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STREAM Approaches (Science, Technology, Religion, Engineering, Arts, Mathematics) Integrated Halal in Chemistry Learning

Fitri Yati Sa'diah [a,1*], Tri Wahyu Agustina [b,2], Tri Cahyanto [c,3], Neneng Windayani [d,4]

[a,b] Department of Master of Science Education, State Islamic University Sunan Gunung Djati Bandung, Bandung, 40614, Indonesia
[c] Department of Biology Science, State Islamic University Sunan Gunung Djati Bandung, Bandung, 40614, Indonesia
[d] Department of Chemistry Education, State Islamic University Sunan Gunung Djati Bandung, Bandung, 40614, Indonesia

[1]fitriyatisadiah1008@gmail.com ; [2]triwahyuagustina@uinsgd.ac.id; [3]tri_cahyanto@uinsgd.ac.id ;
[4]nenengwinda.ftk@uinsgd.ac.id
*corresponding author

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Abstract

This study examines the development and impact of project-based chemistry learning using a STREAM approach that incorporates halal values through a bibliometric analysis. The main issue addressed is the limited integration of halal values in chemistry education, which reduces its relevance for students, as well as the lack of innovative approaches to enhance student engagement and creativity. The study employs bibliometric analysis based on metadata from Publish or Perish, mapped using VOSviewer. Data were collected from Google Scholar over the past decade. The analysis results indicate that while the number of publications fluctuates, there has been a rising trend in research on this topic in recent years. Data visualization identifies several main clusters that illustrate relationships between related concepts. The integration of halal values in chemistry learning through a STREAM approach has been shown to enhance student motivation and engagement while fostering creativity. However, this research is limited by its reliance solely on Google Scholar as a data source and the absence of empirical classroom analysis. Future studies are recommended to conduct direct research in learning environments and expand data sources to obtain a more comprehensive understanding.

1. INTRODUCTION

In this era of globalization, education plays a crucial role in producing students who are prepared for the demands of the 21st century. This includes equipping young people with critical thinking skills, creativity, and the ability to solve problems effectively (Ojetunde & Ramnarain, 2023). Chemistry education is particularly important in developing students' scientific competencies, as well as their critical and creative thinking skills (Novitasari & Aznam, 2023). However, in

practice, chemistry learning in schools remains primarily focused on conventional approaches that emphasize theory, while lacking practical and contextual activities for students (Fahrudin et al., 2021). These traditional learning methods often result in low student engagement and fail to foster critical and creative thinking skills (Mahanal et al., 2019). Therefore, it is essential to explore alternative and innovative learning methods that can enhance the quality of chemistry education, making it more accessible and relevant to everyday life. Additionally, the limited integration of religious and ethical values in chemistry education makes learning feel less meaningful and relevant for students with religious backgrounds (Ningruma et al., 2020).

One approach that is gaining increasing popularity in education is project-based learning (PjBL), which has been proven effective in enhancing student engagement, critical thinking, creativity, and collaboration skills (Wang, 2022). PjBL enables students to learn through direct experience by completing real-world projects relevant to their lives, emphasizing active student involvement in solving authentic problems through meaningful and applicable projects (Wardani, 2023). However, despite its many advantages, the implementation of PjBL in chemistry education in Indonesia offers many benefits but is not without challenges. One of the main problems faced is the insufficient integration of the chemistry curriculum with religious and ethical values, which play a crucial role in shaping students' holistic character. A study by Putri et al. found that integrating chemistry teaching with religious values can have a positive impact on students' understanding of the subject matter (Putri et al., 2023). Another study by Suryaningsih et al. also revealed that chemistry learning materials integrated with Islamic values can serve as an important reference source in chemistry education within an Islamic context (Suryaningsih et al., 2020).

Project-based chemistry learning with a STREAM approach (Science, Technology, Religion, Engineering, Arts, Mathematics) integrated with halal values is a promising solution. The STREAM approach not only combines various disciplines to provide a comprehensive learning experience but also instills religious values and ethics in the learning process. This approach is expected to enhance learning motivation and student engagement while also developing students' critical and creative thinking skills (Agustina et al., 2020).

