GREEN ENERGY LITERACY: A REVIEW AND BIBLIOMETRIC ANALYSIS

Iman Gudiman*, Irvan Permana, Didit Ardianto
Pascasarjana Pendidikan IPA, Universitas Pakuan
Jl. Pakuan, Tegallega, Bogor Tengah, Bogor 16143, Jawa Barat, Indonesia
*email: irvanpermana@unpak.ac.id

Abstract. *Research on the importance of energy literacy has increased, this can be seen from the many articles that have been studied on this theme. Increased attention to the importance of energy literacy is related to the influence of the quality of energy literacy of citizens of a country which directly impacts the good or bad quality of the environment due to climate change. This study aims to evaluate the most relevant themes related to Energy Literacy based on bibliometric analysis, with input using the keywords "Energy Literacy" or "Green Energy Literacy". The data used is based on the Google Scholar database using the Pop (Publish or Perish) search engine software, this data is then stored in a Research Information System (RIS) format for further analysis. The data in RIS format was then analyzed using VOSviewer software to visualize networks consisting of authors, year of publication, publisher's journal name, and citations. Analysis conducted in October 2021 found a total of 100 documents in the 2016-2021 period. The results showed that in the last five years there were four publishers that published the most articles on the topic Green energy Literacy, namely elsevier with a total of 20 articles followed by Taylor & Francis, iopscience and Springer. Keyword analysis shows that the study of Green Energy Literacy is closely related to the themes of student, study, school, knowledge, behavior, attitude, awareness, and effect. Overall the data from this bibliometric analysis makes it possible to answer the question of what are the research trends in the field of Green energy Literacy in the last 5 years.*

Keywords: *energy literacy, bibliometric analysis; VOSviewer*

INTRODUCTION

Energy is one of the most hotly discussed topics in the world today and the problem of energy consumption has attracted serious attention from global community (DeWaters & Powers, 2011 ; J. DeWaters & Powers, 2013). Enerdata (nEnerdata, 2018) places Indonesia in the top 11 position in among the countries with the highest energy consumption in the world. Enhancement energy consumption that continues to occur every year, of course, must be accompanied by technology development to improve energy use efficiency, although it will not be enough to reduce energy consumption (Costanzo et al., 2014). if not supported by changes in attitude, behavior and knowledge of energy use. These three things, starting from attitudes, behavior and knowledge related to energy, are an integral part of the discussion on energy literacy.

On this basis, research themes related to energy literacy are important and urgent for carrying out various innovations and new breakthroughs to increase the energy literacy abilities of citizens around the world. Then a bibliometric analysis was carried out related to energy literacy to provide an overview of knowledge about energy literacy in order to assess the sources of publications, authors, journals and the most cited keywords related to energy literacy. The bibliometric analysis also

Diterbitkan oleh Program Studi Pendidikan Kimia FKIP Universitas Lambung Mangkurat
pISSN: 2086-7328, eISSN: 2550-0716. Terindeks di SINTA (Peringkat 3), IPI, IOS, Google Scholar, MORAREF, BASE, Research Bib, SIS, TEI, ROAD, Garuda dan Scilit.

Received : 26-02-2023, *Accepted* : 24-08-2023, *Published* : 28-10-2023

identifies networks that might be interesting to study due to the novelty in this research field.

Section 2 provides information regarding the methodology used to retrieve documents in the Scopus database and then process them to produce a bibliometric network. Section 3 presents the results and discussion regarding the results of Scopus bibliometric data, and section 4 reviews the literature on themes involving Energy Literacy based on the results of the keyword analysis. The purpose of this research is to answer: (1) How is the publication of Energy Literacy in the last 5 years; (2) Which publisher publishes the most Energy Literacy topics; (3) What keywords appear related to Energy Literacy; and (4) Recent research on Energy Literacy.

METHODOLOGY

This review of the bibliometric literature is based on a systematic and explicit method (Garza-Reyes, 2015) or a mind mapping method emphasizing the limits of knowledge (Tranfield, Denyer, & Smart, 2003). This research method adopts the five-stage method (Tranfield et al., 2003); Setyaningsih, Indarti, & Jie, 2018) as in Figure 1.

