Chapter 2

Comprehensive Analysis of Eye-Tracking Research in Education

Ece AVINÇ[*], Ömer KIRBAŞ[†], Fatih DOĞAN[‡]

Abstract

The evolution of eye-tracking research, spanning from early 20th-century methodologies to contemporary video-based systems, has profoundly impacted neuroscience and education. This study examines 339 articles from the Web of Science database, focusing on the educational utility of eye-tracking technology. Through analysis with R Studio, key trends emerge: the "Computer & Education" journal dominates publications, while scholars like "Halszka, J." and institutions like the "Natl Taiwan Normal Univ" stand out for their influential contributions. Notably, countries such as China and the USA lead in impactful research output. The findings shed light on publication patterns, keyword distributions, and the ascendance of influential journals, offering valuable insights for stakeholders in vision screening, policy development, and systematic review studies. Understanding these trends fosters a deeper comprehension of the evolving landscape of eye-tracking research within educational contexts, enabling informed decision-making and strategic planning for future research endeavors.

Keywords: Eye-tracking, Bibliometric analysis**,** Education**,** Cognitive processes**,** Optimal learning

[*] Research Assistant, Faculty of Education, Department of Mathematics and Science Education, Çanakkale Onsekiz Mart University, Çanakkale/Türkiye
https://orcid.org/0000-0003-1745-3447

[†] Science Teacher, Assistant Manager, 15. Kolordu Secondary School,MEB (Ministry of Education) Kocaeli/Turkey
https://orcid.org/0000-0003-2670-7365

[‡] Professor Doctor, Faculty of Education, Department of Mathematics and Science Education, Çanakkale Onsekiz Mart University, Çanakkale/Türkiye
https://orcid.org/0000-0001-5844-8893

Introduction

Eye-tracking research, which commenced its modern approach in the third quarter of the 20th century with the development of video-based eye trackers in subsequent years, was initially employed by affixing markers to specialized contact lenses in the early 20th century (Einhäuser et al., 1996; Duchowski et al., 2000; Winston, 2012; Forsyth, 2015). It has been posited that eye-tracking provides an optimal neuroscience model for exploring the intricate relationship between brain mechanisms and behavior (Luna, Velanova & Geier, 2008). Eye-tracking, boasting a long-standing history in medical and psychological research as a tool for recording and scrutinizing human visual behavior, is utilized to examine gaze patterns during visual perception and the underlying information processing activities (Erckstein et al., 2017; Rayner, 2019; Yang & Wang, 2023). It elucidates the fundamental mechanisms of these behaviors by translating ocular behaviors into measurable eye movements to discern the focal points of attention (Duchowski, 2017; Erckstein et al., 2017; Ashraf et al., 2018). Common measurement data from eye trackers include changes in initial focusing time, alterations in pupil size, the velocity of eye repositioning to new regions in images, the duration of eye movements, and the cumulative focusing time (Özdoğan, 2008; Dolgunsöz, 2015; Krueger, Koch & Ertl, 2016). Eye-tracking measurements furnish researchers with two fundamental components of eye movement behavior: “eye fixations,” delineating where a subject gazes and for how long, and “eye movements,” specifying the subsequent shifts in eye positioning (Robinson, 2012). These measurements offer crucial insights, enabling the identification of areas of attention, overlooked information, and disturbances, facilitating real-time assessment of task responses (Erckstein et al., 2017; Omur & Görgülü Aydoğdu, 2017).

Due to the significant correlation between eye movements and cognition in contemporary research, eye-tracking has garnered considerable interest across various experimental domains, emerging as a versatile technology for investigating human cognitive processes (Hoffman & Subramaniam, 1995; Patney et al., 2016; Virtual Reality Society, 2017; Clay, König & Koenig, 2019). Eye-tracking, constituting an online recording of eye movements, serves as a prevalent and valuable method for observing visual attention and distractions across various domains, encompassing phenomena such as eye blink, pupil dynamics, vision perception, visual search, and language processing (Robinson, 2012; Fischer & Hartmann, 2014; Carter & Luke, 2020; Yang & Wang, 2023). Extensively explored in realms such as marketing and advertising, eye-tracking employs video-based systems, leveraging computer vision techniques for data collection, facilitating the investigation of human

cognition through the provision of substantial datasets and enabling rapid, precise tracking of eye movements (Wedel & Pieters, 2017; Hoffman & Subramaniam, 1995; Hansen & Ji, 2010; Virtual Reality Society, 2017).

Problem Status

Eye-tracking measurements, encompassing cognitive skills, learning strategies, and the tracking and recording of eye movements across various fields, including complex cognitive processes in education, represent one of the effective methodologies utilized in educational research to comprehend the cognitive processes unfolding in the mind. This method furnishes researchers with insights into how individuals learn and how they can enhance their learning effectiveness and efficiency (Alemdag & Cagiltay, 2018; Kovari, Katona & Costescu, 2020). Eye-tracking measurement data and eye tracking technology are particularly well-suited for educational research as they offer information pertaining to cognitive skills, learning strategies, and complex cognitive processes in education. Individuals assimilate vast amounts of information into their cognitive processes through their eyes (Halszka, Holmqvist, & Gruber, 2017; Kovari, Katona & Costescu, 2020). Eye-tracking yields critical data concerning the aspects to which researchers and learners direct their attention during the learning process, delineating how students and teachers perceive the world, their actions, the duration and intensity of their attention, thus shedding light on the dynamics of learning (Beach & McConnell, 2019; Shvarts & Abrahamson, 2019). Consequently, there has been a surge in intensive research recently to scrutinize teaching and learning processes through the lens of eye-tracking (Lai et al., 2013; Yang et al., 2013; Alemdag & Cagiltay, 2018; Dostálová, Juhaňák & Plch, 2022; Ma et al., 2022; Tsai et al., 2022; Zhai et al., 2022).

