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A Bibliometric Look at Eye Tracking Research in Video-Based Learning

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Abstract: Eye tracking technology has recently become increasingly popular for understanding video-based learning processes. The main purpose of this study is to provide an overview of eye tracking research in the field of video-based learning. For this purpose, 147 eye tracking articles related to video-based learning indexed in the Web of Science Core Collection were analyzed. A bibliometric approach was applied to reveal the intellectual nature of the research. VOSviewer software was used for bibliometric analysis. The results showed that "eye tracking" was the keyword with the highest frequency of occurrence. The most influential authors are Van Gog, T., and Jarodzka, H. Most studies reviewed were conducted in the USA, Germany, and China. It has been determined that the "Journal of Computer Assisted Learning" journal stands out in terms of the number of documents in the journals, and the "Computers & Education" journal ranks first in terms of citations. The results provide insights into recent research on eye tracking in video-based learning processes. It is thought that this study will help researchers see trends in the field and guide future studies and applications.

Keywords: Video, video-based learning, eye tracking research, bibliometric analysis

Video Tabanlı Öğrenme Alanındaki Göz İzleme Araştırmalarına Bibliyometrik Bir Bakış

Öz: Göz izleme teknolojisi, video tabanlı öğrenme süreçlerini anlamak için son zamanlarda daha popüler hale gelmiştir. Bu araştırmanın temel amacı, video tabanlı öğrenme alanındaki göz izleme araştırmalarına ilişkin genel bir bakış sunmaktır. Bu amaçla Web of Science Core Collection'da indekslenen ve video tabanlı öğrenme üzerine yürütülen 147 göz izleme makalesi analiz edilmiştir. Araştırmaların entelektüel yapısını ortaya çıkarmak için bibliyometrik bir yaklaşım uygulanmıştır. Bibliyometrik analiz için VOSviewer yazılımı kullanılmıştır. Sonuçlar, ''göz takibi''nin en fazla tekrarlanma sıklığına sahip anahtar kelime olduğunu göstermiştir. En etkili yazarlar Van Gog, T. ve Jarodzka, H. dir. İncelenen çalışmaların çoğu Amerika Birleşik Devletleri, Almanya ve Çin Halk Cumhuriyeti'nde yapılmıştır. Dergilerde yer alan doküman sayısı açısından "Journal of Computer Assisted Learning" dergisinin öne çıktığı, atıf sayısı açısından ise " Computers & Education" dergisinin ilk sırada yer aldığı tespit edilmiştir. Sonuçlar, video tabanlı öğrenme süreçlerinde göz izleme teknolojisinin kullanımına ilişkin son araştırmalar hakkında içgörüler sağlar. Bu çalışmanın, araştırmacıların alandaki eğilimleri görmelerine, gelecek çalışmalara ve uygulamalara rehberlik etmesine yardımcı olacağı düşünülmektedir.

Anahtar kelimeler: Video, video tabanlı öğrenme, göz izleme araştırmaları, bibliyometrik analiz

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Introduction

The development of mobile devices, the rapid growth of the internet, the emergence of cloud systems, and cheaper and more accessible video production programs have all contributed to the development and proliferation of video (Van der Meij, 2017). With the proliferation of platforms such as short video clips, YouTube, and Vimeo, the use of video is rapidly increasing in various fields (Adnan & Redzuan, 2017; Bétrancourt & Benetos, 2018; Kılıç & Yılmaz, 2021; Poquet et al., 2018). Similarly, in education, the use of videos is increasing and has become an essential element of learning and teaching processes.

The use of videos is becoming increasingly common in formal and informal learning environments (Kokoç et al., 2020; Park et al., 2022). Looking at the history, the use of videos in educational and training processes dates back to the 1970s, first with film devices and then with educational television programs (Hjorth, 2023). In the 1980s, this use increased rapidly with the increasing availability and practicality of video recordings (Bétrancourt & Benetos, 2018). By the end of the 1990s, there was a rise in video conferencing, cameras, and video CDs (Mendoza et al., 2015). By the 2000s, Internet connections, interactive digital videos, and videoconferencing were technologies available to students in classrooms (Sablić et al., 2021). As the popularity of videos as educational tools is increasing, we are currently living in the age of internet video as Mayer et al. (2020) describe. Today, videos are widely used in educational contexts such as massive open online courses (MOOCs), flipped classrooms, distance learning, open or blended learning, and traditional learning-teaching processes. Video-assisted applications in teaching and learning are referred to as video-based learning or video-assisted learning (Kokoç, 2020). It is defined as "the systematic use of video resources in the learning process to acquire the targeted knowledge, competence, and skill."

In recent years, videos have not only become increasingly popular and accessible, but have also become an increasingly powerful teaching tool, especially since the COVID-19 pandemic severely disrupted learning systems worldwide (Cojean & Jamet, 2022; Deng & Gao, 2023). Although we have witnessed an unprecedented increase in the use of videos in teaching, in recent years, we can argue that not enough attention has been given to individuals' learning processes in video-based instruction. Interviews, self-report measures, and questionnaires were mostly used to draw inferences about the processes during video-based learning (Fiorella et al., 2017; Pan et al., 2020). While these measures provide relative explanations of learning activities, they are not successful in revealing individual moment-to-moment processes, unconscious responses, and latent changes (Deng & Gao, 2023). The limitations of such self-reporting metrics can be overcome with eye tracking technology. Eye tracking technology stands out as a more reliable method because of its data collection methodology, which eliminates subjective judgments of the researcher or participants (Zammarchi & Conversano, 2021). Today, eye tracking technology has emerged as an exciting and important development for obtaining more information and data about video-based learning processes.

Eye tracking allows researchers to study participants' visual attention by showing which elements of a stimulus a participant looks at, for how long, and in what order (Hahn & Klein, 2022). Eye tracking technology provides a direct and objective way to monitor, measure, and interpret visual and cognitive processes by recording eye movements (Wang et al., 2020; Zhai et al., 2018). In other words, eye tracking represents a noninvasive technique for collecting objective and precise data that enables the examination of complex features such as mind, emotion, and social interaction

(Zammarchi & Conversano, 2021). Therefore, eye tracking technology has been used extensively in many research areas, including computer science, language learning, health care, psychology, sociology, marketing, tourism, and education, specifically teacher education (Lund, 2016; Zhai et al., 2018).

