



Research Trends on Ethnoscience in Physics Learning (EPL): A Bibliometric Network Analysis

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ABSTRACT

In this modern era of education, understanding EPL research trends plays an important role in the development of innovative physics education. The general aim of this research is to comprehensively explore the landscape of Ethnoscience in Physics Learning (EPL). This study used bibliometric analysis to evaluate publications. Data was collected from Scopus and analyzed using VOSviewer and Biblioshiny-Bibliometrix software. The publication trend of EPL research varies annually, with significant growth since 2000 and the highest peak in 2021. Articles are the dominant document type in EPL research, with the average total citations per article varying significantly from year to year. Journal of Physics: Conference Series is the top source for EPL research. The main affiliations and countries contributing significantly are Semarang State University and Indonesia, while physics and astronomy dominate as the main subjects. The authors who contributed and had the most citations in EPL-related research were Beggs J. M. & Plenz D. The keywords that dominated and became a new trend were Physics, Cell Culture, Article, Human, and Student. The novelty of this study lies in its bibliometric approach and network analysis that provides deep insights into research trends and relationships within the field of ethnoscience in physics learning, contributing to a better understanding of the development of physics education.

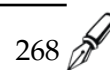


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INTRODUCTION

Physics education is one of the key aspects in developing people's understanding of scientific concepts. In recent decades, there has been a significant increase in the exploration of new approaches in physics learning (Lin et al., 2023), one of which is through the concept of EPL (Badino, 2019; Hidaayatullaah et al., 2021; Suprpto, Prahani, & Cheng, 2021). Ethnoscience is an approach that incorporates elements of local culture in physics learning, with the aim of providing a more relevant context and stimulating student interest in learning materials (Ardianti et al., 2019; Sholahuddin et al., 2021; Suprpto, Prahani, & Cheng, 2021). Ethnoscience-based learning can have a positive impact on student achievement and interest and make students become people with character (Andani et al., 2020; Ardianti & Raida, 2022; Jufrida, 2021).

The role of ethnoscience as a bridge to modern knowledge (Cordoni et al., 2023; DeVore-Wedding et al., 2019; Kawagley, 2020), as shown in various studies, is an important aspect to consider. The integration of ethnoscience with conventional education not only improves students' scientific skills (Sudarmin et al., 2019), but also contributes to the development of their cognitive abilities (Izzah et al., 2020; Rihayati, 2021). Ethnoscience-based learning can have a positive impact on students' achievement and interest in physics. In addition, the use of ethnoscience-based learning in physics has attracted attention as a way to bridge the gap between



students' cultural background and scientific concepts (Azalia et al., 2020; Suciayati et al., 2021; Verawati et al., 2023). By incorporating local wisdom and cultural knowledge into the physics curriculum, students can understand the subject matter at a deeper level and apply their learning to a real-world context (Azalia et al., 2020; Nuroso et al., 2018; Suryanti et al., 2021).

Although the concept of EPL offers great potential to improve the quality of physics education, there is still an information gap that needs to be filled to understand the development and research trends in this domain (Haspen & Syafriani, 2020; Kurniawan & Syafriani, 2020; Susilawati et al., 2018). This condition creates a gap between expectations and reality, where the potential of the EPL concept has not been fully utilized in physics learning practices at various levels of education. Seeing the importance of filling the gap, this study aims to explore the current research trends on EPL through a network bibliometric analysis. Bibliometric analysis is a quantitative method to analyze bibliographic data in articles/journals (Liu & Zhang, 2021; Reymert, 2021; Yang et al., 2023). This analysis is usually used to investigate the references of scientific articles cited in a journal, map the scientific field of a journal, and group scientific articles according to the research field (Guo et al., 2019; Suprpto, Prahani, & Deta, 2021; Suprpto, Sukarmin, et al., 2021). Research related to the implementation of EPL has been widely developed. However, bibliometric analysis related to EPL has not been widely developed.

This research aims to explore the current trends in EPL through a bibliometric network analysis. The analysis will provide insights into the key themes, influential authors, and collaborative networks in this field. Through this research, we hope to identify the most prominent areas of study within EPL, as well as the leading researchers and their contributions. By examining the existing literature, this study will contribute to the understanding of the impact and potential of ethnoscience-based learning in physics education. The specific objectives of this research are:

1. To analyze the distribution of documents and the mean total citations in research related to EPL.
2. To examine the production of sources over time, identify the top subject areas, and assess the local impact of EPL research.
3. To investigate the top affiliations, countries involved, and major sources of funding in EPL research.
4. To assess the production of authors over time and identify the most cited publications in the field of EPL.
5. To explore terms and novelty through visualization mapping

RESEARCH METHOD

This study employed a literature review methodology and applied a bibliometric approach to analyze it. This involved tracing the frequency and influence of citations in scientific papers, as well as examining the contributions of authors and institutions (Hidaayatullaah & Suprpto, 2022; Phoong et al., 2022; Yang et al., 2023). The data for this bibliometric network analysis was collected from Scopus (www.scopus.com), a reputable scholarly database known for its comprehensive coverage of scientific literature across various disciplines. Keyword Selection to identify relevant publications, a comprehensive set of keywords was employed for searching within Scopus's EPL field.