Although bibliometric studies on the subject have been carried out abroad, no such publication has been found in our country and language. Studies in our country have generally been researched by focusing on a single subject, concept or discipline and in association with eye-tracking. The important points of the studies will be revealed. A general overview of the subject will be presented. It will be a resource for both industry professionals and researchers. In addition to contributing to literature, examining the evolution of influential publications, authors and sources, and the themes of the subject within the scope of the study will guide new publications. The fact that it will contribute to an issue that affects the whole society reveals the importance of study. With the aid of various analyses and statistical methods applied to academic publications, it is feasible to conduct bibliometric studies that examine sources of information

regarding eye-tracking. Utilizing statistical indices enables the evaluation of the effectiveness of scientific research across institutions, authors, countries, journals, and citations, thereby providing access to diverse sources of information pertaining to research trends in this field (Papadimitriou & Kidman, 2012).

Method

In the research, the aim is to conduct a bibliometric analysis of articles pertaining to the use of "eye-tracking" in "education" subjects. Bibliometric research enables the identification of trends in the field by measuring and evaluating various aspects of research within a specific domain (Ahmi, 2022). Bibliometrics, a quantitative and statistical technique, facilitates the generation and dissemination of scientific knowledge within a particular field. It serves as a valuable method for identifying influential and highly cited articles, emerging topics, prominent researchers or research groups, as well as potential collaborators or competitors within the subject area (Huang et al., 2019; Agarwal et al., 2016). Zupic and Carter (2015) highlighted that bibliometric analysis reveals co-authors, publications, and identifies leading authors, organizations, and countries involved in the subject under scrutiny. Furthermore, bibliometric analysis enables the dissemination of high-impact findings and offers visualization of authors, institutions, and trending keywords (Huang et al., 2019). Despite the recent application of bibliometric approaches in education, it has only recently emerged as a coherent and contemporary alternative for examining research (Hernandez-Torrano et al., 2020).

Data Collection Process

In this study, articles from the Web of Science (WoS) database were used for bibliometric analysis. WoS is widely recognized for its utility in academic and bibliometric research, as it consistently encompasses journal coverage of scientifically published articles (Li et al., 2018). The terms "eye-tracking (all fields)" or "eye tracking (all fields)" and "education (all fields)" were scrutinized from the search interface of the WoS database. Topics relevant to "Education" were included in the filter via the "Citation Topic Meso" section. In the 'Document Types' section, only 'Article' OR 'Review Article' documents were considered. English was selected as the preferred language to mitigate potential data loss during keyword analysis, primarily due to the limited number of publications in other languages. Subsequent to these constraints, 356 data sets obtained in the research as of January 16, 2023, were exported for analysis. The research utilized a flow chart, as illustrated in Figure

1. Today, different tools such as CiteSpace, WOSviewer, HirsCite and CitNetExplorer are available for performing bibliometric studies (Moral-Muñoz et al., 2020). In the study, the R software supported Biblioshiny program was adopted to obtain a general view of eye tracking studies written in the field of education. The Biblioshiny software was developed by Massimo Aria and Corrado Cuccurullo from the University of Naples and Luigi Vanvitelli from the University of Campania (Hao, 2018). Biblioshiny software supports to analyze WoS, Scopus and Dimensions data (Aria and Cuccurullo, 2017).

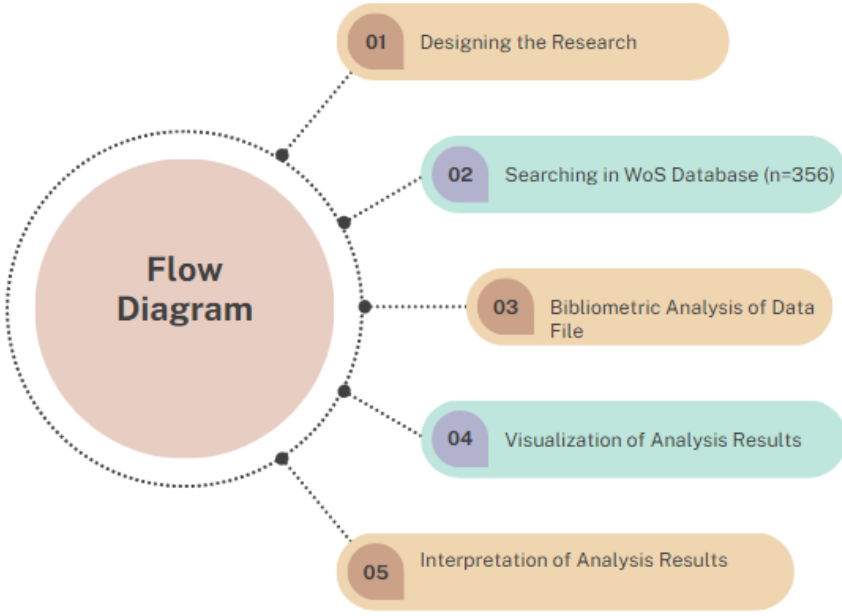


Figure 1. Flow Diagram of Research

Results

In this section, the findings of the research are given. The research findings were analyzed in sub-headings according to the problem statements. General information about the research is given in Table 1.