Recently, in parallel with the increasing emergence of studies using eye tracking, systematic reviews of the use of eye tracking technology in education have increased significantly (Alemdağ & Çağıltay, 2018; Ashraf et al., 2018; Beach & McConnel, 2018; Çoşkun & Çağıltay, 2018; Deng & Gao, 2023; Dönmez, 2023; Hahn & Klein 2022; Lai et al., 2013; Mikhailenko et al., 2022; Özer, 2022; Sağlam & Yılmaz, 2021; Strohmaier et al., 2020). Alemdağ and Çağıltay (2018) systematically reviewed 52 articles on the use of eye tracking technology in multimedia learning. Beach and McConnel (2018) reviewed ten articles using eye tracking methodology to examine teacher learning. Çoşkun and Çağıltay (2022) examined research on the use of eye tracking technology in students' cognitive processes in the field of animated multimedia learning. Dönmez (2023) systematically reviewed 48 articles to reveal how eye tracking is used in particular education research. Hahn and Klein (2022) reviewed 33 empirical articles published between 2005 and 2021 using eye tracking in physics education. Mikhailenko et al. (2022) focused on eye tracking research in immersive virtual reality. Strohmaier et al. (2020) systematically evaluated 161 eye tracking studies in mathematics education research. The research has shown that the number of studies using eye tracking in various educational settings has increased. Lai et al. (2013) reviewed eye tracking research in education. The study results revealed that eye tracking technology is a valuable tool for educational researchers to link learning outcomes to cognitive processes and mechanisms.

Looking at all these systematic review articles from a general perspective, it can be seen that the studies focus on a limited number of research articles and a specific area. In addition, it is noted that there are few studies on bibliometric analysis that show the general trend and direction of research on the use of eye tracking technology in education and make this direction visible with quantitative data (Salgado-Fernández, 2022; Xu et al., 2022; Zammarchi & Conversano, 2021; Zhi-Tiao et al., 2022). Previous bibliometric studies have focused on bibliometric analysis of education in specific disciplines, such as medical practice (Zammarchi & Conversano, 2021), eye movements in reading (Zhi-Tiao et al., 2022), and neuroscience in education (Xu et al., 2022). Although existing studies have produced many valuable ideas, it has been seen that there is a need to draw a general picture of the use of eye tracking technology in video-based learning with the help of bibliometric analysis. To our knowledge, bibliometric analysis of this research area has not yet been performed. The study aims to examine eye tracking research in video-based learning with bibliometric analysis. Deng and Gao (2023) reviewed 44 eye tracking studies conducted between 2010 and 2021 to reveal how eye-tracking technology provides insight into the mechanisms underlying effective video-based learning. The results of this study demonstrated the current potential and challenges of eye tracking in this field. Few studies have successfully elucidated the mechanisms underlying effective video-based learning using eye tracking technology. Unlike the study by Deng and Gao (2023), this article will provide insight into current trends, common concepts, countries and authors with the highest scientific production, and the most cited documents and sources. Thus, researchers can be shown the current status and development of the subject, which helps researchers become more familiar with the subject and allows them to discover new research topics. This study, aims to find answers to the following research questions:

1. How is the distribution of the relevant publications by year?
2. Which countries are the most productive?
3. Who are the most prolific and influential authors?
4. Who are the most co-citation authors?
5. What are the most cited publications?
6. What are the most cited journals?
7. What are the distributions and trends of keywords?

Method

This study used bibliometric analysis to provide an overview of research on the use of eye tracking technology in video-based learning. Bibliometric analysis is an essential tool for quantitatively measuring and analyzing certain indicators in the literature published in a specific field and creating knowledge maps based on an extensive database (Hung, 2012; Zeng & Chini, 2017). In bibliometric research, it is possible to obtain large-scale quantitative data such as the relationships among the keywords used by the authors, the most reliable sources of scientific publications, important scientific actors such as authors and institutions, collaborations, and advanced cocitations (Li et al., 2019). In addition, this type of analysis assesses the current state of publications in a particular research area and allows the identification of trends in this area (Song et al., 2019).

Data Collection Process

The Web of Science (WoS) database was used to identify studies to be included in this review. One of the reasons for choosing this database is that it is one of the most widely used bibliometric databases (Cobo et al., 2015). Another reason is that WoS contains the category "education and educational research". Moreover, this database is frequently favored in previous studies in various disciplines (Djeki et al., 2022; Hao et al., 2018; Lorenzo et al., 2020; Ulukök, 2022), and users can export records from WoS as plain text based on search parameters such as topic, title, author/s, and publication time. It allows reliable data collection in a preferred standardized format along with information about keywords or terms (Li et al., 2019).

Previous studies were examined to identify keywords related to the current topic (Deng & Gao, 2023; Hahn & Klein, 2022; Lai et al., 2013). To ensure the comprehensive nature of our search, the search string shown below was created in the WoS Core Collection database using the Boolean operators 'AND' and 'OR' in the "Title," "Abstract," and "Keywords" tabs. No date range has been defined for the article selection. The first search found 1074 scientific publications (accessed in January 2024). As the data flow was ongoing, 2024 data was not considered during the analysis. Only articles were chosen as the document types to review studies of more consistent quality and obtain a meaningful dataset. Then, another filtering was performed by selecting the categories of "Education and Educational Research," "Education Scientific Disciplines," "Education Special," and "Psychology Educational." Thus, the number of scientific publications was reduced to 151. Next, the language was selected. Only publications in English were included, and the number of articles to be reviewed was determined to be 150. Finally, a related literature set was created by selecting the indexes in the WoS database. The data from 147 publications from

WoS were downloaded in plain text format (.txt). The metadata used for bibliometric analysis included publication type, publication date, author information, citation information, publication source information, keywords, language, etc. The search parameters for the current study are shown in Table 1.

