the last string is limited to the subject area of social sciences. This query produced a total of 1161 documents. All the data gathered from the Scopus database were then downloaded into the dataset into Scopus OLD version (scopus export refine value, scopus ris, scopus .csv NO REF, scopus .csv WITH REF) and Scopus NEW version (scopus .csv TRUNCATED). All the datasets were uploaded into bibliomagika and bibliosplit files using Microsoft Excel (Ahmi, 2021).

The dataset was sorted from largest to smallest in Column H (scopus export refine value) before being copied to biblioMagika. We used Open Refine to clean and harmonize authors' keywords and indexed keywords. Dataset from Scopus NEW TRUNCATED sorted by cited from largest to smallest (Ahmi, 2022).

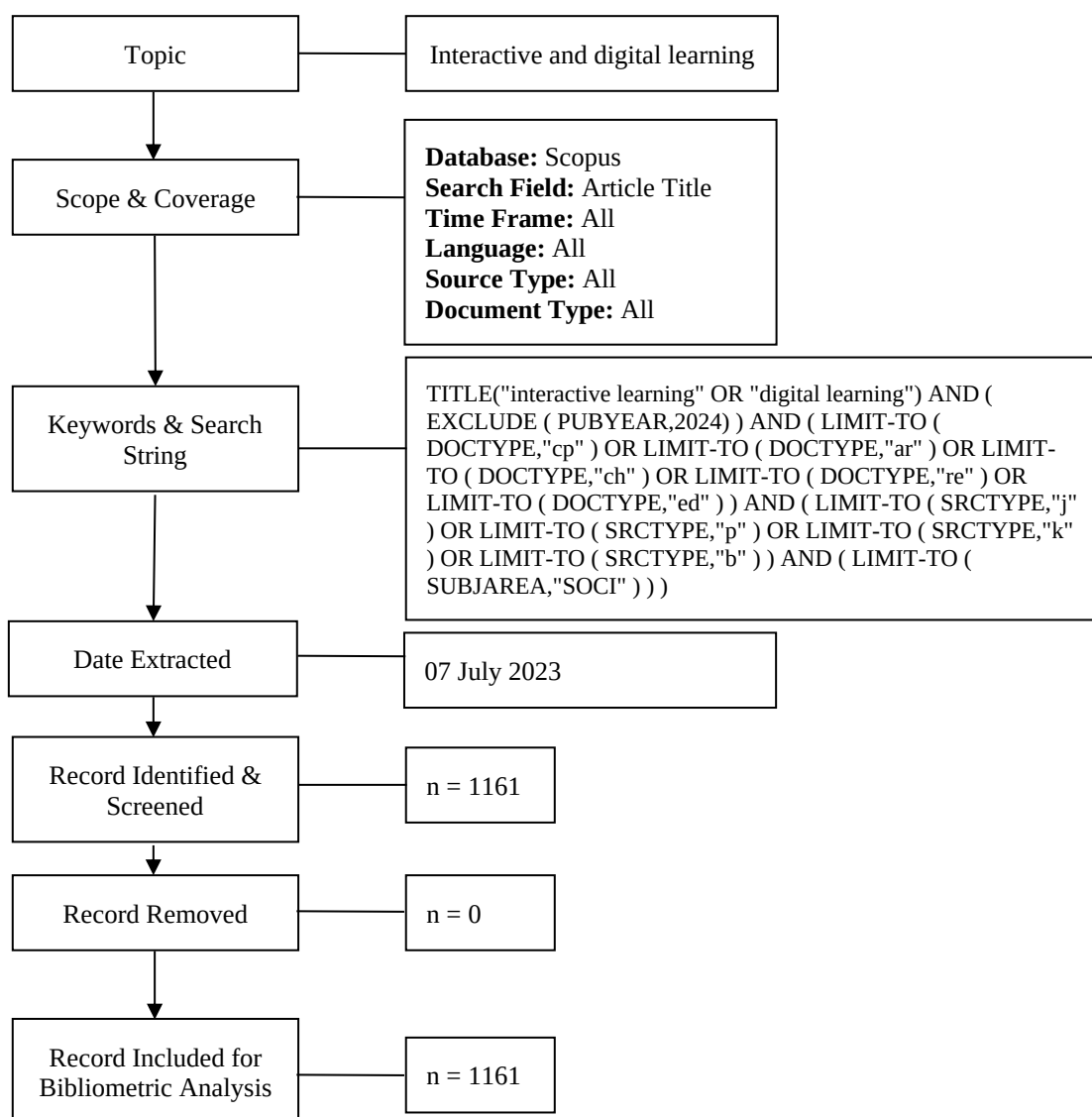


Figure 1. Flow diagram of the search strategy (Zakaria et al., 2021; Lin & Yu, 2023)

3. Results and Discussions

Document type refers to the type of the document, classified into a few categories

such as article, conference paper, book chapter, review, and editorial. Table 1 summarizes the distribution of documents published on interactive and digital learning, in which more than half of all publications were categorized as an article (59%), followed by a conference paper (25%).

