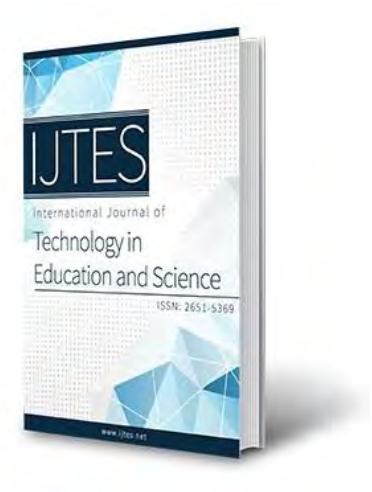

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An Examination of the Studies on Learning Analytics: A Bibliometric Mapping Analysis

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An Examination of the Studies on Learning Analytics: A Bibliometric Mapping Analysis

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Abstract

This research aims to create a bibliometric map of studies on learning analytics. In this research, the bibliometric mapping technique was used from an international perspective to evaluate trends in learning analytics research by describing the factors of author, publication, keyword, journal, country, and citation. Most of the research on the subject has been published in the Journal of Learning Analytics. The results show that Gasevic D. is the most relevant author. Open University is the most relevant university. The USA has the most publications, co-authored publications, single national publications, and cited articles overall. The terms "learning," "higher education," and "analytics" are frequently used keywords. As a result of the thematic mapping analysis of the keywords, the themes in the Q1 area were learning analytics and education concepts. It has been seen that the concepts of learning analytics, analytics, and performance are at the center of the created co-occurrence network diagram.

Introduction

Learning is the essential feature that distinguishes human beings from all other living and non-living beings. However, the creation of each person as a different species also creates differences in their learning styles (Kuzgun & Deryakulu, 2006). The teacher was always at the center of teaching activities for many years. The exact curriculum was given to each student with the same methods, although every student has unique characteristic. Although student-centered education has started to be presented in the studies on education over the last 20 years, it was also a challenging situation to provide personalized education by considering individual differences (Boyapati, 2000). The widespread use of information and communication technologies and the fact that web-based education can be applied at all educational levels have started to facilitate personalized education environments.

The idea of analyzing the data collected from web-based education environments and providing content according to the results lies based on personalized education (Klašnja-Milićević et al., 2020). Students' behaviors in educational environments are recorded, and student profiles are created by analyzing these records. Based on these data, when the content is presented to the student, the student reaches the information they need as much as they need. Previously, some analysis results could only be obtained by calculations made with basic statistical methods. With the spread use of artificial intelligence, it has become possible to make much more advanced calculations

on big data. Artificial intelligence techniques are used to make forward-looking predictions or make sense of current situations. In education, the concepts of learning analytics, academic analytics, and education-based data mining come into play (Siemens, 2012).

It is possible to summarize learning analytics as performing some analyzes on the data obtained by recording students' behaviors in learning environments to improve current learning or make predictions. While revealing this definition, some learning analytics definitions in the literature were used. For the first time, at the International Conference on Learning Analytics & Knowledge (LAK) held in 2011, a student-centered definition was made. In this definition, learning analytics is expressed as the "measurement, collection, analysis, and reporting of data about students and their contexts to understand and optimize learning and the environments in which learning takes place" (SoLAR, 2021).

Learning analytics has a critical role in understanding human learning, teaching, and education by identifying and validating relevant measures of processes, outcomes, and activities (Mangaroska & Giannakos, 2019). Although it initially had a technological perspective due to its roots in learning analytics, business intelligence, recommendation systems, and educational data mining, it has gradually shifted towards an education perspective in recent years (Ferguson, 2012). Learning analytics emerged as a separate field due to the digital transformation in education, the emergence of distributed learning environments, and the increasing interest in online learning (Long & Siemens, 2011). Learning analytics has developed around using the power of digital technologies to collect the traces left on the system to understand the activities and behaviors based on student learning (Siemens, 2013). The potentials of learning analytics are summarized as explaining unexpected learning behaviors, identifying successful learning patterns, detecting misunderstandings and false efforts, offering appropriate interventions, and raising users' awareness of their actions and progress (Long & Siemens, 2011). Learning analytics is an interdisciplinary field that takes a holistic approach to examining learning contexts and environments and addressing questions in educational research (Siemens & Gasevic, 2012).

It is possible to find studies that map learning analytics in the literature. Chen and Liu (2011) reviewed articles published between 2011-2021 to reveal learning analytics trends. For this purpose, they compared the data of 178 articles obtained from the China National Knowledge Infrastructure database and the data of 1056 articles obtained from the Web of Science database. Zhang et al. (2018) similarly scanned the Web of Science core database and performed bibliometric mapping on 1579 publications published between 1995 and 2018 on the subject, only indexed by SCI and SSCI. Shi et al. (2019) examined 623 articles published between 2011 and 2018 in the Web of Science core database over a time range, region distribution, and bibliography. Phillips and Ozogul (2020) scanned the Web of Science database and selected and analyzed 90 articles that fit their criteria among 1344 articles published between 2011 and 2018. Pei et al. (2021) scanned the databases of Scopus, Web of Science, IEEE Xplore Digital Library, ACM Digital Library, and ScienceDirect to examine the articles published between 2010-2020 on multimodal learning analytics. After passing 1584 articles, they reached through various filters; they analyzed the remaining 194 articles. Apart from the studies mentioned above, it is possible to find systematic literature review studies published on learning analytics (Dawson et al., 2014; Papamitsiou et al., 2014). When the common features of these studies are examined, it can be summarized that they provide very

important information about learning analytics. However, since each study examined articles and journals with different characteristics, they obtained different results on learning analytics. Recently, the number of studies on learning analytics has been increasing rapidly. Therefore, an up-to-date map is needed.

