Research Trends in Ethno-STEAM-PjBL and Religion Integration oriented Educational Sustainable Development in Science Learning through Bibliometric Analysis

Dede Cahyati Sahrir¹,²*, Sutikno Madnasri¹, Dyah Rini Indriyanti¹, Reni Sapitri³

¹Science Education Programme, FMIPA, Universitas Negeri Semarang, Kampus Sekaran, Gunungpati, Semarang, Indonesia
²Biology Educational Program, FITK, IAIN Syekh Nurjati Cirebon, Jl. Perjuangan, Sunyaragi, Cirebon, Indonesia
³Faculty Education Department, Universiti Malaya, Jalan Universiti, 50603 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur, Malaysia

*Email: dedecahyati@syekhnurjati.ac.id

Abstract. Science learning in the 21st century must provide a set of skills contained in 6c: creativity and innovation, communication, critical thinking and problem solving, collaboration, computational thinking and compassion. The problem studied in this literature review is how research on science, technology, religion and educational sustainable development (ESD) is oriented in science learning and how the bibliometric network and research trends in learning research are. An article search using Publish or Perish software was carried out on October 24 2020. The resulting data was metadata extracted from google scholar and copus via API key, with the keywords science learning, STEM, religion, PjBL, ESD from 2018-2023. The results obtained were 495 articles that were successfully downloaded along with their metadata which was saved in RIS and CSV formats. The data obtained does not include theses, books, proceedings, modules, theses and reports. The VOS viewer supports three types of visualizations: network, overlay, and density. Meanwhile, visualization with biblioshiny includes the distribution of publications based on year, affiliation, and most cited sources on the integration of STEM, religion, PjBL and ESD as well as topics that are trending and relevant for further research. The results of the analysis show that research trends in 2023 related to the topics of STEM, religion, PjBL and ESD are that each topic is researched individually and not many have integrated them. A topic that is less researched is the integration of STEM or PjBL with religion and there is not much ESD orientation in science learning.

Keywords: VOSviewer, biblioshiny, science learning, STEM, religion, ESD

Introduction

The spirit of science learning is embodied in scientific results, processes, and attitudes, regardless of the materials, methods, or media used. (Jumini et al., 2022). Science learning syntax is a learning process that always follows curriculum developments and current developments. The process is carried out using scientific methods in obtaining
knowledge from existing developments. However, science learning is still mostly done in the classroom, limited to theory and mathematical calculations. The scientific principles studied must be linked to their technical application in society so that students grasp the benefits of the concepts learned. In schools and colleges, scientific education should represent a learning model for acquiring information and introducing knowledge products. (Alkhabra et al., 2023; Arpaci et al., 2023). Likewise, the graduation qualifications that students must obtain should be directed at skills that support the development of 21st century skills (Kautsar, 2023). These skills include 6c (creativity and innovation, communication, critical thinking and problem solving, collaboration, computational thinking and compassion) (Bilgiç et al., 2021; Keleman, 2021). Critical thinking is one of the skills of the 21st century. One way to improve students’ critical thinking skills (CTS) is the need for a supportive learning model so that students’ CTS can be improved (Syukri et al., 2022). CTS are important for professional and academic success in various fields, including decision making, rational and critical thinking abilities (Abbasi & Izadpanah, 2018; Addy et al., 2014; Ghazlane et al., 2022; Saputra et al., 2019). Students are required to be able to think critically in changing modern education (Alawi & Soh, 2019). Critical thinking emphasizes understanding meaning, finding out causes, and providing evidence as material for consideration in making decisions (Ampartzaki, 2023; Mahanal et al., 2019; Zubaidah et al., 2018).

The industrial revolution 4.0 requires everyone to be able to develop a science and technology-based economy, one of the efforts to be achieved through education is by implementing science, technology, arts, and mathematics (STEAM) learning. STEAM learning emerged as an answer to the need to increase students' interest and skills in the fields of science, technology, engineering and mathematics (STEM) fields (Agustina et al., 2020; Chemerys et al., 2022; Corrigan et al., 2021). A learning model that can integrate science, technology, engineering, art and mathematics components is project based learning. The PjBL learning model emphasizes contextual learning through complex activities such as giving students the freedom to explore, plan learning activities, carry out projects collaboratively and ultimately produce a product.