The integration of halal values into project-based chemistry learning, particularly through the STREAM approach, represents a significant development for educational contexts in Indonesia, which is predominantly Muslim. The incorporation of halal principles extends beyond dietary restrictions to influence various domains, including ethics within science and technology, as well as aligning educational practices with cultural and religious values. Incorporating halal values within the broader educational framework is essential, as it promotes an understanding that the ethics of science should reflect the values of the communities it serves. Studies indicate that the integration of halal education in educational institutions correlates with enhancing halal literacy among students (Risza, 2024). This supports the idea that halal-oriented education fosters awareness and comprehension of ethical practices specific to Muslim traditions, which is crucial for developing a culturally responsive educational model in Indonesia (Faizah et al., 2023). Thus, integrating halal values into chemistry learning can help students understand the importance of religious principles in both daily life and scientific contexts.

Therefore, this bibliometric analysis is conducted to examine the development and impact of project-based chemistry learning with an integrated STREAM approach. This analysis aims to identify research trends, research gaps, and the effectiveness of this approach in enhancing students' critical thinking skills (Herawati et al., 2022). Additionally, it provides a comprehensive overview of research developments in this field, including the identification of frequently discussed topics. Through this study, it is expected to offer guidance and recommendations for educators in implementing an integrated STREAM approach to halal-based chemistry learning, thereby fostering a more inclusive, relevant, and practical learning environment grounded in religious and ethical values.

2. METHOD

This study employs bibliometric analysis methods based on metadata generated by Publish or Perish (POP) (Susanti et al., 2022). Bibliometric analysis is a method that involves summarizing multiple articles on specific topics into a single document. Research articles were retrieved using Harzing's Publish or Perish application (Horata, 2024). Data collection in POP was conducted three

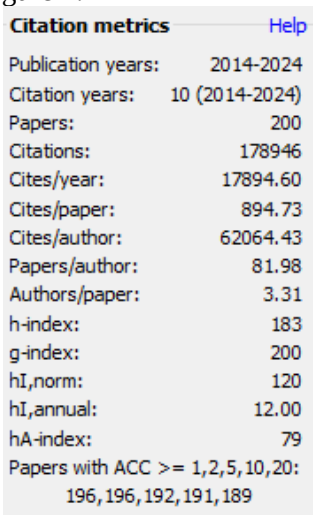
times using the following keywords: (1) Science-Technology-Religion-Engineering-Arts-Mathematics (STREAM) and Project-Based Learning, (2) STREAM and Halal Literacy, and (3) STREAM and Chemistry Learning.

All articles analyzed in this study were sourced from the Google Scholar database. The data search was conducted in June 2024 using a time interval filter of 2014–2024 (the past 10 years). This approach aimed to generate relevant references for further research and identify recent developments in the field. Google Scholar, as a web-based service, provides access to various academic literature sources, including peer-reviewed papers, theses, and journal articles, ensuring the diversity and quality of the data obtained (Mulyani et al., 2024). In this study, data collected using Publish or Perish (PoP) were saved in RIS (Research Information System) format for further processing in VOSviewer, utilizing a binary calculation pattern to enable visual data analysis (Herman et al., 2024). By using Google Scholar, researchers can leverage a reliable tool for finding and managing literature based on strict document selection criteria (Rahmadina et al., 2024; Doyan et al., 2024).

The word frequency in the title and abstract is set to three occurrences, assuming this is sufficient to represent the frequency of word usage in these sections. The results from VOSviewer are visualized through network mapping, overlay, and density representations. The Network Visualization function is used to interpret relationships between clusters, as well as relationships between clusters and items or between items themselves. The Overlay Visualization illustrates the research trends over the past few years (McAllister et al., 2022). The Density Visualization represents the concentration of research output (Sood et al., 2021).

3. RESULTS AND DISCUSSION

Based on the results of article collection from POP using the Google Scholar database, 200 articles were found for the first keyword combination, "STREAM and Project-Based Learning," as shown in the POP output matrix in Figure 1.



Citation metrics	Help
Publication years:	2014-2024
Citation years:	10 (2014-2024)
Papers:	200
Citations:	178946
Cites/year:	17894.60
Cites/paper:	894.73
Cites/author:	62064.43
Papers/author:	81.98
Authors/paper:	3.31
h-index:	183
g-index:	200
hI,norm:	120
hI,annual:	12.00
hA-index:	79
Papers with ACC >= 1,2,5,10,20:	
196,196,192,191,189	

Figure 1. STREAM and Project-Based Learning Matrix

The pop citation matrix, which includes the keywords "STREAM" and "Project-Based Learning," has received 178,946 citations. The average number of citations per year is 17,894.60, with an average of 894.73 citations per article. The number of articles published over the past 10 years is presented in Table 1. The highest number of publications was in 2017, with 37 articles, while no articles were published in 2023. The H-index is 183..