The number of studies on learning analytics is increasing daily, so most studies on this subject are out of date a few years after they are published. There is a need for an up-to-date bibliometric analysis that will reveal the course of increasing learning analytics studies. Talan and Demirbilek (2022) conducted one of the most recent studies on the subject, scanned the Web of Science database, and performed a bibliometric analysis on 659 articles published between 2011 and 2021. In the study mentioned above, they filtered the categories of "Education Scientific Disciplines," "Education Educational Research," "Education Special," "Psychology Educational," and SSCI, SCI-EXPANDED, and A&HCI indexes of Web of Science. This study examines all learning analytics articles from the past to the present without filtering the year. In this study, the authors' journal, author, country, and university information, quotations, and trending topics were discussed in detail. It is crucial to determine the emergence of trends and disciplinary hierarchies that have influenced the development of the field to date, through citation analysis and structured mapping, in terms of guiding the studies to be done on this subject. This study aims to examine the studies on learning analytics and determine the trends in learning analytics in various variables using the bibliometric mapping method, considering all these needs. For this purpose, answers to the following questions were sought:

1. Which are the most relevant journals on learning analytics?
2. Which are the most relevant authors on learning analytics?
3. Which are the most relevant universities and countries on learning analytics?
4. What is the citation status on learning analytics?
5. What are the keywords and trending topics on learning analytics?
6. How is the thematic map of the keywords of the studies on the use of artificial intelligence in education?
7. How is the co-occurrence network of the keywords of the studies on the use of artificial intelligence in education?

Method

Research Design

This study used the bibliometric mapping method to examine the articles written on learning analytics regarding various variables. Bibliometric mapping is a spatial representation of relationships between disciplines, fields, individual publications, or authors (Small, 1999). Bibliometric studies allow for identifying trends in the field by quantifying some features of research in a particular area and evaluating the results (Kasemodel et al., 2016). Bibliometric analysis ensures that the studies, researchers, institutions, and scientific flow related to the determined scientific subject are followed (Martí-Parreño et al., 2016). Quantitative analysis and statistics are used to identify publication patterns within a particular field of literature. Researchers use bibliometric evaluation methods to determine the influence of a single author or to identify the relationship between two or more authors or works (Thanuskodi, 2010). The accepted analysis procedure consists of three main steps; research mapping, quantitative analysis, and analysis of trends and patterns.

Obtaining the Meta-Data Set

As a result of a search on Web of Science (WOS) with the keywords "learning analytics" in June 2022, 16101 articles were found. Then, 1590 studies were obtained as a result of document type (Document Types = Articles), WOS category (WOS Categories = Education Educational Research), and language (Languages = English) filters. Descriptive data of the studies obtained are given in Table 1.

Table 1. Descriptive Data of Obtained Studies

Description	Results
Timespan	1999:2022
Sources (Journals, Books, etc)	249
Average years from publication	3,34
Average citations per documents	11,97
Average citations per year per doc	2,425
Authors of single-authored documents	191
Authors of multi-authored documents	3309
Documents per Author	0,454
Authors per Document	2,2
Co-Authors per Documents	3,18

When Table 1 is examined, it is seen that the publications obtained from 249 different sources started in 1999 and continue until today. Also, we can see an average of 3.34 publications per year, an average citation rate of 11.97 per document, and an average citation rate of 2.43 per document and year. While the number of articles with a single author is 191, the number of articles with multiple authors is 3309. While there are 0.45 documents per author, there are 2.2 authors per document. The number of co-authors per document is 3.18. The distribution of the number of studies by year is given in Figure 1. It is seen that the number of publications started to increase gradually after 2011.

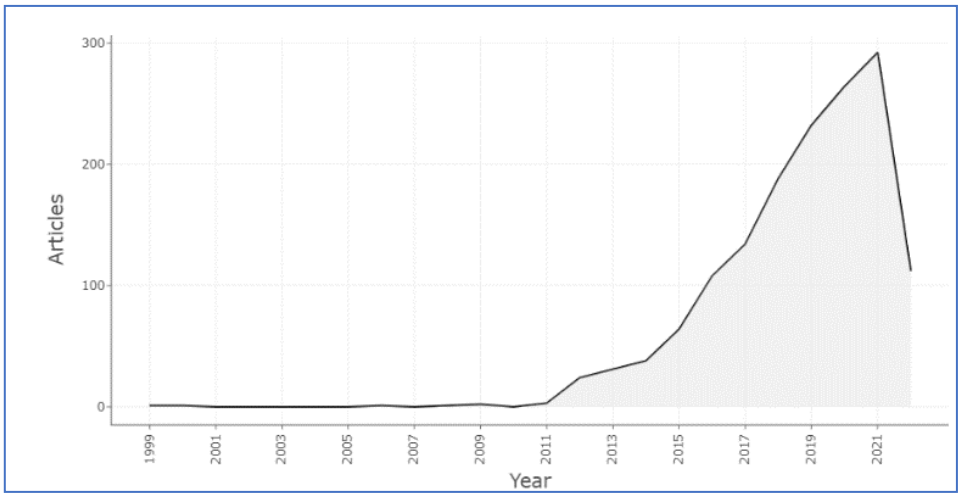

Figure 1. Distribution of the Number of Studies by Years

Data Analysis

The metadata data of the articles published in the Web of Science related to the subject were downloaded in BibTeX file format and analyzed using the "Bibliometrix" library developed for the R programming language. The Bibliometrix is a reliable, open-source tool designed to perform a comprehensive science mapping analysis of the scientific literature (Aria & Cuccurullo, 2017).

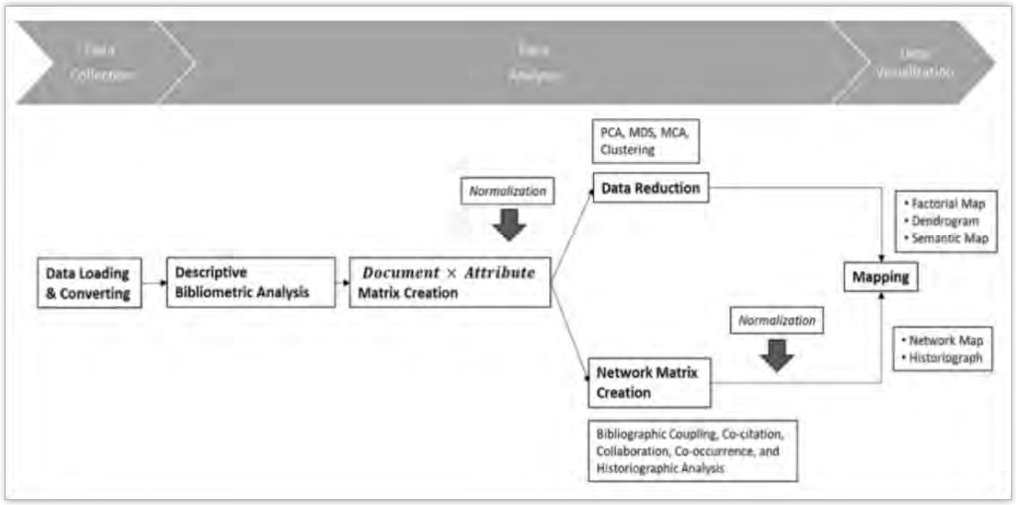

Figure 2. Recommended Bibliometric Analysis Process (Aria & Cuccurullo, 2017)

