Trend Analysis of Blended Learning Research Output from Scopus: A Scientometric Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This research study is a scientometric analysis of blended learning research output indexed in Scopus from 2015 to 2023, revealing significant growth in publications and citation metrics. The analysis indicates an upward trend in records, escalating from 854 publications in 2015 to 22,344 in 2023. The findings highlight that articles constitute the majority of publications (~83.11%), with an impressive citation per record average of 10.49. Notably, 2020 exhibited a peak in records (1,466) and citations (22,455). Utilizing Time Series and Trend Analysis, projections for 2030 and 2045 suggest continued positive growth in blended learning research output. Overall, this study underscores the increasing global interest in blended learning and its implications for future research directions.

Keywords: Trend analysis; blended learning research; Scopus; time series analysis.

1. INTRODUCTION

Blended learning, an educational approach that combines digital tools with traditional face-to-face instruction, has gained popularity since its foundation in the 2006 Handbook of Blended Learning. This hybrid model enhances student engagement and optimizes learning experiences by allowing flexibility in accessing educational resources. This study analyzes blended learning research trends from 2015 to 2023 using data from the Scopus database. The analysis aims to quantify publication patterns, authorship trends, and citation metrics, providing insights into the evolving landscape of blended learning research. The results will help understand the field's growth and inform future research initiatives. Blended learning, initially a combination of various technologies and methods, gained more concrete definition in 2006 with the publication of the first Handbook of Blended Learning by Bonk and Graham. It refers to the educational practice of combining digital tools with traditional face-to-face teaching, with both students and teachers physically located in the same space [1-3].

Blended learning is an educational strategy that combines traditional education with online learning, allowing students to learn the basics of a topic online and then attend in-person seminars to engage with experts. This mixed-mode instruction combines traditional face-to-face instruction with technology-mediated online instruction; allowing teachers to streamline lessons and help students reach their potential. Blended learning ensures that the audience remains engaged and their overall learning experience is productive, ensuring that the learning process is efficient and effective [4-6].

Scientometric analysis is a method used to measure and calculate parameters related to a researcher's research output, including article distribution, authorship patterns, productivity, growth rates, and collaboration. It was coined by Vassily V. Nalimov in the 1960s and is related to bibliometrics and informetrics [7]. It involves analyzing author patterns and characteristics using techniques like citation analysis, providing indicators for science and technology policy processes and research and development management.

2. REVIEW OF RELATED LITERATURE

A study of Isa [8] explored to analyze 20 years of trends in Mobile Learning, Blended Learning, Online Learning, E-Learning, Electronic Learning, and Dental Education research. The research was extracted and analyzed using the Web of Science database, using VOSViewer software to identify key trends and influential authors. The 374 filtered documents were selected based on three criteria: topics, type of documents, and year published between 2000 and 2020. The study conducted various analyses using VOSViewer, including co-authorship, co-occurrence, citation, and co-citation analysis. The main contribution is a conceptual framework for Dental Health Education based on stakeholders' orientation, guiding future research in interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning, and supporting the UN Sustainable Development Goals agenda on Quality Education. Five major keyword theme clusters were determined based on these clusters: program provider, curriculum designer, dental students, dental hygiene education provider, and interprofessional education provider themes.

Arumugam Raman [9] analyzed article publications on blended learning in higher education using statistics from the Scopus database. The study used Microsoft Excel for frequency analysis, VOSviewer for data

visualization, and Harzing's Publish or Perish for citation metrics. The analysis found that the number of publications per year increased from 2000 to 2018, with English being the most widely used language. The United States contributed the most publications. The article also lists active journals, influential institutions, citation metrics, and highly cited articles. Network visualization maps show keyword analysis, co-authorship by country and author, number of authors per document, citations by country and document, co-occurrence of all keywords, and co-citation by cited sources. The visibility of work on blended learning in highly cited journals in the past two decades indicates that blended learning has gained significant attention among educators and researchers.

