



Global Research Dynamics: A Bibliometric Exploration of Child Education in Artisanal Mining

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Abstract: This study investigates the trends in child education and artisanal mining research over the past two decades, aiming to provide a quantitative analysis of the network structure within these studies. The research utilizes a bibliometric method to analyze scientific publications from the Scopus database, with results visualized using VOSviewer. A total of 208 documents from multiple countries were examined. The findings reveal that Galvin Hilson is this field's most prolific and influential author. The United Kingdom leads in terms of publication volume and citations, followed by Canada and China. The Journal of Extractive Industries and Society is the most prominent journal by volume, while the Journal of Science of The Total Environment stands out for having the highest number of citations (930). The most cited article is "Contamination Features and Health Risk of Soil Heavy Metals in China" by Chen et al. The dominant topic explored is artisanal and small-scale gold mining in Sub-Saharan Africa. While child labor remains a primary focus, the relationship between education, poverty, and socioeconomic improvements is underexplored. This study highlights the need for further research on how socioeconomic changes influence children's education and the broader context of artisanal mining across developing nations.

Keywords: artisanal mining; bibliometric analysis; child education; development; socioeconomic; scopus; VOSviewer;

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INTRODUCTION

Education plays a major role in national development. One of the Sustainable Development Goals (SDGs) agenda is to achieve the quality of education. In particular, the SDGs emphasize the need for inclusive and equitable quality education that promotes lifelong learning opportunities for all. Education as a basic human right is expected to create a young generation that can bring significant changes to the nation. The progress of a nation depends on the quality of its human resources, which can be improved through education. However, there are still obstacles in infrastructure facilities, teaching staff, and the quality of education itself. Indonesia, for example, even though it has been independent for 79 years, people with low education still dominate its level of education, and there are even illiterates. Several obstacles to education services in the 2020/2021 school year include the decline in the number of schools at each level of education, the gap in the number of students between public and private schools, schools that do not have a library, inequality in access to education in disaggregation according to disability status and household economy, as well as high incidence of dropouts as the level of education increases (Agustina et al., 2021).

Children's education cannot be separated from the involvement and participation of parents and families. The family's economic limitations often hinder children from continuing their education and switching to supporting family needs (Owusu et al., 2021). Twenty-one out of 100 children aged 16-18 in Indonesia are not in school (Agustina et al., 2021). 6.91% of students aged 10-24 worked, while about 7 out of 100 elementary school students worked as laborers. Working students are affected not only by economic pressure but also by other preference factors. It turned out that the improvement in the family's economy also contributed to the increase in the number of students participating in work. Apart from working, they also take care of the household. However, the involvement of children in meeting the family needs can create a poverty chain (Lambon-Quayefio & Owoo, 2021). Even though children work to pay for their education and escape poverty (Hilson, 2010), it is still a challenge and needs mutual support. It is interesting to know about children's education with Artisanal and Small-scale Mining (ASM), which has provided potential financial support for rural residents of developing countries (Hilson & Garforth, 2013; Maconachie & Hilson, 2016). Thus, a bibliometric analysis of child education in ASM is important.

Bibliometric studies have become an increasingly relevant approach in academic and professional circles (Cox et al., 2019; Ninkov et al., 2022; Rousseau et al., 2018). They are valuable in identifying research trends, capturing insights into emerging topics, and mapping the knowledge structure in a field. Bibliometric studies greatly enrich academics, allowing them to grasp the current research landscape and the direction of

development in their field of expertise. Bibliometric studies have the advantages of tangible impact, and authorship supports a strong theoretical background (Karanatsiou et al., 2015). It assesses the impact of research or publications based on the influence of authors, research groups, countries, or institutions (Blakeman, 2018). For professionals, bibliometric studies can provide a comprehensive overview of best practices, strategic issues, and opportunities to develop collaboration and innovation in their fields. Bibliographic studies rely on quantitative data from scholarly publications to enable a more targeted evaluation of library services, collection development, policy refinement, decision-making, and resource allocation (Rousseau et al., 2018). These analyses provide deep insights into the state of a research field and provide tools to objectively measure its impact. Thereby, bibliometric studies not only support library quality improvement but also strengthen the institution's role in providing relevant literature to stakeholders.

In the context of research management, bibliometrics has a significant role to take in evaluating academic progress and contributions. For instance, Padrós-Cuxart et al. (2016) highlight how bibliometric analysis can help identify the position of a study in a broader context, including trends in theory development and publications. This process is crucial in leading researchers to understand the scientific community's underlying needs and opportunities to expand the scope of their research. By using bibliometric data, researchers can map trends, determine emerging topics, and avoid unnecessary duplication of research. In this light, bibliometrics is useful in measuring the quantitative impact of past research, but it does not automatically reflect the quality of the research itself (Blakeman, 2018). Furthermore, it might contribute to filling in the gaps of potential studies, but it certainly does not predict future research success or failure.