Figure 1. Five-step method bibliometric analysis

Determine search keywords

Literature search was conducted in October 2021 with the keyword 'Energy literacy'. Google Scholar was selected since it is currently the biggest data base and Publish or Perish was chosen since it has been proven to be the most effective way of searching articles on the GS (Baneyx, 2008). The first search included query language to the PoP software with the keyword 'Energy literacy'.

Initial search results

This search is specific to 'journals', ‘title words’ only, and the year '2015-2021'. 100 articles were found at the initial search. The results are compiled in Research Information Systems (RIS) format to include all important article information such as paper titles, author and affiliation names, abstracts, keywords and references.

Refinement of search results

Appropriate and indexed articles in the Google scholar (GS) database are filtered. Proceedings, newspapers, books, book reviews, and book chapters are not included in this data. Only journal articles were selected. Then to make the appropriate improvements, the file is saved in the form of an RIS file. RIS data is imported into Mendeley desktop software. The resulting RIS file is used for further data analysis.

Compile preliminary data statistics

The data collected were stored in the form of RIS. At the initial stage, the complete components of the journal articles (publication year, volume, number, page, etc.) were checked and we added required information if there were some incomplete data found. Data analysis was carried out so that articles could be classified by year and source of publication and publisher.

Data analysis

The bibliometric analysis in this study employed PoP software (Baneyx, 2008; Parmar, Ganesh, & Mishra, 2019). However, to analyze and visualize bibliometric networks, VOSviewer software is used (Martinez-López, Merigó, Gázquez-Abad, & Ruiz-Real, 2019; Shukla, Merigó, Lammers, & Miranda, 2020). VOSviewer is used because of its ability to work efficiently with large data sets and provide a variety of interesting visuals, analyzes, and investigations (Van Eck & Waltman, 2010). VOSviewer can also create publication maps, author maps, or journal maps based on co-citation networks or to build keyword maps based on shared networks.

RESULT AND DISCUSSION

Publications and citation structures

The output is analyzed based on the PoP software through the VOSviewer software to determine the most frequently appeared keywords. However, the number of the most frequently-appearing keywords is adjusted to the needs of the data collection and analysis. VOSviewer is used to visualize bibliometric maps. This software shows bibliometric mapping on three different visualizations namely, tissue visualization, overlay visualization, and density visualization.

Tabel 1. Comparison matric

Matric data	Initial search	Refinement search
Source	"Energy Literacy"	"Green Energy literacy"
Publication Year	2016-2021	2016-2021
Papers	100	97
Citations	1679	1749
Cities/year	279.33	349.80
Cites/paper	16.76	17.49
Authors/paper	2.68	2.87
h-indeks	21	21
g-indeks	38	40
hI,norm	14	15
hI,annual	2.33	3.00
hA-index	12	14

This data has been verified well on the Google Scholar (GS) database from 2016-2021 with the keyword 'Green Energy Literacy'. From table 1 it can be seen that by improving the search keywords from Energy literacy to Green Energy Literacy there was a change in output results, for example the number of documents produced from 100 to 97, the number of citations increased from 1679 to 1749, the number of citations/year increased from 279.33 to 349.80, the number of citations/papers increased from 16.76 to 17.49 and authors/papers increased from 2.68 to 2.87. Furthermore, the h-index (an index that tries to measure both the productivity and the impact of works published by an author) has the same value, namely 21, the g-index (a benchmark often used by h-index scientists to carry out their scientific work) increases from 38 to 40. For other information the reader can adjust to his needs.

The researcher tries to present the most relevant contributions in this study. The step taken is to take 100 articles with the keyword "Green Energy Literacy"

which has the highest citation score (top 10 articles cited). Obtained results as in Table 2.