Table 1

Article Selection Process

Parameter	Details
Database	WoS
Keywords	(“video-based learning” OR “video lecture” OR “lecture video” OR “learning video” OR “educational video” OR “instructional video” OR “computer-based video” OR “video supported learning’’) AND (“eye tracking” OR “eye- tracking” OR “eye gaze” OR “eye movement” OR “eye movements” OR “eye gaze tracking” OR “eye-gaze tracking” OR “eye-based gaze tracking” OR “eye movement- eye tracker’’)
Research Area	“Education and Educational Research” OR “Education Scientific Disciplines” OR “Education Special” OR “Psychology Educational”
Publication Type	Article
Publication Years	…
Indexes	SCI-EXPANDED, SSCI, A&HCI, ESCI
Languages	English
Date	January 2024

Data Analysis

The WoS database and VOSviewer software were used to reveal descriptive results in the data analysis. Descriptive analysis showed frequency values according to the number of articles. Then, citation analysis, co-citation analysis, and keyword co-occurrence were performed using VOSviewer software. The scientific community uses this software to create and analyze scientific literature maps based on bibliographic data. VOSviewer can predict and create networks of authors, publications, journals, countries, institutions and keywords (Martins et al., 2022). The free software can be downloaded from the VOSviewer (www.vosviewer.com) website.

Citation analysis is widely used in academic research in areas such as bibliometrics. This analysis identifies the most influential publications, journals, and authors in a subject area and shows their interdisciplinary relationships (Biehl et al., 2006; Göksu, 2021). This study revealed the most influential authors, journals, and publications on the subject by using citation analysis. In bibliometric analysis, one of the critical parameters is total link strength. Van Eck and Waltman

(2022) expressed total link strength as a standard weight attribute that indicates the total strength of an item's connections with other items. A coauthor analysis was then conducted. Co-citation analysis refers to the frequency/presence of citing two items independently by one or more items to examine the similarity between publications, authors, and journals (Caputo et al., 2021). Finally, the analysis of the co-occurrence of keywords was performed. Common word analysis is one of the most well-established and popular types of bibliometric analysis. Co-occurrence analysis of keywords allows identification of hotspots and development of a field or topic (Li et al., 2016; Mutluer, 2023; Ulukök & Merdan, 2022; Yıldızhan & Atmaca Aksoy, 2023). Corrections were made for synonyms, abbreviations, singular/plural forms, and spelling errors to standardize the study keywords. The findings are presented as tables and network visualization maps.

Findings

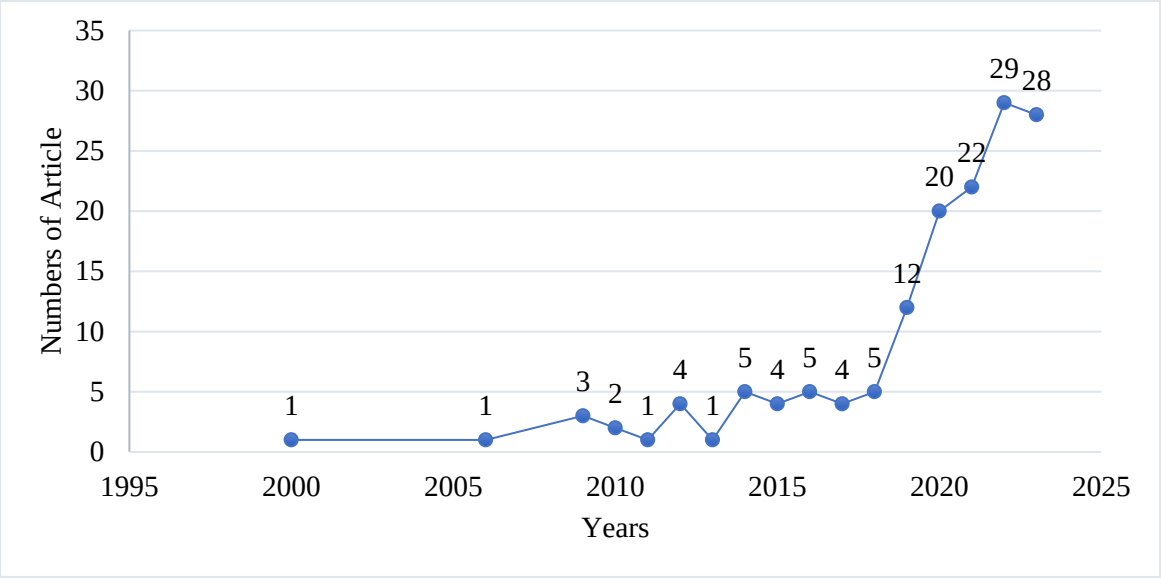
The findings are presented in two stages. Considering the order of the subproblems, first, the distribution of publications by year and country, then the most influential authors, publications, journals, and the most used keywords are included.

A Distribution of the Number of Studies by Year

Figure 1 shows how it has progressed from the date of the first publication of the relevant publications to the present.

Figure 1

Distribution of Publications by Year



When we look at the distribution of 147 articles in the WoS database on the use of eye tracking technology in the field of video-based learning in Figure 1, it can be seen that a significant portion of them have been published recently. While the annual number of articles did not exceed five from 2000 to 2018, a significant increase was observed in the number of studies conducted after this date. In 2022, the number of publications reached the highest level.

A Distribution of Publications by Country

Table 2 shows the geographical distribution of publications. In analyzing the most productive countries in scientific studies, a minimum threshold of 5 documents and 1 citation was set.

Table 2

A Distribution of Publications by Ten Top Countries

Country/Region	Number of publications	Citation
USA	37	696
China	30	255
Germany	28	367
Netherlands	11	402
England (UK)	8	78
Spain	7	105
Finland	6	17
Canada	7	66
Taiwan	7	65
Australia	5	117

In total, 31 countries/regions contributed to research on the use of eye tracking technology in education in video-based learning. Table 2 shows that the USA is the most productive country, with 37 publications. In addition, the USA, with 696 citations, is not only dominant in the number of publications, but also dominates the research field with the most cited research. China follows this country with 30 publications, and Germany has 28 publications. Regarding citation count, it is worth noting that the Netherlands, Germany, and China are the countries with the second, third, and fourth-highest citations, respectively.

Most Influential Researchers in Terms of the Number of Citations

Authors with a minimum number of three documents were included in the citation analysis. The top 10 authors with the highest total link strength (TLS) as a result of the analysis are presented in Table 3.