Table 1. Document Type

Document Type	Total Publications (TP)	Percentage (%)
Article	683	59
Conference Paper	294	25
Book Chapter	112	10
Review	42	4
Editorial	30	3
Total	1161	100

The source type was measured based on the category of source title presented in the Table 2 shows the categorization of the source title, which can be classified into four types. Distinctively, journal represents the highest type of source with 768 documents (66%), followed by conference proceedings of 278 publications (24%). Book sources were collected from 102, and 13 book series publications were found.

Table 2. Source type

Source Type	Total Publications (TP)	Percentage (%)
Journal	768	66
Conference Proceeding	278	24
Book	102	9
Book Series	13	1
Total	1161	100

There are 12 languages (see Table 3) used for publications, including Norwegian and Slovenian. The most written language is English (97%), as depicted in Table 3, followed by Spanish with 14 publications.

Table 3. Languages

Language	Total Publication (TP)	Percentage (%)
English	1127	97
Spanish	14	1
Russian	6	1
French	5	0
Chinese	4	0
Portuguese	3	0
Dutch	2	0
German	2	0
Turkish	2	0
Korean	1	0
Norwegian	1	0
Slovenian	1	0

*seven documents have been prepared in dual languages

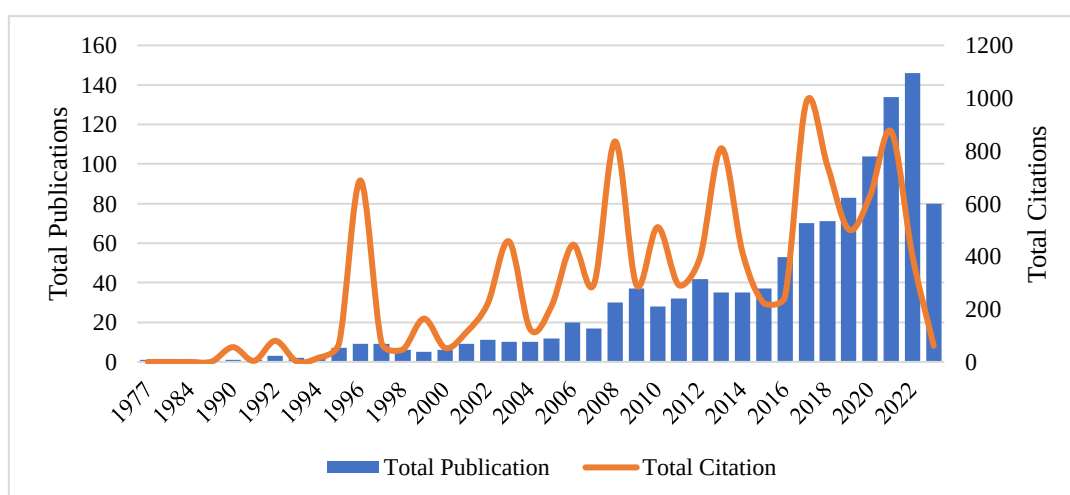
Based on all the documents from the Scopus database, interactive and digital learning are focused on the social sciences area with 1161 publications, and 44% were in computer sciences, engineering 16%, and arts and humanities 7%, as shown in Table 4.

Table 4. Subject area

Subject Area	Total Publications (TP)	Percentage (%)
Social Sciences	1161	100
Computer Science	509	44
Engineering	187	16
Arts and Humanities	81	7
Business, Management & Accounting	58	5
Psychology	49	4
Decision Sciences	31	3
Environmental Science	30	3
Mathematics	29	2
Energy	26	2
Medicine	21	2
Economics, Econometrics & Finance	15	1
Health Professions	13	1
Nursing	13	1
Dentistry	7	1
Physics and Astronomy	7	1

To answer the Research Question 1 (RQ1: What are the publication trends in the field of interactive and digital learning, and how have they changed over time?), we analyzed the publication trend of interactive and digital learning using total publications by year, document type, publication by source title, publication by country, publication by institution, language, and subject area of the publication. We used the bibliographic data collected from the Scopus database to calculate the data for that analysis.