Tabel 2. Top 10 cited article

No.	Cites	Authors	Title	Year	Source	Publisher
1	163	A Paço, T Lavrador	Environmental knowledge and attitudes and behaviours towards energy Consumption	2017	Journal of environmental management	Elsevier
2	145	C Brick, DK S herman, HS	Green to be seen" and "brown to keepdown": Visibility moderates the effect of identity on pro-Environmental Behaviour	2017	Journal of Environmental Psychology,	Elsevier
3	121	L Zhang, JWu, H Liu	Turning green intogold: A review on The conomics of green buildings	2018	Journal of cleaner production	Elsevier
4	88	A Al Mamun, MR Mohamad, MRB Yaacob	Intention and behavior towards green consumption among low-income households.	2018	Journal of environmental	Elsevier
5	83	S Wei, T Ang, VE Jancenelle	Willingness to paymore for green products: The interplay of consumer characteristics andcustomer participation	2018	Journal of Retailing and Consumer Services	Elsevier
6	74	T Coles, C Dinan, N Warren	Energy practices amongsmall-and medium-sized tourism enterprises: a case of misdirected effort?	2016	Journal of Cleaner Production	Elsevier
7	74	R Aisyah, IA	Learning crude oil	2017	Journal of	iopscience.

No.	Cites	Authors	Title	Year	Source	Publisher
		Zakiyah, I Farida	by using scientific literacy comics		Physics	i op.org
8	68	J Zhang	Evaluating regional low-carbon tourism strategies using the fuzzy Delphi-analytic network process approach	2017	Journal of Cleaner Production	Elsevier
9	63	SM Daniel, M Martin- Beltrán, MM Peercy	Moving Beyond Yes or No: Shifting From Over- Scaffolding to Contingent Scaffolding in Literacy Instruction With Emergent	2016	… Journal,	Elsevier
10	62	SN Jorgenson, JC Stephens, B White	Environmental education in transition: A critical review of recent research on climate change and	2019	The Journal of……	Taylor and Francis

The top 4 publishers who publish articles on this topic are presented in Table 3.

Table 3. Top 4 publishers who publish Green energy Literacy topic

No.	Publisher	Article
1	Elsevier	20
2	Taylor & Francis	10
3	iopscience.iop.org	64
4	Springer	20

From Table 3 it can be seen that Elsevier publisher ranks first to publish articles on this topic with 20 articles, second place publisher Taylor & Francis with 10 articles, followed iopscience publisher with 6 articles and finally Springer publisher with 4 articles. Journals that have relevant articles are presented in Table 4.

Table 4. Top 4 journals that have relevant articles on Green Energy Literacy topic

No.	Publisher	Article	Cites
1	Journal of cleaner production	14	399
2	Journal of environmental	8	396
3	Journal of Physics	6	84
4	Journal of Sustainability	3	20

Based on table 4 there are 4 journals that have articles relevant to the topic of Green Energy Literacy, including the Journal of cleaner production with a total of 14

articles 399 citations, followed byJournal of environmental with a total of 8 articles, 396 citations, followed by the Journal of Physics with 8 articles, 84 citations and finally the Journal of Sustainability with 3 articles, 20 citations.

The data network visualization display on GS data related to the keyword "Green Energy Literacy" that has been refined in search can be seen in Figure 2, overlay visualization can be seen in Figure 3, and visualization of density in Figure 4.