Table 1. Main Overview

Description	Results
Articles	339
Timespan	2005:2022
Sources (Journals, Books, etc)	120
Author's Keywords	925
Authors	794
Authors of single-authored articles	13
Authors of multiple-authored articles	781
Average citations per articles	19,37
References	11264
Article per authors	0,36

When Table 1 is examined, it is seen that 339 articles were written between the years 2005-2022. The articles were published by 120 different sources and written by 764 authors. A total of 925 keywords were included in these studies. While 13 different articles were determined to be written by a single author, 781 people wrote 326 different articles by multiple authors. It was found that 19.37 citations were received per article. The authors used 11264 references to their work. It has been determined that there are 0.36 articles per author. In Figure 2, the growth graph of the articles written about eye-tracking in the field of education by years is given.

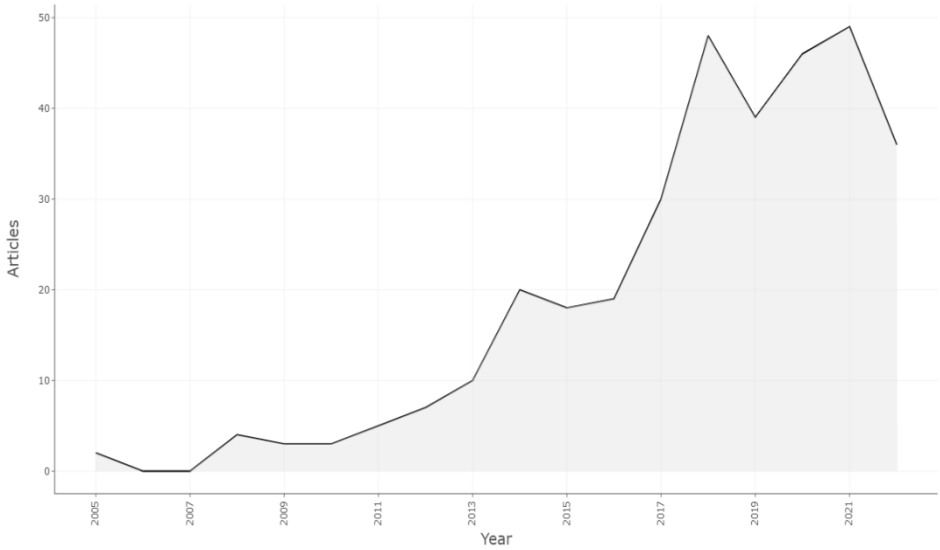


Figure 2. Annual Scientific Production

Findings for Journals

In the Web of Science database, 339 articles on the concept of eye-tracking in education were published in 120 different sources. These data are given in Table 2.

Table 2. Top 20 Journal with the Most Article

Journal	ArtN*	h_index	g_index	TC*	PY start*
Computers & Education	25	16	25	1081	2009
Computers In Human Behavior	23	16	23	714	2010
Physical Review Physics Education Research	15	7	11	137	2017
Learning And Instruction	14	11	14	436	2010
Journal Of Computer Assisted Learning	14	7	11	132	2015
Frontiers In Psychology	14	5	11	142	2014
Instructional Science	11	8	11	386	2012
Journal Of Chemical Education	11	7	11	183	2012
Educational Psychology Review	8	7	8	151	2018
International Journal of Science and Mathematics Education	8	7	8	207	2014

British Journal of Educational Technology	8	5	8	127	2014
Applied Cognitive Psychology	7	5	7	195	2005
Educational Technology & Society	6	5	6	108	2015
International Journal of Science Education	6	4	6	100	2008
Journal Of Science Education and Technology	6	4	6	64	2011
Interactive Learning Environments	5	5	5	69	2011
Teaching And Teacher Education	5	5	5	176	2014
Journal Of Educational Psychology	4	4	4	99	2018
Acta Chimica Slovenica	3	3	3	17	2016
Etr\&D-Educational Technology Research and Development	3	3	3	19	2012

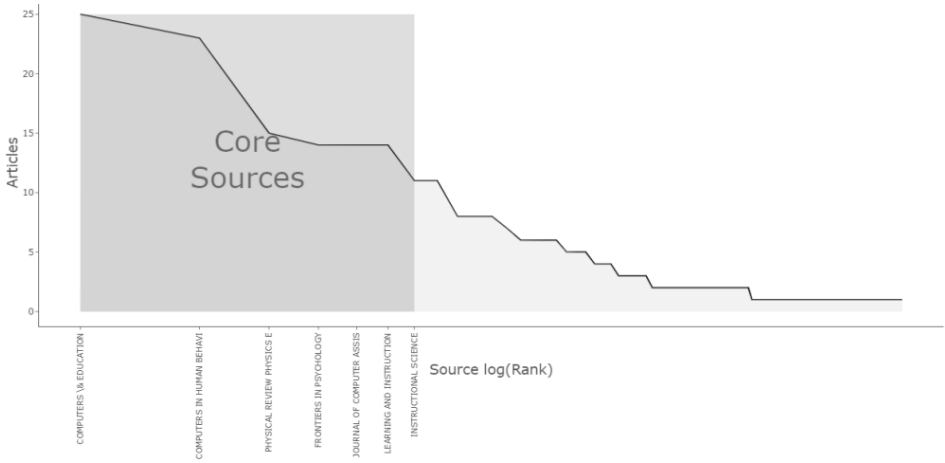


Figure 3. Bradford's Law

It was seen that "Coputers /& Education" Journal made the most publications among 20 journals (ArtN=25). The total number of citations of the same journal was also found to be the highest (TC=1081). The second most published journal on eye-tracking research in education was "Computers in Human Behavior" (ArtN=23). Among the 20 journals with the highest number of publications, "Applied Cognitive Psychology" was determined to be the journal that started the oldest publication (PY start=2005).