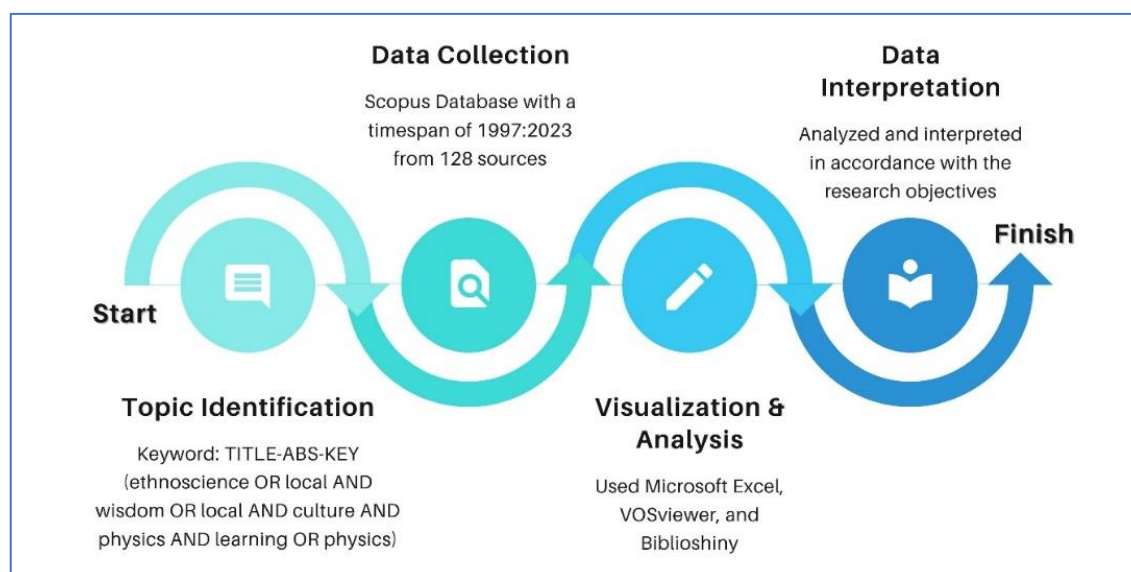


Figure 1. Research flowchart

The flowchart in this study is presented in Figure 1. The keywords employed for this research were: "TITLE-ABS-KEY (ethnoscience OR local AND wisdom OR local AND culture AND physics AND learning OR physics)". Data collection was conducted on August 19, 2023, covering the entire year. Basic dataset details are provided in Table 1. Subsequently, the data was downloaded in .csv format. Data visualization was performed using Microsoft Excel, VOSviewer, and Biblioshiny-Bibliometrix in R Studio. In the final stage, the results of data visualization were analyzed and interpreted in alignment with the research objectives.

Table 1. Basic details regarding datasets from the Scopus database

Description	Results
Timespan	1977 to 2023
Documents	200
Sources	128
Authors	671
Author of single-authored docs	48
Co-authors per docs	3.52

RESULTS AND DISCUSSION

In this section, we will present and discuss the results of our study, which aims to achieve the following objectives: firstly, to analyze the distribution of documents and the mean total citations in research related to EPL; secondly, to examine the production of sources over time, identify the top subject areas, and assess the local impact of EPL research; thirdly, to investigate the top affiliations, countries involved, and major sources of funding in EPL research; fourthly, to assess the production of authors over time and identify the most cited publications in the field of EPL; and finally, to identify emerging terms and innovations through keyword-mapping visualization.

Distribution of Documents and Mean Total Citations in EPL Research

The results of this study illustrate document distribution patterns that show how scientific publications in EPL are scattered in Scopus and reflect the collective efforts of researchers. The majority of documents distributed are articles, but there are also conference papers, book chapters, reviews, and editorials. Based on the results of the Scopus database search, the research trends in EPL up to the present are depicted in Figure 2.