Indonesia is now establishing an independent project-based curriculum, therefore Ethno-STREAM-PjBL could be an alternative to suit the demands of science education in the twenty-first century. Apart from that, referring to the sustainable development goals, the learning model developed needs to be oriented towards ESD (Concina, 2019; Cörvers et al., 2016). Apart from that, by combining the ESD concept into the integration of the Ethno-STREAM-PjBL lecture model, it is hoped that it can also raise sustainability awareness. Sustainability awareness can be defined as a person's respect for the natural world and the life that lives in it when confronted with environmental issues. Sustainability awareness promotes the longevity of the concept of environmentally friendly development, which begins with appropriate environmental education as a kind of innovation. How to apply these innovations in education for ESD is still rarely studied (Hung et al., 2023). The potential for ESD-oriented learning that integrates it with STEAM learning has been carried out by Widarti & Roshayanti, 2021 which states that the potential for implementing ESD-oriented STEAM in learning provides students with provisions and skills to face life in the real world. In line with other research which states that STEAM learning can also be integrated with PjBL to support the mastery of higher order thinking skills (Martawijaya et al., 2023; Rahmawati et al., 2021; Tresnawati et al., 2021).

The application of Ethno-STREAM-PjBL which is oriented towards ESD in building CTS and sustainability awareness in students is a complex approach and requires a deep understanding of various aspects. There are several potential discrepancies or differences between ideal conditions and conditions in the field. From the aspect of resources and facilities, ideal conditions may assume the availability of sophisticated resources and facilities, such as complete laboratories, libraries and sophisticated technology. However,
in the field, educational institutions may experience limitations in terms of budget, facilities and equipment.

Efforts that can be done to promote CTS in ESD-oriented biology instruction while also instilling sustainability consciousness include providing relevant learning. Based on various literature reviews, integrating the STEAM approach with project and ESD-oriented models can be an alternative. For students who receive religion-based education, STEAM needs to be developed into STREAM by adding the religion (R) aspect. The STREAM approach follows the STEM perspective by integrating aspects of technology-religion-engineering-arts-mathematics in the science circle (Agustina et al., 2020). The STREAM framework refers to the dimensions of science learning. The STREAM approach is contextual like the STEM approach by first recognizing issues in the students' environment.

Exploration of science learning research mapping can be done through bibliometric network visualization (Kulakli & Osmanaj, 2020). Bibliometric analysis provides an accurate and objective method for measuring the contribution of an article to the advancement of knowledge, and is a tool that is often used to analyze trends and performance on a particular subject. This technique is used so that mapping can be done easily. Visualization techniques in network analysis are used to map relationships between journals, co-authors, researchers, and the emergence of keywords. This technique also reveals the main topics, how the topics are related and the development of the topics over time (Waltman et al., 2010). The role of science learning in solving these problems requires an integration of learning that will complement each other. Therefore, this research was conducted to answer the following questions.

1) What is the bibliometric analysis and research trends in science learning that integrates STEM, religion, PjBL and ESD using VOSviewer analysis?
2) What is the distribution of publications based on year, affiliation and most cited sources on the integration of STEM, religion, PjBL and ESD?
3) What are the trending and relevant topics for further research with bibilioshiny analysis?

**Methods**

This research follows bibliometric research guidelines (Jumini et al., 2022; Kulakli & Osmanaj, 2020; Suprapto et al., 2021). Researchers utilize the scopus database, because this source includes journal articles that are considered more relevant by the scientific community. The research began by conducting an online search on October 24 2023. The complete steps are shown in Figure 1.
A database search using Publish or Perish software was carried out on Scopus with "API Key" using the keywords STEM education, religion, project based learning, and ESD. The initial search results obtained 2128 documents of data, then filtered the document metadata by limiting the search year from 2018-2023 and only in the form of articles, 495 documents were obtained that met the search criteria. Data is documented in (.ris) and (.csv) form and then saved in Zootero software. Next, the metadata is processed for bibliometric analysis using VOSviewer and biblioshiny. Visualization is carried out on metadata that has been downloaded and stored in RIS form based on the VOSviewer software algorithm (Jeong & Koo, 2016; Putri et al., 2021). Apart from that, visualization was also carried out using R biblioshiny (Cuccurullo et al., 2016; Zafrullah et al., 2023).

Results and Discussion

In this research, bibliometric analysis is used to determine research trends in STEM, religion, PjBL and ESD in science learning. This is an important step to find out the development of research on the themes of STEM, religion, PjBL and ESD which plays a role in writing articles and research results in the field of science education.

Bibliometric Analysis and Science Learning Research

Visualization of the results of downloading article metadata with Publish or Perish software is carried out using VOSviewer (Waltman et al., 2010). Visualization is carried out in terms of network, overlay and density. The bibliometric network consists of circles and edges (Figure 2). Circles can be publications, journals, researchers, or keywords; while the edges show the relationship between pairs of circles. Moreover, edges not only indicate the relationship between two spheres but also the strength of the relationship represented by distance. The closer the distance between one sphere and another sphere, the higher the relationship between the spheres. The first stage of metadata visualization obtained 4 clusters marked with colors, namely: 1 Red, 2. Green, 3. Blue and 4. Yellow.