Table 3

Ranking of the Most Influential Researchers by Citation

Author	Number of publications	Citation	TLS
T. van Gog	9	300	50
H. Jarodzka	4	266	29
K. Scheiter	5	263	25
Z.Pi	13	172	33
L. Mason	3	144	25
J. Yang	10	94	24
M. Van Wermeskerken	5	93	38
K. Mueller	4	65	3
S. Tina	3	64	0
K. Xu	3	47	8

When Table 3 is examined, it is seen that the most productive authors are Z.Pi and J. Yang. The most cited authors are T. van Gog (300 citations), H. Jarodzka (266 citations), K. Scheiter (263 citations), and Z. Pi (172 citations). In addition, 'Co-citation' was chosen as the analysis type, and 'Cited authors' was selected as the analysis unit in the VOSviewer program. The threshold value was set at 20 to reduce clutter in data visualization. The created map is presented in Figure 2.

Table 4

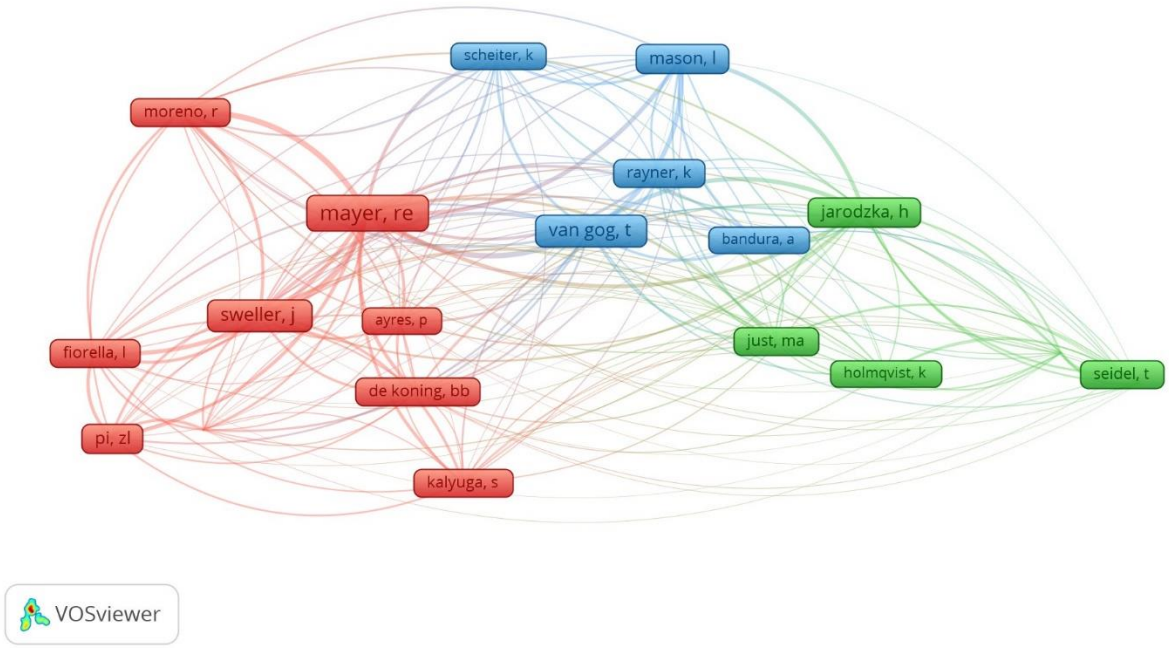
The Most Influential Researchers by TLS

Author	Number of publications	Citation	TLS
Z.Pi	13	172	33
J. Yang	10	94	24
T. van Gog	9	300	50
M. Van Wermeskerken	5	93	38
K. Scheiter	5	263	25
Y. Zang	5	23	14
H. Jarodzka	4	266	29
K. Mueller	4	65	3
L. Mason	3	144	25
A.Schueler	3	31	15

Looking at Table 4, it is seen that the author with the highest TLS value is T. van Gog. It is followed by M. Van Wermeskarken and Z.Pi. In Table 4, the information of the influential authors in the top ten is listed according to the number of citations they received.

Figure 2

Co-Author Citation Network



When the map in Figure 2 is examined, it is seen that there are three different colored clusters related to the common referenced authors. The colors represent the cluster to which they belong. Multiple cited authors are located in the same cluster and closer together in the network map. R. Mayer is in the center of the names in the red cluster. Among Mayer's work topics, multimedia learning comes to the fore. At the center of the blue cluster is T. van Gog, and she frequently uses eye tracking in her research. Van Gog's research topics include example-based, multimedia, and self-regulated learning. At the center of the green cluster is H. Jarodzka. Jarodzka's work areas include eye tracking, expertise development, learning, and instruction. R. Mayer (140 co-citations), T. van Gog (77 co-citations), J. Sweller (63 co-citations), Z. Pi (54 co-citations), H. Jarodzka (47 co-citations), and L. Mason (46 co-citations) are highly cited authors.

The Most Influential Publications in Terms of the Number of Citations

Out of 147 articles that were analyzed only 10 were cited 47 or more times. Table 5 shows the top 10 most influential publications.

Table 5

Most Cited Publications

Rank	Authors	Year	Title	Source	Citation
1	Jarodzka, H., Van Gog, T., Dorr, M., Scheiter, K., & Gerjets, P.	2013	Learning to see: Guiding students' attention via a model's eye movements fosters learning	Learning and Instruction	134
2	Jarodzka, H., Balslev, T., Holmqvist, K., Nyström, M., Scheiter, K., Gerjets, P., & Eika, B.	2012	Conveying clinical reasoning based on visual observation via eye-movement modelling examples	Instructional Science	101
3	Mason, L., Pluchino, P., & Tornatora, M. C.	2015	Eye-movement modeling of integrative reading of an illustrated text: Effects on processing and learning	Contemporary Educational Psychology	83
4	Kruger, J. L., & Steyn, F.	2014	Subtitles and eye tracking: Reading and performance	Reading Research Quarterly	69
5	Van Gog, T., Verveer, I., & Verveer, L.	2014	Learning from video modeling examples: Effects of seeing the human model's face	Computers & Education	64
6	Wang, J., Antonenko, P., & Dawson, K.	2020	Does visual attention to the instructor in online video affect learning and learner perceptions? An eye-tracking analysis	Computers & Education	63
7	Van Wermeskerken, M., & Van Gog, T.	2017	Seeing the instructor's face and gaze in demonstration video examples affects attention allocation but not learning	Computers & Education	54