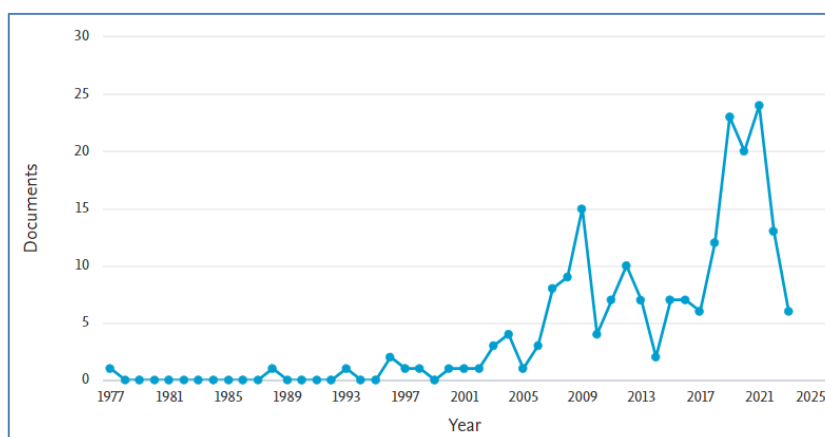


Figure 2. Distribution of documents on EPL research

Documents related to EPL have been identified from 1977 to 2023 (Data search: August 19, 2023). The number of documents published annually varies. In the initial 10-year period (1977-1995), research on EPL was notably scarce, with no documents found for 5 years (1979-1987). However, research on EPL began to experience significant growth from the year 2000 onwards. In fact, 2021 marked the highest peak in document production, with 24 documents. The document types include articles, books, book chapters, and review papers, with articles being the most dominant type in EPL research. The average citations per year and article in EPL research over the last 10 years are presented in Table 2.

Table 2. Citation per Year (last 10 year) on EPL research

Year	MeanTCA	MeanTCY
2013	16.83	1.53
2014	1	0.10
2015	4.29	0.48
2016	5	0.62
2017	10.67	1.52
2018	17.92*	2.99*
2019	2.17	0.43
2020	1.65	0.41
2021	2.79	0.93
2022	2.85	1.43
2023	0.2	0.20

Notes: MeanTCA= Mean Total Citation per Article;
MeanTCY= Mean Total Citation per Year; *= Highest score

The mean total citations per article exhibit significant variation across different years, with the highest average citations per article recorded in 2018 (17.92) and the lowest in 2023 (0.20). The mean total citations per year provide an overview of the average impact of articles published in each respective year, with 2018 once again standing out for having the highest average impact. An increase in the number of documents published in a given year has the potential to enhance both the mean total citations per article and the mean total citations per year (Garg et al., 2022; Rabbani et al., 2022). With a better understanding of document distribution and average citations, this study provides valuable insights in appreciating the contribution and impact of EPL research (Lorusso et al., 2020; Mirghaderi et al., 2022).

Sources' Production Over Time and Local Impact in EPL Research

In research on EPL, there are 128 sources available in the Scopus database. The majority of researchers published EPL research in reputable international journals and indexed international conferences. The top 5 sources' production over time in 2013 to date related to EPL research is

presented in Table 3. Meanwhile, the top 10 sources' local impact from 128 sources on EPL research is presented in Table 4.

Table 3. Top 5 of sources' production over time on EPL research

Year	Journal of Physics: Conference Series	AIP Conference Proceedings	Physics in Medicine and Biology	IFMBE Proceedings	IOP Conference Series: Materials Science and Engineering
2013	0	4	5	5	0
2014	0	4	5	5	0
2015	0	4	5	5	0
2016	1	4	5	5	0
2017	2	4	5	5	0
2018	6	4	5	5	2
2019	17	5	5	5	4
2020	33	5	5	5	4
2021	42	6	5	5	4
2022	42	7	5	5	4
2023	42	7	6	5	4

Table 4. Top 10 of sources' local impact on EPL research

Sources	h_index	g_index	m_index	TC
Physics in Medicine and Biology	5	6	0.313	123
Journal of Physics: Conference Series	4	8	0.500	92
Australasian Physical and Engineering Sciences in Medicine	2	2	0.167	8
Biomechanics and Modeling in Mechanobiology	2	2	0.182	74
Biomicrofluidics	2	2	0.154	90
Chaos	2	2	0.118	79
International Journal of Instruction	2	2	0.333	69
Review of Scientific Instruments	2	2	0.074	27
A Companion to Psychological Anthropology: Modernity and Psychocultural Change	1	1	0.059	3
ACM International Conference Proceeding Series	1	1	0.500	7

Notes: TC= Total Citations

The top source in EPL research is the Journal of Physics: Conference Series (SJR: 0.18) with publications produced to date, namely 42 documents even though the first 3 years there were no documents at all. The second source is AIP Conference Proceedings (SJR: 0.16) with 7 documents. Physics in Medicine and Biology (SJR: 0.87 or Q1) is ranked third with 6 documents. Then followed by IFMBE Proceedings (SJR: 0.16) in fourth place with 5 documents, and 4 documents published in the IOP Conference Series: Materials Science and Engineering.