![Figure 2. Clustering Article Meta Data](image-url)
This mapping shows a detailed picture of the bibliometric network structure of research on the integration of STEM, religion, PjBL and ESD in science learning. Meanwhile, clustering shows bibliometric grouping. Color indicates clusters, closeness between words indicates close relationship, and the larger the text, the greater the intensity of the article. Each circle in Figure 2 shows keywords that frequently appear in the obtained metadata. The number of publications that are related to a keyword is indicated by the size of the circle. The larger the size, the greater the number of published articles that are related to the keyword. Keywords that are close together and appear frequently are located close to each other. From the results of the network visualization analysis, several terms were found that have not been widely researched, including the STEM-religion relationship; Culture (ethno)-STEM with gender; culture-STEM-PjBL(PBL)-religion, STEM-ESD. The emergence of the topic of culture in the integration of STEM-PjBL in science learning is very interesting. Learning through ethno-STREAM-PjBL prepares learning in the era of the industrial revolution 4.0, also known as the disruptive innovation phenomenon, which emphasizes students having technological literacy, multicultural and innovative skills, skilled in socio-cultural life, collaborative, critical thinking and good communication. effective (Sudarmin et al., 2019; Sumarni et al., 2023; Sumarni & Kadarwati, 2020).

The next analysis is an overlay visualization shown in color. Colors indicate research trends from year to year. Dark colors represent previous years of research. Yellow indicates the most recent research (Figure 3). Current research trends are shown in the following: (1) Science learning with computational thinking; (2) The results of science learning and student performance, (3) The keyword religion appears in dark colors but there is no connecting line with the stem or science learning; (4) The thin connecting line between culture and STEM and PjBL still provides opportunities for integration of the three.

![Figure 3. Overlay Visualization](image)

The next analysis is a density visualization shown in Figure 4. This analysis shows saturation, in other words the color blue has not been studied much, yellow has begun to be studied a lot, and red has often been studied.
Incorporating keywords such as religion and ESD in science learning has not been widely researched. Likewise, to measure learning achievement in the form of computational thinking, creativity and attitude. One of the attitudes related to ESD-oriented learning is sustainability awareness (Alló et al., 2021; Ekamilasari & Pursitasari, 2021; Hakio & Mattelmäki, 2019). Science learning is currently starting to shift from science to a more practical direction. Learning must be more applicable and efficient and play a broad role in supporting the realization of national sustainable development goals. The learning process is directed at providing an experience, so that students will experience a learning process. Ministry of Education and Culture policy through the curriculum emphasizes student performance assignments in the form of projects. The projects that students will work on are also encouraged to meet the demands of 21st century learning by including technological elements in them, so that STEM-PjBL can become an effective learning alternative. The development of science learning in the 21st century has begun to be developed with technology-based learning, both in processes, assignments and evaluations.

A curriculum that integrates STEM-PjBL for students with linguistic and cultural differences can improve communication and collaboration skills in the classroom (Chemerys et al., 2022; Indriyana & Susilowati, 2020). Increasing science and technology-based products in society requires the ability not only to master science and technology but also arts related to creativity, innovation and design. Students' abilities in the arts combined with mastery of science and technology can be stimulated with STEAM learning (Anggraeni & Suratno, 2021; Arpaci et al., 2023; Bertrand & Namukasa, 2023a; Eitah & Abueita, 2023). Seeing research trends and opportunities to conduct interdisciplinary and transdisciplinary research, as well as the importance of integrating science, technology and society, as well as having an ESD orientation in solving problems in society, it is necessary to carry out research with a more in-depth study regarding integrated science learning innovations in STEM, religion, PjBL and ESD in science learnings (Bezeljak et al., 2020; Cazorla-Montero et al., 2019; Derler et al., 2019). The main focus of ESD is to prepare the young generation to become responsible citizens in the future (Bertrand & Namukasa, 2023b; Karampelas, 2023).
Distribution of Publications by Year, Affiliation, and Most cited sources

Main information STEM, religion, PjBL and ESD

Once the metadata is exported to the biblioshiny application, the initial display of the software is the main information of all the articles that have been exported and are ready for analysis (Silva et al., 2022). Basic information regarding documents to be analyzed using the bibliometric method is presented in Table 1 and Figure 5.