The h-index and g-index values of the journals are also given in the table. The H-index is the value that emerges from the popularity and interest level of the journal in the scientific community (Glänzel, 2006). Considering these values, it is seen that the journals "Computers \& Education" and "Computer in Human Behavior" have the highest index with 16 (h-index=16). Again, the g-index values of the journals are a criterion that gives popularity credits according to the citations given to the journals (Tol, 2008). In the G-index values, it was seen that "Computers & Education" journal was ahead of the others with 25. In Figure 3, the distribution of journals according to Bradford's Law is given. It appears that the 7 journals are "first zone" journals according to Bradford's law.

Findings for Author

In studies on eye tracking in the field of education, 794 different authors were found to work in the WoS database (Table 1). The number of publications, indexes, total citations and the first years they worked on the 20 authors who have done the most work in this field are given. When the table is examined, Halszka, J. is the leader in eye-tracking studies in education with a total of 13

publications (h-index=11; g-index=13). The citation numbers of the articles of the authors in the data set are also given in the table. Accordingly, Tsai MJ is the most cited author with 560 citations (h-index=7; g-index=9). Among the top 20 authors in the table, Halszka, J. published his first article on the subject in 2008. Kuechemann S, on the other hand, is the newest author to make its first publication in 2019 and participate in the publications in the table. The article publication efficiency of the 10 authors with the highest number of publications by time is given in Figure 4.

Tablo 3. Top 20 Authors with the Most Article

Author	ArtN	h_index	g_index	TC	PY start
Halszka, J.	13	11	13	478	2008
Bruenken, R.	11	8	11	287	2015
Van Gog, T.	11	7	11	454	2005
Tsai, Mj.	9	7	9	560	2012
Jian, Yc.	9	6	9	89	2015
Klein, P.	9	6	9	93	2018
Azevedo, R.	8	5	8	182	2016
Kuhn, J.	8	5	8	82	2018
Cagıltay, K.	8	4	8	410	2009
Park, B.	7	7	7	259	2015
Pi, Z.	7	5	7	88	2016
Yang, FY.	7	5	7	356	2013
Bubic, A.	6	5	6	113	2014
Planinic, M.	6	5	6	113	2014
Susac, A.	6	5	6	113	2014
Van Wermeskerken, M.	6	5	6	146	2016
Kuechemann, S.	6	4	6	51	2019
Korbach, A.	5	5	5	159	2015
Mayer, Re.	5	5	5	120	2018
Chiou, GI.	4	4	4	328	2013

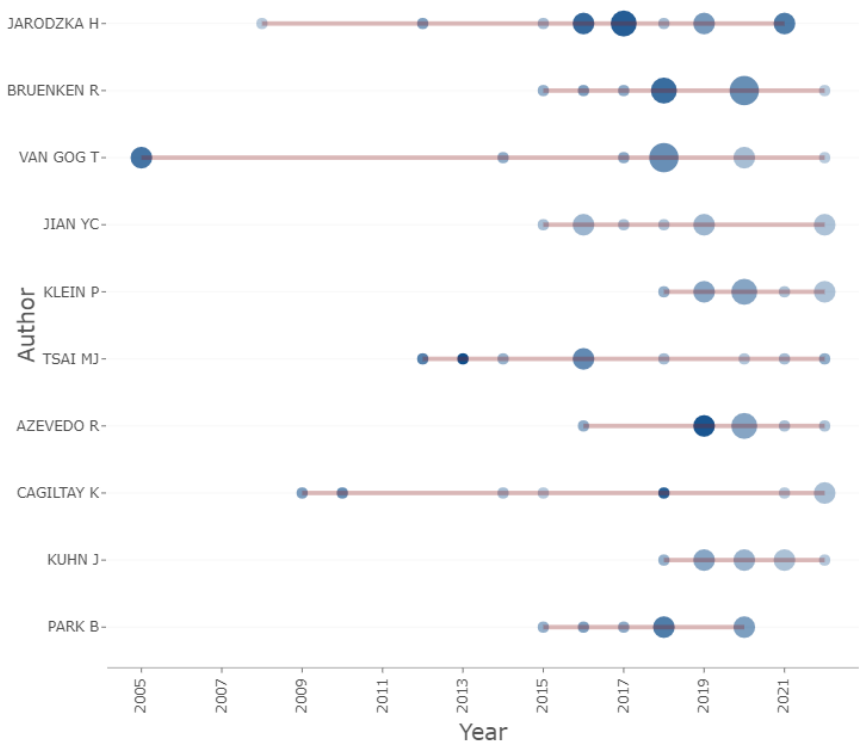


Figure 4. Authors' Production over Time

The citations made by the authors in the data set to each other in the articles they published were examined. Accordingly, the first 20 articles with the highest number of citations in the data set are presented in figure 5. When the table is examined, Cagiltay K is the most cited author with 78 citations. Mason L and Pluchino P are the authors ranked second with 77 citations.