Physics in Medicine and Biology became the first top of sources' local impact with 123 total citations and 5 h-index. Ranked second with the highest number of citations is Journal of Physics: Conference Series, with 4 h-index and has the highest g-index and m-index among other sources. ACM International Conference Proceeding Series ranked last with 7 TCs and 1 h-index. Despite ranking last in the top 10 sources' local impact, ACM International Conference Proceeding has a high m-index. Overall, this analysis shows the diversity of sources' impact in EPL research, with some of them having a stronger influence in the research.

Top Affiliation, Countries, Top Subject Area, and Funding in EPL Research

The top 10 affiliations in EPL research are presented in Figure 3. It can be seen that Yogyakarta State University stands out as the most dominant affiliation in EPL research with a total contribution of 24. This shows that this university plays an important role in the development of the EPL research field. Followed by Jakarta State University, Universitas Sebelas Maret, and Universitas Pendidikan Indonesia with significant contributions of 16, 14, and 10 respectively.

With 9 contributions, Malang State University also plays a significant role in EPL research. Overall, this collaboration and cooperation between universities can result in richer and more varied research in the field of EPL.

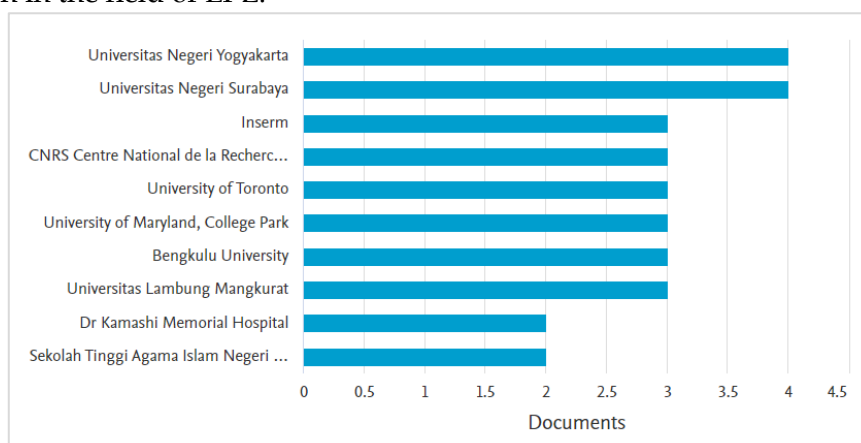


Figure 3. Top 10 affiliates contributing to EPL research

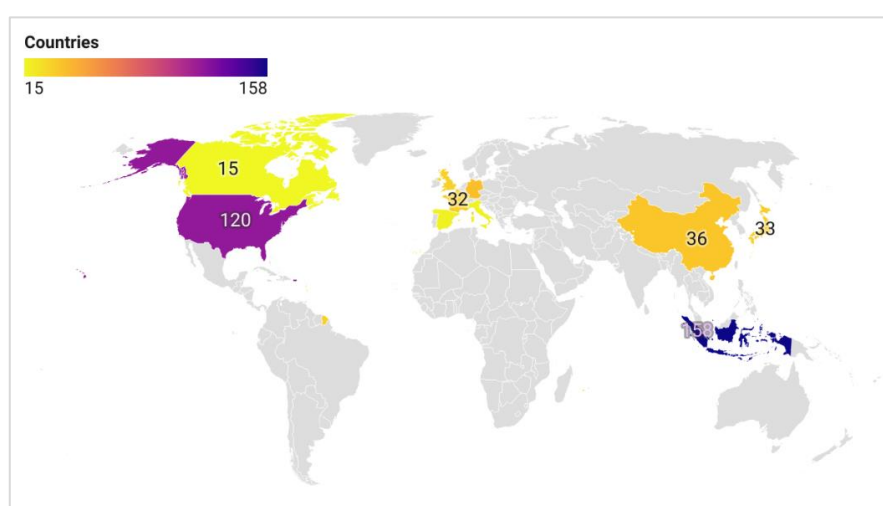


Figure 4. Top countries contributing to the publication

In Figure 4, Indonesia is the largest contributor to EPL research with 145 studies. This shows that the interest and focus of EPL research is quite high in Indonesia. However, it is worth noting that other countries such as the United States and China also have significant contributions, with 33 and 22 studies respectively. This shows that EPL is a research topic that has received international attention, with several countries playing a role in its development. Furthermore, the top subject areas and funding sponsors that support research on EPL are presented in Table 5.

