What India needs to learn in e-Learning? Insights from Bibliometric Analysis

Junali Sahoo
Research Scholar,
School of Development Studies,
IIHMR University, Jaipur,
Rajasthan, India
sahoo.junali@gmail.com

Hemanta Kumar Mishra
Assistant Professor,
School of Development Studies,
IIHMR University, Jaipur,
Rajasthan, India
hemant@iihmr.edu.in

Lokesh Vijayvargy
Professor,
Jaipuria Institute of Management,
Jaipur, Rajasthan, India
lokesh.vijayvargy@jaipuria.ac.in

Abstract

Education has been mostly impacted in recent times due to progressive communication and technological advancement. However, with technology advancement, E-leaning in India has not been researched much and gaps are continued to be a barrier in e-learning. This paper examined what need to be done to improve the e-learning in India. This bibliometric paper examines the e-learning research field in developing countries through PRISMA approach and carried out an analysis from 663 Scopus articles published in-between 1988-2022. It emphasizes publication trends, key research topics and influence of the papers in the market. Findings show that much research was not conducted till 2006 and the rigor increased after the pandemic. Analysis shows emphasis was on system development during these periods; however, the need was on curriculum development. Library Philosophy and Practice (LPP) has published maximum no. of articles post Covid-19, whereas papers published in Indira Gandhi National Open University get maximum citations. Kolekar, S.V., in 2020 is the most influential author and it concludes that more research needs to be done for collaboration on e-learning among different countries which could give a better result to the coming generations on how to inculcate learning through gaming. No such analysis has been made yet on e-learning research in context to India and the findings will assist the researchers to adopt the suggestions for improving e-learning.

Keywords: e-learning, ICT, MOOCs, Performance Analysis, Science Mapping, National Education Policy 2020.

Introduction

The novel coronavirus (n-Cov) caused a worldwide pandemic in 2019, causing widespread disruption across many industries such as travel (Yadav & Mohsin Qureshi, 2021), manufacturing (Pradhan et al., 2020), agriculture (Cariappa et al., 2022), and education (Chaturvedi et al.,

2021). Lack of resources and infrastructure has hampered education, particularly in rural regions. In response to these challenges, e-learning and other forms of ICT (Information and Communication Technology) have emerged as a crucial solution. Hence, students made a smooth transition to digital platforms, hastening the move to online education (Nayak et al., 2022) with access to high-quality instruction whenever and wherever required.

Like other countries, the Indian government launched novel initiatives despite unpreparedness using its e-learning infrastructure to promote online education, including Study Webs of Active-learning for Young Aspiring Minds (SWAYAM) and focus on e-learning resources for school children, particularly in rural regions (Sengupta, 2022), while private sector thrived with Diksha, Byju's, and Unacademy.

Technology's centralization and growth are crucial for modern tutoring and learning. Due to its popularity, educators at all levels are using technology more. However, differentiating difficulties remains a challenge. Differentiating Information Technology (IT) from ICT is difficult (Suleiman et al., 2020), as ICT involves communication and information exchange, supported by smartphones and strong internet connections. This development offers integrated ICT ways to improve teacher training and quality.

The NEP 2020 (National Education Policy) provides comprehensive education to support 'self-reliance campaign' by incorporating UN SDGs 4 (Sustainable Development Goals). NEP 2020's focus on transdisciplinary learning, lifelong education, and curricular improvements promoting quality and employment opportunities (Muralidharan et al., 2022), making India more competent and knowledgeable. However, none of the authors have highlighted the use of e-learning in India with respect to education. By keeping this key gap in view, the current paper addresses two key Research Questions (RQs) through systematic literature review, referring PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol and the article's structure includes methodology, findings, conclusions and limitations:

RQ1: What is the latest e-learning publication trends within India and the articles that influence the market along with the most influential authors?
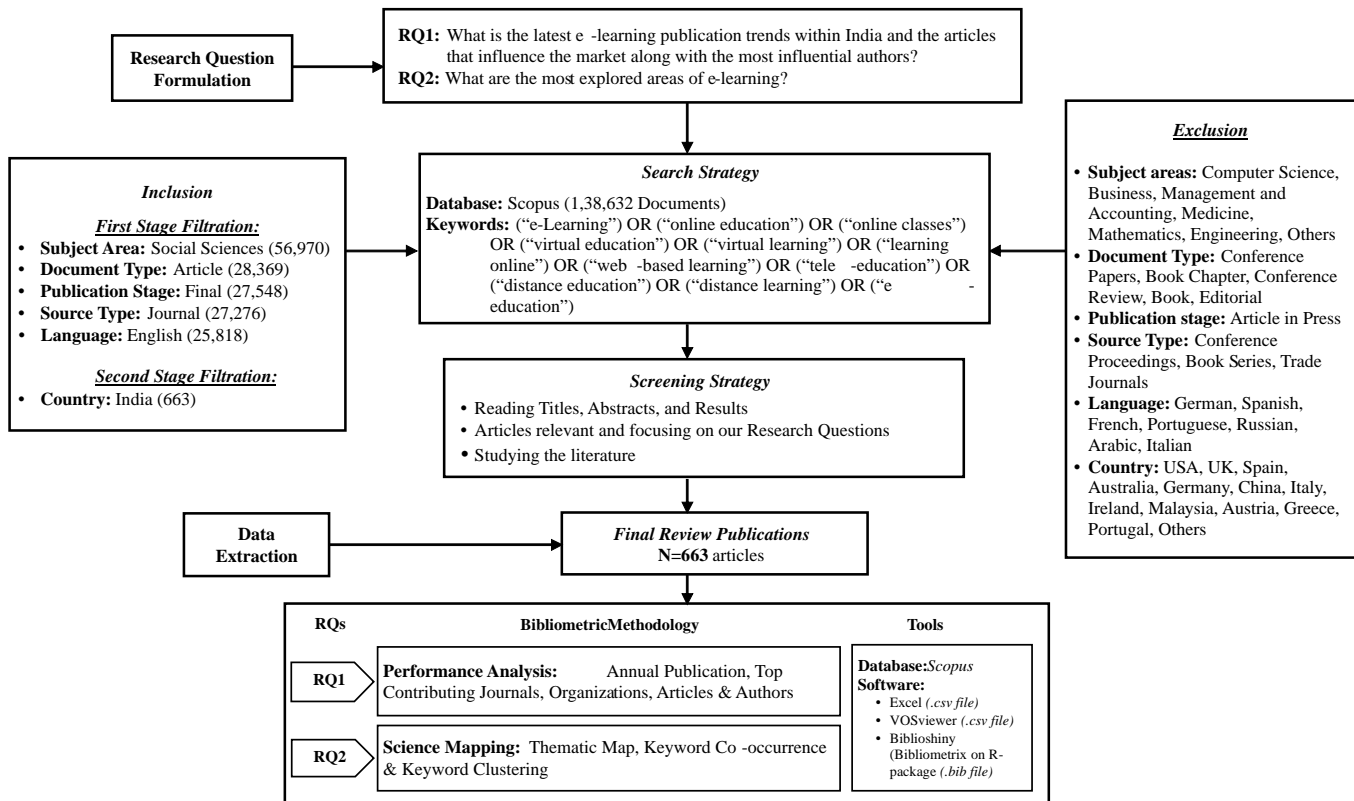
RQ2: What are the most explored areas of e-learning?

Methodology

Data was retrieved on July 18, 2022 conducting the search (combination of article titles, abstracts and keywords in Scopus) with words: ("e-Learning") OR ("online education") OR ("online classes") OR ("virtual education") OR ("virtual learning") OR ("learning online") OR ("web-based learning") OR ("tele-education") OR ("distance education") OR ("distance learning") OR ("e-education") leading to 1,38,632 documents, requiring additional filtration in two stages as shown in Figure 1. Out of this, inclusion and exclusion criteria and data extraction uncover 663 relevant research articles for the study. Bibliometric and Social network analysis (Donthu et al., 2021) were conducted to show the overall shape and major themes of the research area which researcher use to draw a map of e-learning research landscape and identify research trends to drive e-learning development.

Further, the study uses "Performance Analysis", a bibliometric strategy for cataloguing and analyzing scholarly literature to answer RQ1. Data set of 663 articles was exported as ".csv" and ".bib" files for use in VOSviewer and Biblioshiny software. "Science Mapping", (bibliometric method) depicting intellectual structure through RQ2 via thematic evolution mapping, keyword co-occurrence, and clustering which effectively showing research patterns and hidden themes were conducted.

Figure 1. PRISMA Flow diagram of the study

Research Question Formulation

RQ1: What is the latest e -learning publication trends within India and the articles that influence the market along with the most influential authors?
RQ2: What are the most explored areas of e-learning?

Inclusion

First Stage Filtration:
• **Subject Area:** Social Sciences (56,970)
• **Document Type:** Article (28,369)
• **Publication Stage:** Final (27,548)
• **Source Type:** Journal (27,276)
• **Language:** English (25,818)

Second Stage Filtration:
• **Country:** India (663)

Search Strategy
Database: Scopus (1,38,632 Documents)
Keywords: ("e-Learning") OR ("online education") OR ("online classes") OR ("virtual education") OR ("virtual learning") OR ("learning online") OR ("web -based learning") OR ("tele -education") OR ("distance education") OR ("distance learning") OR ("e - education")