Figure 2 summarizes the statistical details of annual publications related to interactive and digital learning. Based on the Scopus database, it shows a substantial increase in publications, particularly from 2019 to mid-2023. In 2017, a total of 984 citations were made by researchers (Blayone, vanOostveen, Barber, DiGiuseppe, & Childs, 2017; Chong & Smith, 2017; Diwakar, Patwardhan, & Murthy, 2012; Greener, 2017; Ifenthaler, 2017; Matsuda, 2022), resulting in an h-index of 15 and a g-index of 30. This reflects the ongoing transformations in the delivery of interactive and digital learning in the current century.

**Figure 2.** Total publications and citations by year

In 2022, there were 146 publications with 401 citations, accompanied by an h-index of 10 and a g-index of 16. As of mid-2023, 80 documents have been successfully

published, focusing on interactive and digital learning research. This data underscores the remarkable growth in academic interest and scholarly output in the field of interactive and digital learning, demonstrating the evolution and significance of this area of study during the specified period. The provided information in Figure 2 signifies the escalating interest and engagement of the academic community in the realm of interactive and digital learning, with the number of publications and citations serving as key indicators of its relevance and prominence in educational research.

To answer Research Question 2 (RQ2: What are the most influential institutions in the field of interactive and digital learning, and how have they contributed to the development of the field?), we analyzed the publications by institution as Table 5. Previously, Vaicondam et al. (2022) reported that between 2002 – 2021, the United States was the most productive country in terms of productive institutions and citations. However, this study shows that Hong Kong and Taiwan received a drastic increment in awareness of interactive and digital learning. With a minimum of seven publications, 16 institutions are listed as the most productive institutions, including the University of Melbourne, Deakin University, Queensland, and Nanyang Technological University.

Table 5. Most productive institutions with a minimum of seven publications

Institution	Country	TP	TC	NCP	C/P	C/CP
The Education University of Hong Kong	Hong Kong	15	134	10	8.93	13.4
National Central University	Taiwan	13	289	12	22.23	24.08
University of Melbourne	Australia	12	130	10	10.83	13
Open University of Netherlands	Netherlands	12	153	11	12.75	13.90
Carnegie Mellon University	United States	11	629	7	57.18	89.85
Aalborg University	Denmark	10	34	6	3.4	5.66
Beijing Normal University	China	9	139	7	15.44	19.85
Khon Kaen University	Thailand	9	8	4	0.88	2
Deakin University	Australia	9	67	8	7.44	8.37
Queensland University of Technology	Australia	8	37	5	4.625	7.4
University of Georgia	United States	8	746	8	93.25	93.25
University of California	United States	8	170	8	21.25	21.25
Qufu Normal University	China	7	53	6	7.57	8.83
Open University	United Kingdom	7	61	6	8.71	10.16
Nanyang Technological University	Singapore	7	89	6	12.71	14.83
Monash University	Australia	7	55	6	7.85	9.16

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

To answer the Research Question 3 (RQ3: What are the most active countries in the field of interactive and digital learning, and how does this vary across different regions and periods?), we analyzed 15 countries recorded as the most productive countries with a minimum 27 number of publications (see Table 6). The top on the list is the United States, with a total of 257 publications, followed by the United Kingdom 85 publications. Australia and China each have 67 publications, respectively, while Germany has 64. The United States leads in terms of the highest number of citations, totaling 4,113, and Germany follows with 1,308 citations. Thailand and Malaysia each have 29 documents, with Malaysia receiving 292 citations while Thailand has 71 citations.

This data highlights the publication output and citation impact of different countries in the field of interactive and digital learning. It showcases the significant research contributions from Australia, China, Germany, the United States, Thailand, and Malaysia, underscoring the global reach and scholarly influence of this area of study.

Table 6. Top 15 countries contributed to the publications

Country	TP	TC	NCP	C/P	C/CP	h	g
United States	257	4113	203	16.00	20.26	28	14
United Kingdom	85	687	61	8.08	11.26	13	8
Australia	67	734	55	10.95	13.34	13	6
China	67	451	45	6.73	10.02	10	7
Germany	64	1308	44	20.43	29.72	15	6
Taiwan	61	1057	44	17.32	24.02	12	6
Spain	51	524	38	10.27	13.78	9	5
Indonesia	48	214	32	4.45	6.68	8	6
Canada	35	275	27	7.85	10.18	9	4
India	33	99	20	3	4.95	7	5
Netherlands	30	276	23	9.2	12	9	3
Thailand	29	71	16	2.44	4.43	5	5
Malaysia	29	292	20	10.06	14.6	8	4
Hong Kong	28	216	22	7.71	9.81	8	3
Norway	27	311	24	11.51	12.95	10	3