Table 1. Number of Research Topic Publications: STREAM and Project-Based Learning

Publication year	Number of publications
2014	32
2015	29
2016	27
2017	37
2018	19

2019	13
2020	23
2021	10
2022	5
2023	0
2024	5
Amount	200

Based on the trend of STREAM research topics and project-based learning over the past 10 years, the number of publications has experienced significant fluctuations. Although there were several years with an increase in publications, the overall trend showed a decline, especially after the peak in 2017. However, within the first six months of 2024, it can be assumed that the trend of research topics will increase.

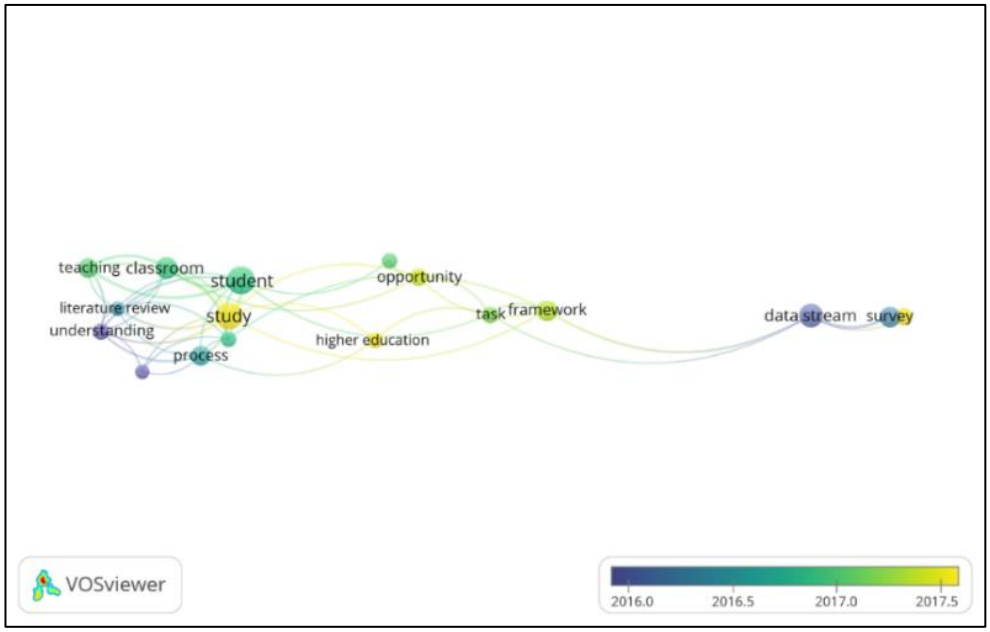


Figure 2. Overlay Visualization STREAM dan Project-Based Learning

The overlay visualization mapping of STREAM research topics and Project-Based Learning is shown in Figure 2. There are four main clusters. Cluster 1 consists of six items: Application, Literature Review, Project-Based Learning, Process, Study, and Understanding. Cluster 2 consists of five items: Framework, Higher Education, Innovation, Opportunity, and Task. Cluster 3 consists of three items: Classroom, Student, and Teaching. Cluster 4 consists of three items: Data STREAM, Deep Learning, and Survey.

Based on the visual mapping of the Network STREAM Research Topics and Project-Based Learning in these four clusters, the application of the STREAM and PjBL concepts has excellent potential for integration into the learning process. The use of the PjBL model has a positive impact on increasing student motivation and learning outcomes, as it engages students in collaboration and teamwork, fostering social interaction and support among group members (Minarti et al., 2023).

In the overlay visualization mapping, blue items represent research topics that researchers have extensively discussed over time. Conversely, yellow items indicate research topics that are still actively being discussed. Based on Figure 5, the blue items include understanding, STREAM data, survey, process, literature review, and application. Meanwhile, the yellow items include studies, higher education, frameworks, deep learning, tasks, teaching, opportunities, and innovation.

Researchers continue to discuss the topic of STREAM and project-based learning as a learning framework to foster innovation and deepen understanding. PjBL, as a pedagogical approach, can enhance students' comprehension through real-world projects related to STREAM concepts, thereby creating opportunities for innovation in classroom assignments (Hotimah, 2022).