8	Lieberman, D. A., Fisk, M. C., & Biely, E.	2009	Digital games for young children ages three to six: From research to design	Computers in the Schools	53
9	Montero Perez, M., Peters, E., & Desmet, P.	2015	Enhancing vocabulary learning through captioned Video: An eye-tracking study	The Modern Language Journal	52
10	Gersten, R., Baker, S. K., Smith-Johnson, J., Dimino, J., & Peterson, A.	2006	Eyes on the prize: Teaching complex historical content to middle school students with learning disabilities	Exceptional children	48

The article titled "Learning to See: Guiding Students' Attention via a Model's Eye Movements Fosters Learning" written by Jarodzka et al. (2013), was published in "Learning and Instruction" and received 134 citations. In this article, Jarodzka et al. (2013) explored how to teach perceptual tasks through eye movement modeling examples. The second most cited article, titled "Conveying Clinical Reasoning Based on Visual Observation via Eye-Movement Modeling Examples" by Jarodzka et al. (2012), was published in the journal "Instructional Science" and was cited 101 times. The third most cited article is the article titled "Eye-movement Modeling of Integrative Reading of an Illustrated Text: Effects on Processing and Learning" written by Mason et al. (2015), which was published in the journal "Contemporary Educational Psychology" and has been cited 83 times.

The Most Influential Journals in Terms of the Number of Citations

Journals with a minimum of five documents were included in the analysis. Citation analysis was performed to identify the most influential publications in the field. The citation analysis revealed that eight of 70 journals published at least five or more studies on the subject. Table 6 shows the top eight most influential journals.

Table 6

The Most Influential Journals

Rank	Journals	Number of publications	Citation	TLS
1	Computers & Education	9	310	11
2	Learning and Instruction	6	195	17
3	Instructional Science	5	120	17
4	Journal of Computer Assisted Learning	12	95	19
5	Educational Technology Research and Development	6	75	5

6	British Journal of Educational Technology	7	33	4
7	Frontiers in Education	12	21	8
8	Education and Information Technologies	6	11	5

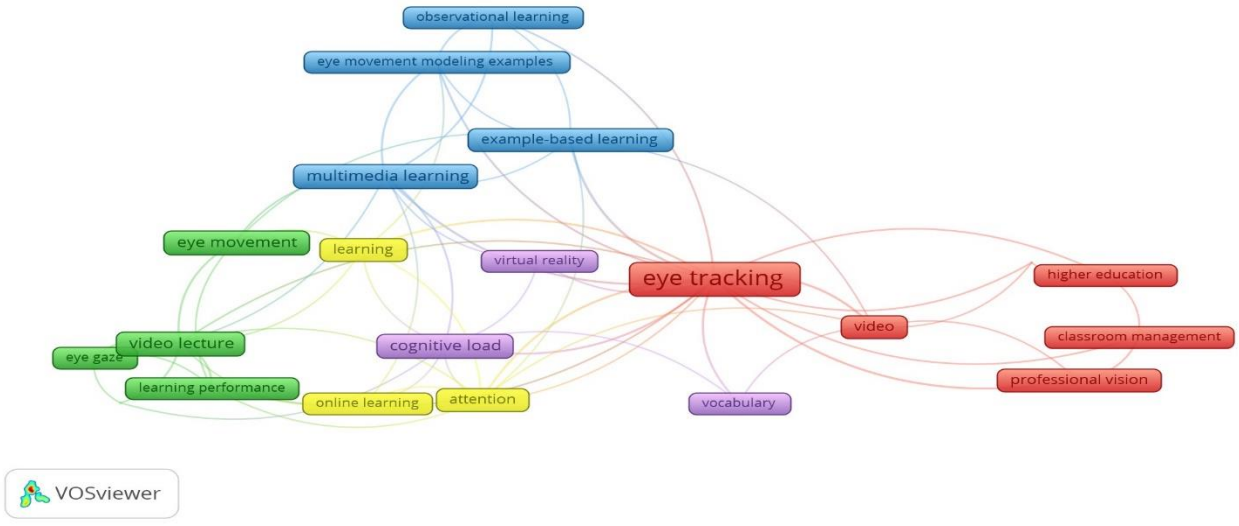
According to the findings in Table 6, the journals "Journal of Computer Assisted Learning" and "Frontiers in Education" are in first place with twelve articles. "Computers & Education" ranks second with nine publications. It is followed by the "British Journal of Educational Technology," with seven articles. The journal with the highest TLS value is "The Journal of Computer-Assisted Learning." The most cited journal is "Computers & Education." In addition to this journal, "Learning and Instruction," "Instructional Science," and "Journal of Computer Assisted Learning" are the leading journals.

Keyword Analysis and Trending Topics

A total of 490 keywords were used in 147 publications regarding eye tracking technology in video-based learning. The minimum threshold number of a keyword in VOSviewer is set to 4. As a result of the analysis, 21 keywords and 5 clusters that met the usage criteria emerged. Clustered keywords provide information about the relevant field of study (Göksu, 2021). Figure 3 presents the co-occurrence map of keywords, and each color (red, blue, yellow, green, and magenta) corresponds to a specific cluster.