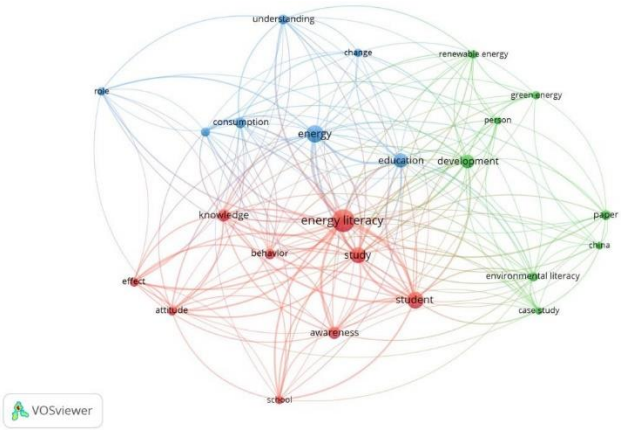

Figure 2. Network visualization on the GS database

Based on figure 2, research on the importance of green energy literacy has begun to be widely studied, as evidenced by the results of the analysis in cluster 1 (cluster 1 is marked in red). Green Energy Literacy Research has a lot to do with energy literacy, students, studies, knowledge, awareness, behavior, attitudes, effects, and schools. In cluster 1, several terms such as knowledge, attitude and behavior are very closely related. This is as stated in a reference which states that energy literacy is not only about knowledge, namely cognitive, but also aspects related to attitudes and behavior, people with energy literacy are expected to be able to take responsible actions in accordance with the knowledge they assimilate with the values that are built (St. Clair, R.2003). Energy literacy has been studied in many countries around the world for different purposes. Similar to research works related to environmental literacy, there are three aspects that are measured: cognitive, affective, and behavioral taken to frame energy literacy (DeWaters, Powers. 2011, Chen et al. 2015; Lee et al. 2015). As mentioned above, with awareness or knowledge serving as a basis, along with certain attitudes, responsible behavior can be expected. Energy-related knowledge is a major concern in many studies (Chen et al. 2015; Lee et al. 2015; Maddock, Kriewaldt. 2014).

In cluster 2 what is highlighted is development. Cluster 2 is marked in blue, showing the main words that appear include green energy, person, renewable energy, environmental literacy, and case study. Some of the main terms related to energy literacy such as development, person and renewable energy are one of the focuses of discussion related to energy literacy. Energy literate individuals are characterized as conscious and knowledgeable personals; understand the use of energy in everyday life, the impact of excessive energy consumption on society and the environment, and the need for energy conservation and the development of alternative energy sources; be able to make the right energy choices and decisions; and can take actions that reflect one's skills and actions for a sustainable society (Akitsu et al., 2017).

In cluster 3, terms related to energy education appear more frequently, such as energy, education, understanding, consumption, role and change. Cluster 3 is marked in blue. Student performance in high or low energy literacy is not the main issue. Instead, data analysis and strategic discussions are more important for energy education. The basic concept of energy literacy in basic education is discussed and is expected to be as concrete as possible because children are still in the concrete stage (Winter, I.1987). For secondary and tertiary education, constructive learning strategies can be used. For example, a study in STEM education emphasized that, to understand how renewable energy works, people need to understand basic mathematics, science, engineering, and technology, and the relationships between them (Pecen et al., 2012). In other words, training in understanding and applying the scientific method to energy issues is a central issue.

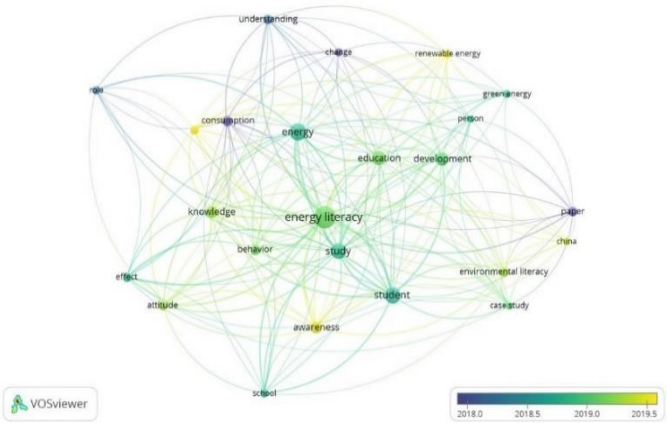

Figure 3. Visualization of overlays in the GS data base

Based on the results of the overlay visualization analysis in figure 3 which is marked in yellow, the latest research on green energy literacy with the topic of renewable energy applications as a solution to energy poverty, knowledge and environmental attitudes and behavior towards energy consumption, and criticism of the latest research reviews on climate change and energy education as well as environmental literacy and wise energy consumption are at least things that can continue to be echoed to increase energy literacy in facing the energy crisis in the future.

