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Eye Tracking Trends in Chemistry Learning: Bibliometric Study 2018-2023 on Google Scholar with VOSviewer and Pivot Table

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Abstract

Eye tracking has become a popular research topic worldwide because it can be used in various research fields such as health, psychology and education. This research aims to identify trend and opportunities for eye-tracking research in chemistry learning (including science and pure chemistry learning) using bibliometric methods from Google Scholar articles. VOSviewer software is used to analyze and visualize the relationship of various elements in the dataset; Pivot Tables also assist it. The research results show that the development of eye-tracking publications in the context of chemistry learning (including science and pure chemistry learning) experienced fluctuations in 2018-2023. The research results on eye tracking, if published, could penetrate reputable journals Q1-Q3, such as the Computers & Education journal, and be published by publishers such as Elsevier. Keywords that often appear in research on eye tracking in learning are "eye movements, eye tracking and virtual reality." Meanwhile, research topics on eye tracking in chemistry learning that are still little researched are related to "drawing, learning processes, stem content knowledge, visual spatial content, gaze tracking, visual problems, perceptual learning." Keywords that is still little research on eye tracking in chemistry learning can be trends and opportunities for further research and publication. Apart from that, it can also be stated together that through VOSviewer and Pivot Table analysis, important information can be found regarding eye tracking research trends in chemistry learning as well as research trend and opportunities regarding the topic of eye tracking in chemistry learning (including science and pure chemistry learning).

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INTRODUCTION

Technology has brought about a significant transformation in the field of education, providing new possibilities for learning, teaching and collaborating. Technological advances in the field of education open up great opportunities for teachers to create exciting teaching materials in the form of text and images, graphics, sound and visuals so as to provide information that is easily understood by students (Molina et al., 2018). The use of technology in education can also help students understand learning material more easily (Pang, 2015) (Molina et al., 2018). According to (Ogochukwu, 2010), the use of technology in learning can make students more motivated, attract students' attention and provide stimulation during the learning process. The use of technology in learning can provide benefits for obtaining efficient information and getting better learning outcomes (Liu & Chuang, 2018). The success of learning by applying technology must be connected to the role of the eyes in receiving information through visual attention (Hahn & Klein, 2022). According to (Sharafi et al., 2015), the method that can be used to determine visual attention during the learning process is using eye tracking.

Eye tracking is a technique used to measure eye movement activity, such as what is seen, what is looked for, what is ignored, and why the eyes blink (Chivu et al., 2018). Eye Tracking is a hardware device that recognizes eye movements on a computer screen or on an object (Bojko, 2013). In the field of research, eye tracking can be used on desktops, smartphones, portable glasses and head-mounted eye tracking devices (King et al., 2019). The use of eye tracking in learning can provide information on eye movements and eye gaze direction (Alemdag & Cagiltay, 2018). Eye tracking can also provide accurate information about a person's interest in a text, object or image (Xiao et al., 2018). In education, eye tracking can be used to observe eye movements and visual attention during the learning process so that cognitive processes can be understood (Hahn & Klein, 2022). Apart from that, eye tracking can also be used to obtain objective research data related to visual attention (King et al., 2019).

Currently, the use of eye tracking is becoming increasingly popular in various fields, such as health, psychology, and has recently begun to see application in education research including chemistry or science learning (Havanki & VandenPlas, 2014). By using eye tracking, researchers can track students' eye movements when studying science or chemistry material, and when solving problems, researchers can also understand how students process information, which areas attract attention and where students may experience difficulties (Cullipher et al., 2018).

The predictive significance of eye tracking for student performance has been shown in earlier research. Since chemistry is a highly visual field, studying visual tactics is especially useful. Additionally, eye tracking detects pupil dilation, which has yet to be tested in authentic learning contexts but correlates with cognitive processes crucial to learning (Peterson et al., 2015). Therefore, to see trends and updates in the use of eye tracking in chemistry learning (including science and pure chemistry), this research carried out a bibliometric analysis. Bibliometric analysis was carried out for the corresponding literature from 2018 – 2023 using VOSviewer and Pivot Table. VOSViewer is used to visualize research results that have been published in various publishers (both books, journals and proceedings). VOSviewer is software created to comprehensively visualize bibliometric networks (van Eck & Waltman, 2014), and its validity can be accounted for (Kurniawati & Cakravastia, 2023). Three types of bibliometric visualization using VOSviewer are Network, Overlay and Density (Li et al., 2023). This research also uses Pivot Tables from Microsoft Excel to analyze research data. Overall, almost 50% of Excel users do not know or even use 80% of all the features in Microsoft Excel (Diana, Nova Eka et al., 2019). Of all the features that Excel has, Pivot Tables are the least used because they are challenging to learn. In fact, Pivot Tables can process millions of rows of data and transform them into a summary report in just a few seconds (Jelen & Alexander, 2010). Pivot Tables are handy in research data analysis because they allow researchers to summarize, organize, and analyze large datasets in a structured and easy to understand way.