Results

Most Relevant Journals

As a result of the search and filtering in the Web of Science database, it is seen that 1590 articles related to "learning analytics" were published in 249 different journals (Table 1). The "Bradford's Law" graph is shown in Figure 3. The graphic grouped the journals according to the number of publications and visually expressed the names of the journals in the 1st group.

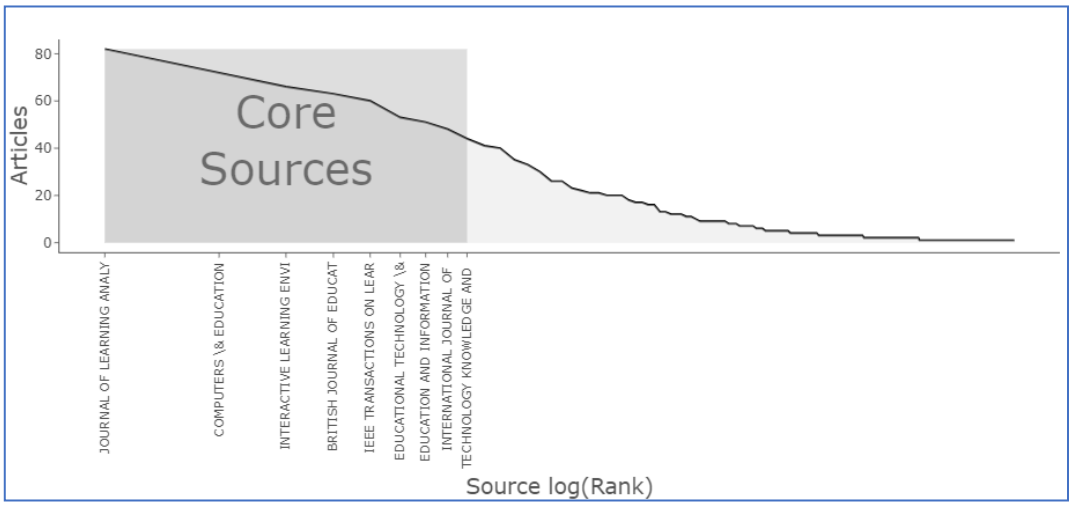

Figure 3. Most Relevant Journal According to Bradford's Law Analysis

The information of the 20 most popular journals in which the articles subject to the research were published is given in Table 2, again according to Bradford's Law order. According to the table, the most published journal is the Journal of Learning Analytics (ArtN=82), while the most cited journal with the highest h_index, g_index, and TC values is Computers & Education (CiteN=2588, h_index=24, g_index=43, TC=1976). The second highest published journal is Computers & Education (ArtN=72). The second most cited journal is the British Journal of Educational Technology (CiteN=1291). The journal with the second highest h_index value is the Internet and Higher Education (h_index=20). The second highest g_index and the journal with TC values became Educational Technology & Society (g_index=39, TC=1575).

Table 2. Most Relevant Journals According to Number of Articles

Rank	**SO**	**ArtN**	**CiteN**	**h_index**	**g_index**	**TC**
1	Journal of Learning Analytics	**82**	779	12	19	594
2	Computers & Education	**72**	**2588**	**24**	**43**	**1976**
3	Interactive Learning Environments	66	378	13	20	540
4	British Journal of Educational Technology	63	**1291**	19	34	1308
5	IEEE Transactions on Learning Technologies	60	501	16	27	889
6	Educational Technology & Society	53	1037	16	**39**	**1575**
7	Education and Information Technologies	51	227	11	15	295
8	Int. Journal of Emerging Technologies in Learning	48	140	9	14	284
9	Technology Knowledge and Learning	44	253	14	22	542
10	Journal of Computer Assisted Learning	41	435	17	29	860
11	ETR&D-Edu. Tech. Research and Development	40	612	12	18	362
12	Int. Rev. of Res. in Open and Distributed Learning	35	511	11	22	559
13	Internet and Higher Education	33	914	**20**	32	1524
14	Australasian Journal of Educational Technology	30	11	10	14	242
15	Assessment & Evaluation in Higher Education	26	333	9	11	175
16	Int. J. of Ed. Technology in Higher Education	26	135	8	14	238
17	Decision Sciences-Journal of Innovative Education	23	102	4	9	91
18	Journal of Computing in Higher Education	22	146	8	13	186
19	Journal of Educational Computing Research	21	180	6	12	171
20	Online Learning	21	123	8	11	143

ArtN= Article Number, CiteN=Citation Number, TC=Total Cite

Most Relevant Authors

As a result of the search made in the Web of Science database, it has been determined that 3500 authors are publishing on the subject of "learning analytics." While 191 authors published their studies alone, 3309 published collaborative studies (see Table 1). Various numerical information of the 20 authors who published the most on the subject is given in Table 3.