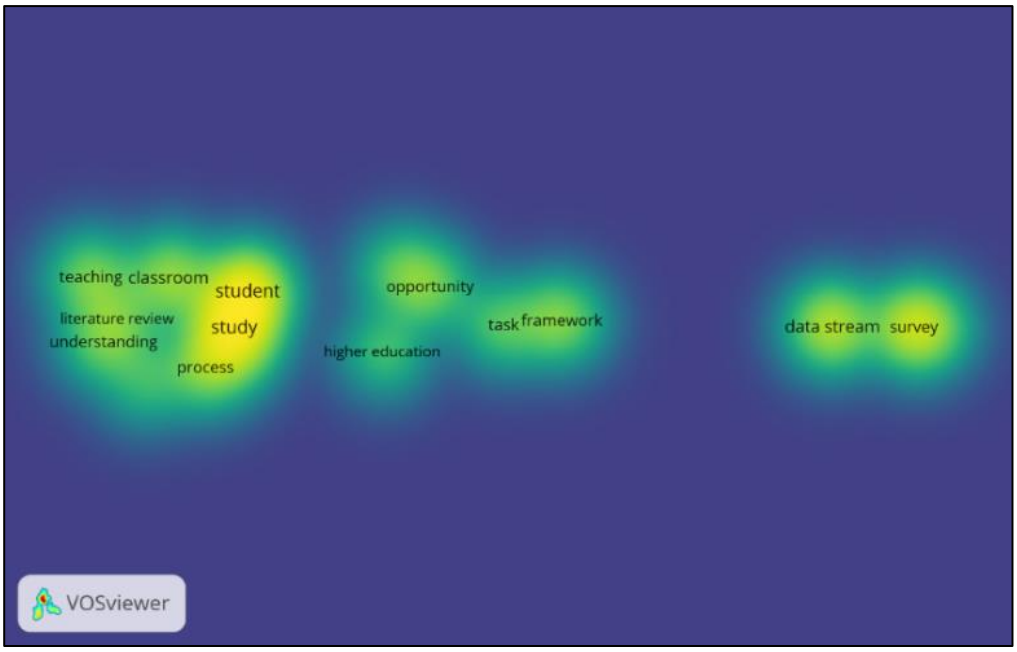


Figure 3. Density Visualization STREAM dan Project-Based Learning

In visual density analysis, the brighter the color of an item, the more frequently it has been examined. Figure 3 shows that, over the past 10 years, the most widely studied items have included Study, Understanding, Student, Classroom, Process, and Survey. In contrast, less frequently studied items include Innovation, Project-Based Learning, Opportunities, higher education, Application, data stream, Process, Literature Review, Task, and Framework. This indicates that research on STREAM-integrated PjBL is still limited, particularly in developing a framework that applies learning innovations at higher education levels.

The integration of STREAM and PjBL allows students to engage in real-world projects that combine various disciplines, enhance critical and collaborative thinking skills, and foster innovation and creativity (Effendi & Yoto, 2024). A well-defined framework for implementing PjBL can facilitate a deeper understanding and effective utilization of STREAM data to improve student learning outcomes (Almuzhir, 2022). Future research on the application of PjBL can employ survey methods to collect data and deep learning techniques to analyze results, providing deeper insights into the effectiveness of this approach in developing 21st-century skills.

The second keyword, "STREAM" and "halal literacy," has produced 200 articles, with the output matrices shown in Figure 4.

Citation metrics	Help
Publication years:	2014-2024
Citation years:	10 (2014-2024)
Papers:	200
Citations:	2335
Cites/year:	233.50
Cites/paper:	11.68
Cites/author:	1354.00
Papers/author:	115.28
Authors/paper:	2.41
h-index:	24
g-index:	46
hI,norm:	15
hI,annual:	1.50
hA-index:	13
Papers with ACC >= 1,2,5,10,20:	88,62,37,19,9

Figure 4. STREAM and Halal Literacy Citational Matrix

The pop citation matrix, which includes the keywords "STREAM" and "Halal Literacy," has received 2,335 citations. The average number of citations per year is 233.50, with an average of 11.68 citations per article. The number of published articles over the past decade is shown in Figure 18. The highest number of publications was in 2023, with 41 articles, while the lowest was in 2014, with five articles. The H-index is 24.