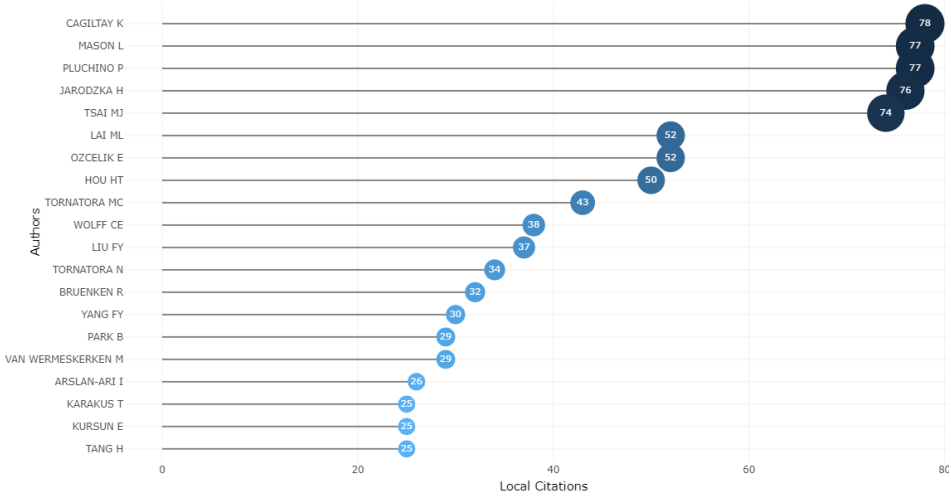


Figure 5. Most Local Cited Authors

Findings for Affiliations and Countries

In Table 4, 20 universities with the highest number of publications on eye tracking studies in education are given. Among the 20 institutions with the most publications, the university with the most publications was the "National Taiwan Normal University" (ArtN=59). At the same time, 3 different Taiwan universities were included in the top 20 universities with the highest number of publications.

Table 4. Top 20 Affiliations with the Most Articles

Affiliation	ArtN
Natl Taiwan Normal Unıv	59
Open Univ Netherlands	33
Univ Zagreb	25
Saarland Univ	23
Univ Utrecht	23
Cent China Normal Univ	22
Natl Taiwan Univ Sci and Technol	14
Erasmus Univ	13
Lund Univ	13
Natl Chiao Tung Univ	13
Open Univ	12
Tech Univ Kaiserslautern	12
Univ Cent Florida	12
Univ Georgia	12
Univ Tubıngen	12
Univ Padua	11
Univ Turku	11
Ludwig Maximilians Univ Munchen	10
Middle East Tech Unıv	10
Univ Burgos	10

In addition, the countries of the authors who sent the article, their cooperation with other countries and the total number of citations they received are given in Table 5. Accordingly, China is the country with the highest number of publications in this field (ArtN=69), Germany ranks second with 68 publications, and the USA ranks third with 61 publications. Germany (MCP=27) is the leader with 27 articles in the articles published in collaboration. The country with the highest number of citations was again China (TC=1287). The USA, which is the closest to China, received 1223 citations.

Table 5. Top 20 Countries with the Most Articles

Country	ArtN	SCP*	MCP*	TC
CHINA	69	63	6	1287
GERMANY	68	41	27	1047
USA	61	49	12	1223
NETHERLANDS	30	16	14	1021
TURKEY	11	11	0	427
UNITED KINGDOM	9	6	3	74
AUSTRALIA	8	2	6	263
CANADA	8	7	1	167
CZECH REPUBLIC	7	6	1	17
FINLAND	7	6	1	81
NORWAY	7	4	3	117
CROATIA	6	4	2	113
SWEDEN	6	3	3	47
SPAIN	5	3	2	40
ITALY	4	3	1	305
JAPAN	4	3	1	14
SWITZERLAND	4	1	3	23
BELGIUM	3	2	1	119
NEW ZEALAND	3	2	1	3
POLAND	3	3	0	23

In Figure 6, the cooperation map of the countries is given. According to the map given above, the countries with the highest cooperation were Germany and the Netherlands (MCP=17). For a more detailed representation, the collaboration network is given in figure 7.

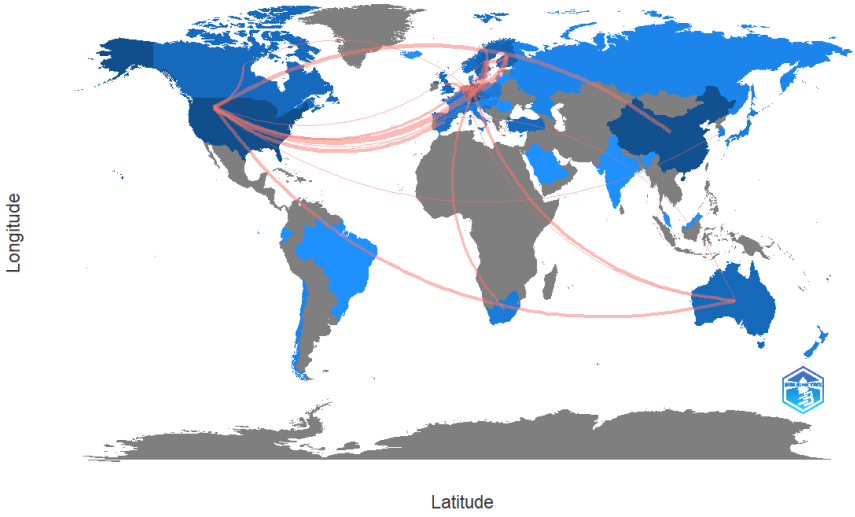


Figure 6. Collaboration WorldMap

When the cooperation network is examined, it is seen that the cooperation between countries is in the form of 3 different clusters. In the “red” colored cluster, Germany is in the center, the “blue” colored cluster is the central USA, and in the “green” colored cluster, 3 countries are a cluster together.