Figure 3

Keywords Co-Occurrence Map

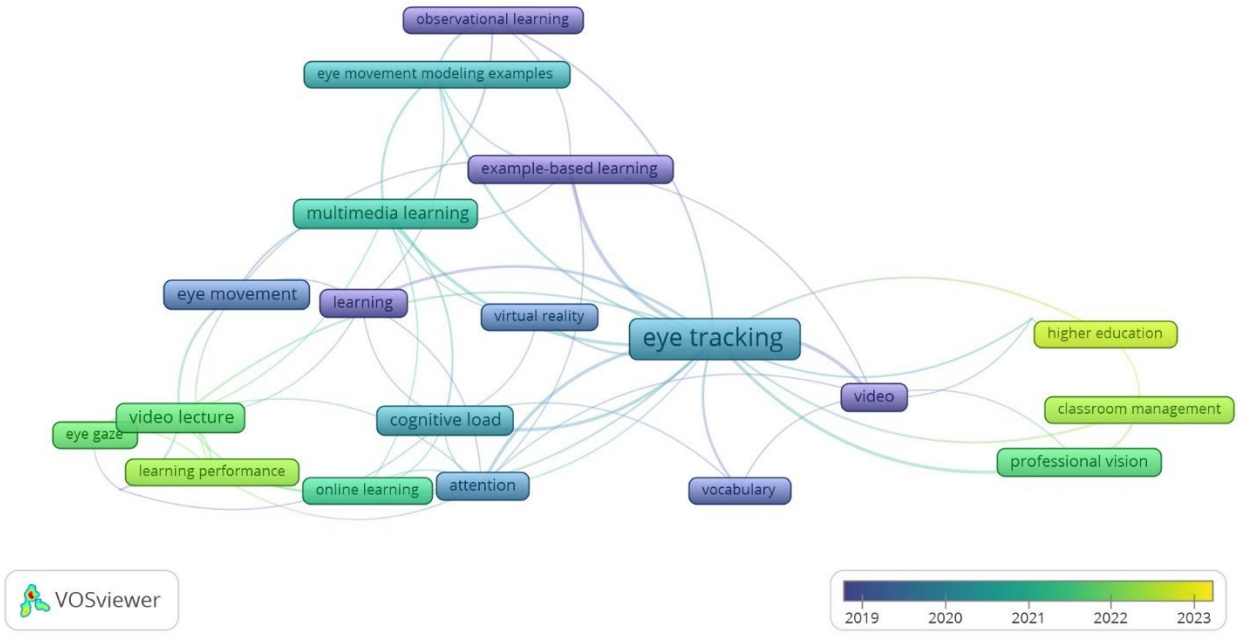


As shown in Figure 3, the first red cluster contains the words eye tracking, classroom management, higher education, multimedia, professional vision, and video. The second cluster, colored green, includes eye movement, e-learning, eye gaze, learning performance, and video

lectures. The keywords in this cluster show that video lectures are used in e-learning environments, and the learning performance variable is investigated in these environments. The words observational learning, multimedia learning, example-based learning, and eye movement modeling examples are included in the blue cluster. The fourth cluster is yellow. The prominent keywords in this cluster are online learning, attention, and learning. The last set contains three keywords and is represented by magenta. This cluster includes the words vocabulary, cognitive load, and virtual reality. These findings demonstrate the use of eye tracking technology in all these research areas. In addition, "eye tracking" (f=59), "video lecture" (f=12), "multimedia learning" (f=12), and "cognitive load"' (f=11) are the most frequently used keywords. Other critical key phrases include "eye movement" (f=9), "example-based learning" (f=8), and “attention" (f=8). This type of keyword frequency analysis provides insights into which topics are most discussed. The overlay visualization map resulting from the keyword co-occurrence analysis is presented in Figure 4. The overlay visualization map reveals the trend of research on the subject.

Figure 4

Visualization Map of Keywords by Years



When Figure 4 is examined, it is striking that there has been a change in research subjects between 2018 and 2023. The colors represent the time of the appearance in the literature, while the yellow-colored terms indicate the relatively newest keywords. It has been determined that there is a tendency toward keywords such as "higher education," "learning performance," and "classroom management" in recent years.

Conclusion and Discussion

In this study, a bibliometric analysis was used to obtain a comprehensive picture of the status and trends of 147 eye tracking studies on video-based learning collected in the WoS database. Through this study, the most productive countries, authors, trending topics, influential authors, journals, and publications were identified and visualized.

The results of this study show that the number of eye tracking studies dealing with video-based learning has increased significantly, especially in recent years. This significant growth can be explained by the development of open-source software for data collection in eye tracking systems, the continuous improvement of usability and accessibility, and the benefits of high research impact. In addition, the difficulties associated with measuring interviews, such as self-reports, may have motivated researchers to utilize this technology, which allows for quantitative analysis. This study shows that interest in eye tracking technology in video-based learning research is increasing. This finding is also supported by findings that have revealed a significant increase in the use of eye tracking technology in mathematics education (Strohmaier et al., 2020), special education (Dönmez, 2023), different medical conditions (Zammarchi & Conversano, 2021), multimedia learning research (Alemdağ & Çağıltay, 2018), animated multimedia learning (Çoşkun & Çağıltay, 2022) and computer-based environments (Van Gog & Jarodzka, 2013).

While the USA, China, and Germany have the highest scientific production, the most influential research has been conducted in the USA, the Netherlands, and Germany. Although the studies differ in terms of the number of publications and citations, the USA is the leader in this particular area of research. According to data from bibliometric studies using eye tracking technology, the USA ranks first in the list of the most productive countries (Xu et al., 2022; Zhi-Tiao et al., 2022). This finding has also been reported in other bibliometric analysis studies (Kılınç et al., 2017; Yıldırım et al., 2023). The fact that the USA has advanced technologies, the necessary infrastructure, and advantages in funding and attaches importance to innovative ideas, research, and development activities may be the main reasons for making a significant contribution to this field. The Netherlands has especially shown its dominant position with its most influential writers.

Z.Pi and J. Yang have the most publications in this field. T. van Gog and H. Jarodzka are the most influential writers. In light of these findings, it is possible to say that the number of authors' publications is not directly proportional to the number of citations. According to the co-citation analysis of the authors of the articles, the most cited authors were R. Mayer and T. van Gog.

Another result of the current research is that the most cited study is the article titled "Learning to See: Guiding students' attention via a model's eye movements fosters learning" by Jarodzka et al. (2013). An examination of the most influential articles on this subject reveal that they mainly focus on the effects of eye movement modeling examples. Halszka et al. (2017) stated that eye tracking technology has recently been used to enhance visual expertise through eye movement modeling examples. Tunga and Çağıltay (2023) stated that eye tracking technology has become more accessible, and increasing demand for educational videos has made eye movement modeling examples a remarkable research topic.

"Frontiers in Education," "Journal of Computer Assisted Learning," and "Computers & Education" are the top 3 journals that publish the most articles. Although the number of articles is less than that of other journals, the most cited journal is "Computers & Education". This journal is among the prestigious scientific journals with a high academic impact in the field of educational technology. It is scanned in many international indexes, especially SSCI. This information can be

a good reference for researchers working in the relevant field to choose the right partner and resources to follow to submit their articles, as Xu et al. (2022) stated.