Irwanto Irwanto [10] endorsed Blended learning (BL) applications, which combine online and face-to-face education, have gained attention due to the pandemic. Despite the wide range of content and applications in the literature, bibliometric studies on BL are limited. This research aims to conduct a systematic analysis of BL studies worldwide and reveal general research trends using bibliometric methods. The study analyzed 4,059 publications from 1965-2022, focusing on social sciences, computer, medicine, and engineering. The USA, UK, China,

and Australia were the most cited countries. Common word analysis revealed that studies mostly focus on technology use during the pandemic, current trends in education and technology, online learning environments, learner characteristics, teaching approaches, social media, motivation, and medical education. The most common terms in abstracts reflect the learning process, learner, classroom environment, model adopted, system designed, and medical education. The research reveals that BL studies have increased in number since 2006, with the USA, UK, China, and Australia being the most cited countries.

3. RESULTS AND DISCUSSION

The Table 1 revealed that the year wise publications of blended learning research output during the years 2015 to 2023 in the global context. Each year shows an increase in the number of records, indicating a growing interest and output in blended learning research. The number of records has consistently increased from 854 (6.10%) in 2015 to 22344 in 2023 (16.76%). In the year 2020 have 1466 records with high citations are 22455. Among the total number of publications, the citations per record are 10.49.

Table 1. Year wise publications of Blended Learning Research Output

S.No	Years	Publications	%	Citations	%	Citation per Publication
1.	2015	854	6.10	22470	15.31	26.31
2.	2016	936	6.69	14732	10.04	15.74
3.	2017	966	6.90	14553	9.92	15.07
4.	2018	1198	8.56	16614	11.32	13.87
5.	2019	1466	10.48	16968	11.56	11.57
6.	2020	1690	12.08	22455	15.30	13.29
7.	2021	2275	16.26	21208	14.47	9.32
8.	2022	2263	16.17	12008	8.18	5.31
9.	2023	2344	16.76	5727	3.90	2.44
Total		**13992**	**100.00**	**146735**	**100.00**	**10.49**

Table 2. Type of publications of in blended learning research output drawn from Scopus

Years	Articles	Book chapters	Conference papers	Reviews	Notes	Total
2015	752	65	31	5	1	854
2016	813	82	30	6	5	936
2017	825	86	36	10	9	966
2018	1006	119	51	12	10	1198
2019	1246	126	63	19	12	1466
2020	1368	218	68	22	14	1690
2021	1870	263	85	30	27	2275
2022	1845	273	86	31	28	2263
2023	1904	275	99	36	30	2344
Total	**11629**	**1507**	**549**	**171**	**136**	**13992**
%	**83.11**	**10.77**	**3.92**	**1.23**	**0.97**	**100.00**
Citation	**123526**	**19526**	**2100**	**1412**	**171**	**146735**

Table 3. Time series analysis in blended learning research output

S.No	Year	Count (Y)	X	X^2	XY
1.	2015	854	-4	16	-3416
2.	2016	936	-3	9	-2808
3.	2017	966	-2	4	-1932
4.	2018	1198	-1	1	-1198
5.	2019	1466	0	0	0
6.	2020	1690	1	1	1690
7.	2021	2275	2	4	4550
8.	2022	2263	3	9	6789
9.	2023	2344	4	16	9376
Total		**13992**	**0**	**60**	**13051**

Straight line equation is applied to arrive at projections for future growth under Time Series analysis.

Among the total publications, there are more than eighty three percent (~83.11) publications in articles, followed by more than ten percent (~10.77) publications in book chapters, more than three percent (~3.92) publications in conference papers, more than one percent (~1.23) publications in reviews and more than point nine percent (~0.97) publications in notes. The highest citations scored articles are 123526.

3.1 Time Series Analysis for the Total Publications

Time series analysis is generally adapted to put forth the continuous and discrete data into a meaningful way so that the relationship, growth trend, prediction of future course of occurrences with velocity can be formulated.