Table 3. Most Relevant Authors According to the Number of Articles

Authors	ArtN	Pub. Year	CiteN	CpY	h_index	g_index	TC
Gasevic D.	**45**	2012-2021	**551**	**206,20**	**18**	**42**	**2062**
Pardo A.	**28**	2012-2022	94	**108,73**	13	**25**	857
Rienties B.	25	2016-2021	54	72,90	11	18	370
Ogata H.	22	2018-2022	42	38,80	7	15	235
Dawson S.	21	2012-2022	**354**	49,00	**13**	20	**1196**
Ifenthaler D.	18	2014-2022	43	77,91	7	14	212
Xing W.	16	2015-2022	10	38,57	7	13	198
Saqr M.	15	2018-2022	23	61,67	5	10	107
Tsai Y. S.	13	2018-2021	35	23,56	7	11	140
Chen G.	11	2018-2022	18	72,00	6	9	99
Drachsler H.	11	2012-2021	189	47,00	9	11	729
Shum S. B.	11	2012-2021	147	42,44	8	9	388
Jovanovic J.	11	2012-2021	111	35,00	8	10	490
Baker R. S.	11	2014-2022	33	18,00	6	10	162
Jo I. H.	10	2015-2021	69	26,80	8	9	270
Herodotou C.	10	2017-2021	26	24,75	7	10	134
Kovanovic V.	10	2014-2022	39	21,40	4	7	382
Williamson B.	10	2015-2021	32	19,80	10	10	504
Hernandez-Leo D.	10	2015-2021	0	16,00	5	9	112
Kinshuk K.	10	2014-2021	0	6,00	4	6	48

ArtN= Article Number, CiteN=Citation Number, TC=Total Cite, CpY= Citations per Year

When Table 3 is examined, Gasevic D., who made the most publications about "learning analytics" on the Web of Science, is also the author with the most citations and the most CpY, h_index, g_index, and TC values (ArtN=45, CiteN=551, CpY=206.20, h_index=18, g_index=42, TC=2062). Pardo A. was the second most published author, had the most articles on a yearly basis, and had the highest g_index value (ArtN=28, CpY=108.73, g_index=25), while Dawson S. was the author with the most cited h_index and TC values (CiteN=354, h_index=13, TC=1196).

The graph that gives the number of publications by the authors by years is shown in Figure 4. The size of the circles represents the number of publications, while the darkness of the color represents the number of citations

received by the publication. Dark blue circles in the graph show heavily cited publications. Gasevic D., Pardo A., Dawson S., Drachsler H., Jovanovic J., and Shum S. B., who are among the authors who have published the most on the subject, have been producing articles almost every year since 2012. It is observed that there is a concentration in the number of articles written after 2016.

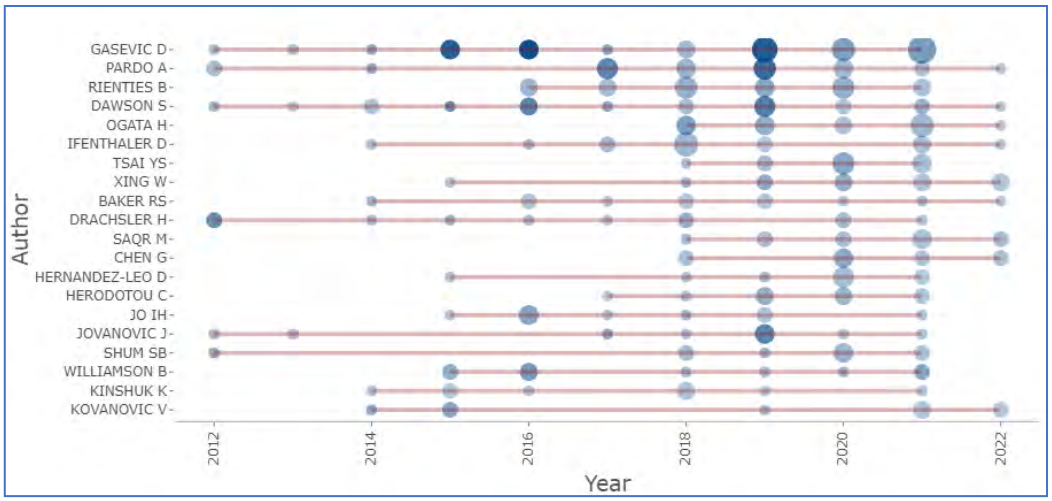

Figure 4. Top Authors' Production over Time

Most Relevant Universities and Countries

When the studies on "learning analytics" in the Web of Science database are examined based on the universities where the authors work, it is seen that 1304 articles were published from different universities. Among these, the 20 universities that published the most are given in Table 4. The first 20 universities published on the subject produced 953 articles. The most published university is Open University (ArtN=105), followed by Monash University (ArtN=82) and the University of Edinburgh (ArtN=73).

Table 4. Most Relevant Universities According to the Number of Articles

Affiliations	**ArtN**
Open University	105
Monash University	82
University of Edinburgh	73
University of South Australia	68
Beijing Normal University	54
Kyoto University	51
Cent China Normal University	50
Curtin University	48
University of Technology Sydney	44
University of Sydney	42
Katholieke University Leuven	40
University of Florida	39

Affiliations	ArtN
Tallinn University	36
Tel Aviv University	33
Norwegian University of Science and Technology	32
Simon Fraser University	32
University of Mannheim	32
University of Melbourne	32
Athabasca University	30
Kyushu University	30
Total	953

ArtN= Article Number

When the articles written on the subject are examined based on the countries where the authors are located, it is seen that there are participants from 79 different countries. Among these, the first 20 countries with the most articles on the subject are given in Table 5. The USA, which has the highest number of articles, is also the country with the highest number of co-authored, single-authored, multinational, and total citations (ArtN=1202, CAAN=357, SCP=301, MCP=56, TCN=4013). The country with the highest average number of publication-based citations is the United Kingdom (AAC=24.35).