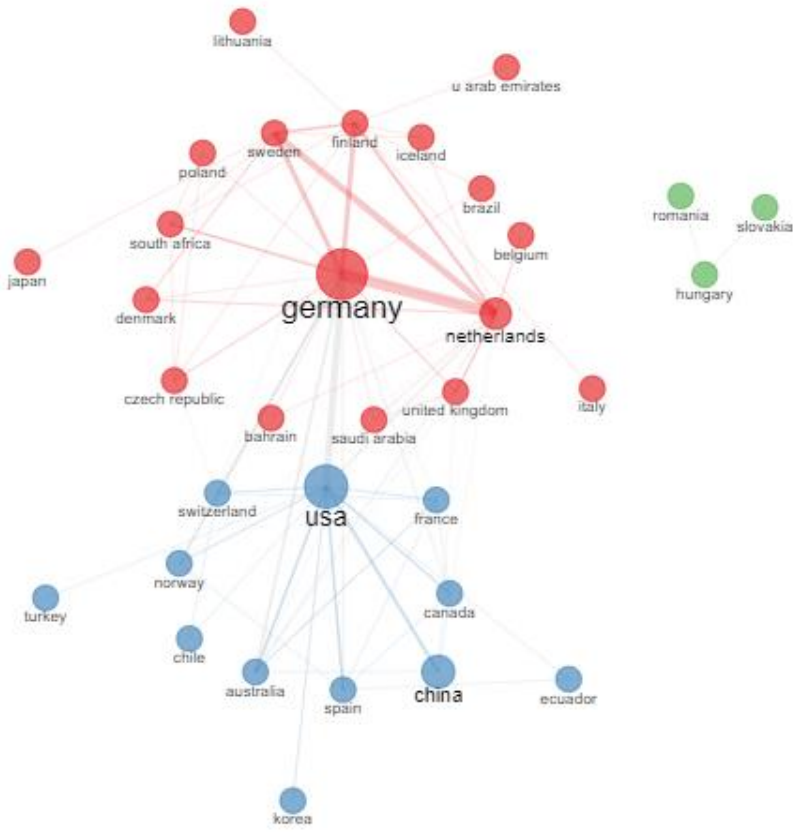


Figure 7. Collaboration Network

Findings for Citiation Status

In Table 6, the global and local citation status of the articles in the data set are given. The most cited article in terms of global citations was "A review of using eye-tracking technology in exploring learning from 2000 to 2012" (GC=240) written by Lai ML. However, it could not be cited as a local reference (LC=0) in the data set. Of the 20 articles with the highest number of global citations (GC), 5 did not receive any local citations (LC). The most cited article locally was "Do fourth graders integrate text and picture in processing and learning from an illustrated science text? Evidence from eye-movement patterns" (LC=43) published in Computer \& Education journal, written by Mason L.

Table 6. Top 20 Articles with the Most Global Citation

Document	DOI	Year	GC*	LC*
Laı, M.L., 2013, Educ Res Rev	10.1016/j.edurev.2013.10.001	2013	240	0
Van Gog, T., 2005, J Exp Psychol -Appl	10.1037/1076-898X.11.4.237	2005	185	0
D'mello S., 2012, Int J Hum - Comput Stud	10.1016/j.ijhcs.2012.01.004	2012	161	0
Tsaı, M.J., 2012, Comput Educ	10.1016/j.compedu.2011.07.012	2012	154	37
Ozcelık, E., 2010, Comput Hum Behav	10.1016/j.chb.2009.09.001	2010	149	26
Mason, L., 2013, Comput Educ	10.1016/j.compedu.2012.07.011	2013	145	43
Ozcelık, E., 2009, Comput Educ	10.1016/j.compedu.2009.03.002	2009	119	25
Alemdag, E., 2018, Comput Educ	10.1016/j.compedu.2018.06.023	2018	112	24
Van Gog, T., 2005, Appl Cogn Psychol	10.1002/acp.1112	2005	102	0
Mason, L., 2013, J Exp Educ	10.1080/00220973.2012.727885	2013	95	34
Wolff, Ce., 2016, Instr Scı	10.1007/s11251-016-9367-z	2016	91	23
Cook, M., 2008, Scı Educ	10.1002/sce.20262	2008	89	14
Halszka, J., 2012, Instr Scı	10.1007/s11251-012-9218-5	2012	86	14
Van Den Bogert, N., 2014, Teach Educ	10.1016/j.tate.2013.09.001	2014	84	24
Debue, N., 2014, Front Psychol	10.3389/fpsyg.2014.01099	2014	84	4
Lenzner, A., 2013, Instr Scı	10.1007/s11251-012-9256-z	2013	72	7
Azevedo, R., 2019, Comput Hum Behav	10.1016/j.chb.2019.03.025	2019	68	8
Koc-Januchta, M., 2017, Comput Hum Behav	10.1016/j.chb.2016.11.028	2017	66	5
Halszka, J., 2017, J Eye Mov Res	10.16910/jemr.10.1.3	2017	65	0
Tsaı, M.J., 2016, Comput Educ	10.1016/j.compedu.2016.03.011	2016	63	13

Keywords and Trend Topics

In the research, the keywords in the articles of the authors were analyzed, 25 keywords were defined on WordCloud as a result of the analysis. Analysis results are given in figure 7.