Table 2. Number of Research Topic Publications STREAM and Halal Literacy

Publication year	Number of publications
2014	5
2015	7
2016	7
2017	7
2018	9
2019	13
2020	19
2021	17
2022	23
2023	41
2024	33
Amount	200

Based on the trend of STREAM and halal literacy research topics over the last 10 years, there has been an increasing trend in the number of publications from 2014 to 2023, with a particularly significant rise in 2023. However, in 2024, the number of publications has decreased compared to the previous year, although it remains relatively high compared to the early years of the analyzed period. Nevertheless, considering the span of the first six months of 2024, research on STREAM and halal literacy will likely increase by the end of the year

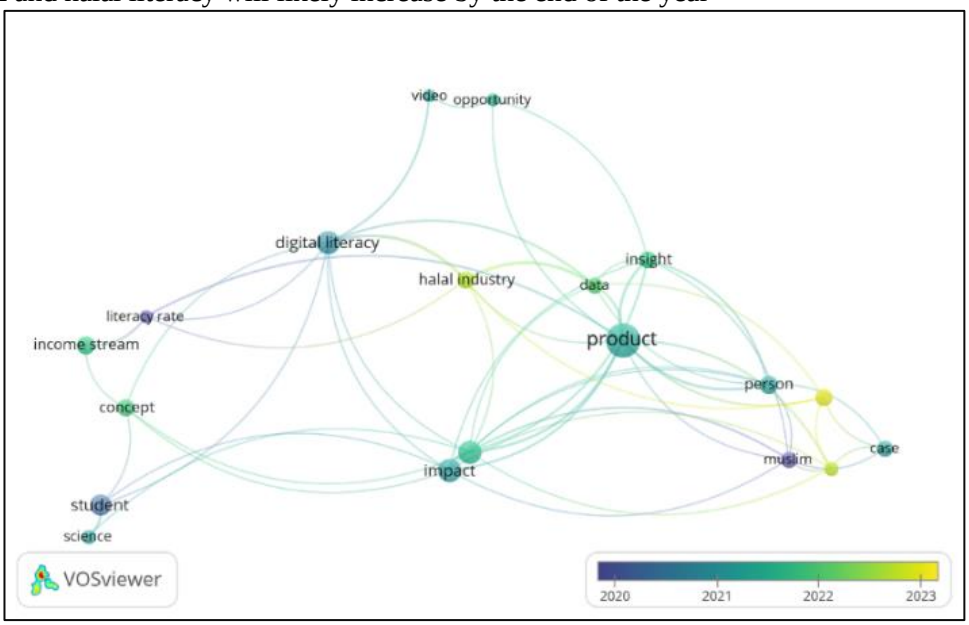


Figure 5. Overlay Visualization STREAM and Halal Literacy

The overlay visualization network mapping of STREAM and Halal Literacy research topics is shown in Figure 5. There are five main clusters. Cluster 1 consists of six items: cases, halal certification, halal literacy, Muslim, person, and product. Cluster 2 consists of four items: impact, research STREAM, science, and student. Cluster 3 consists of four items: digital literacy, insight, opportunity, and video. Cluster 4 consists of three items: concept, income STREAM, and literacy rate. Cluster 5 comprises two items: data and the halal industry. Based on these five clusters, topics such as halal certification and halal literacy illustrate how halal literacy influences Muslim consumers' awareness of the products they consume. Halal literacy empowers Muslim students to appreciate the significance of consuming halal products, not only from a religious perspective but also in terms of their health and economic benefits. By developing a strong understanding of halal

certification, students can become more critical in selecting products that align with halal principles (Miladanta et al., 2024).

The Visual Overlay of authentic assessment keywords is shown in Figure 5. The dimly lit items include Student, Literacy Rate, Muslim, Impact, Product, Video, and Person, indicating that these topics have been discussed for a long time. In contrast, the brightly lit items, such as Halal Certification, Halal Industry, Halal Literacy, Income STREAM, Data, Concept, Research STREAM, and Opportunity, represent research topics that are still actively discussed by researchers today. Halal Certification, Halal Literacy, and STREAM remain trending topics widely explored by researchers. This presents an opportunity for further research integrating STREAM with Halal Literacy to enhance critical thinking skills in identifying halal products that comply with Islamic law (Rahayu et al., 2023).