Table 5. The Most Relevant Countries According to the Number of Articles

Country	ArtN	CAAN	SCP	MCP	TCN	AAC
USA	**1202**	**357**	**301**	**56**	**4013**	11,24
Australia	**621**	**163**	116	**47**	1858	11,40
China	535	158	**118**	40	1175	7,44
United Kingdom	490	159	116	43	**3872**	**24,35**
Spain	288	82	60	22	984	12,00
Canada	187	47	29	18	882	18,77
Netherlands	156	49	28	21	1152	**23,51**
Germany	149	45	22	23	765	17,00
Japan	139	33	17	16	200	6,06
Türkiye	101	33	26	7	192	5,82
Finland	97	32	14	18	219	6,84
Norway	90	30	14	16	239	7,97
Italy	79	25	22	3	142	5,68
Belgium	68	13	7	6	191	14,69
Israel	67	20	16	4	275	13,75
Greece	67	20	17	3	268	13,40
Korea	63	21	13	8	467	22,24

Country	ArtN	CAAN	SCP	MCP	TCN	AAC
India	57	18	16	2	110	6,11
Brazil	54	16	9	7	79	4,94
South Africa	50	16	11	5	113	7,06

ArtN= Article Number, CAAN= Corresponding Author Article, SCP=Single Country Publication, MCP=Multiple Country Publication, TCN= Total Citations Number, AAC= Average Article Citation

Citation Status

Among the articles written on learning analytics, the 20 most cited papers are given in Table 6. The most cited article globally is Ferguson's article titled "Learning analytics: drivers, developments and challenges" (Ferguson, 2012), followed by Greller's article titled "Translating learning into numbers: A generic framework for learning analytics" (Greller & Drachsler, 2012). The most cited article at the local level is Gasevic's article titled "Let's not forget: Learning analytics is about learning" (Gašević et al., 2014), followed by Greller's article (Greller & Drachsler, 2012).

Table 6. The Most Cited Papers

Author	Year	Journal	GC	LC
Ferguson R.	2012	Int. J. Technol. Enhanc. Learn.	**510**	0
Greller W.	2012	Educ. Technol. Soc.	**338**	**107**
Gasevic D.	2015	Techtrends	314	**130**
Kizilcec R. F.	2017	Comput. Educ.	298	30
Chatti M. A.	2012	Int. J. Technol. Enhanc. Learn.	260	0
Gasevic D.	2016	Internet High. Educ.	256	103
Shum S. B.	2012	Educ. Technol. Soc.	246	84
Gasevic D.	2014	Int. Rev. Res. Open Distrib. Lrn.	169	0
Dyckhoff A. L.	2012	Educ. Technol. Soc.	163	53
You J. W.	2016	Internet High. Educ.	160	39
Williamson B.	2016	J. Educ. Policy	158	8
Pardo A.	2014	Br. J. Educ. Technol.	157	0
De Barba P. G.	2016	J. Comput. Assist. Learn.	156	0
Schwendimann B. A.	2017	IEEE Trans. Learn. Tec.	148	0
Cerezo R.	2016	Comput. Educ.	139	24
Macfadyen L. P.	2012	Educ. Technol. Soc.	137	52
Dietz-Uhler B.	2013	J. Interact. Online Learn.	129	0
Clow D.	2013	Teach. High. Educ.	124	56
Jovanovic J.	2017	Internet High. Educ.	124	33
Zacharis N. Z.	2015	Internet High. Educ.	124	28

GC: Global Cite, LC: Local Cite

Articles about learning analytics published in Web of Science were examined, and the 20 most cited references in the bibliography of these articles are given in Table 7. When Table 7 is examined, it is seen that the sources used in the citations are mostly in the article type. Among these, the most cited source was Ferguson's (Ferguson, 2012) article titled "Learning analytics: Drivers, developments and challenges" (*f*=150).

Table 7. Annual Average Number of Citations per Article

Corr. Author	Year	Type	Source	f
Ferguson R.	2012	Journal	International Journal of Technology Enhanced Learning	150
Gasevic D.	2015	Journal	TechTrends	130
Long Phil	2011	Journal	EDUCAUSE Review	125
Macfadyen L. P.	2010	Journal	Computers & Education	120
Arnold K. E.	2012	Conference	LAK '12: Proc. of the 2nd Int. Conf. on L. An. and Knw.	109
Greller W.	2012	Journal	Journal of Educational Technology & Society	107
Siemens G.	2013	Journal	American Behavioral Scientist	106
Gasevic D.	2016	Journal	The Internet and Higher Education	103
Lockyer L.	2013	Journal	American Behavioral Scientist	98
Slade S.	2013	Journal	American Behavioral Scientist	94
Shum S. B.	2012	Journal	Journal of Educational Technology & Society	84
Papamitsiou Z.	2014	Journal	Journal of Educational Technology & Society	82
Verbert K.	2013	Journal	American Behavioral Scientist	82
Tempelaar D. T.	2015	Journal	Computers in Human Behavior	75
Siemens G.	2012	Conference	LAK '12: Proc. of the 2nd Int. Conf. on L. An. and Knw.	71
Baker R.	2009	Journal	Journal of Educational Data Mining	67
Viberg O.	2018	Journal	Computers in Human Behavior	66
Hattie J.	2007	Journal	Review of Educational Research	62
Romero C.	2010	Journal	IEEE Transactions on Systems, Man, and Cybernetics	62
Chatti M. A.	2012	Journal	International Journal of Technology Enhanced Learning	61

Key Words and Trend Topics

Analyzing the keywords used by the authors in the publications is a crucial tool in determining the trending topics and presenting ideas to the researchers who will work on the topic (Y. Song et al., 2019). Keyword analysis helps to determine the topic and focus of that post quickly. Articles scanned in Web of Science have KeyWords Plus data besides their keywords. Although these data are not included in the article's title, they are automatically derived from frequently repeated words in the titles of the references in the bibliography list. Based on a

proprietary algorithm specific to Clarivate databases, KeyWords Plus increases the power of citation-reference search by searching across disciplines for all articles with standard references (Clarivate, 2022). The 50 most repeated words from KeyWords Plus generated from articles related to the subject are shown in Figure 5.