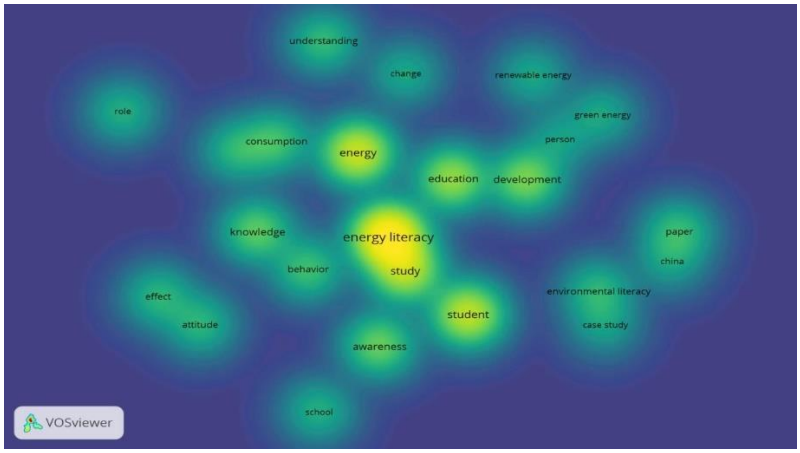

Figure 4. Visualization of density in GS data base

Based on the results of the Visualization of density too, there is a significant gap regarding research on green energy literacy. Topics that have been extensively researched are shown in bright yellow, including the topics of energy literacy, energy ,education,student and development. As for what has not been studied much, it is shown in green, among others, about enviromental literacy, case study, and green energy. This wide gap is expected to motivate researchers to study more about this topic.

Table 5. Keywords representing each cluster

No.	Cluster	Element
1	The first cluster (red)	Energy literacy (146), study (85), student (86), knowledge (53), behavior (33), school (32), effect (30)
2	The second cluster (green)	Renewable energy 21), green energy (15), person (21), development (19), enviromental literacy (26), case study (22)
3	The third cluster (blue)	consumption (30), energy (73), education (44), role (19), understanding (28), change (17)

This result was extracted from the title, keywords, and abstract with full calculation of the minimum number of events set to 5. About 19 items were found that met the criteria of 800 items. Common words are excluded in this item. Each item representing the keyword is added, which is indicated by the size of the node. In other words, the node size indicates the co- occurrence frequency of the keyword. Five groups are identified here. The keywords appear in each cluster represent the flow of study green energy literacy can be seen in Table 5.

CONCLUSION

The most relevant contribution in this study is the number of citations. Based on table 2, the highest citations indexed by GS are articles from A Paço, T Lavrador. 2017. This article discusses Environmental knowledge and attitudes and behaviours towards energy consumption:. This article is cited in 163 research articles. Meanwhile, there is one publisher with the highest frequency of citation based on the data, namely Elesevier. In addition, the publisher who contributed the most articles to this study were also analyzed. In 100 articles published, 20 articles were published from major publishers namely Elsevier, followed by Taylor & Francis 10 articles, Iopsciences 6 articles, and Springer 4 articles. For other publishers, an average of 1 article is published on this topic in addition to the number of articles per publisher, it is also analyzed based on the relevance of the journal. The results obtained in the top 4 journals that contain this topic. There are journals that have the most citations, namely Journal of Cleaner Production.

This shows that articles with subjects related to green energy literacy are scattered in certain journals, although there are also other journals. Analysis overlay visualization and visualization of density is used to identify key themes in each study or scope of knowledge. The analysis was made with the help of VOSviewer software. It can be identified that each cluster connects to other keywords. This can be indicated that the development of research on this subject is related. Overall, this data allows this paper to answer the question of what research trends in the field of green energy literacy in the past 6 years. Those aforementioned elements could provide a more comprehensive analysis. Articles are collected from the GS database

by PoP software. Then 100 of these articles were selected published in the period 2016 to 2021. To meet the objectives of this study, all articles found were classified by author, year of publication, name of the publisher's journal, cites, and author.

This study has two limitations. First, this study is generally based on a limited set of keywords and also potentially limited by the narrow database (GS) used for article collection. Second, although this study uses formal software as tools (PoP software, VOSviewer, Mendeley desktop, and Microsoft Excel), the subjective assessments of the author occur and still possibly lead to errors. The future studies are recommended to use a larger sample by expanding the keywords used and the more accessible databases. It also can use a comparison of different and recommended bibliometric analysis results (such as BibExcel and HistCite). It is recommended that further related studies provide more elaborate explanations for that there is limited number of studies discussing green energy literacy

DAFTAR RUJUKAN

Aisyah, R., Zakiyah, I. A., Farida, I., & Ramdhani, M. A. (2017, September). Learning crude oil by using scientific literacy comics. *In Journal of Physics: Conference Series* (Vol. 895, No. 1, p. 012011). IOP Publishing. https://doi.org/10.1088/1742-6596/895/1/012011