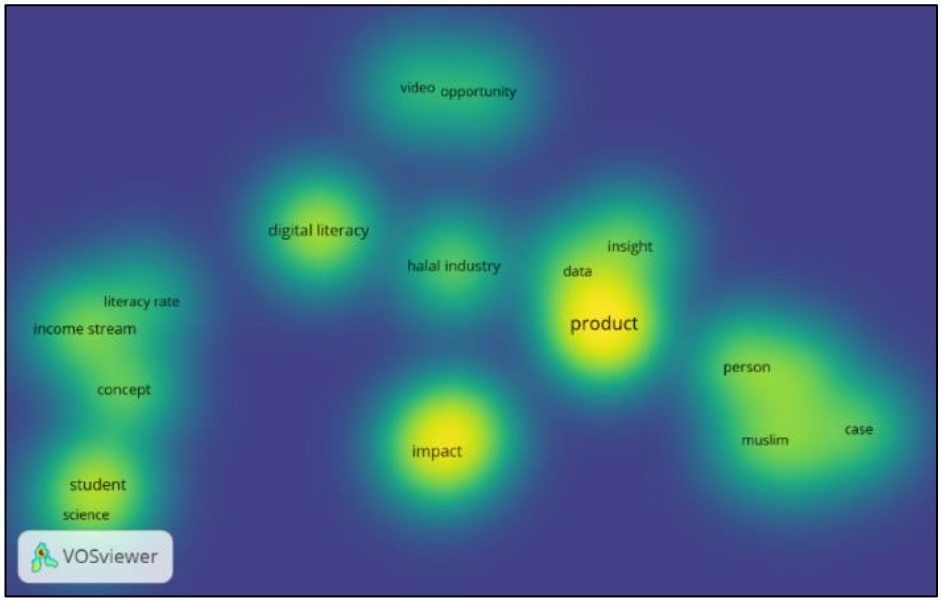


Figure 6. Density Visualization STREAM and Halal Literacy

The visual density of keywords related to STREAM and Halal Literacy is evident in Figure 6. The dimly lit items include Halal Certification, Halal Industry, Literacy Rate, Research STREAM, Concept, Income STREAM, Video, and Opportunity, indicating that these research topics have not been widely explored. In contrast, the brightly lit items represent product and impact, suggesting that these topics have been extensively researched. STREAM research topics leverage digital literacy to enhance students' understanding of scientific and technical concepts through media such as videos and data. This presents opportunities to improve students' literacy levels. Additionally, this research topic presents an opportunity to enhance science education among Muslim students, expand their knowledge, and improve digital literacy, which has a positive impact on the halal industry.

The fifth keyword, "STREAM and Chemistry Learning," has produced 200 articles, with the output matrix shown in Figure 7.

Citation metrics Help

Publication years:	2014-2024
Citation years:	10 (2014-2024)
Papers:	200
Citations:	92925
Cites/year:	9292.50
Cites/paper:	464.63
Cites/author:	36218.33
Papers/author:	70.75
Authors/paper:	3.62
h-index:	156
g-index:	200
hI,norm:	81
hI,annual:	8.10
hA-index:	65
Papers with ACC >= 1,2,5,10,20:	190,189,182,175,157

Figure 7. STREAM and Chemistry Learning

The pop citation matrix, which includes the keywords "STREAM" and "Chemistry Learning," has received a total of 9,292.50 citations. The average number of citations per year is 9,292.50, with an average of 464.63 citations per article. The number of articles published over the past 10 years is presented in Table 3. The highest number of publications was in 2020, with 27 articles, while the lowest number of publications was in 2023, with only three articles. The H-index is 156.

Table 3. Number of Research Topic Publications STREAM and Chemistry Learning

Publication year	Number of publications
2014	25
2015	19
2016	20
2017	22
2018	21
2019	23
2020	27
2021	18
2022	14
2023	3
2024	5
Amount	200

There was a decreasing trend in the number of publications from 2014 to 2024, especially after reaching its peak in 2020. A significant decline was observed from 2021 to 2023, with a drastic decrease in the number of publications. In 2024, although there was a slight increase, the number of publications remains very low. However, since 2024 still has six months remaining, the trend on this topic could increase compared to previous years.