The results of the co-occurrence analysis provide a holistic picture of the current state of the area of interest. According to the co-occurrence analysis, keywords such as eye tracking, eye movement, video lectures, multimedia learning, cognitive load, and attention were the most preferred. Similarly, a study examining online learning videos revealed that one of the most frequently repeated keywords was "video lectures" (Yıldırım et al., 2023). Özdinç (2020) stated that eye tracking and attention, wearable measuring tools, and self-regulation skills had become important research topics in educational videos. Yousef et al. (2014) report that in their compilation study, in which they identified new trends, research on educational video is gathered under the themes of effectiveness, teaching methods, design, and reflection. Kokoç and Altun (2018), in their research examining studies on video-based learning and course videos, found that similarly, the studies focused on the psychosocial characteristics of learners and their effects on learning outcomes. In addition, the prominent keywords in recent years are learning performance, higher education, and classroom management. These data can serve as a good reference for those who want to research related fields in the future. In the future, conducting additional studies on the effects of video-based learning on student performance and analyzing them based on behavioral data obtained through objective measurements may contribute to improving learning and teaching processes. Research can be conducted to assess and enhance instructors' classroom management skills by using video-based learning applications and eye tracking technologies.

As a result, considering the technological developments in recent years, the use of objective measurement tools such as eye tracking devices is expected to continue increasing in video-based learning. This can provide new insights into how learning develops with the use of video. The current study maps eye tracking studies related to video-based learning in general terms. However, the findings from this study need to be interpreted with some limitations in mind. First, only the WoS database was used as a source of information in this study, and articles published in English were included in the research. In future studies, using different databases such as Scopus and Google Scholar, and including different types of publications such as conference proceedings, book chapters, and theses can provide a deeper understanding of the field. Additionally, research published in other languages may be included in future bibliometric research. Finally, the bibliometric analysis method used is among the limitations of the research. Mishra et al. (2021) stated the limitation of this analysis as taking into account the metadata of the publications rather than their actual content. Bibliometric analysis, network analysis, systematic literature reviews, and meta-analyses are valuable tools used to gain a deeper understanding of information relevant to any discipline (Comarú et al., 2021). Yılmaz (2021) stated that bibliometric methods complement traditional literature reviews rather than replacing them. For this reason, in future studies, different dimensions of the relevant subject can be examined using content analysis, thematic analysis, systematic review studies, social network analysis, and other bibliometric methods. Engineering and health education encompasses both theoretical and practical courses. Videos are increasingly utilized in both healthcare and engineering education. Therefore, exploring eye tracking studies regarding video-based learning in health and engineering can yield significant findings for the respective fields.

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Geniş Özet

Problem Durumu

Videoların önemli kullanım alanlarından biri de eğitimdir. Bu nedenle video tabanlı öğrenme hem formal hem de informal öğrenme ortamlarında bilgi edinmenin en popüler yollarından biri haline gelmiştir (Kokoç vd., 2020; Park vd., 2022). Göz izleme teknolojisi, video tabanlı öğrenme süreçlerini anlamak, daha fazla bilgi ve veri edinmek adına giderek daha fazla kullanılmaktadır. Çalışmanın amacı, video tabanlı öğrenme alanındaki göz izleme araştırmalarını bibliyometrik analiz ile incelemektir. Bu sayede, video tabanlı öğrenme alanındaki göz izleme araştırmalarına ilişkin eğilimleri, ortak kavramları, en yüksek bilimsel üretime sahip ülkeleri ve yazarları, en çok atıf yapılan belgeleri ve kaynakları görmek mümkün olacaktır. Böylece araştırmacılara konunun mevcut durumu ve gelişimi gösterilebilir, araştırmacıların araştırma süresinden tasarruf etmeleri ve yeni araştırma noktalarını keşfetmeleri sağlanabilir. Bu çalışmada aşağıdaki araştırma sorularının yanıtlarının bulunması hedeflenmiştir:

1. Araştırmaların yıllara göre dağılımı nasıldır?
2. En üretken ülkeler hangileridir?
3. En üretken ve etkili yazarlar kimlerdir?
4. En çok ortak alıntı yapılan yazarlar kimlerdir?
5. En etkili yayınlar hangileridir?
6. En etkili dergiler hangileridir?
7. Anahtar kelimelerin dağılımı ve eğilimi nedir?

Yöntem

Bu çalışmada göz izleme teknolojisinin video tabanlı öğrenme alanında kullanımına ilişkin araştırmalara genel bir bakış sunmak için bibliyometrik analiz kullanılmıştır. Bibliyometrik analiz, belirli bir alanda yayınlanan literatürdeki belirli göstergeleri niceliksel olarak ölçmek, analiz etmek ve geniş bir veri tabanı temelinde bilgi haritaları oluşturmak için kullanılan önemli bir araçtır (Hung, 2012; Zeng & Chini, 2017). Bu incelemeye dahil edilecek çalışmaları belirlemek için Web of Science (WoS) veri tabanı kullanılmıştır. Bu veri tabanının seçilmesinin nedeni, yaygın olarak kullanılan bibliyometrik veri tabanlarının başında gelmesidir (Cobo vd., 2015). Diğer bir neden ise WoS'un ''Eğitim ve Eğitim Araştırmaları'' kategorisini içermesidir. Ayrıca bu veri tabanı daha önce farklı disiplinlerde yapılan araştırmalarda da sıklıkla tercih edilen bir veri tabanıdır (Djeki vd., 2022; Hao vd., 2018; Lorenzo vd., 2020; Ulukök, 2022). Mevcut konuya ilişkin anahtar kelimeleri belirlemek için önceki alan yazın çalışmaları incelenmiştir (Deng & Gao, 2023; Hahn & Klein, 2022; Lai vd., 2013). Aramamızın kapsamlı doğasını sağlamak için WoS Core Collection veri tabanında, "Başlık", "Özet" ve "Anahtar Kelimeler" sekmesinde 'AND' ve 'OR' Boolean operatörü kullanılarak arama dizisi oluşturulmuştur. Makale seçimi için herhangi bir tarih aralığı tanımlanmamıştır. Veri akışı devam ettiği için 2024 verileri göz ardı edilmiştir. Yapılan ilk aramada 1074 bilimsel yayına ulaşılmıştır. (Erişim tarihi: Ocak 2024). Daha tutarlı kalitede çalışmaları gözden geçirmek ve anlamlı veri seti elde etmek amacıyla belge türü olarak sadece makaleler seçilmiştir. Daha sonra "Education and Educational Research", "Education Scientific Diciplines", "Education Special" ve "Psychology Educational" kategorileri seçilerek bir filtreleme daha yapılmıştır. Böylece bilimsel yayın sayısı 151'e düşürülmüştür. Daha sonra dil seçimi