It is hoped that the results obtained from this research can provide future research ideas regarding eye tracking in chemistry learning (including science and pure chemistry). Especially regarding the relationship or use of eye tracking with keywords (topics), rarely researched in learning.

METHODS

The method used in this research is an adaptation of the bibliometric method carried out by Fahimnia (Ellegaard & Wallin, 2015; Fahimnia et al., 2015). The aim of using this bibliometric method is to measure and evaluate the results of research so that it can provide information regarding research trends or gaps, opportunities for research and the latest research topics, which in this case is eye tracking in chemistry learning.

As a step to sharpen the research results and answer the problems in the research carried out, bibliometric analysis was carried out and explained quantitatively and qualitatively. Research by (Velasco et al., 2012) stated that topics in bibliometric analysis are carried out and explained qualitatively and quantitatively. Literature mapping using pivot table (excel) and VOSviewer full counting (for authors and keywords). The steps taken in this research are as follows:

Defining Search Keywords and Initial Search Results

Literature searches were carried out using the Google Scholar search engine using keywords such as research titles, namely eye tracking in chemistry learning. All articles analyzed come from the Google Scholar database from 2018 to 2023. The number of articles is limited to a maximum of 200 articles (20 pages from Google Scholar or ten articles/page) plus 11 articles from Google Scholar search results using the "sort by date" category.". Researchers use Google Scholar as a data source because Google Scholar is a service that allows users to search for materials in the form of text in various publication formats. Launched in 2004, the Google Scholar index includes online journals and scientific publications. Through Google Scholar, we can read academic literature from various scientific disciplines, such as articles, papers, books, and scientific works, widely (Jubilee Enterprise, 2010). Researchers set provisions for the literature analyzed to come from any source, be it proceedings, journals, books.

Refinement of The Search Results

The literature resulting from the initial search was then re-selected according to the keywords "eye tracking", "eye movement", "gaze", in "chemistry/science learning/chemistry". Reading keywords that may also appear are "eye gaze", or "eye movement" or "eye movements" or "eye-movement" or "eyemovements" or "eyetracking" or "eye tracking" or "eye-tracking" or "eye gaze tracking" or "eye-gaze tracking" or "eye-based gaze tracking" or "eye gaze tracking" or "visual attention" and "chemistry" or "science" and "education" or "instruction" or "teaching" OR "learning". These keywords can also appear in references used in the literature. This reselection is carried out so that the literature analyzed is of quality. The selected literature is then (carried out at the same time as selection) entered into the Zotero software for further analysis.

Compiling the Initial Data Statistics

All essential information related to the literature, including title, author's origin, abstract, keywords and other literature specifications (publisher and year of publication), are exported to RIS format (research information systems) for analysis so that the literature can be classified based on year of publication, publisher, author's country, journal name and journal ranking (if the literature is published in a journal).

Data Analysis

Bibliometric data analysis in this research used VOSviewer software, which displays (1) visualization of author and keyword networks, (2) overlay visualization of authors and keywords, and (3) novelty and research opportunities. Apart from that, data analysis is also presented using a pivot table regarding the number of publications from year to year (2018-2023), publisher, country of author, journal name and journal ranking (if the literature is published in a journal).

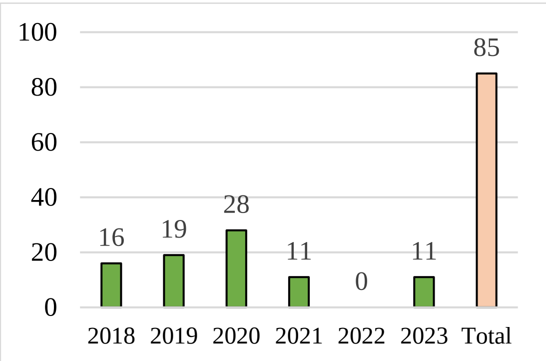
RESULTS AND DISCUSSION

Eye tracking is an interesting topic to use in educational research in order to find out how students learn by tracking eye movements what areas attract students' attention, how long they focus on material, and where there may be comprehension difficulties. This information can help teachers design more effective teaching methods and adapt lesson materials.