Table 5. Top 10 subject areas and funding sponsor on EPL research

Subject Area	Freq	Funding Sponsor	Freq
Physics and Astronomy	78	National Science Foundation	6
Social Sciences	46	European Research Council	6
Engineering	34	Seventh Framework Programme	5
Arts and Humanities	30	National Institutes of Health	3
Medicine	19	Vetenskapsrådet	2
Materials Science	15	Russian Foundation for Basic Research	2
Mathematics	13	Horizon 2020 Framework Programme	2
Biochemistry, Genetics and Molecular Biology	12	Agence Nationale de la Recherche	2
Computer Science	11	Université de Strasbourg	1
Chemistry	11	Université de Sherbrooke	1

Analysis of the key subjects in the EPL research reveals the complexity and diversity of approaches in this field. Physics and Astronomy dominate as the main subjects, highlighting the focus on understanding physics concepts and teaching. In addition, social sciences and arts and humanities also play an important role, emphasizing the importance of social, cultural and psychological aspects in physics learning. Overall, the diversity of these subjects reflects the rich interdisciplinary approach in EPL, where various disciplines contribute to understanding and improving the teaching and understanding of physics by considering ethnoscience and cultural aspects.

The National Natural Science Foundation of China dominates as the main sponsor in EPL research with 11 studies supported. This shows China's commitment to supporting research in this area. In addition, the National Science Foundation (USA) also provided significant support with 5 studies. This shows that there is strong international cooperation in supporting EPL research. In addition to these sponsoring institutions, there are several other institutions that also contribute to the financing of EPL research, showing the diversity of funding sources for this field.

Authors' Production Over Time and Top Cited Publication in EPL Research

Based on the Authors' production over time visualization from Biblioshiny, the author published a maximum of 2 articles during the time period. The following are the top 10 authors who have published the most research related to EPL, where there are 32 authors who have published 2 articles over time. This top 10 is taken based on the first letter of the author. Based on this visualization, the majority of authors published 2 articles at different times, such as Baker D who published articles in 2009 and 2010 and several other authors. However, Hamidi Y published 2 articles at once in 2011 about the role and impact of social networks in exchanging knowledge in various fields and supporting local culture.

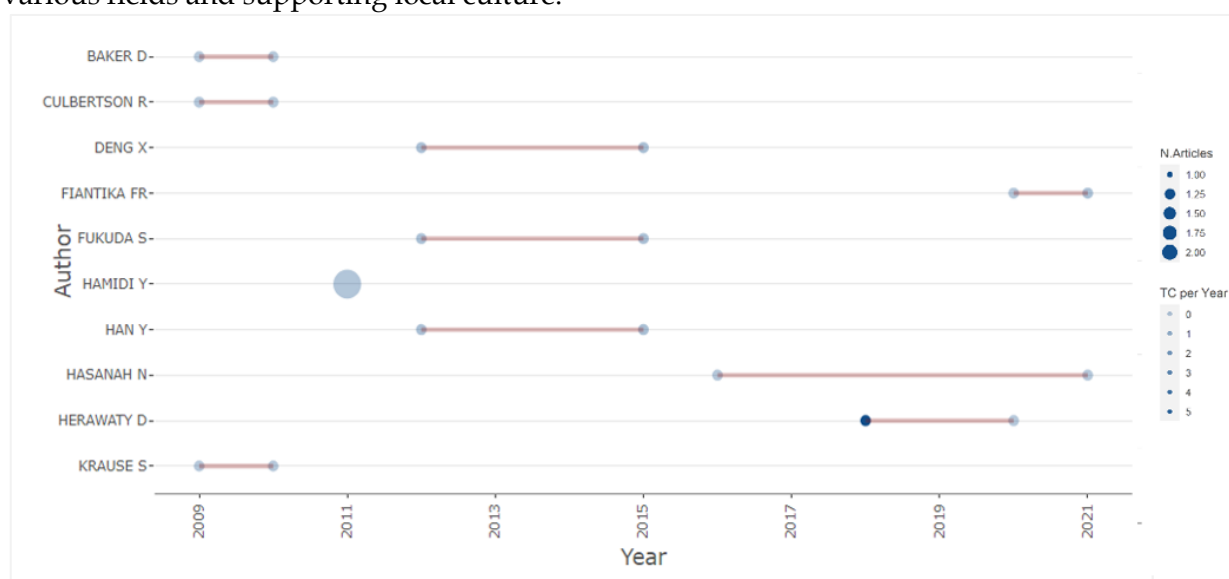


Figure 5. Top authors' production over time

The top most cited article related to EPL is the article written by Beggs J.M. and Plenz D. in 2003. The article is related to Patterns of neuronal activity including oscillations, synchronization, and wave behavior that show similarities to natural events such as landslides, earthquakes, and forest fires (Beggs & Plenz, 2003). Modern physics is closely related to neuron networks. This indicates a correlation between modern physics in neurons and life and culture in everyday life (Beggs & Plenz, 2003).