The bibliometric approach is also regarded as efficient and effective in improving librarians' knowledge in a planned and structured manner. Indeed, according to Onsun Kentan (2021), using bibliometrics facilitates knowledge transfer and enables librarians to become strategic partners in supporting research and development activities. Using bibliometric data, librarians can provide evidence-based recommendations to academics, creating synergy between the library and the research community. This approach ultimately strengthens the library's position as a scholarly resource center that is adaptive and responsive to changing user needs. Furthermore, bibliometrics allows for a more informed selection of resources, identifying emerging research trends, and assessing the impact and relevance of scholarly outputs. By analyzing citation patterns, publication frequencies, and collaboration networks, librarians can gain deeper insights into the academic landscape and contribute more effectively to advancing knowledge. Additionally, this data-driven approach enhances librarians' ability to curate specialized collections that align with the evolving demands of researchers, fostering an environment that supports high-impact academic work. As a result, the integration of bibliometrics optimizes library management and positions libraries as integral components in the overall success of academic institutions and research initiatives.

The Journal of Innovation in Educational and Cultural Research has addressed various aspects of improving the quality of learning, such as micro-teaching models that have an impact on teacher development (Blegur et al., 2023), bibliometric studies in physical education to improve the quality of learning (Hardiansyah et al., 2024), and ethical studies in educational organizations (Hidayat et al., 2023). Meanwhile, research on electronic modules for social and science mastery (Nuraeni et al., 2023) and a research map of learning media and character values (Salmia et al., 2023) have also been published. Without previous literature, this article focuses on the socioeconomic challenges marginalized artisanal mining communities face, an area largely ignored in the existing literature. The article is valuable in enhancing understanding of the developing literature and provides strategic guidance for future research. Moreover, by highlighting the intersection between education, poverty, and child labor, this research advocates for interdisciplinary collaboration in education, sociology, and economics, offering more impactful solutions for children in vulnerable communities.

A bibliometric study of child education in artisanal mining areas offers valuable insights into how this issue is positioned within the global literature. The novelty of this study lies in its comprehensive mapping of the author network structure, collaborations between researchers, and geographical trends in child education and artisanal small-scale mining (ASM) research over the past two decades (2001-2022). By identifying the most influential literature and geographical areas or communities that require more attention, this study contributes to a deeper understanding of the field's development and provides a clear direction for future research. Additionally, the study offers a novel perspective by linking child education to the socioeconomic challenges families face in artisanal mining communities, highlighting the need for more research that addresses the intersection of education, poverty, and labor in these contexts. This broader view also underscores the importance of interdisciplinary approaches that combine education, sociology, and economics to generate more impactful solutions for children in these vulnerable communities.

The contribution of this research to the scientific field is significant, as it not only advances theoretical frameworks in the study of child education and ASM but also informs policy-making and the implementation of educational programs in regions affected by ASM. This study offers a unique perspective by emphasizing research gaps that can lead to targeted interventions, enhancing educational opportunities for children in these

communities. From a sociological and economic standpoint, the research highlights the interconnection between family poverty, socioeconomic changes, and educational access. It underscores how the economic challenges in artisanal mining areas directly impact children's educational outcomes while also exploring the role of education as a catalyst for breaking the cycle of poverty.

By providing a quantitative analysis of publication trends and the structure of research networks, the study aids in identifying emerging topics and guiding future research priorities. The bibliometric approach hereby contributes to further studies' development by visualizing data and making it easier to identify key research areas that remain unexplored. This method also facilitates a more efficient allocation of resources in future research endeavors, helping scholars and policymakers prioritize areas with the most significant potential for impact. In line with the journal's focus on education innovation, this study emphasizes how socioeconomic dynamics shape the educational landscape, offering both interdisciplinary perspectives and global relevance with a particular focus on the socioeconomic challenges in Indonesia and similar developing countries. Moreover, it highlights the potential for integrating innovative educational solutions that address these challenges, promoting sustainable development and educational equity in resource-deprived communities.

METHODS

This study employs a bibliometric descriptive-analytical approach to examine the relationship between child education and artisanal mining. Bibliometrics, as a quantitative analysis tool, is used to assess scientific publications and their patterns of collaboration, citation, and influence (Rousseau et al., 2018). This method is particularly effective in analyzing research dynamics in any field and provides valuable insights into the overall structure and trends within a specific scientific domain. According to Padrós-Cuxart et al. (2016), bibliometrics plays a crucial role in the management and evaluation of publication quality, helping to assess the relevance and impact of studies. Furthermore, bibliometrics reveals patterns of scientific collaboration and outcomes, making it an ideal approach for mapping research trends and identifying emerging areas in a specific field (Mongeon & Paul-Hus, 2016).

The primary objective of this study is to quantitatively analyze the trends and network structure of research related to child education and artisanal mining. By examining the publication trends over the past two decades (2001-2022), the study aims to identify the research's key themes, influential authors, and geographical distribution. Additionally, the study seeks to provide an overview of the field's current state, pinpoint emerging topics, and highlight areas that require further investigation. The bibliometric analysis conducted in this study aims to bridge gaps in the literature, particularly in linking child education to the socioeconomic realities of artisanal mining communities, which has often been overlooked in previous studies.