Akitsu, Y., & Ishihara, K. N. (2018). An integrated model approach: exploring the energy literacy and values of lower secondary students in japan. *International Journal of Educational Methodology*, *4*(3), 161-186. https://doi.org/10.12973/ijem.4.3.161

Akitsu, Y., Ishihara, K.N., Okumura, H. & Yamasu , E. (2017). Investigating energy literacy and its structural model for lower secondary students in Japan. *International Journal of Environmental and Science Education*, 12(5), 1067-1095. https://eric.ed.gov/?id=EJ1145592

Akizu, O., Urkidi, L., Bueno, G., Lago, R., Barcena, I., Mantxo, M., ... & Lopez-Guede, J. M. (2017). Tracing the emerging energy transitions in the Global North and the Global South. *International journal of hydrogen energy*, 42(28), 18045-18063. https://doi.org/10.1016/j.ijhydene.2017.04.297

Atkin, C. H. R. I. S., & Rose, A. N. T. H. E. A. (2019). An energy literacy matrix: tool for adult and continuing education curriculum design. *Journal of Global Research in Education and Social Science*, 13(3), 106-113.

Alghamdi, A. K. H., & El-Hassan, W. S. (2019). Raising Saudi students'(energy) sustainability awareness through ESL–teachers' thoughts. *Journal of Teacher Education for Sustainability*, 21(1), 137-154. https://doi.org/10.2478/jtes-2019-0011

Alghamdi, A. K. H., & El-Hassan, W. S. (2019). Saudi undergraduate students' needs of pedagogical education for energy literacy. Journal of Turkish Science Education, 16(4), 521-537. https://doi.org/10.36681/tused.2020.5

Andor, M. A., Gerster, A., & Sommer, S. (2020). Consumer inattention, heuristic thinking and the role of energy labels. The Energy Journal, 41(1). https://doi.org/10.5547/01956574.41.1.mand

Atkin, C. H. R. I. S., & Rose, A. N. T. H. E. A. (2019). An energy literacy matrix: tool for adult and continuing education curriculum design. *Journal of Global Research in Education and Social Science*, 13(3), 106-113.

Azevedo, J., & Marques, M. (2017). Climate literacy: a systematic review and model integration. *International Journal of Global Warming*, *12*(3-4), 414-430. https://doi.org/10.1504/IJGW.2017.084789

Bamisile, O., Abbasoglu, S., Dagbasi, M., & Garba, M. (2016). Evaluation of energy literacy among Nigerian senior secondary students. *Journal of Educational Studies*, *3*(1), 11-18.

Bozorgparvar, E., Yazdanpanah, M., Forouzani, M., & Khosravipour, B. (2018). Cleaner and greener livestock production: Appraising producers' perceptions regarding renewable energy in Iran. *Journal of Cleaner Production*, *203*, 769-776. https://doi.org/10.1016/j.jclepro.2018.08.280

Brent, D. A., & Ward, M. B. (2018). Energy efficiency and financial literacy. *Journal of Environmental Economics and Management*, *90*, 181-216. https://doi.org/10.1016/j.jeem.2018.05.004

van den Broek, K. L., & Walker, I. (2019). Heuristics in energy judgement tasks. *Journal of Environmental Psychology*, 62, 95-104. https://doi.org/10.1016/j.jenvp.2019.02.008

Canfield, C., Bruine de Bruin, W., & Wong-Parodi, G. (2017). Perceptions of electricity-use communications: effects of information, format, and individual differences. *Journal of Risk Research*, *20*(9), 1132-1153. https://doi.org/10.1080/13669877.2015.1121909

Chen, S. Y., & Liu, S. Y. (2018). Reinforcement of scientific literacy through effective argumentation on an energy-related environmental issue. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(12), em1625. https://doi.org/10.29333/ejmste/95171

Chiu, M. S., & DeWaters, J. (2018). Development and validation of the energy-issue attitude questionnaire: relations with energy knowledge, affect, and behavior. *Journal of Advances in Education Research*, *3*(1). https://dx.doi.org/10.22606/jaer.2018.31003