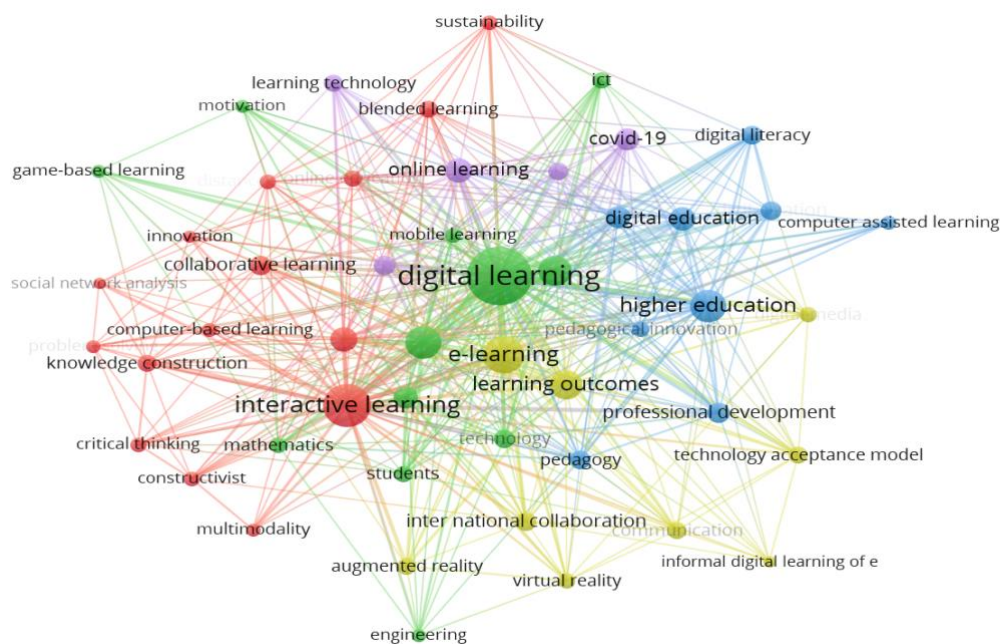
Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

To address Research Question 4 (RQ4: What are the most highly cited documents in the field of interactive and digital learning, and what are the key themes and topics that they address?), we conducted an analysis that identified 20 authors who have received a substantial number of citations, as outlined in Table 7. Rieber (1996), with the paper titled “Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games,” has garnered the highest number of citations, totaling 639, with an average of 22.82 citations per year. This observation highlights that the topic of COVID-19 emerged as a highly significant trend during the year 2020 and has remained relevant in the field of interactive and digital learning up to the present. This analysis delves into the most influential documents and themes in the domain of interactive and digital learning, providing insights into the research contributions that have garnered the most attention and the contemporary relevance of topics, particularly in the context of the COVID-19 pandemic.

Table 7. Top 10 highly cited articles

No.	Authors	Title	Cites	Cites per Year
1	Rieber (1996)	Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games	639	22.82
2	Aleven, Stahl, Schworm, Fischer, & Wallace (2003)	Help-Seeking and Help Design in Interactive Learning Environments	382	18.19
3	Liaw & Huang (2013)	Perceived satisfaction, perceived usefulness and interactive learning environments as predictors to self-regulation in e-learning environments	298	27.09
4	Narciss (2008)	Feedback Strategies for Interactive Learning Tasks	244	15.25
5	Dickey (2006)	Game design narrative for learning: Appropriating adventure game design narrative devices and techniques for the design of interactive learning environments	240	13.33
6	Irwin, Ball, Desbrow, & Leveritt (2012)	Students' perceptions of using Facebook as an interactive learning resource at university	199	16.58

No.	Authors	Title	Cites	Cites per Year
7	Baker et al. (2008)	Why students engage in “gaming the system” behavior in interactive learning environments	197	12.31
8	Lin et al. (2017)	A study of the effects of digital learning on learning motivation and learning outcome	189	27
9	Bowen et al. (2014)	Interactive learning online at public universities: Evidence from a six-campus randomized trial	179	17.9
10	Yang et al. (2010)	Integrating video-capture virtual reality technology into a physically interactive learning environment for English learning	151	10.78



With a setting of 10 as the minimum number of occurrences of a keyword, 50 items met the threshold out of the 1653 keywords. The 50 number of keywords were selected with total link strength. We saved the dataset using the VOSviewer map file and VOSviewer network file. Table 8 shows all keywords that occur at least 10 times. There are five keywords in clusters used in interactive and digital learning research – cluster 1 with the theme of Digital Learning and Technology (red circle), cluster 2 theme 2 Technology in Education (green), cluster 3 Theme 3: Adult Learning and Education (blue), cluster 4 theme 4; Learning Technology and Tools (yellow) and cluster 5 theme 5; Adapting education in digital era (purple).