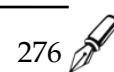
Table 6. Top author with the most citations

Author & Year	Sources (SJR)	DOI	Citation	Findings & Recommendations
Beggs J.M. & Plenz D. (2003)	Journal of Neuroscience (SJR: 2.35)	10.1523/jneurosci.11167.2003	1437	Networks comprised of living neurons display a wide array of activity patterns. These patterns encompass oscillations, synchrony, and wave-like behaviors, particularly in systems that consist of numerous nonlinear units that interact locally. This phenomenon bears a resemblance to occurrences such as avalanches, earthquakes, and forest fires.
Young E.W.K. & Beebe D.J. (2010)	Chemical Society Reviews (SJR: 15.11)	10.1039/b909900j	452	Considerable advancements have been achieved in the creation and application of innovative microfluidic devices for cell culture, as well as subsequent treatment and analysis. Cultivating cells within microscale environments necessitates a multidisciplinary approach, involving an understanding of physics, biochemistry, and engineering.
Jeffryes C. <i>et al.</i> (2008)	ACS Nano (SJR: 4.73)	10.1021/nn800470x	131	Diatoms are unicellular algae that form silica shells or frustules with complex nanoscale characteristics embedded within regular two-dimensional pore structures. The incorporation of titanium into the culture had no adverse impact on cell growth and maintained the frustule's shape. This investigation involves the controlled fabrication of TiO ₂ semiconductor nanostructures using a living organism through a bottom-up self-assembly approach.
Buchwald P. (2009)	Theoretical Biology and Medical Modelling (SJR: 0.55)	10.1186/1742-4682-6-5	122	The effectiveness and sustainability of cultured, transplanted, or encapsulated pancreatic islets are frequently constrained by hypoxia, as these islets have lost their blood vessels during the isolation procedure and must depend on passive diffusion driven by concentration gradients, which is insufficient for adequate oxygen supply. Finite element method (FEM) based multiphysics models are being investigated to elucidate oxygen transport and the viability of cells in avascular islets, both in static and dynamic culture media.
Bayan C. <i>et al.</i> (2009)	Journal of Applied Physics (SJR: 0.71)	10.1063/1.3116626	103	This research utilizes noninvasive Second Harmonic Generation (SHG) imaging to produce high-quality images of collagen fibers within tissues. The automated analysis method employed allows for

Author & Year	Sources (SJR)	DOI	Citation	Findings & Recommendations
				monitoring the dynamic remodeling of the collagen matrix in the absence and presence of fibroblast cells. The results of this study reveal that the presence and density of fibroblasts significantly impact the collagen matrix remodeling, affecting the orientation, organization, and composition of collagen fibers. These findings hold great promise for advancing tissue engineering and disease diagnostic efforts.
Stevens C. <i>et al.</i> (2008)	Aquacultural Engineering (SJR: 0.67)	10.1016/j.aquaeng.2008.01.006	73	The review explores the design and mechanics of offshore shellfish longline structures in the context of expanding shellfish aquaculture. It emphasizes two key aspects: the influence of environmental factors like waves and currents on these farms and the reciprocal effect of the farms on the surrounding environment. Insights are drawn from analogous systems, both natural (such as kelp beds) and man-made (e.g., floating breakwaters and fish farms). The review also highlights techniques for measuring local oceanographic conditions and structural responses, along with innovative methods for assessing critical properties. Crucially, this research identifies key areas for further study, including mooring design, vertical drag coefficients, wave-current interactions, stratification, and ecological impacts, which are pivotal for advancing the offshore shellfish industry.

Exploring Terms and Novelty Through Visualization Mapping

The Visualization Mapping is aimed at uncovering patterns and potential novelties to advance our understanding and contribute to the growth of knowledge in this research. Based on visual mapping through VOSviewer, four identifiable clusters have been found. These clusters encompass a total of 33 research items, interconnected by 254 links with a total link strength of 671. This mapping illustrates the presence of several interconnected research topics within EPL, indicating a substantial degree of interrelation among these studies (Figure 6). The most dominant keywords identified are "Physics" with a total link strength of 40, followed by "Cell culture" (98), "Article" (139), "Human" (100), and "Student" (23). This indicates that these topics play a central role in research related to EPL (Figures 7 and 8). The dominant occurrence of these keywords provides valuable insights into the primary focus and prioritized aspects within EPL research.