(1) Analysis With Pivot Tables

1.1 Number of publications from year to year

Based on the refinement of the search results, 85 pieces of literature (in the form of articles) that matched the keywords in this research (from 211 Google Scholar literature) were found. These 85 articles show that the trend of eye tracking research in chemistry learning from 2018-2023 is experiencing a fluctuating condition. The development trend increased in 2020, as many as 28 articles were published, then in 2021, it decreased to 11 publications, even in 2022 there were no publications related to eye tracking research in chemistry learning (including science and pure chemistry learning). We predict that Covid-19 in 2020-2021 influenced the decline in publications in 2022, where much of the teaching and learning process was online. Large-scale social restrictions made it difficult to conduct empirical research using experimental studies. The trends in eye tracking research in chemistry learning from 2018-2023 can be seen in the graph 1 publication per year.



Graph 1. Publication Every Year

1.2 Publisher Who Published the Article

The pivot table analysis in this research also shows ten (10) publishers who received or published the most related to eye tracking research in chemistry learning from 2018 to 2023. Of the 85 relevant articles, it is known that ten publishers who received or published the most can be seen in table 1.

Table 1. The Top Ten Publisher

No	Publisher	Total
1	Elsavier Ltd and BV	17
2	Multidisciplinary Digital Publishing Institute (MDPI)	7
3	Frontiers Media S.A.	6
4	Nature Publishing Group	5
5	Springer London, Nature and Boston	5
6	Wiley-Blackwell Publishing Ltd	4
7	American Chemical Society	3
8	Public Library of Science	3
9	Springer New York	3
10	SAGE Publications Ltd	2

From Table 1 above, it is known that three publishers have published a lot on eye tracking topics in chemistry learning, namely Elsevier with 17 articles, publisher Multidisciplinary Digital Publishing Institute (MDPI) with 7 articles and publisher Frontiers Media S.A with 6 articles. The three publishers can be explained as follows:

1. Elsevier is a well-known academic publisher providing access to various scientific journals in various fields. The site also offers access to ScienceDirect, which is an important resource in the field of science and technology;
2. MDPI, a leader in academic publishing with open access, has been assisting academic communities since 1996. The Basel, Switzerland-based MDPI seeks to promote free and open scientific communication throughout disciplines. More than 98 journals with significant influence in various domains are published by MDPI. to see the MDPI journals' current impact factors as reported by the Journal Citation Reports. More than 330,000 different writers have had their research published by MDPI, and each month, more than 25 million people visit our journals; and
3. Peer-reviewed, open-access scientific journals in the fields of science, technology, and medicine are published by Frontiers Media SA. The Directory of Open Access Journals (DOAJ) lists Frontiers journals; the publisher has served on the DOAJ council and advisory board since 2019.[6] In addition, Frontiers is a member of the Committee on Publication Ethics (COPE), the International Association of Scientific, Technical, and Medical Publishers (STM), the Open Access Scholarly

Publishers Association (OASPA), and the Initiative for Open Citations.

From the information in Table 1 above, eye tracking research in chemistry learning is widely published in reputable international journals indexed by Scopus. The publication of the theme of eye tracking in chemistry learning in internationally reputable journals indexed by Scopus shows that this topic has received widespread attention in the scientific community and is an indication of the importance of using eye tracking technology in the context of chemistry learning.

1.3 Top 10 Countries of Origin of Researchers

This research also analyzes countries that have conducted a lot of eye tracking research in chemistry learning from 2018 to 2023. Of the 85 relevant articles obtained via Google Scholar, it is known that 10 countries have conducted a lot of research and published research results regarding eye tracking in chemistry learning can be seen in Table 2.