Exclusion
• **Subject areas:** Computer Science, Business, Management and Accounting, Medicine, Mathematics, Engineering, Others
• **Document Type:** Conference Papers, Book Chapter, Conference Review, Book, Editorial
• **Publication stage:** Article in Press
• **Source Type:** Conference Proceedings, Book Series, Trade Journals
• **Language:** German, Spanish, French, Portuguese, Russian, Arabic, Italian
• **Country:** USA, UK, Spain, Australia, Germany, China, Italy, Ireland, Malaysia, Austria, Greece, Portugal, Others

Screening Strategy
• Reading Titles, Abstracts, and Results
• Articles relevant and focusing on our Research Questions
• Studying the literature

Data Extraction

Final Review Publications
N=663 articles

| RQs	BibliometricMethodology	Tools
RQ1	**Performance Analysis:** Annual Publication, Top Contributing Journals, Organizations, Articles & Authors	**Database:***Scopus* **Software:** • Excel *(.csv file)* • VOSviewer *(.csv file)* • Biblioshiny (Bibliometrix on R-package *(.bib file)*
RQ2	**Science Mapping:** Thematic Map, Keyword Co -occurrence & Keyword Clustering	

Findings

Performance Analysis

Using 663 articles, the study utilized performance analysis (Donthu et al., 2021) to answer RQ1 and identify how many articles were published in each year in the field of e-learning spotting the most prolific journals, organizations, authors, etc.

Publication trend for e-learning research

Figure 2 illustrates publication trend analysis of articles published in the study period. Research was scarce until 2006 and grown exponentially after 2007. Year 2021 peak in publication coincides with real-world difficulties and concerns after COVID-19. Between 2020 and 2021, topics including "MOOCs (Massive Open Online Course), Open and Distance Learning (ODL), Online tools, Student engagement, barriers, effectiveness of e-learning amongst the students of higher education, education policy, teachers' mobile learning acceptance" were published. It highlights

that researchers conducted more research on only the system development part of e-learning and not the curriculum of the courses given in e-learnings.

Figure 2. Annual distribution of articles between 1988 and 2022
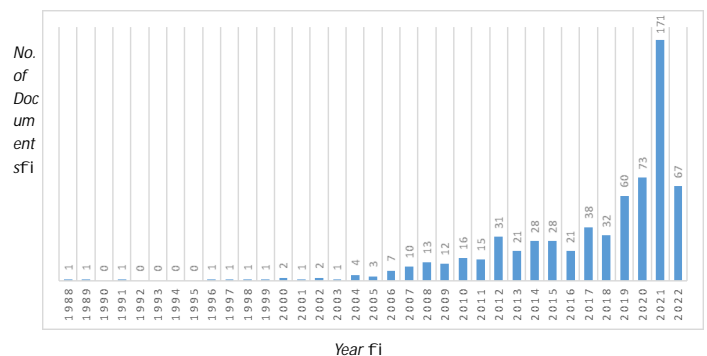
Top contributing journals for e-learning research

As analyzed, total of 663 articles appear in 614 journals and Table 1 lists the top e-learning journals according to the number of articles published (1988-18 July, 2022). In the year 2020, Journal of Engineering Education Transformations (JEET), published 4 articles post Covid-19 (focusing on learning management systems, students engagement, e-learning tools, learner centered approach), followed by Library Philosophy and Practice (LPP) in 2021

publishing 27 articles (special attention to INFLIBNET, Online resources, teaching technologies, online learning platforms, digital resources, National Digital Library, Open educational resources, Moodle), and 5 articles were published in the year 2022 so far by JEET again (intensifying on active learning techniques for effective online teaching and learning, conducting online examinations and its challenges, and utilization of ICT tools for enhancing teaching learning activity). Moreover, it reflects that the journal TOJDE who published more article on e-learning has stopped publishing in post-pandemic criteria, irrespective of its need.

Table 1. Top Publishing Journals (Yearly Basis)

Code	Journal	Publishers	No. of Articles	Frequency Distribution of Publications							
				<2016	2016	2017	2018	2019	2020	2021	2022
TOJDE	Turkish Online Journal of Distance Education	Anadolu Universities	53	47	1	1	3	1	-	-	-
LPP	Library Philosophy and Practice	University of Idaho Library	49	3	-	-	2	15	2	27	-
JEET	Journal of Engineering Education Transformations	Rajarambapu Institute of Technology	34	-	-	-	5	2	4	18	5
EAT	Education and Information Technologies	Kluwer Academic Publishers	31	1	4	3	3	6	3	9	2
IJETL	International Journal of Emerging Technologies in Learning	Kassel University Press	25	5	1	5	-	-	1	10	3

Top contributing organizations for e-learning research

Table 2 outlines the top 10 organizations based on descending total citations and yearly distribution for 591 articles by a total of 60 organizations. Indira Gandhi National Open University leads with 49 citations in 2020, addressing retention, administrative support, open educational resources, teacher readiness, and more,

followed by Jawaharlal Nehru University (156 citations) in 2021, focusing on digitization challenges and mental health. In 2022, it amassed 111 citations on UTAUT model, distance education barriers, anxiety effects, and parental support, revealing a need for K-12 e-learning research's comprehensive accessibility, curriculum, and effectiveness for Rurban students.