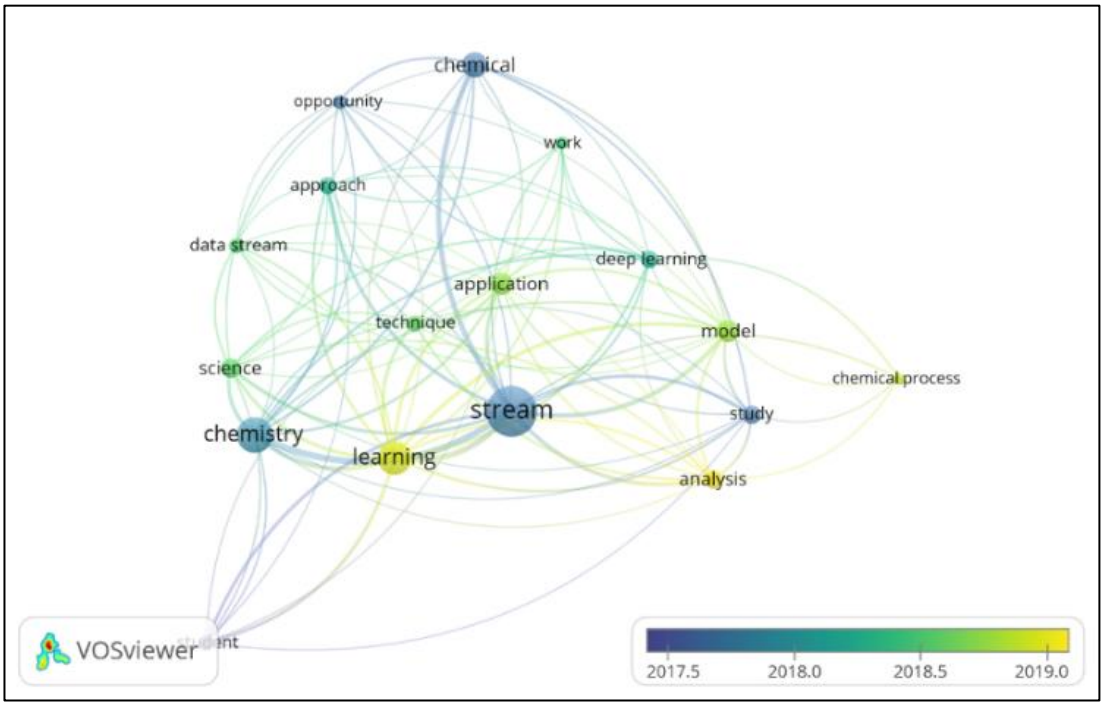


Figure 8. Overlay Visualization STREAM and Chemistry Learning

The overlay visualization mapping of STREAM research topics and chemistry learning is shown in Figure 8, revealing four main clusters. Cluster 1 consists of five items: Chemical, Data STREAM, Opportunity, Science, and Technique. Cluster 2 includes Analysis, Chemical Process, Deep Learning, Model, and Study. Cluster 3 comprises Chemistry, Learning, STREAM, and

Student, while Cluster 4 contains Application, Approach, and Work. Based on these clusters, an interesting topic in STREAM research and chemistry learning is the integration of STREAM into chemistry education, which enables the application of project-based approaches to address real-world problems by fostering deeper critical thinking and developing practical solutions (Sumartati, 2020).

The dim items include Student, STREAM, Chemical, Study, Chemistry, and Opportunity, indicating that these topics have been discussed for a long time. In contrast, the bright items, such as learning, analysis, model, application, chemical process, science, data STREAM, work, deep learning, technique, and approach, represent research topics that are still actively being discussed today.

The integration of STEM subjects has been shown to foster essential 21st-century skills among students. For instance, a study by Koçulu et al. highlighted that STEM education significantly improved pre-service science teachers' perceptions of necessary skills and problem-solving capabilities, illustrating how a cohesive learning approach can cultivate vital competencies for future challenges (Koçulu et al., 2022). Similarly, Hidayatulloh et al. focused on developing STEM-based chemistry textbooks that improved students' problem-solving skills through practical applications and pedagogical tools that facilitate experiential learning (Hidayatulloh et al., 2020). This evidence supports the assertion that STEM education effectively addresses the pressing need for enhanced problem-solving abilities in educational settings. The STREAM approach is an extension of STEM. Although STREAM has been around for a long time, it remains a relevant research topic, particularly in the field of education (Mujaddi et al., 2022).