Tabel 2. Top 10 countries of originof researchers

No	Countries	Total
1	United State	27
2	Germany	9
3	England	6
4	China	4
5	Canada	3
6	Finland	3
7	Netherlands	3
8	Spain	3
9	Polandia	2
10	Belgium	2

From Table 2 above, it is known that three countries have conducted a lot of eye tracking research in chemistry learning, namely the United States with 27 articles, Germany with 9 articles and England with 6 articles. From these data, it can be concluded that these three countries have significant interest in applying eye tracking technology in chemistry learning studies (including science and pure chemistry learning). The high number of publications from these three countries indicates the existence of research centres. These universities focus on the field of eye tracking in learning, including chemistry and the existence of solid collaboration between institutions and researchers in the country. The following are some of the article titles from researchers from the United States, Germany and England:

1. Pupil Dilation as Cognitive Load Measure in Instructional Videos on Complex Chemical Representations (Rodemer et al., 2023);
2. Using Concept Maps to Support Prospective Chemistry Teachers in Interconnecting Chemical Contents (Birkenstock & Di Fuccia, 2023);
3. Multipurpose and Reusable Ultrathin Electronic Tattoos Based on PtSe2 and PtTe2 (Kireev et al., 2021);
4. Machine Learning Algorithm Validation with a Limited Sample Size (Vabalas et al., 2019);
5. Integrating Metacognitive Judgments and Eye Movements Using Sequential Pattern Mining to Understand Processes Underlying Multimedia Learning (Mudrick et al., 2019).

In Indonesia, as far as we have observed and searched as researchers, there has been no research in the form of experiments regarding the use of eye tracking in chemistry learning, science learning or pure chemistry. The research we conducted regarding eye tracking and published in 2020 is a literature review entitled "Eye-tracking and metacognitive skills: A review on the use of eye-tracking for measuring students' metacognitive skills in chemistry learning" (Muna & Bahit, 2020). This research has been cited 12 times, with 6 published in publishers indexed by Scopus

1.4 The Top Ten Journals Contributing to Eye Tracking in Chemistry Learning

The results of data analysis also obtained ten journals that received a lot of research results on the topic of eye tracking in chemistry learning from 2018 to 2023. Ten (10) journals that received research results on the topic of eye tracking in chemistry learning (including science and pure chemistry learning) were able to see in Table 3.

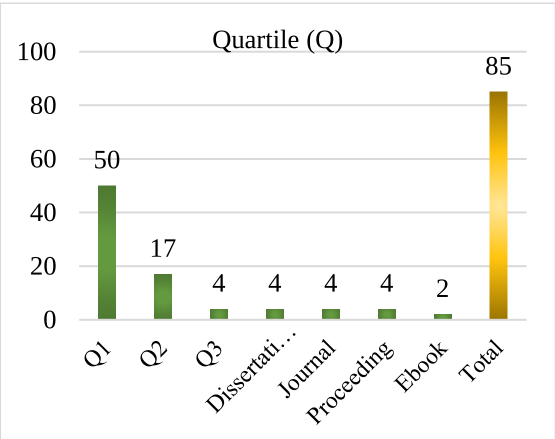
Table 3. The Top Ten Best Journals that Publish Eye Tracking in Chemistry Learning

No	Journal	Total
1	Computers & Education	4
2	Computers in Human Behavior	3
3	PLOS ONE	3
4	Scientific Reports	3
5	Acta Chimica Slovenica	2
6	Education and Information Technologies	2
7	Education Sciences	2
8	Educational Psychology Review	2
9	Frontiers in Education	2
10	Learning and Instruction	2

From Table 3 above, it is known that the journals that receive the most eye tracking topics in chemistry learning (including science and pure chemistry learning) are journals in the fields of education, science and technology. The topic of eye tracking has cross-disciplinary relevance and is accepted in journals in specific fields. This indeed allows for broader dissemination of information between different scientific communities.

1.5 Journal Ranking (Quartile Scopus) Research Eye Tracking in Chemistry Learning

The results of data analysis on 85 relevant articles showed that 83.5% or 71 articles were published in journals with Quartiles 1 to 3. Graph 2 Journal Ranking (Quartile Scopus) research eye tracking in chemistry learning.



Grafik 2. Journal Ranking (Quartile Scopus) research eye tracking in chemistry learning

From Graph 2 above, it is known that 58.8% or 50 eye tracking research articles in chemistry learning were accepted in the international journal Scopus Quartile 1, 20% or 17 articles were accepted in Scopus Quartile 2, and 4.4% or 4 articles were accepted in Scopus Quartile 3. Total articles that are widely accepted in international journals indexed in Scopus Quartile 1, 2 and 3 show that these articles have been recognized academically in the scientific community because journals indexed in Scopus undergo a strict peer review process and have high quality standards in their publication. This illustrates that research in the field of eye tracking in chemistry learning has been well received in internationally recognized scientific literature. This trend shows that the use of eye tracking in the context of chemistry learning (including science and pure chemistry learning) is a significant and exciting topic for researchers in various parts of the world. Eye tracking in chemistry learning can be used to measure metacognitive skills. The use of eye tracking, makes it easier to find out the relevant factors that influence the use of eye tracking in learning, including problem solving (Muna & Bahit, 2020).