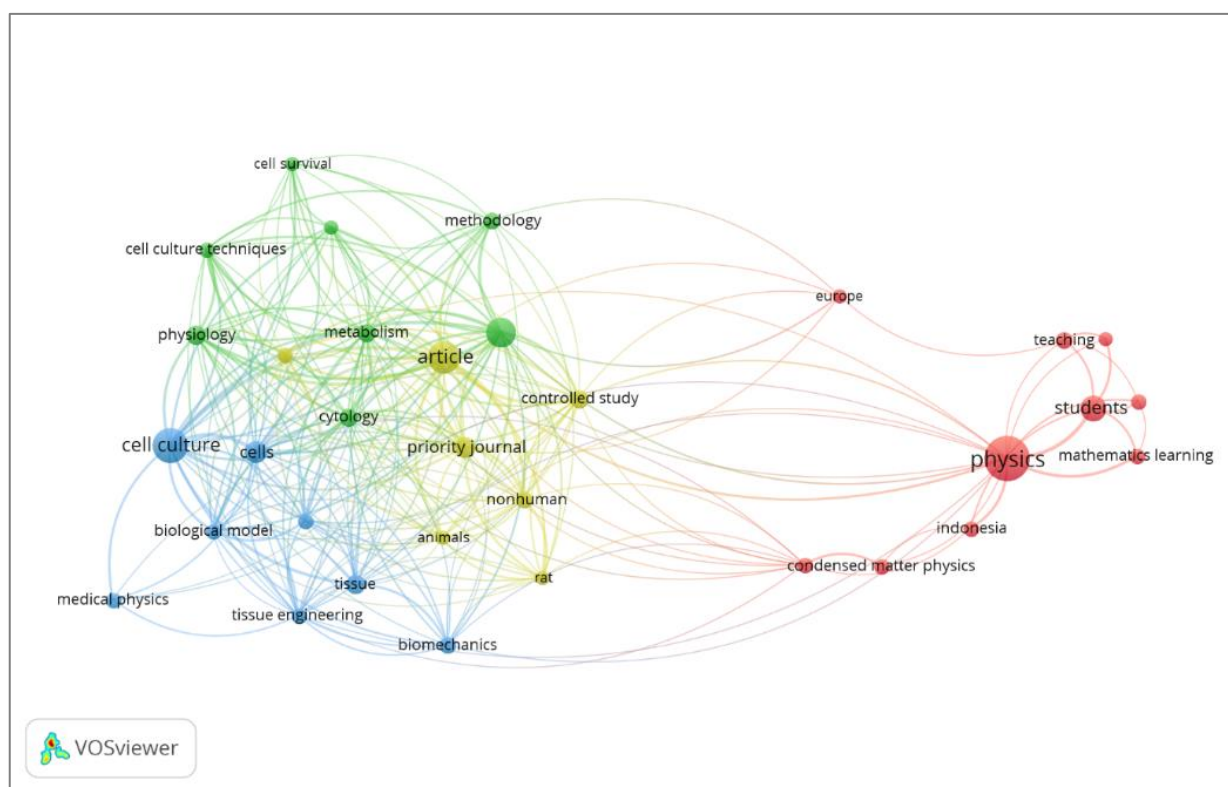


Figure 6. Mapping visualization of EPL research

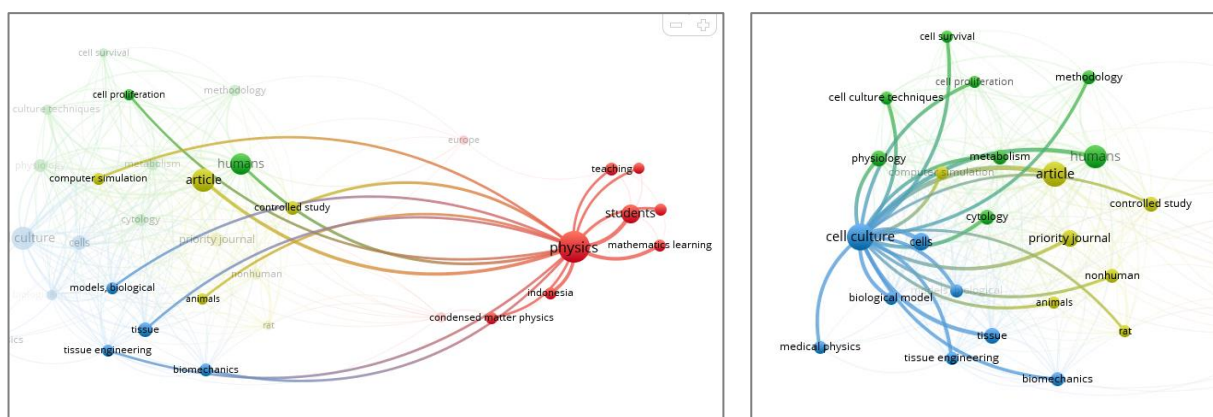


Figure 7. Visualization of physics and cell culture keyword on EPL research

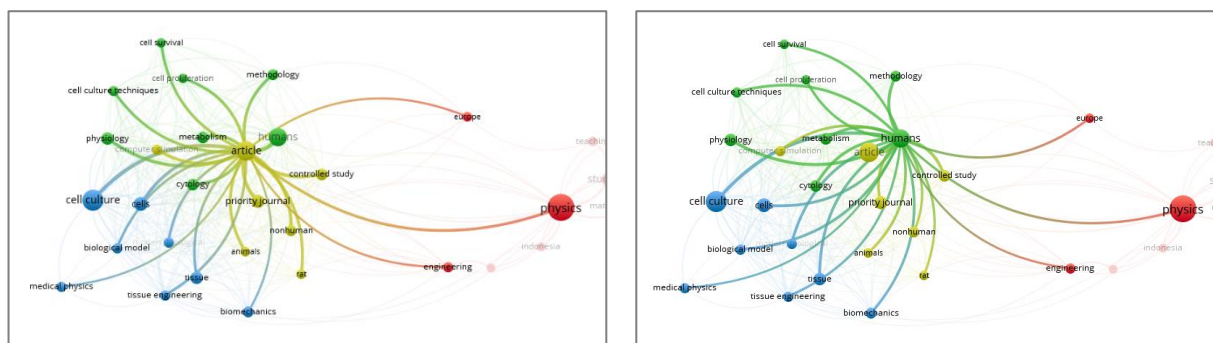


Figure 8. Visualization of article and humans keyword on EPL research

One significant finding is the recent emergence of research trends. It is evident that research related to the integration of ethnoscience into physics learning and its association with cell culture (Cluster 3) stands out as a prominent novelty in EPL research. The integration of ethnoscience

with physics learning offers opportunities for more diverse and contextualized teaching approaches, while the focus on cell culture reflects the development of innovative experimental methods within the physics learning process. Additionally, the keyword "article" (Cluster 4) also emerges as dominant. Scientific articles serve as a primary means of disseminating knowledge and research findings in this field. Therefore, the connection between EPL and articles suggests that EPL research has a strong foundation in scientific literature. These articles may address various aspects of physics education related to ethnoscience.

The next keyword is humans (Cluster 2) with a total link strength of 100, where "human" reflects the specific focus of this research on human interaction in physics learning. Physics education involves the learning and teaching processes that engage humans, both as students and educators. Studies within the context of EPL may explore how ethnoscience approaches can aid in understanding the role of humans in the physics learning process, how culture influences the comprehension of physics, or how ethnoscience-oriented teaching methods can be more effective within the context of humans as the subjects of learning. Therefore, humans represent a vital element in the context of EPL.

CONCLUSION

This research explores the role of EPL. It focuses on analyzing EPL research from various aspects, including document distribution, source production, affiliation, country, funding source, top author, and exploring terms and novelty through visualization mapping. Publication trends in EPL research published each year vary, with significant growth in EPL research since 2000 and the highest peak in 2021. Articles are the most dominant document type in EPL research. In addition, the average total citations per article also showed significant variation from year to year, with the highest average recorded in 2018 (17.92) and the lowest in 2023 (0.20). The top source in EPL research is Journal of Physics: Conference Series. The top affiliates and countries that contribute significantly to EPL research are Semarang State University and Indonesia, respectively. Physics and Astronomy dominate as prominent subject areas. In addition, social sciences and humanities also play an important role by emphasizing the importance of social, cultural, and psychological aspects in physics learning. The National Natural Science Foundation of China dominates as the main sponsor of EPL research. The author who contributes and has the most citations in EPL-related research is Beggs J. M. & Plenz D. Keywords that become dominant and at the same time become a new trend are Physics, Cell Culture, Article, Human, and Student. Recommendations for future researchers are collaboration between database sources and curriculum development that can integrate EPL to advance sustainable physics education.

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