Figure 7. WordCloud of Research

There are 972 keywords in total for eye-tracking studies in education. The 25 most frequently repeated words from these keywords are shown on WordCloud. The most recurring keyword is big, and the next ones have sizes according to their frequency. The concept of “eye tracking” was used as a keyword 172 times. The concept of “eye tracking” is used together with synonymous words. The concepts of “eye-tracking”, “eye tracking”, “eye”, “tracking” was collected as a single keyword. After the concept of eye tracking, “multimedia learning” was the second most frequently repeated keyword (f=31), and “learning” was the third most frequently repeated keyword (f=27). The trending status of the keywords given above by years is presented in Figure 8.

The distribution of the keywords used by years is given in Figure 8. According to this figure, it has been determined that the keywords “comprehension”, “visual”, “eye movements” have been replaced by the keyword’s “simulation”, “science learning” and “Professional Vision” in recent years.

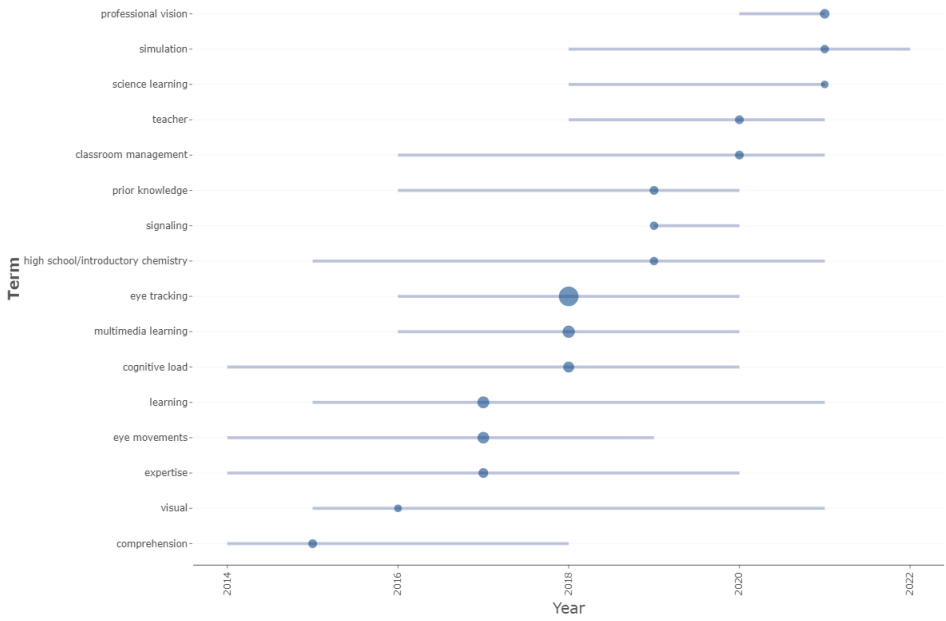


Figure 8. Trend Topics

Discussion and Conclusion

Pupil size variation, repositioning velocity of the eyes, eye movement lengths, and fixation time in aggregate are a few of the straightforward outputs obtained from eye trackers, and these outputs provide users with various kinds of information about focus of attention and cognition. Eye tracking is a very important and serious tool utilized in various domains (like psychology, marketing, human-computer interaction, and neuroscience) today. Eye tracking, providing data and yield especially on attention, perception, and cognition, aids in maximization of the interface design within human-computer interaction, besides helping in judging advertising effectiveness when it comes to marketing. Eye movements also have diagnostic value for cognitive impairment and are significant in the research of skill acquisition in fields like aviation and surgery. In general, eye tracking provides significant information on human behavior and cognition and is of critical significance in research as well as everyday application. Eye tracking is a potent tool in education for untangling cognitive ability, learning approaches, and complex cognitive processes. Eye tracking, by measuring people's gaze and behavior in relation to studying material, makes visible effective modes of learning and pedagogy. Current literature reports growing research on the use of eye-tracking technology to study learning and teaching dynamics because of its increased role in education

studies. Given the vast quantity of publications in the field, the bibliometric review provides a quantitative overview for distinguishing trends, leading researchers, and foundation journals in eye-tracking studies in education. Through tools such as Biblioshiny, researchers can discern patterns, collaboration networks, and shifts in keywords over time, fostering a comprehensive understanding of research trajectories and scholarly contributions. This synthesis underscores the interdisciplinary importance of eye-tracking research in elucidating human cognition and educational methodologies, signaling a fertile ground for exploration and innovation.

This study aims to examine studies on eye-tracking in education from a bibliometric perspective. For this purpose, the journals, authors, institutions and countries that published the most on the subject were determined. The citation status of the publications was examined in detail. The distribution of keywords and trending titles regarding the concept of eye-tracking in education by year was examined.

In the research, it was examined which journals published the most articles on eye-tracking. It was determined that Computer &/ Education (ArtN=25) and Computer in Human Behavior (ArtN=23) journals (Table-2) gave the most space to articles on eye-tracking. In the bibliometric analysis conducted by Chen and Ho (2020) on Technology-enhanced learning in higher education, Computer &/Education journal again made the most publications. In contrast, in a study conducted by Ali, Heldal and Helgelsen (2021), 499 references were examined between 2019 and 2021 (excluding 2021) with the help of Bibliometrics and WOSviewer. In these references, it was determined that the source journal in which such articles were published most was the Journal of Vision, with a total of 21 articles.