Straight Line equation:

Formula:

Strait line equation = Yc=a+b

Since ΣX = 0
a+ ΣY/N
a+13992/9=1554.67
b = Σxy/ΣX2   = 13051/60 = 217.52

Suppose, we estimate productivity for the year 2030, so when 2019=0
Estimated literature in 2030 is when X= 2030 – 2019 = 11
= 1554.67 + 217.52 * 11 = 1554.67 + 2392.72 = **3947.39**
Estimated literature in 2045 is when X= 2045 – 2019 = 26
= 1554.67 + 217.52 * 26 = 1554.67 + 5655.52 = **7210.19**

On the application of the formula of Time Series Analysis and subsequently, from the results obtained separately for the years 2030 and 2045, it is found that the future trend of publication productivity of blended learning research output may take an increasing trend during the years to come. The inference is that there is a positive growth at the global level in research literature output in publication productivity of blended learning research output.

Table 4. Trend analysis in blended learning research output for articles

S.No	Year	Count (Y)	X	X^2	XY
1.	2015	752	-4	16	-3008
2.	2016	813	-3	9	-2439
3.	2017	825	-2	4	-1650
4.	2018	1006	-1	1	-1006
5.	2019	1246	0	0	0
6.	2020	1368	1	1	1368
7.	2021	1870	2	4	3740
8.	2022	1845	3	9	5535
9.	2023	1904	4	16	7616
Total		**11629**	**0**	**60**	**10156**

Straight line equation is applied to arrive at projections for future growth under Trend analysis.

Table 5. Trend analysis in blended learning research output for book chapters

S.No	Year	Count (Y)	X	X^2	XY
1.	2015	65	-4	16	-260
2.	2016	82	-3	9	-246
3.	2017	86	-2	4	-172
4.	2018	119	-1	1	-119
5.	2019	126	0	0	0
6.	2020	218	1	1	218
7.	2021	263	2	4	526
8.	2022	273	3	9	819
9.	2023	275	4	16	1100
Total		**1507**	**0**	**60**	**1866**

Straight line equation is applied to arrive at projections for future growth under Trend analysis.

Table 6. Trend analysis in blended learning research output for conference papers

S.No	Year	Count (Y)	X	X^2	XY
1.	2015	31	-4	16	-124
2.	2016	30	-3	9	-90
3.	2017	36	-2	4	-72
4.	2018	51	-1	1	-51
5.	2019	63	0	0	0
6.	2020	68	1	1	68
7.	2021	85	2	4	170
8.	2022	86	3	9	258
9.	2023	99	4	16	396
Total		**549**	**0**	**60**	**555**

Straight line equation is applied to arrive at projections for future growth under Trend analysis.

Straight Line equation:

Formula:

Strait line equation = Yc=a+b
Since ΣX = 0
a+ ΣY/N
a+11629/9 =1292.11
b = Σxy/ΣX2   = 10156/60 = 169.27

Suppose, we estimate productivity for the year 2030, so when 2019=0
Estimated literature in 2030 is when X= 2030 – 2019 = 11
= 1292.11 + 169.27 * 11 = 1292.11 + 2392.72 = 3154.08

On the application of the formula of Trend Analysis and subsequently, from the results obtained separately for the year 2030, it is found that the future trend productivity of blended learning research output for articles may take an increasing trend during the years to come. The inference is that there is a positive growth at the global level in research literature output in productivity of blended learning research output for articles.

Straight Line equation:

Formula:

Strait line equation = Yc=a+b
Since ΣX = 0
a+ ΣY/N
a+1507/9 =167.44
b = Σxy/ΣX2   = 1866/60 = 31.10
Suppose, we estimate productivity for the year 2030, so when 2019=0
Estimated literature in 2030 is when X= 2030 – 2019 = 11
= 167.44 + 31.10 * 11 = 167.44 + 342.10 = 509.54

On the application of the formula of Trend Analysis and subsequently, from the results obtained separately for the year 2030, it is found that the future trend productivity of blended learning research output for book chapters may take an increasing trend during the years to come. The inference is that there is a positive growth at the global level in research literature output in productivity of blended learning research output for book chapters.

Straight Line equation:

Formula:

Strait line equation = Yc=a+b
Since ΣX = 0
a+ ΣY/N
a+549/9 =61
b = Σxy/ΣX2 = 555/60 = 9.25
Suppose, we estimate productivity for the year 2030, so when 2019=0
Estimated literature in 2030 is when X= 2030 – 2019 = 11
= 61 + 9.25 * 11 = 61 + 101.75 = **162.75**

On the application of the formula of Trend Analysis and subsequently, from the results obtained separately for the year 2030, it is found that the future trend productivity of blended learning research output for conference papers may take an increasing trend during the years to come. The inference is that there is a positive growth at the global level in research literature output in productivity of blended learning research output for conference papers.