Table 2. Top Organizations Contributing towards e-Learning (Yearly Basis)

Organization	Total Publications	H-index	Total Citations	Citation Distribution of Organizations					
				<2018	2018	2019	2020	2021	2022
Indira Gandhi National Open University (New Delhi)	66	10	455	215	48	34	49	67	42
Jawaharlal Nehru University (New Delhi)	5	4	350	16	8	18	41	156	111
Anna University (Chennai)	13	7	217	106	18	24	22	34	13
Amrita University, Amritapuri Campus (Kerala)	7	6	177	48	21	15	31	37	25

Organization	Total Publications	H-index	Total Citations	Citation Distribution of Organizations					
				<2018	2018	2019	2020	2021	2022
University of Delhi (New Delhi)	13	4	125	3	-	5	13	41	63
Chitkara University (Punjab)	8	4	123	-	-	1	3	41	78
Manipal Academy of Higher Education (Manipal)	13	5	120	-	8	5	26	45	36
Vellore Institute of Technology (Vellore)	15	4	103	9	4	2	19	29	40
Amity University (Noida, Uttar Pradesh, Kolkata)	10	5	94	16	10	10	13	24	21
Jamia Millia Islamia (New Delhi)	6	3	87	-	-	-	2	45	40

Top contributing articles on e-learning research

Table 3 presents top 10 globally cited articles on e-learning. Post Covid-19, researchers focused on how students felt about the transition to online education, how they performed academically, how much they liked the programme, how emotionally intelligent and depressed they were. Webinars, online team building, remote work, and skill training modules all gained popularity as methods for engaging employees.

Table 3. Top Contributing Articles as per number of citations

Article	Authors	Total Citations
"Online teaching-learning in higher education during lockdown period of COVID-19 pandemic"	Mishra et al., 2020	394
"Impact of lockdown on learning status of undergraduate and postgraduate students during COVID-19 pandemic in West Bengal, India"	Kapasia et al., 2020	214
"e-Learning in a Mega Open University: Faculty attitude, barriers and motivators"	Panda & Mishra, 2007	113
"COVID-19 and its impact on education, social life and mental health of students: A Survey"	Chaturvedi et al., 2021	103
"Prioritization of online instructor roles: Implications for competency -based teacher education programs"	Bhawane & Spector, 2009	100
"Structural equation model (SEM) - neural network (NN) model for predicting quality determinants of e-learning management systems"	Sharma et al., 2017	73
"A new approach to personalization: Integrating e-learning and m-learning"	Nedungadi & Raman, 2012	73
"Performance analysis of mobile agent failure recovery in e-service applications"	Venkatesan et al., 2010	66
"Opinion of students on online education during the COVID-19 pandemic"	Chakraborty et al., 2021	62
"Quality assurance in distance education: the challenges to be addressed"	Stella & Gnanam, 2004	62
"Emerging themes in e-learning: A review from the stakeholders' perspective"	Choudhury & Pattnaik, 2020	61
"Review of ontology-based recommender systems in e-learning"	George & Lal, 2019	59

Influencing authors contributing to e-learning research

Table 4 shows the most influential authors who assist the growth of e-learning research in India, with their dominance as first authors. Scopus revealed 159 authors publishing 380 articles and the top three authors as per number of documents published were Kolekar, S.V., in 2020, planned to implement an innovative, indigenous, and in-built browser extension to collect the usage characteristics of the learner and evaluate the learning behavior in order to determine the students' preferred learning style by interacting with the MOOCs. In 2021, since the e-learning systems are becoming popular amongst students and educators due to its portability in terms of location, time and other resources, and since educational

institutions are constantly revising their policies in an effort to boost their students' academic performance, the author in his study explains how a Service Oriented Architecture (SOA) approach can help to reduce the cost and time to develop the e-learning systems. Furthermore, authenticating and assessing students' emotional behavior using the bioinformatics to be a challenging task for researchers and academicians has been identified by both the authors i.e., Khamparia, A. and Pandey, B. in the year 2020, as some of the problems like developing educational games for teaching with involvement of robotics seems to be challenging in the e-learning.