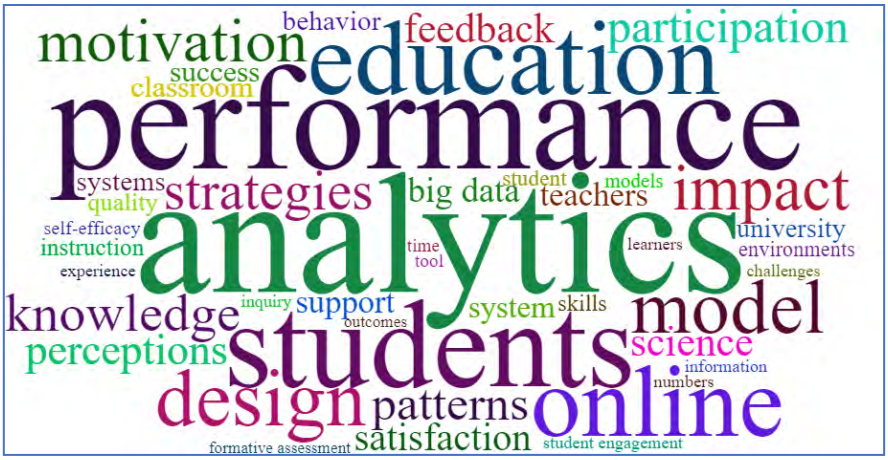

Figure 5. Word Cloud of KeyWords Plus

The 10 most repeated KeyWords Plus words given in Figure 5 are "analytics" (*f*=177), "performance" (*f*=153), "students" (*f*=129), "learning analytics" (*f*=115), "education" (*f*=109), "online" (*f*=104), "design" (*f*=83), "framework" (*f*=83), "model" (*f*=80), and "higher-education" (*f*=71). The word cloud generated with the 50 most repeated keywords given by the authors in the articles is given in Figure 6.

Figure 6. Word Cloud of Authors' Keywords

When Figure 6 is examined, the 10 most repeated words are "learning" (*f*=170), "higher education" (*f*=128), "analytics" (*f*=117), "educational data mining" (*f*=81), "online learning" (*f*=80), "education" (*f*=64), "big data" (*f*=49), "self-regulated learning" (*f*=48), "blended learning" (*f*=45), and "machine learning" (*f*=45). The graph that gives the distribution of the frequency of use of 3-word (ngram=3) expressions obtained from the article titles by years is given in Figure 7. While the lines in the graph show the time period when the topic is effective, the position and size of the circles represent the time and amount of the subject when the subject is most intense.

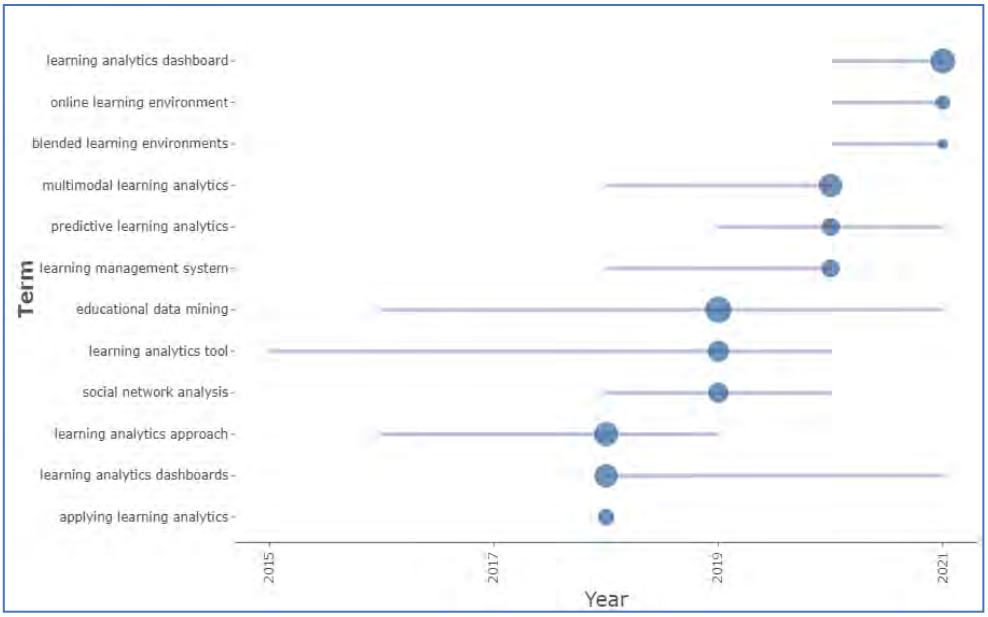

Figure 7. Trending Topics by Article Titles

In the analysis made according to the article titles in groups of 3 words, it is seen that the topics of "learning analytics approach" (*f*=14) and "learning analytics dashboards" (*f*=13) are in demand until 2018. It is observed that the topic of "educational data mining" (*f*=17) in 2019 and the topic of "multimodal learning analytics" (*f*=13) in 2020 were trending. In 2021, it was seen that the subject of "learning analytics dashboards" (*f*=15) has become widespread again. The graph that gives the distribution of the frequency of use of the authors' keywords by years is given in Figure 8. While the lines in the graph show the time period when the topic is effective, the position and size of the circles represent the time and amount of the subject when the subject is most intense.

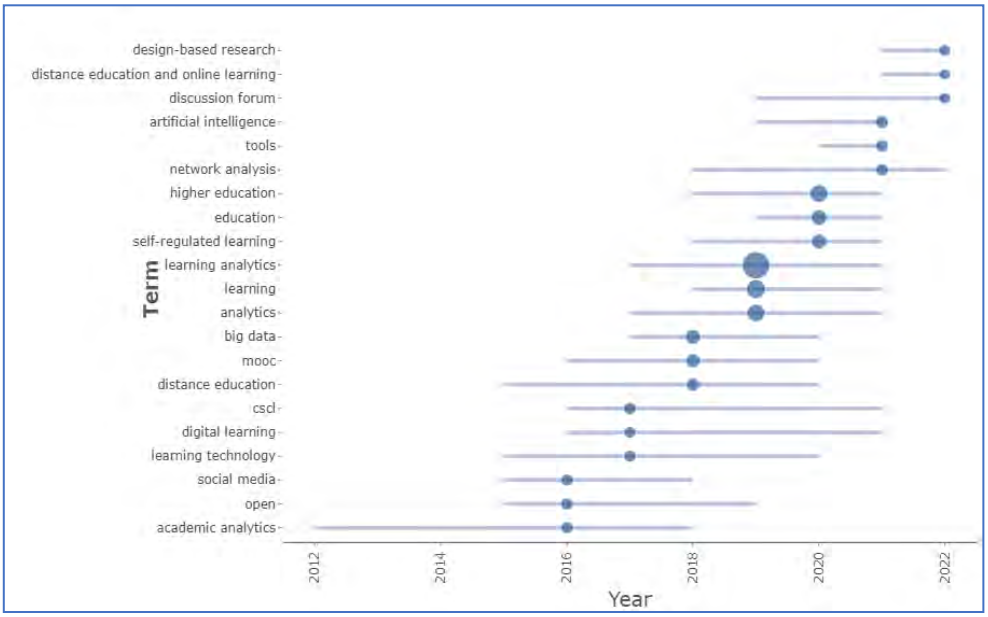

Figure 8. Trending Topics by Authors' Keywords

When Figure 8 is examined, it is seen that the expression "learning analytics" (*f*=677), which started to become

widespread between 2017-2021, was followed by the expressions "learning" (*f*=170) and "higher education" (*f*=128) between the years 2018-2021.