Table 1. Main Information regarding Integration of STEM, religion, PjBL and ESD

<table>
<thead>
<tr>
<th>Main Information About Data</th>
<th>Document Contents</th>
<th>Document Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timespan</td>
<td>Keywords Plus (ID)</td>
<td>462 article</td>
</tr>
<tr>
<td>Sources (Journals, Books,</td>
<td>Author’s Keywords (DE)</td>
<td>1452</td>
</tr>
<tr>
<td>etc)</td>
<td>Authors</td>
<td></td>
</tr>
<tr>
<td>Documents</td>
<td>495</td>
<td></td>
</tr>
<tr>
<td>Annual Growth Rate %</td>
<td>19.34 Authors</td>
<td>1488</td>
</tr>
<tr>
<td>Document Average Age</td>
<td>2.08 Authors</td>
<td></td>
</tr>
<tr>
<td>Average citations per doc</td>
<td>10.87 Authors Collaboration</td>
<td>77</td>
</tr>
<tr>
<td>References</td>
<td>27175</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single-authored docs</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Co-Authors per Doc</td>
<td>3.31</td>
</tr>
</tbody>
</table>

Enriching the data obtained in the main information can also be displayed in Figure 5.

Figure 5. Main Information regarding the Integration of STEM, religion, PjBL and ESD

Table 1 and Figure 5 provide an overview of the bibliometric analysis carried out on the 495 documents that were the focus of the research. These documents, published between 2018 and 2023, came from various sources of journal articles registered with Scopus, when document selection did not include other sources such as proceedings and books. Interestingly, publication growth appears to be increasing by an average of 19.34% every year, reflecting the increasing interest in the topic of question analysis in the world of education.

Apart from that, this biblioshiny analysis also reveals several important facts regarding the author's contribution and international collaboration in this research. Of the total 1488 authors involved, interestingly 77 of them were sole authors. This shows the diversity of author collaboration in this field. However, only about 16.16% of author collaborations are international, with an average of 3.31 authors per document. This data illustrates that most of the research is on the theme of integration of STEM, religion, PjBL and ESD nationally. These documents also had significant impact, with an average of 10.87 citations per document, indicating their relevance in the broader scientific literature.

Sahrir et al.: Research Trends in Ethno-STEAM-PjBL and Religion……|409
Most Productive affiliate

Below is presented data regarding the most productive affiliations on the themes of STEM, religion, PjBL and ESD. The results of the bibliometric analysis can be seen in Figure 6.

According to Figure 6, National Taiwan Normal University is the most productive affiliate in publishing articles related to the theme of integrating STEM, religion, PjBL and ESD in science learning, which has published more than 23 articles, a significant number compared to other affiliates. This shows that National Taiwan Normal University has a number of researchers who are very active in this domain and have made important contributions. Apart from that, the University of California also appears to be actively publishing articles in this field by publishing 21 articles related to the themes of STEM integration, religion, PjBL and ESD. Followed by Universidad De Extremadura and University of Northumbria at Newcastle which are also quite active in publishing articles, both of them published 19 articles related to the integration of STEM, religion, PjBL and ESD. Apart from these four affiliates, there are several other affiliates which are also in the top ten affiliates with the highest number of publications in this field, such as Michigan State University, University of Minnesota, North Carolina State University, Beijing Normal University, The University of Alabama in Huntsville, and North Western University. This shows that research interest in the integration of STEM, religion, PjBL and ESD in science learning has attracted many researchers from various universities in the world.

This information will be a valuable resource for researchers and academics to understand the latest developments in domains related to the integration of STEM, religion, PjBL and ESD. By knowing the affiliates that are most productive in terms of publications in this field, researchers can direct their research more precisely, follow current trends and contribute to its development.
Most Productive Sources (Articles and Citations)

Citation analysis begins with ten main sources that have the largest number of publications in the fields of STEM integration, religion, PjBL and ESD listed in the Scopus index. Therefore, this analysis focuses on tracing the citations and impact of these key publications, providing deeper insight into the development and relevance of STEM, religion, PjBL and ESD integrated in the scientific literature. Related information can be seen in Table 2.