(2) Analysis with VOSviewer – Full Counting Authors (Researchers) and Keywords

VOSViewer 1.6.19 software is used to map eye tracking research trends in chemistry learning (which also includes science and pure chemistry learning) using based on text data that has been processed using Zotero software. Data that has been processed using Zotero is exported into RIS form for import into VOSViewer.

The "Full counting author" analysis using "create a map based on bibliographic data" (Karim, 2022). Then, in the data source, use the read data form reference manager file with type RIS. The counting method uses full counting with "maximum number of authors per document" and "minimum number of documents of an author", according to the default from VOSveiwer.

The "full counting keyword" analysis also uses "create a map based on bibliographic data" (Karim, 2022). "Type of analysis" is in the form of co-occurrence, "unit analysis" is keywords, "counting method" is full counting. In full counting with "choose threshold, the minimum number of occurrences of a keyword is 1" and "choose number of keywords is 208".

The output resulting from analysis using VOSviewer is (1) visualization of the author's network, which can be seen in Figures 1 and 2; (2) author overlay visualization, which can be seen in Figure 3. Next, (3) keyword visualization, which can be seen in Figure 4 and Figure 5; (4) overlay visualization and density visualization of keywords, which can be seen in Figures 6 and 7, and (5) research gaps and opportunities.

2.1 Full Counting Author (Researcher)

Two clusters were found in the writer's network. The Cluster 1 was occupied by two writers (red dots), and the Cluster 2 was occupied by one writer (green dots). The number of networks and network strength of each author can be seen in the network visualization. For example, Claudia Gonzalez Viejo has a total of 1 network with other authors (Figure 1), with a total link strength of 3 (Figure 2).

Figure 1. Author Network Visualization

Figure 2. Most Productive Writers

There are three authors (researchers) who have published a lot of research on eye tracking in learning, including learning chemistry, science and pure chemistry, namely:

1. Sigfredo Fuentez (Gonzalez Viejo et al., 2018, 2019, 2023): School of Agriculture and Food, Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Parkville, VIC 3010.
2. Claudia Gonzalez Viejo (Gonzalez Viejo et al., 2018, 2019, 2023): School of Agriculture and Food, Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Parkville, VIC 3010.
3. Richard E. Mayer (Mayer et al., 2020): University of California, Santa Barbara, USA. Department of Psychological and Brain Sciences, University of California, Santa Barbara, CA, 93106, USA.

The results of the analysis on the author's overlay visualization found that for authors with bright dots, the literature (articles) they wrote were the latest articles. In contrast, authors with dark dots showed that their articles had been published previously. Writers from Cluster 1 are new writers, while writers from Cluster 2 are old writers (Figure 3).

Figure 3. Author Overlay Visualization

2.2 Full Counting Keywords

VOSViewer results for "full counting keywords" obtained 162 keywords that appeared 1 to more than 1 time. The 162 keywords are spread across 19 clusters, with 513 links and 518 link strengths (can be seen in Figure 4). That is:

(1) **Kluster 1 (15 items)**: anterior segment, cornea, data mining, eyes, gaze, inference, iris, optical coherence tomography angiography, provacy, pupil, questuinnaires, signal filtering, vascularisation, vision, and working memory.

(2) **Kluster 2 (14 items)**: agency, augmented reality, eye fixation, gestures, multimedia, physics, social processes, systematic review, teaching, teaching methods, technology-

enhanced learning, test instruction, virtual laboratories, visual tracking.

(3) **Kluster 3 (13 items)**: direct gaze, electroencephalogram, engagement, eye gaze behavor, face detection, gamification, gaze guidance, moocs, motivation, online learning, science education, student-teacher interaction, systematic literature review.

(4) **Kluster 4 (12 items)**: ar, candle, chemistry, cognitive sciencem design parameters, ed.ucation, experiment, eye-tracking, intelligent ui, learning environment, mind wandering, wax

(5) **Kluster 5 (11 items)** : gaze tracking, industrial maintenance, operator training simulation, process simulators, safety, spatial ability, stem, training assessment, virtual prototyping, augmented reality, virtual reality, vr.