Table 8. Themes of research based on the author's keywords

Authors's Keywords	Cluster	Total link Strength	Occurrences	Themes
Blended Learning	1	28	14	Theme 1: Digital Learning and Technology (red)
Collaborative Learning	1	35	22	
Computer-Based Learning	1	17	10	
Constructivist	1	21	15	
Critical Thinking	1	19	11	
Distance Learning	1	20	10	
Innovation	1	14	10	
Interactive Learning	1	170	204	
Knowledge Construction	1	28	18	
Learning Objects	1	55	39	
Multimodality	1	15	10	
Online Education	1	24	11	
Problem-Solving	1	15	10	
Social Network Analysis	1	13	11	
Sustainability	1	20	10	
Digital Learning	2	306	254	Theme 2: Technology in Education (green)
Education	2	45	27	
Educational Technology	2	82	53	
Engineering	2	15	13	
Game-Based Learning	2	16	13	
ICT	2	24	18	
Learning Analytics	2	97	68	
Mathematics	2	22	13	
Mobile Learning	2	20	15	
Motivation	2	16	13	
Students	2	25	11	
Technology	2	31	18	
Computer Assisted Learning	3	17	12	Theme 3: Adult Learning and Education (blue)
Digital Education	3	52	26	
Digital Literacy	3	31	18	
Digitalization	3	32	17	
Higher Education	3	95	49	
Information & Communication Technology	3	43	27	
Pedagogical Innovation	3	23	13	
Pedagogy	3	31	17	
Professional Development	3	39	23	
Augmented Reality	4	26	16	Theme 4: Learning Technology and Tools (yellow)
Communication	4	26	14	
Digital Media	4	22	13	
E-Learning	4	128	86	
Informal Digital Learning of English	4	12	17	
Inter National Collaboration	4	33	16	
Learning Outcomes	4	80	46	
Technology Acceptance Model	4	28	19	
Virtual Reality	4	23	13	
Covid-19	5	45	30	Theme 5: Adapting education in the digital era (Purple)
Digital Competence	5	30	12	
Instructional Design	5	36	22	
Learning Technology	5	27	20	
Online Learning	5	56	37	

In this comprehensive trend analysis spanning four and a half decades, our research has shed light on the evolving landscape of interactive and digital learning. Through meticulous examination and analysis of a dataset derived from the Scopus database, encompassing 1161 documents, this study has made significant contributions to understanding the trajectory of this critical field of educational research. Our findings illuminate the temporal dynamics of interactive and digital learning publications, with a noteworthy surge in 2021 and 2022. This surge reflects the growing relevance and demand for innovative pedagogical approaches facilitated by technology. The most prolific authors, themes, and topics, as well as institutions, countries, and highly cited documents, were meticulously identified. Among these findings, the work of Lee J. S. (2019) who authored 14 publications, has left an indelible mark on the field. The most cited publication, “Seriously considering play: designing interactive learning environments based on the blending of microworlds, simulations, and games” by Rieber (1996), stands as a testament to the enduring impact of seminal research.

4. Conclusions

This research meticulously unraveled the essential keywords and themes intrinsic to interactive and digital learning. The comprehensive examination of author keywords revealed a pattern of co-authorship, illuminating the interrelatedness of topics and the collaborative nature of research in this domain. The five overarching themes identified-Digital Learning and Technology, Technology in Education, Adult Learning and Education, Learning Technology and Tools, and Adapting Education in the Digital Era-underscore the multidimensionality of the field.

As a result of this analysis, we advocate for a systematic literature review that delves deeper into popular topics such as e-learning and learning systems. These topics have been identified as key focal points within the realm of interactive and digital learning and warrant sustained exploration and investigation.

This study employed a rigorous methodological approach, utilizing a range of data analysis tools, including BiblioMagica, BiblioMagika@Split, Microsoft Excel, and VOSviewer. This approach ensured the precision and reliability of our results. In summary, this trend analysis has provided an extensive and profound understanding of the interactive and digital learning landscape. The rich tapestry of research contributions, influential authors, institutional involvement, and thematic categorization has broadened the horizon for future scholarship in this field. As the field continues to evolve, researchers must remain vigilant, focusing on the dynamic themes and trends within interactive and digital learning. This research discussion not only contributes to the understanding of past and current developments but also paves the way for future scholars to explore uncharted territories in this ever-evolving educational domain. The findings of this study provide a foundation for further inquiry, ensuring that the realm of interactive and digital learning continues to thrive and adapt in response to the needs and opportunities of the digital age.

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