### Table 2. Most Productive Sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Artikel</th>
<th>h-index</th>
<th>T.C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal Of Research In Science Teaching</td>
<td>63</td>
<td>16</td>
<td>1078</td>
</tr>
<tr>
<td>Education Sciences</td>
<td>110</td>
<td>14</td>
<td>828</td>
</tr>
<tr>
<td>International Journal Of Science Education</td>
<td>47</td>
<td>14</td>
<td>655</td>
</tr>
<tr>
<td>International Journal Of STEM Education</td>
<td>47</td>
<td>14</td>
<td>686</td>
</tr>
<tr>
<td>Journal Of Science Education And Technology</td>
<td>45</td>
<td>13</td>
<td>635</td>
</tr>
<tr>
<td>Educational Technology And Society</td>
<td>16</td>
<td>10</td>
<td>211</td>
</tr>
<tr>
<td>Science Education</td>
<td>27</td>
<td>10</td>
<td>335</td>
</tr>
<tr>
<td>Research In Science Education</td>
<td>36</td>
<td>9</td>
<td>283</td>
</tr>
<tr>
<td>Jurnal Pendidikan IPA Indonesia</td>
<td>24</td>
<td>8</td>
<td>247</td>
</tr>
<tr>
<td>Cultural Studies of Science Education</td>
<td>29</td>
<td>7</td>
<td>170</td>
</tr>
</tbody>
</table>

Table 2 presents information on the most productive journals and publication sources in terms of the number of publications and citations related to differentiated learning. From this table, "Journal of Research in Science Teaching" is the most productive publication with 63 articles and 1078 citations. The journal originating from Indonesia is in 9th place, namely the Science Education Journal with a total of 24 articles published and 247 citations. The information in Table 2 also shows that the higher the number of citations for a journal or source, the higher the h-index value. This shows that journals or sources with a high number of citations have a significant influence in the fields of STEM integration theory, religion, PjBL and ESD and are highly recognized by researchers in these fields.

### Trending And Relevant Topics For Further Research With Biblioshiny Analysis

Next, trending topic data on the themes of integration of STEM, religion, PjBL and ESD in education are presented. Figure 7 illustrates the findings from this bibliometric analysis.

---

Sahrir et al.: Research Trends in Ethno-STEAM-PjBL and Religion......[411]
Based on Figure 7, in the time period from 2018 to 2023, the themes of integration of STEM, religion, PjBL and ESD can be grouped into four main themes which reflect various trends within them. The themes in integration that emerged were STEM and PjBL, but there was no visible culture, religion and educational sustainable development that had yet emerged. Thus, the increasing popularity of “integration of STEM, religion, PjBL and ESD” in scientific literature can be attributed to factors that support a deeper understanding seen from the keywords that appear, including computational thinking and creativity.

**Conclusion**

This research has outlined the mapping and grouping of research themes regarding the integration of STEM, religion, PjBL and ESD from the metadata of 495 articles from the Google Scholar and Scopus databases. The use of VOSviewer in visualizing the results of downloading article metadata with publish or perish software shows three main points that are the basis for photographing learning integration in science education. The results of the networking visualization analysis include several terms that have not been widely researched and provide research opportunities, including STEM-religion relations; Culture (ethno)-STEM with gender; culture-STEM-PjBL-religion, STEM-ESD. The overlay visualization results provide an overview of research trends and opportunities for conducting research that connects culture, STEM, religion, PjBL and ESD. The results of the density visualization analysis provide a picture that has not been widely researched, including religion and ESD in science learning, as well as measuring learning achievement in the form of computational thinking, creativity and attitude. Biblioshiny’s analysis has provided a comprehensive picture of the current state of the field regarding the topics of STEM integration, religion, PjBL and ESD. The analysis shows that research trends in 2023 related to the topics of STEM, religion, PjBL and ESD are that each topic is researched individually and not many have integrated them. A topic that is less researched is the integration of STEM or PjBL with religion and there is not much ESD orientation in science learning. The international distribution of publications shows a strong research presence at universities in Taiwan and California, with a smaller presence in other regions of the world. Analysis of temporal trends shows that the field has evolved over time, with new research themes emerging and some topics becoming more popular. However, this research has limitations, namely that it only summarizes information based on the Scopus database. Thus, interpretation is only limited to findings contained in journals indexed by Scopus.

**Acknowledgement**

Thank you to the Indonesia Bangkit Scholarship from the collaboration of the Ministry of Religion and LPDP which has provided full educational costs to the author.

**References**


Ampartzaki, M. 2023. Utilizing creative and critical thinking to build knowledge and comprehension through inquiry-based and art-based learning: a practical tool for teaching local history in pre-primary and Primary Education. *Pedagogy, Learning, and Creativity [Working Title]*, Query date: 2023-09-19 14:10:34. https://doi.org/10.5772/intechopen.112688


Indriyana, R.S. & Susilowati, S. 2020. The effects of model project-based learning approach on STEM (science, technology, engineering, mathematic) on natural science learning to junior high school student’s critical thinking skills and cooperative skills at SMP N 1 Berbah. *Journal of Science Education Research*, 4(2):70–75. https://doi.org/10.21831/jser.v4i2.35717