The STREAM approach demonstrates how a multidisciplinary perspective can enrich the learning process in chemistry. For example, the use of analytical techniques and Deep Learning models can create new opportunities for processing chemical data and enhancing the understanding of chemical processes in a broader and more practical context (Górriz et al., 2023). Additionally, integrating STREAM into chemistry learning through projects allows students to see the direct relevance of their studies to real-world applications, thereby increasing their motivation and learning outcomes.

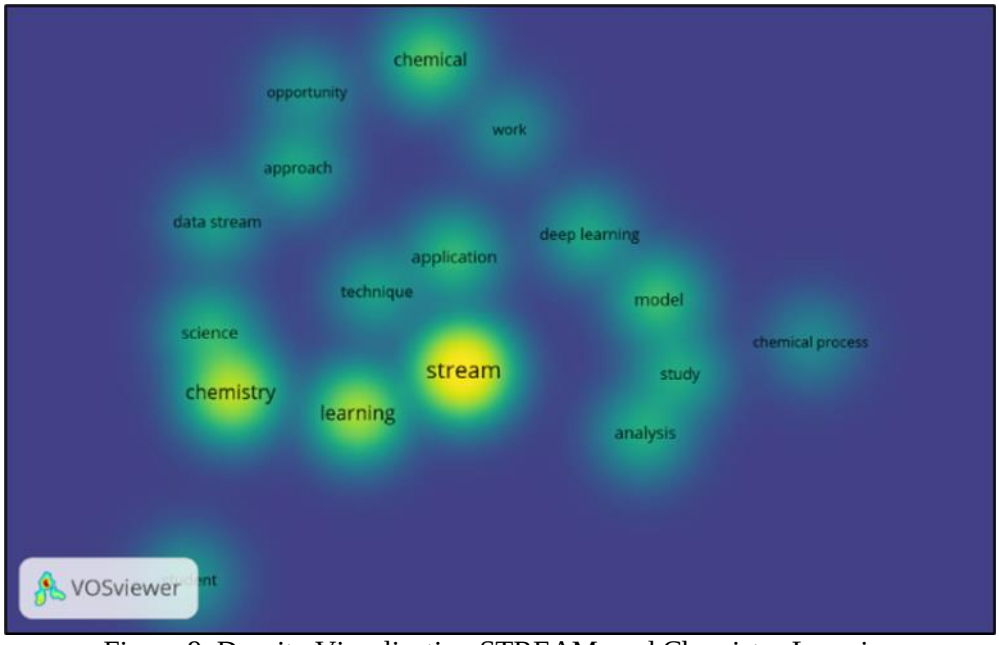


Figure 9. Density Visualization STREAM, and Chemistry Learning

The visual density of the keywords "STREAM" and "Chemistry Learning" is evident in Figure 9. The bright-highlighted items are STREAM, Learning, and Chemistry, while the remaining items appear dim. The bright-highlighted items indicate that many researchers have extensively studied these research topics, whereas the dim items represent topics that have not been widely explored.

The STREAM approach, similar to STEM and STEAM, has shown positive results in students' scientific knowledge by teaching them to think critically and solve problems actively, creatively, and innovatively (Hadinugrahaningsih et al., 2017). The STREAM approach can bridge abstract systematic concepts with science, technology, inquiry, and art. Through technology, students can transform their ideas into innovative advancements. The integration of art within STREAM fosters student creativity in developing engaging learning experiences. Additionally, incorporating religious values into STREAM can strengthen students' faith and contribute to building the nation's moral character (Mujaddi et al., 2022). Therefore, the STREAM approach enables students to apply their learning outcomes in everyday life.

4. CONCLUSION

Based on bibliometric analysis, research trends in chemistry education show an increasing interest in the STREAM approach, which integrates halal values. This finding supports further research focused on innovations in curriculum development that not only emphasize mastery of science and technology but also incorporate religious and artistic aspects to create a holistic learning experience. Through the STREAM approach, future research can develop learning modules that integrate chemical concepts with halal values, such as case studies in the halal industry and the application of environmentally friendly technology. Additionally, further research can develop a comprehensive evaluation tool to measure the effectiveness of this approach in enhancing students' understanding of chemical concepts and the application of halal values in daily life. Moreover, collaboration with the halal industry can provide practical insights and increase the relevance of chemistry education to job market demands.

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