Table 4. Top Publishing Authors Contributing to e-Learning

Author	No. of Documents	First Author	Dominance Index*	Total Citations	TC/ND	Publication Information (Year/Journal)					
Kolekar, S. V	6	4	0.67	77	12.83	2016/IJKL	2017/ASL	2017/IJETL	2019/EIT	2020/IJETL	2021/IJETL
Panda, S.	6	2	0.33	156	26.00	2007/EMI	2012/TOJDE	2013/IJI	2013/EMI	2014/BJET	2017/IRRODL
Khamparia, A.	5	5	1.00	82	16.40	2015/IJTEL	2017/EIT	2017/IJTEL	2018/IJWLTT	2020/EIT	
Pandey, B.	5	0	0.00	83	16.60	2015/IJTEL	2017/EIT	2017/ IJTEL	2018/IJWLTT	2020/EIT	
Sabitha, A.S.	5	4	0.80	39	7.80	2015/EJEL	2016/ IJTEL	2016/EIT	2017/EIT	2019/EIT	
Bansal, A.	4	0	0.00	27	6.75	2015/EJEL	2016/IJETL	2016/EIT	2017/EIT		
Geetha, T.V.	4	0	0.00	92	23.00	2012/IJMSO	2012/IJDET	2015/AIR	2016/ILE		
Ghosh, C.K.	4	0	0.00	4	1.00	2013/TOJDE	2013/TOJDE	2013/TOJDE	2014/JHV		
Jeevan, V.K.J.	4	1	0.25	10	2.50	2002/STL	2008/SR	2008/SR	2012/JERL		
Kant, N.	4	3	0.75	11	2.75	2019/TOJDE	2020/AAOUJ	2020/AAOUJ	2021/AAOUJ		
Khanna, P.	4	4	1.00	22	5.50	2011/TOJDE	2013/IRRODL	2017/OL	2019/EIT		
Mehrotra, D.	4	0	0.00	27	6.75	2015/EJEL	2016/IJETL	2016/EIT	2017/EIT		
Pai, R.M.	4	0	0.00	71	17.75	2016/IJKL	2017/ASL	2017/IJETL	2019/EIT		
Sharma, R.C.	4	1	0.25	13	3.25	2005/OL	2021/S(S)	2022/S(S)	2022/S(S)		
Zachariah, A.	4	0	0.00	30	7.50	2010/DE	2011/MT	2012/EHCLP	2017/EHCLP		

*Author's Dominance Index calculated as: No. of Research Articles as First Author/No. of Multi-Authored Research Articles and TC/ND=Total Citations/No. of Documents.

IJKL=International Journal of Knowledge and Learning, ASL=Advanced Science Letters, IJETL=International Journal of Emerging Technologies in Learning, EIT=Education and Information Technologies,EMI=Educational Media International, TOJDE=Turkish Online Journal of Distance Education, IJI=International Journal of Instruction, BJET=British Journal of Educational Technology, IRRODL=International Review of Research in Open and Distance Learning, IJTEL=International Journal of Technology Enhanced Learning, IJWLTT=International Journal of Web-Based Learning and Teaching Technologies, EJEL=Electronic Journal of E Learning,IJMSO=International Journal of Metadata, Semantics and Ontologies, AIR=Artificial Intelligence Review, ILE=Interactive Learning Environments, JHV=Journal of Human Values, STL=Science and Technology Libraries, SR=Serials Review, JERL=Journal of Electronic Resources Librarianship, AAOUJ=Asian Association of Open Universities Journal, OL=Open Learning, S(S)=Sustainability (Switzerland), DE=Distance Education, MT=Medical Teacher, EHCLP=Education for Health: Change in Learning and Practice.

Science Mapping

This section is dedicated to mapping of available research articles on e-learning in an effort to understand the intellectual and structural connections within research components such as journals, institutions, authors, countries, authors' keywords and, articles, (Baker et al., 2021).The keyword co-occurrence and keyword clustering when amalgamated with network analysis facilitate to reveal bibliometric and scholarly composition of the topic to answer RQ 2.

Network Approach with thematic map of e-learning research

Biblioshiny (a Bibliometrix software) is used to conduct a network-based thematic map analysis of RQ2 to determine current state and sustainability. In this approach, Leading Eigenvalues clustering algorithm, thematic analysis is conducted by considering authors' keywords as a cluster and its interconnections. Thematically these are characterized by features named Density (represented in vertical axis) and Centrality (represented in horizontal axis) (Esfahani et al., 2019). The greater the number of relations received on a node with other thematic areas, higher is the importance and centrality. Similarly, cohesiveness, a similar kind of property of density if found on a node, delineates the capacity to develop and sustain itself.