(6) **Kluster 6 (10 items)**: cognition, collaborative learning, grade prediction, item analysis, knowledge discovery, learning, learning analytics, multimodality, regulation of learning, student performance.

(7) **Kluster 7 (9 items)**: attention, development, dreadds, drift diffusion moel, emotion, nonhuman primate, preferential choice, response times, social.

(8) **Kluster 8 (9 items)**: calibration, effort, effort regulation, granularity, judgements of learning, monitoring, self – regulated learning, self – report, trace data.

(9) **Kluster 9 (8 items)**: drawing, instructional design, instructional video, learning processes, stem content knowledge, video demonstrations, video lectures, visual-spatial content.

(10) **Kluster 10 (8 items)**: biblometric analysis, clustering analysis, differential sequence mining, inststructional principles, metacomprehension, multimedia learning, multiple representations, sequential pattern mining.

(11) **Kluster 11 (7 items)**: earth's moon. Equipment, human learning, moons, psychological attitudes, regression analysis, video games.

(12) **Kluster 12 (7 items)**: best practicesm emme, eye tracking, open science, perceptual learning, pupillometry, visual problems.

(13) **Kluster 13 (7 items)**: elementary proportional logic, mathematics, multimedia effect, multiple symbolic representations, problem solving, test item design, test-taker motivation.

(14) **Kluster 14 (6 items)**: credibility assessment, deceptions detection, eye movements, facial micro-gestures, nonverbal behavior analysis, psychological profiling.

(15) **Kluster 15 (6 items)**: cognitive load, eda, eeg, eog, mental effort, physiology.

(16) **Kluster 16 (6 items)**: evalution methodologies, human-computer interface, multimedia/hypermedia systems, pedagogical issues, post-secondary education, teaching/learning strategies.

(17) **Kluster 17 (5 items)**: data analysis, event classification, head-mounted eye tracking, mobile eye tracking, wearable eye tracking.

(18) **Kluster 18 (5 items)**: distance education and online learning, learning outcome, media in education, signaling, virtual laboratory.

(19) **Kluster 19 (4 items)**: biomedical engineering, human behaviour, learning and memory, predictive markers.

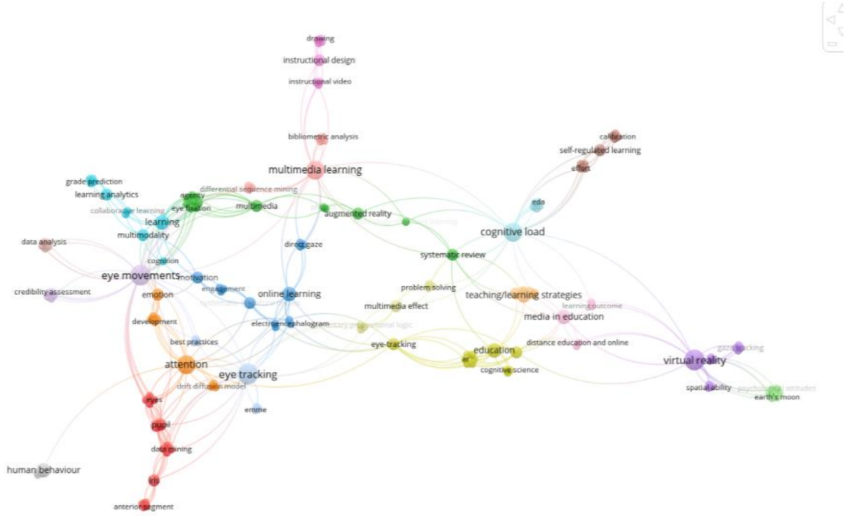


Figure 4. Network visualization for keywords

Each keyword is identified for its occurrence and total path strength. The most occurrences were found in the keyword "eye movement, eye tracking, virtual reality", and the highest total link strength was found in the keyword "eye movement" at 35 (Figure 5).