yapılmıştır. Sadece İngilizce yapılan yayınlar dahil edilmiş ve incelenecek makale sayısı 150 olarak tespit edilmiştir. Son olarak WoS veri tabanı indeksleri seçilerek ilgili literatür seti oluşturulmuştur. WoS'dan toplam 147 yayının verileri düz metin biçiminde (.txt) indirilmiştir. Veri analizinde betimsel sonuçları ortaya çıkarmak için WoS veri tabanı ve VOSviewer yazılımı kullanılmıştır. Betimsel analiz makale sayılarına göre frekans değerlerini göstermiştir. Ardından bibliyometrik veriler üzerinde VOSviewer yazılımı kullanılarak atıf analizi, ortak atıf analizi ve ortak kelime analizleri yapılmıştır.

Bulgular

Bulgular iki aşamada sunulmuştur. Alt problemlerin sıralaması göz önünde bulundurularak ilk olarak yayınların yıllara ve ülkelere göre dağılımı daha sonra en etkili yazarlara, yayınlara, dergilere ve en çok kullanılan anahtar kelimelere yer verilmiştir. WoS veri tabanında göz izleme teknolojisinin video tabanlı öğrenme alanında kullanımına ilişkin 147 makalenin yıllara göre dağılımı incelendiğinde önemli bir kısmının son yıllarda yapıldığı görülmektedir. 2022 yılında yayın sayısı en yüksek seviyeye ulaşmıştır. ABD 37 yayınla en üretken ülkedir. Bu ülkeyi 30 yayınla Çin, 28 yayınla Almanya takip etmektedir. Atıf sayısına gelince, Hollanda, Almanya ve Çin'in en fazla atıf alan ikinci, üçüncü ve dördüncü ülkeler olduğunu belirtmekte fayda vardır. Toplam bağlantı gücü değeri en yüksek olan yazarın T. van Gog olduğu belirlenmiştir. En çok atıf yapılan yazarlar T. van Gog (300 atıf), H. Jarodzka (266 atıf), K. Scheiter (263 atıf) ve Z. Pi (172 atıf)'dir. Bugüne kadar en çok alıntı yapılan Jarodzka ve diğerleri (2013) tarafından yazılan "Learning to see: Guiding students' attention via a model's eye movements fosters learning" başlıklı makale "Learning and Instruction'' da yayınlanmıştır. En çok atıf alan dergi ise ''Computers & Education'' olmuştur. "Göz takibi'' (f=57), "video dersler'' (f=12), "çoklu ortam öğrenme'' (f=12) ve "bilişsel yük'' (f=11) en sık kullanılan anahtar kelimelerdir. Diğer önemli anahtar ifadeler arasında "göz hareketi'' (f=8), "örnek tabanlı öğrenme'' (f=8), "dikkat'' (f=8) yer almaktadır. Bu tür anahtar kelime sıklığı analizi, bize en çok hangi konuların tartışıldığına ilişkin içgörüler sağlamaktadır. ''öğrenme performansı'', ''yükseköğretim'' ve ''sınıf yönetimi'' gibi anahtar kelimeler son yıllarda öne çıkmaktadır.

Sonuç ve Tartışma

Bu çalışmada WoS veri tabanından toplanan video tabanlı öğrenme ile ilgili 147 göz izleme çalışmasının durumu ve eğilimleri hakkında kapsamlı bir resim elde etmek için bibliyometrik analiz kullanılmıştır. En üretken ülkeler, yazarlar, trend konular, etkili yazarlar, dergiler ve yayınlar keşfedilmiş ve görselleştirilmiştir. Bu keşfin sonuçları, ilgili araştırma yayınlarında önemli bir büyüme olduğunu ve özellikle son yıllarda güçlü bir şekilde geliştiğini ortaya koymuştur. ABD, Çin ve Almanya en yüksek bilimsel üretime sahip ülkeler olurken, en etkili araştırmalar ABD, Hollanda ve Almanya'da yapılmıştır. Yazarlara bakıldığında, Z.Pi ve J. Yang bu alanda en çok yayını olan yazarlardır. T. van Gog H. ve Jarodzka en etkili yazarlardır. "Journal of Computer Assisted Learning'', "Frontiers in Education" makaleleri en çok yayınlayan ilk 2 dergidir. Makale sayısı diğerlerine nazaran az olmasına rağmen en çok atıf alan dergi "Computers & Education'' dergisidir. Bu dergi, eğitim teknolojisi alanında akademik etkisi yüksek ve prestijli bilimsel dergiler arasında yer almaktadır. Bu bilgiler, ilgili alanda çalışan araştırmacılara, makalelerini göndermek için doğru ortağı ve takip etmesi gereken kaynakları seçme konusunda iyi bir referans olabilir (Xu vd., 2022). Birlikte oluşum analizine göre, göz takibi, göz hareketi, video dersler, çoklu ortam öğrenme, bilişsel yük ve dikkat gibi anahtar kelimeler en çok tercih edilen anahtar kelimeler

olmuştur. Birlikte oluşum analizinin sonuçları, ilgili alanın mevcut durumuna ilişkin bütüncül bir resim sağlar.

Sonuç olarak, son yıllardaki teknolojik gelişmeler de dikkate alındığında video tabanlı öğrenme alan yazınında göz izleme cihazı gibi nesnel ölçme araçlarının kullanımın artarak devam etmesi beklenmektedir. Böylece öğrenmenin video ile nasıl geliştiğine ilişkin yeni içgörüler sağlanabilir.