Figure 3, illustrates the thematic map in e-learning, categorizing into four quadrants along with their rank centrality and density (calculated by the software): Q1 (Motor Theme)- represent well conceptualized and important for arranging an investigated theme such as "e-learning, moocs, swayam, internet, mobile learning, classification, decision tree, e-resources, online courses, social media, distance education, online education, online learning, distance learning, and online teaching" labelled as e-learning in Cluster 1, Q2 (Niche Theme)- represents the specialized themes includes "artificial intelligence" (cluster 8), and "collaborative learning" (cluster 9), Q3 (Emerging/Declining Theme)- represents the evolving or deteriorating themes, as seen in figure 2 the "open and distance learning" along with "curriculum" are the well-developed and need more efforts to be researched, and Q4

(Basic Theme)- represents the basic and important themes for development in the research field includes the cluster 2, 4 and 5 "covid-19, India, higher education, students, online classes, pandemic, pedagogy, blended learning, medical education, lockdown, assessment, covid-19 pandemic, ignou, perception, effectiveness, ict, virtual learning, engineering education and data mining". Specifically, "covid-19, India, and higher education" remains the leading themes within the field followed by "e-learning, moocs, and swayam". This implies India's higher education department prioritizes MOOCs and SWAYAM and not in primary and secondary e-learning education.

Figure 3. Thematic Map of e-learning research
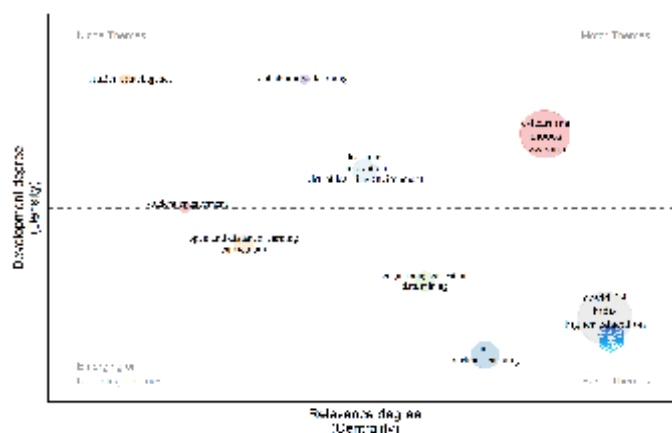
Keyword Co-occurrence

To deconstruct the conceptual framework of e-learning topic, this study uses VOSviewer's co-occurrence analysis of keywords to create a visual depiction of network between the keywords or topics that occurred at least 5 times in the articles. In figure 4, every single keyword represented a node, with (1) size of the node illustrating frequency of that topic/keyword, i.e. greater its occurrences, the larger its node is, (2) thickness of the link between two nodes shows how often two keywords appear together in that link, (3) colors of the keywords indicate the clusters i.e. sharing a common theme (Donthu et al., 2021). The incidences and total established strength between keywords has been listed in the Table 5, indicating "e-learning", "covid-19", "online education", "online learning" and "India" to be the frequently occurring

keywords with strongest link strength, thus highlighting their importance in the e-learning research associated to Indian context, along with Table 5(a) representing the triangulation of clusters obtained from keyword co-occurrences.

Cluster 1 (red) comprises keywords "online learning" (n=36), "India" (n=35), "higher education" (n=30), "distance learning" (n=29), "open and distance learning" (n=16), "engineering education" (n=10) and "ignou" (n=8). In this regard, the theme of this cluster can be broadly assigned as "Promoting higher education with IGNOU in India via open and distance learning systems".

Cluster 2 (green) involve keywords "e-learning" (n=168), "ontology" (n=15), "pedagogy" (n=13), "blended learning" (n=12), "assessment" (n=9), "moodle" (n=9) and "learning styles" (n=8). Thus, the theme for this cluster can be "Creating an effective e-learning pedagogy through blended learning strategy using moodle".

Cluster 3 (blue) is made up of "covid-19" (n=68), "online education" (n=38), "online teaching" (n=19), "pandemic" (n=13), "medical education" (n=12), "lockdown" (n=10) and "perception" (n=8). Thus, in this regard the theme for this cluster stands to be "Perception about online education and teaching of medical education during Covid-19 and lockdown".

In the similar fashion Cluster 4 (yellow) incorporates "ict" (n=20), "students" (n=15), "moocs" (n=15), "mobile learning" (n=10), "machine learning" (n=8). Hence, theme for this cluster can be "Potential of e-learning to the students utilizing ict and machine learning by adopting moocs".

Cluster 5 (purple) includes "online classes" (n=13), "internet" (n=10), and "COVID-19" (n=9), depicting "Leveraging online classes during Covid-19 pandemic utilizing the internet".