Thematic Map of the Keywords

Another analysis made in this study is the thematic map of the keywords of the studies on learning analytics. The purpose of generating a thematic map is to get an idea of the area's current state and what its future sustainability will bring. The thematic analysis takes the authors' keyword sets and interlinks them to derive themes. These themes are revealed by centrality, which expresses the degree of correlation between different subjects, and density, which measures the harmony between nodes (Esfahani et al., 2019). The thematic map of learning analytics studies divided into four quarters (Q1: top-right, Q2: top-left, Q3: bottom-left, Q4: bottom-right) is presented in Figure 9. The size of the circles in the graph represents the number of articles on that topic.

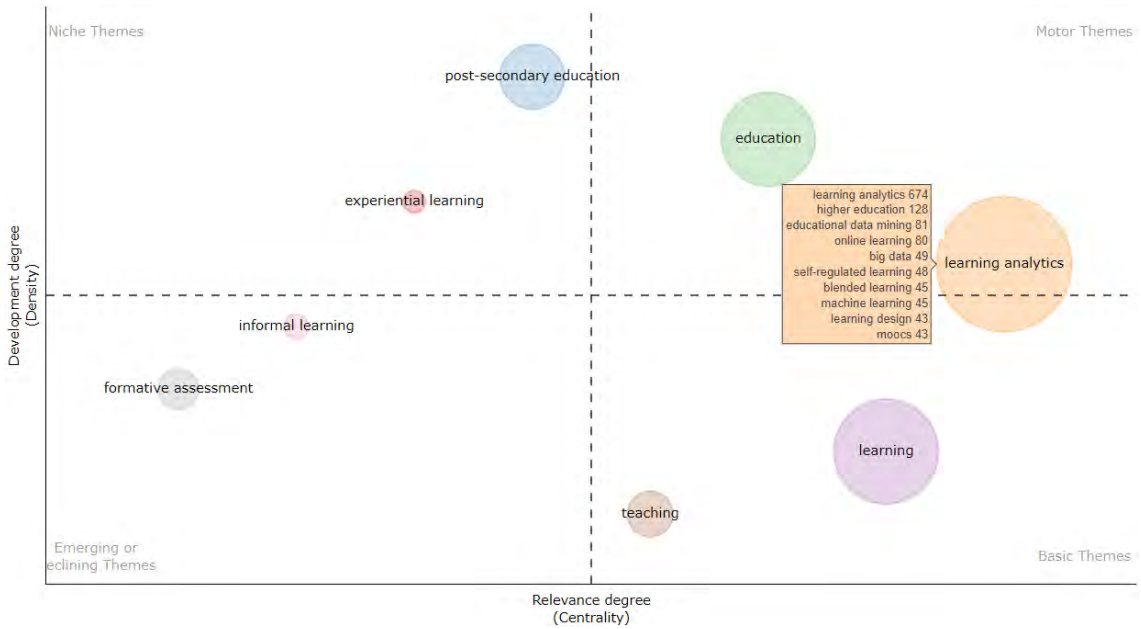

Figure 9. Thematic Map of Artificial Intelligence Topics in Education

When Figure 9 is examined, the concepts of education and learning analytics can be seen in the primary theme quarter (Q1), where the concepts that are very important for the development of the field are given. Post-secondary education and experiential learning themes are very specialized themes (Q2) and they contribute marginally to developing the theme of learning analytics. Q3 themes represent emerging or disappearing themes. It is thought that informal learning and formative assessment themes are about to disappear due to their distance from Q4. The education and distance education themes in Q4 appear as strong themes that support the learning analytics theme.

Co-occurrence Network

The concept network between the KeyWords Plus concepts of the articles published about learning analytics is shown in Figure 10. A co-occurrence network, also called a semantic network, is a text analysis method that

involves graphical visualization of potential relationships between concepts or other entities represented within a written document. When Figure 10 is examined, it is seen that the studies are grouped around the concepts of learning analytics, analytics, and performance. While the colors of the circles show concepts that are close to each other in terms of meaning, their size represents the size of the relationship with other concepts.