Halszka, J. was determined to be the author who did the most research on eye-tracking (Table-3). It was determined that most of the research conducted by Halszka, J. and other authors was conducted after 2015. It is also reflected in the results that the most cited authors locally (authors who wrote articles on the subject of eye-tracking in education) are Çağıltay K (TC=78), Mason L (TC=77) and Halszka, J. (TC=76). In the research conducted by Brasil, Andrade, and Komati, (2020) between 2004 and 2019, the author with the most publications in terms of the number of publications was determined to be Prof. Dr. Oleg Komogortsev. This can be considered as an indicator of how different results can be obtained when similar studies are carried out in different time periods.

It was determined that the university where eye-tracking studies were carried out the most in education was “Natl Taiwan Normal University” (ArtN = 59). It

was also concluded that the countries where eye-tracking research was most conducted in education were China (ArtN=69), Germany (ArtN=68) and the USA (ArtN=61). Karakus, Ersozlu and Clark (2019) found in their bibliometric analysis on augmented reality research in education that China (ArtN=87) and the USA (ArtN=67) made the most publications. Julia et al. (2020)'s bibliometric analysis on flipped classroom, the USA (ArtN = 155) and China (ArtN = 59) lead in the distribution of publications by country. It can be concluded that China and the USA are the leading countries in research on the use of technology in education. In a study on eye-tracking conducted in 2021, the dataset of 2456 articles taken from the Web of Science Core Collection (WoS) database was analyzed using WOSviewer and the Bibliometrix R package. According to research data, extensive collaboration networks were identified between the USA (35.3%), the UK (9.5%) and Germany (7.3%), the three countries with the highest scientific production (Zammarchi & Conversano, 2021). In addition, a study conducted by Ali, Heldal and Helgelsen (2021) aims to analyze and visualize articles published from Web of Science databases. Using Web of Science databases, 499 references were examined between 2019 and 2021 (excluding 2021) with the help of Bibliometrics and WOSviewer. It was found that literature from the USA received the most citations with n = 3939 from only 163 articles. On the other hand, in the study conducted by Atabay and Güzeller (2021) on the concept of eyetracking within the scope of tourism, the Czech Republic was determined to have the highest number in terms of broadcast frequency between countries.

Among the articles included in the research, it was determined that the article with the most global citations belonged to Lai (2013) (GC=240). In a study conducted by Salgado-Fernández et al. (2022) on the concepts of "eye-tracking" and "academic achiev", it was determined that there was a study published by Deubel et al. in 1999 with a citation index of 214.

In the final analysis, the keywords of the articles subject to the research were examined statistically. The concepts of "eye tracking", "eye-tracking", "eye" and "tracking" along with their synonyms were the most repeated keywords (f=172) and the word "learning (f=31)" was the most frequently repeated keyword. It was determined that the word.

As a result of the research, the general characteristics of the articles included in the WoS database in order to conduct bibliometric analysis of the documents obtained by using the concepts of "education" and "eye-tracking" (table-1), the increasing annual accumulation on the subject (table-2), The most influential authors, sources and keywords have been compiled. It was determined that the articles were mostly published in the "Computer &/Education" journal, the most

influential author was “Halszka, J.”, the most influential university was “Natl Taiwan Normal Univ” and the most influential countries were “China and the USA”. The research will help shed light and guide other research on eye-tracking in education.

One of the biggest elements that makes this study special when compared to studies carried out within the framework of the same theme and concept is that the concept of eye-tracking is examined meticulously in the focus of education. When we consider the current state of technology and education, it can be said that the fact that these two concepts have not been studied before is a major deficiency in literature. In parallel with this study, the concept of eye-tracking has been researched with various methods in many fields such as tourism, marketing, medicine, and economy (Ali, Heldal, & Helgesen, 2021; Atabay & Güzeller, 2021; Chen et al., 2021; Li & Wong, 2022; Liu, 2022; Pei et al., 2023; Salgado-Fernández et al., 2022; Xu et al., 2022; Zammarchi, & Conversano, 2021). Studies similar to the methods and techniques used in this study also focused on the same themes (tourism, marketing, medicine, etc.). However, in this study, the eye-tracking concept was implemented entirely in the focus of education. All studies conducted in previous years recommend that the eye-tracking concept be examined together with various disciplines (Brasil, Andrade, & Komati, 2020; Zammarchi, & Conversano, 2021).

Recommendations

When the findings and other studies are compared, obvious differences as well as similarities stand out. This situation reveals the importance of expanding, repeating, specificating and deepening the research, even in research conducted on a single concept according to years, fields or different variables. Additionally, a study conducted by Zhi-Tiao et al. (2022) showed that publications on eye movements scanned in the literature until March 2021 have increased rapidly in the last two decades. Repeating similar studies will bring a different perspective to the studies carried out in this field in the coming years. Future studies can produce studies that provide interesting and new perspectives by analyzing various academic databases or new databases and different types of publications more comprehensively (language, culture, academic unit, etc.). In addition, future studies can contribute to literature by using different bibliometric techniques, while enriching it with various keywords can emphasize the popularity and importance of the eye-tracking concept under various headings.

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