And lastly, Cluster 6 (light blue) involves "distance education" (n=42), "education" (n=28), and "learning" (n=14), forming the theme "Distance education: a guide to learning".
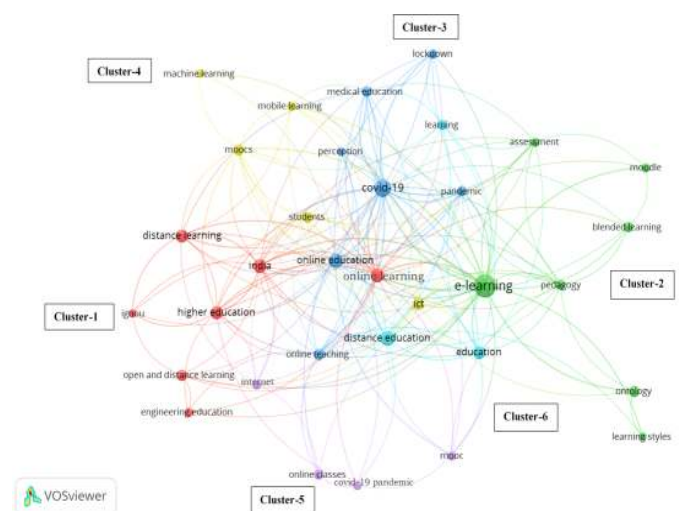
Figure 4. Network Visualization of e-learning research

Table 5. Major keywords from keyword co-occurrence of e-learning research

Keywords	Occurrences	Total Link Strength	Cluster No.	Keywords	Occurrences	Total Link Strength	Cluster No.
e-learning	168	140	2	lockdown	10	20	3
covid-19	68	106	3	internet	10	17	5
online education	38	63	3	assessment	9	15	2
online learning	36	63	1	learning	14	12	6
India	35	55	1	perception	8	12	3
distance education	42	45	6	mobile learning	10	11	4
higher education	30	43	1	ontology	15	10	2
education	28	40	6	blended learning	12	10	2
pandemic	13	28	3	online classes	13	9	5
distance learning	29	27	1	moodle	9	9	2

Keywords	Occurrences	Total Link Strength	Cluster No.	Keywords	Occurrences	Total Link Strength	Cluster No.
online teaching	19	27	3	ignou	8	9	1
students	15	26	4	covid-19 pandemic	9	8	5
Ict	20	24	4	open and distance learning	16	7	1
Moocs	15	21	4	learning styles	8	6	2
pedagogy	13	21	2	engineering education	10	5	1
medical education	12	21	3	machine learning	8	4	4

Table 5 (a). Triangulation of clusters from keyword co-occurrences

Cluster	Keywords	Themes
1.	distance learning, engineering education, higher education, ignou, India, online learning, open and distance learning	Promoting higher education with ignou in India via open and distance learning systems
2.	assessment, blended learning, e-learning, learning styles, moodle, ontology, pedagogy	Creating an effective e -learning pedag ogy through blended learning strategy using moodle
3.	covid-19, lockdown, medical education, online education, online teaching, pandemic, perception	Perception on online education/online teaching of medical education during Covid-19 and lockdown
4.	ict, machine learning, mobile learning, moocs, students	Potential of e -learning to the students utilizing ict and machine learning by adopting moocs
5.	covid-19 pandemic, online classes, internet	Leveraging online classes during Covid -19 pandemic utilizing the internet
6.	distance education, education, learning	Distance education: A guide to learning

Keyword Clustering

Keyword clustering is used to examine inter-relationships between cited works, therefore illuminating temporal or current evolution of topics in the research field through Biblioshiny. This method is based on the idea that articles having common references are likely to have same subject area and based on the thematic cluster formed from citation analysis (Donthu et al., 2020). With "impact" on x-axis and "centrality" on y-axis, a four-quadrant map as shown in Figure 5, generated information on various clusters along with articles within each cluster. The analysis demonstrated a total of 6 clusters emerging from a combination of highest cited articles post covid as listed in Table 6. The left quadrant on upper side indicates low centrality and high impact comprising 27 articles with their respective number of citations from Cluster 4. The left quadrant on bottom, reflects low centrality and low impact, containing 15 articles from Cluster 5 and 5 articles from Cluster 6, the right quadrant on bottom advocates high centrality and low

impact/influence comprising Cluster 2 with 37 articles. Lastly, the right quadrant on upper represents high centrality and high impact as could be seen in Cluster 1 (n=105) and Cluster 3 (n=128). This means academicians advocates to explore the cluster 4 more as compared to cluster 6 which shows less work is done on distance learning or self-instruction, or multimedia or internet-based learning.

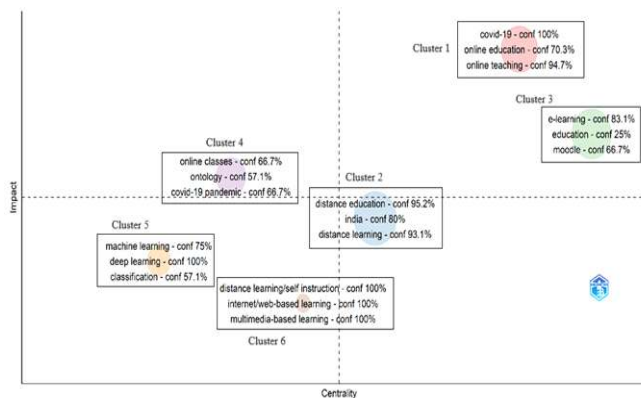**Figure 5. Bibliographic Coupling for e-learning research**