Selected	Keyword	Occurrences	Total link strength
☑	eye movements	6	35
☑	eye tracking	6	25
☑	virtual reality	6	25
☑	attention	5	22
☑	cognitive load	5	22
☑	multimedia learning	5	20
☑	learning	3	18
☑	machine learning	3	16
☑	education	3	15
☑	pupil	2	14
☑	vision	2	14
☑	eye-tracking	2	13
☑	multimedia	2	13
☑	chemistry	2	12
☑	media in education	3	12
☑	online learning	3	12
☑	iris	2	11
☑	agency	1	10
☑	eye fixation	1	10
☑	gestures	1	10
☑	social processes	1	10
☑	teaching	1	10
☑	teaching methods	1	10
☑	teaching/learning strategies	3	10
☑	test construction	1	10
☑	visual tracking	1	10

Figure 5. Keywords – Occurrence and Total Link Strength

Furthermore, the overlay visualization (Figure 6) resulting from the analysis results can be used to identify areas of research focus, changes in trends over time, or correlations between different variables in the study. In other words, through overlay visualization, we can detect keywords from current research by focusing on keywords with bright circles (Nurlaila et al., 2023).

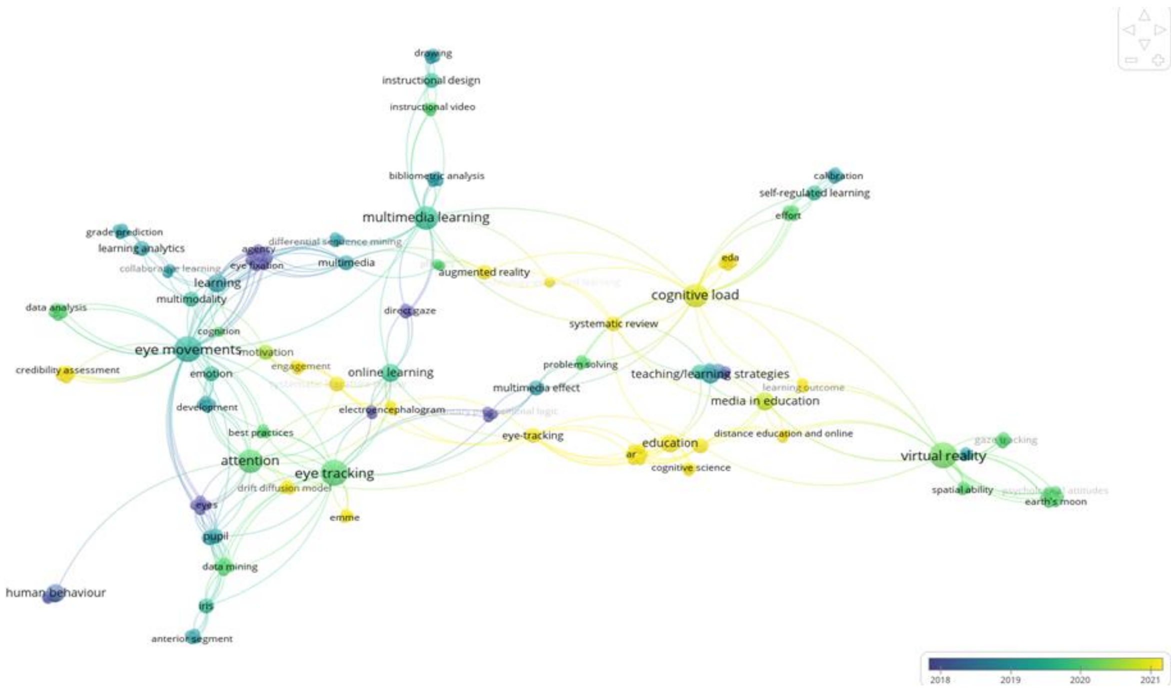


Figure 6. Overlay Visualization for Keywords

Keywords with bright circles also show the current keyword's relationship with other related keywords. The final visualization presented from the analysis using VOSviewer is density visualization. This density visualization is another form of overlay visualization, which shows the research area (related topics in the research). The darker the colour in the density visualization (e.g. yellow), the more research has been carried out regarding that topic or keyword), and vice versa (e.g. bright yellow or greenish). Density visualization can be seen in Figure 7.