Straight Line equation:

Formula:

Strait line equation = Yc=a+b
Since ΣX = 0
a+ ΣY/N
a+171/9 = 19
b = Σxy/ΣX2 = 249/60 = 4.15
Suppose, we estimate productivity for the year 2030, so when 2019=0
Estimated literature in 2030 is when X= 2030 – 2019 = 11
= 19 + 4.15 * 11 = 19 + 45.65 = **64.65**

On the application of the formula of trend analysis and subsequently, from the results obtained separately for the year 2030, it is found that the future trend productivity of blended learning research output for reviews may take an increasing trend during the years to come. The inference is that there is a positive growth at the global level in research literature output in productivity of blended learning research output for reviews.

Table 7. Trend Analysis in Blended Learning Research Output for Reviews

S.No	Year	Count (Y)	X	X^2	XY
1.	2015	5	-4	16	-20
2.	2016	6	-3	9	-18
3.	2017	10	-2	4	-20
4.	2018	12	-1	1	-12
5.	2019	19	0	0	0
6.	2020	22	1	1	22
7.	2021	30	2	4	60
8.	2022	31	3	9	93
9.	2023	36	4	16	144
Total		**171**	**0**	**60**	**249**

Straight line equation is applied to arrive at projections for future growth under Trend analysis.

Table 8. Trend analysis in blended learning research output for notes

S.No	Year	Count (Y)	X	X^2	XY
1.	2015	1	-4	16	-4
2.	2016	5	-3	9	-15
3.	2017	9	-2	4	-18
4.	2018	10	-1	1	-10
5.	2019	12	0	0	0
6.	2020	14	1	1	14
7.	2021	27	2	4	54
8.	2022	28	3	9	84
9.	2023	30	4	16	120
Total		**136**	**0**	**60**	**225**

Straight line equation is applied to arrive at projections for future growth under Trend analysis.

Table 9. Growth for trend analysis in blended learning research output publications

Years	Articles	Book chapters	Conference papers	Reviews	Notes	Total
2015	752	65	31	5	1	854
2016	813	82	30	6	5	936
2017	825	86	36	10	9	966
2018	1006	119	51	12	10	1198
2019	1246	126	63	19	12	1466
2020	1368	218	68	22	14	1690
2021	1870	263	85	30	27	2275
2022	1845	273	86	31	28	2263
2023	1904	275	99	36	30	2344

Table 10. Publications Growth Tend analyses in the year 2030

2030	3154	510	163	65	56	3948
%	79.89	12.92	4.13	1.65	1.43	**100.00**

Straight Line equation:

Formula:

Strait line equation = Yc=a+b

Since $\Sigma X = 0$
a+ $\Sigma Y/N$
a+136/9 = 15.11
b = $\Sigma xy/\Sigma X2$ = 225/60 = 3.75

Suppose, we estimate productivity for the year 2030, so when 2019=0
Estimated literature in 2030 is when X= 2030 − 2019 = 11
= 15.11 + 3.75 * 11 = 15.11 + 41.25 = **56.36**

On the application of the formula of trend analysis and subsequently, from the results obtained separately for the year 2030, it is found that the future trend productivity of blended learning research output for notes may take an increasing trend during the years to come. The inference is that there is a positive growth at the global level in research literature output in productivity of blended learning research output for notes.

Compare to the Table 9, Publications Growth Tend analyses in the year 2030 (Table 10) the growth is high. So the trend analysis is positive.

4. CONCLUSION

The study reveals a significant increase in blended learning research output from 2015 to 2023, indicating a growing scholarly interest in this field. The study also highlights the importance of research productivity in future years, particularly in 2030 and 2045, indicating a positive trend in blended learning. The study emphasizes the need for further research into its effectiveness, implementation strategies, and technological advancements. As the field evolves, researchers and educators must stay updated on emerging trends and findings to ensure that blended learning practices are informed by robust empirical evidence.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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