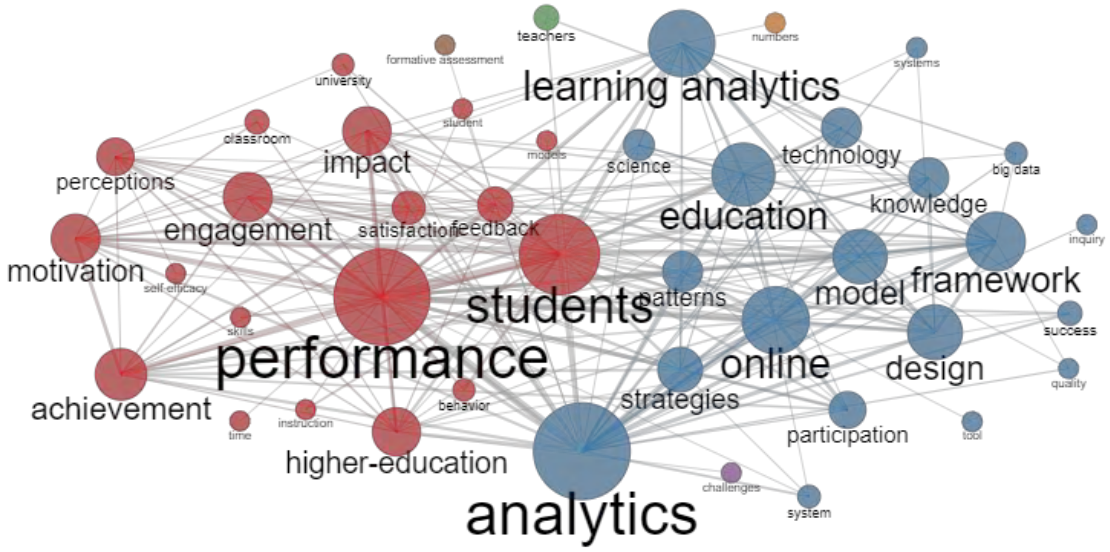

Figure 10. Co-occurrence Network of Keywords Plus

Discussion

This study it is aimed to examine the studies on learning analytics from a bibliometric perspective. For this purpose, the most published journals, authors, universities, and countries were tried to be determined. The citation status of the publications has been comprehensively discussed. Keywords and trending topics related to learning analytics were examined. Cluster analysis was performed by considering the keywords of the publications on the authors' studies.

Journal of Learning Analytics has been the journal with the most publications on learning analytics. After this journal, which focuses on learning analytics, Computers & Education was the journal with the highest number of publications and the most cited journal. Bradford's Law (Bradford, 1934) groups core journals as follows: Journal of Learning Analytics, Computers & Education, Interactive Learning Environments, British Journal of Educational Technology, IEEE Transactions on Learning Technologies, Educational Technology & Society, Education and Information Technologies, Int. Journal of Emerging Technologies in Learning, and Technology Knowledge and Learning. When the standard features of these journals are examined, it is seen that they focus on instructional technologies and learning. Talan and Demirbilek (2022) filtered only those included in the SSCI, SCI-E, and A&HCI indexes among the studies published between 2011-2021 and listed the top three publications as the British Journal of Educational Technology, Interactive Learning Environments, and Computers & Education. Since the Journal of Learning Analytics is included in the ESCI index, it is thought not to be included in this list.

When the publications related to learning analytics are examined in terms of the author, it is seen that the author who published the most is Gasevic D. The author has been the most cited author on the subject with his publications. Pardo A. follows this author in terms of the number of publications and Dawson S. in terms of the number of citations. When the publications of the authors are examined in terms of the time range, it is seen that Gasevic D., Pardo A., Dawson S., and Drachsler H. have been publishing almost every year since 2012. Chen and Liu (2011) examined the studies conducted between 2011-2021 and similarly concluded that the author who published the most was Gasevic D.

When the universities where the publishing authors work are examined, it is seen that most publications are from the Open University. The second most publishing university is Monash University. When analyzed in terms of countries, it is seen that the USA has the highest number of publications, co-authored publications, single national publications, and cited articles. Australia follows this with the highest number of publications and the number of authors, China with the highest number of single-author publications, and the UK with the total and the average number of citations. Similarly, Waheed et al. (2018) also concluded in their study that the most publications came from the USA, and the country with the highest number of citations was the USA. On the other hand, Chen and Liu (2011) concluded that the universities that published the most publications between the years 2011-2021 came from Open and Monash Universities, similar to this study.

Ferguson's 2012 article on learning analytics titled "Learning analytics: drivers, developments and challenges" has been the most cited work since the year it was published. In the bibliography section of the articles examined within the scope of the study, this article was also the most referenced study. The most cited article locally, Gasevic's (2015) article titled "Let's not forget: Learning analytics is about learning," was also the second most cited article. Zhang et al. (2018) examined the articles up to 2017 in their study and concluded that the most cited author until that year was Siemens G. With the publications made between 2017-2022, this list has changed, and different results have been obtained in this study. Talan and Demirbilek (2022) examined the studies published between 2011-2021 and concluded that the most cited study was the second place in this study, titled "Translating learning into numbers: A generic framework for learning analytics" by Greller and Drachsler.

Both KeyWords Plus and the keywords of the authors of the articles related to the subject were analyzed. While "analytics," "performance," and "students" were prominent in the KeyWords Plus analysis, the terms "learning," "higher education," and "analytics" came to the fore in the analysis of author keywords. It is seen that the subject of "learning analytics tools" is in demand between the years 2015-2020, considering the article titles. It is seen that the subjects of "educational data mining" after 2016 and "analytics dashboards" after 2018 started to be studied and continue to this day. The topics of "online learning environment," "blended learning environment," and "predictive learning analytics" are still trending today. Pei et al. (2021) examined the studies on multimodal learning analytics between 2010 and 2020 and concluded that the keywords "learning performance prediction," "multimodal prediction," and "learning design" are frequently used.

When the KeyWords Plus concepts of the articles published on learning analytics are analyzed, a concept map is formed in the formation network, where the concepts of learning analytics, analytics, and performance are at the

center. Other concepts related to education are gathered around these three concepts. Talan and Demirbilek (2022), in his study, produced a map in which the concept of learning analytics is at the center.

Conclusion and Recommendations

This study, which aims to examine the studies on learning analytics from a bibliometric perspective, has been tried to determine the journals, authors, universities, and countries with the most publications on the subject. As a result of the examination, the most published journal is the Journal of Learning Analytics, and the most published author is Gasevic D. When the authors are examined in terms of the institution they work and the country they live in, it is seen that the most publications come from Open University and the USA. Ferguson's 2012 article on learning analytics titled "Learning analytics: drivers, developments and challenges" became both the most cited and the most cited article in the bibliography. In the keyword analysis, it was concluded that the most repeated terms are "analytics," "performance," and "higher education." When the article titles are examined, it is seen that the topics of "learning environment," "blended learning environment," and "predictive learning analytics" are still trending today. Another result of the study is that the author's keywords are collected in 4 clusters, and the learning analytics tag is included in each cluster.

It is recommended that researchers who will publish on learning analytics should examine the journals mentioned above, considering the results summarized above. In addition, considering that the most cited publications contain detailed information on the subject, these publications can be used in the introduction and discussion sections of the articles. It can be suggested to focus on these issues in learning analytics studies by examining trends related to the subject.

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