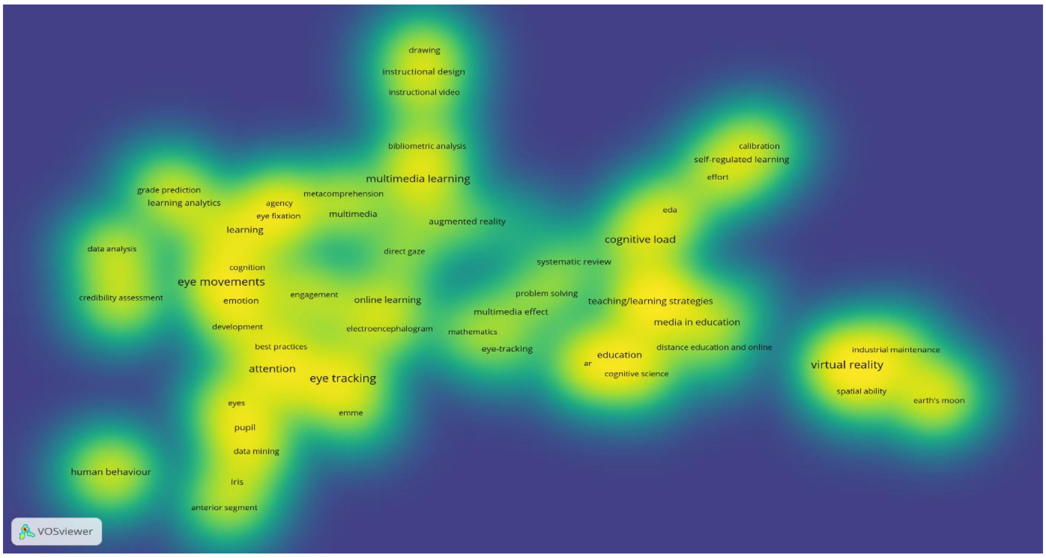


Figure 7. Density Visualization

Figure 7, shows that eye tracking research in chemistry learning (including science and pure chemistry learning) is mainly related to keywords including "eye tracking, eye movement, education, virtual reality, multimedia learning, teaching/learning strategies, cognitive load, and attention". There is still little research related to keywords marked with unlit colours, such as "drawing, learning processes, stem content knowledge, visual spatial content, gaze tracking, visual problems, perceptual learning". Then there are trends and also as gaps and opportunities for renewable research by taking these topics or keywords in research on the topic of eye tracking in chemistry learning.

Some examples of research titles that might be developed for future research refer to keywords that are still little used, such as:

1. the use of eye tracking in measuring the ability to draw the molecular structure of chemical compounds in studying chemical bonds. Previous research on a similar topic that can be used as a reference is "Let's draw molecules: Students' sequential drawing processes of resonance structures in organic chemistry" (Braun et al., 2022).
2. Analysis of the chemistry learning process using eye tracking to measure students' attention and focus. Previous researches on a similar topic that can be used as a reference are "Analysis of the learning process through eye tracking technology and feature selection technique" (Sáiz-Manzanares et al., 2021), and "An eye tracking based investiogation of multimedia learning design in science education textbook" (Altan & Cagiltay, 2022).
3. Teacher and student perception about learning process in chemistry: study eye tracking. Previous researches on a similar topic that can be used as a reference are "Studentt's perspective and teachers' metacognition: applications of eye-tracking in education and scientific research in schools" (da Silva Soares et al., 2021), and "Investigating visual perception in teaching and learning with advanced eye-tracking methodologies: rewards and challenges of an innovative research paradigm" (Nückles, 2021)

The results of data analysis and reading of relevant literature also gave rise to information that the use of eye tracking in learning is expected to help educators obtain a variety of information that can be used as a basis for developing learning innovations (Muna & Bahit, 2020). The development of learning innovation can also help students solve problems during and after the learning process, as well as help students reflect on what they have done during learning and problem solving.

CONCLUSION

The importance of eye tracking in the context of chemistry learning (including science and pure chemistry learning) allows exploration of how eye tracking technology can be used to understand students' thinking patterns, visual responses to chemical material and problem solving, or even the effectiveness of teaching methods. Based on the results and discussion it can be concluded that the development of eye-tracking publications in the context of chemistry learning (including science and pure chemistry learning) experienced fluctuations in 2018-2023. The research results on eye tracking, if published, could penetrate reputable journals Q1-Q3, such as the Computers & Education journal, and be published by publishers such as Elsevier. Keywords that often appear in research on eye tracking in learning are "eye movements, eye tracking and virtual reality." Meanwhile, research topics on eye tracking in chemistry learning that are still little researched are related to "drawing, learning processes, stem content knowledge, visual spatial content, gaze tracking, visual problems, perceptual learning." Keywords that is still little research on eye tracking in chemistry learning can be trends and opportunities for further research and publication. With VOSviewer and Pivot Table analysis, important information can be found regarding eye tracking research trends in chemistry learning (including science and pure chemistry learning) as well as research gaps and opportunities (recentness) regarding the topic of eye tracking in chemistry learning (including science and pure chemistry learning).

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