Table 6. Major themes from keywords clustering of e-learning research

Cluster	Theme	Prominent keywords (% of occurrences)	Centrality	Impact	Article(s)	Citations (Top 5 articles as per highest citations post Covid-19)
1.	Insights from COVID-19: Today's lessons and tomorrow's principles	covid-19 (100%) online education (70.3%) online teaching (94.7%)	0.1993	5.4150	105	Mishra et al., 2020 (443); Kapasia et al., 2020 (237); Chaturvedi et al., 2021 (121); Chakraborty et al., 2021 (73); Gopal et al., 2021 (66).
2.	India's distance education: Learning anytime-anywhere	distance education (95.2%) India (80%) distance learning (93.1%)	0.1273	2.2861	37	Khan et al., 2021 (58); Singh et al., 2021 (23); Selvaraj et al., 2021 (22); Mohan et al., 2021 (19); Khan, Kamal et al., 2021 (13).
3.	Moodle: An e-learning system for education	e-learning (83.1%) education (25%) moodle (66.7%)	0.2819	3.0674	128	Kapasia et al., 2020 (235); Choudhury & Pattnaik, 2020 (65); Khan et al., 2021 (29); Pal & Patra, 2021 (29); Singh et al., 2021 (28); H.K. Singh et al., 2021 (22)
4.	Covid-19 pandemic: Ontology and Online classes	online classes (66.7%) ontology (57.1%) covid-19 pandemic (66.7%)	0.0794	2.6114	27	Singh et al., 2021 (22); Jeevamol & Renumol, 2021 (9); Stracke et al., 2022 (5); Kalita & Deka, 2020 (4); Nayak et al., 2022 (2); D.S.Mishra et al., 2021 (2); Kukreja et al., 2021 (2).
5.	Machine learning vs. Deep learning: Classification	machine learning (75%) deep learning (100%) classification (57.1%)	0.0667	1.8164	15	Ashwin & Guddeti, 2020 (11); Sathe & Adamuthe, 2021 (9); Indi et al., 2021 (6); Ramesh & Sanampudi, 2022 (5); Rajasoundraran et al., 2021 (5); Sahoo et al., 2021 (5).
6.	Digital learning: self-instruction/ web-based/ multimedia-based mode	distance learning/ self-instruction (100%) internet/ web -based learning (100%) multimedia-based learning (100%)	0.1197	1.2657	5	Tigaa & Sonawane, 2020 (15); Giri & Dutta, 2021 (9); Seshadri et al., 2020 (4); Jennifer & Lipin, 2020 (2)

Conclusions

Covid-19 emphasizes need of widespread e-learning as a prerequisite for development. E-learning aims to be flexible, interactive and immersive in time, location, pace, participation, and access. Post pandemic challenges included poor internet quality, lack of ICT knowledge, low parental income, less educated mothers, and a limited number of rooms for online classes. The Government of India has taken steps to overcome the situation and reduce the digital divide to provide compulsory education to all. As students regularly use MOOCs platform, every MOOCs (SWAYAM and Coursera) designer must analysis and

evaluate users' sentiments, ratings and feedback to improve users' requirement and bringing better understanding on the issues by removing bugs and introducing some additional features such as study games to develop clarity.

Research demonstrates that MOOCs help both students and teachers at State Universities, but female students are less likely to enroll and complete MOOCs courses due to unawareness and inadequate infrastructure. ICT usage inability is the main reason students don't utilize MOOCs. Lack of physical interaction with instructor is also viewed as a constraint in understanding topic/course via MOOCs.

The third NEP, agreed by the Union Cabinet on July 29,

2020, recognizes and strives for universal access and equality from prior educational programmes after 34 years. The policy ensures quality, honesty and equity in education to reduce inequalities. Special education zones should be created in places with large number of socioeconomically and educationally disadvantaged students. Enhanced teamwork and e-learning may assist these zones execute all initiatives and policies. As revealed from the study, curriculum development for both rural as well as urban students, fee structure, easy accessibility to the resource at village level, partnership with corporates need to be considered. It further recommends research on international collaboration on e-learning to better guide future researchers on how to use gamification and robotics.

Limitations

The study used Scopus data and included publications by Indian authors and findings could only be used to design e-learning solutions in developing countries. Additional research is required to compare solutions from developed countries to overcome policy gaps and contribute to system's strengthening.

Statements and Declarations

This paper aimed to highlight future research work required to be done in e-learning in developing countries and is a noble research work conducted by the authors. The authors did not receive any funding for the study and anticipate policymakers and educators to utilize the results to develop new e-learning policies. The dataset used for this paper is available with the paper.

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