The data for this study were gathered from the Scopus database, which is widely regarded for its comprehensive coverage of scientific publications and its high impact factor. The authors selected documents based on specific keywords—"child," "education," and "artisanal mining." These keywords were chosen to align with existing research that generally discusses child labor in artisanal mining and its connection to poverty (Edmonds & Theoharides, 2020; Lambon-Quayefio & Owoo, 2021; Maconachie & Hilson, 2016), although the explicit link to education in this context has been insufficiently explored (Banchirigah & Hilson, 2010; Hilson, 2010). The search criteria excluded studies that focused solely on artisanal mining and chemistry education (Draman & Mohd, 2021) or mining conflicts (Doussoulouin & Mougnot, 2022), as these were deemed inadequate for exploring the specific linkages between child education and artisanal mining. The authors accessed the Scopus database on May 23rd, 2022, and obtained 208 documents for analysis, ensuring that only English-language documents were selected for this study.

The data were processed and analyzed using Microsoft Excel and VOSviewer version 1.6.16, widely used bibliometric analysis tools (Lim et al., 2024). Microsoft Excel was used to organize and clean the data, while VOSviewer was employed to visualize trends, co-authorship networks, citation patterns, and thematic clusters (Ninkov et al., 2022). VOSviewer allowed for a graphical representation of the relationships between authors, countries, and key topics within the research on child education and artisanal mining. This visual approach facilitated the identification of significant research clusters and provided a clear understanding of the network structure. By employing these tools, the study provides an effective overview of the bibliometric landscape, offering valuable insights into the development and future directions of research in this field. In addition, this article also attempts to counter criticisms of bibliometric studies that have been accused of only producing descriptive visual data (Hulland, 2024; Torres-Salinas et al., 2023), so it continues with in-depth insights to offer some guidance.

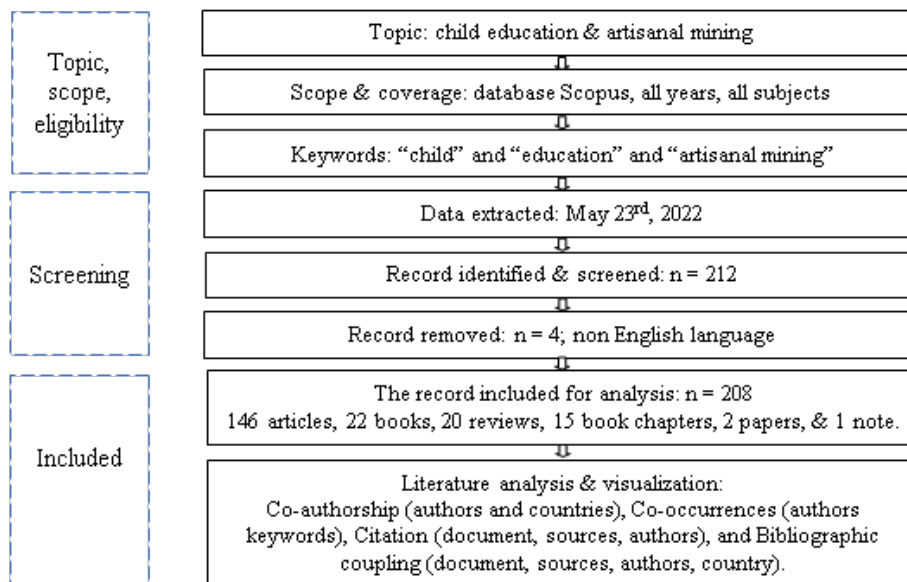


Figure 1. Retrieval process

RESULT AND DISCUSSION

In the last two decades (2001-2022), publications on children's education and artisanal and small-scale mining (ASM) communities in the Scopus database showed an increasing trend. The bibliometric analysis conducted in this study exposed citation patterns, collaboration between authors, and topics that dominate scientific discussions in this field. The findings confirm that the issue of child labor in the ASM sector is not just a child rights issue but is also closely related to complex socioeconomic challenges. The approach used in this study emphasizes the importance of integrating education reforms and improving family economic welfare to break the cycle of poverty and reduce children's involvement in the world of work. By offering a more holistic perspective, this study enriches academic discourse and opens up opportunities for further research exploring the influence of cultural norms and gender equality in improving access to education in artisanal mining communities. The literature search using the keywords "child," "education," and "artisanal mining" in the Scopus database with English-only literature found 208 documents. There were seven types of documents related to child education and artisanal mining. The most common publication is articles (n=146), followed by books (n=22), reviews (n=20), book chapters (n=15), conference articles (n=2), editorials (n=2), and notes (n=1)—a search for publications obtained 208 documents from 2001 to 2022. The author did not find these issues during 2002-2003 in Scopus documents. However, there has been a significant increase in publications since 2012. The peak was 40 publications in 2021 (see Fig. 2.). It can be predicted that the publication of artisanal mining issues will be more open for debate in the following years.

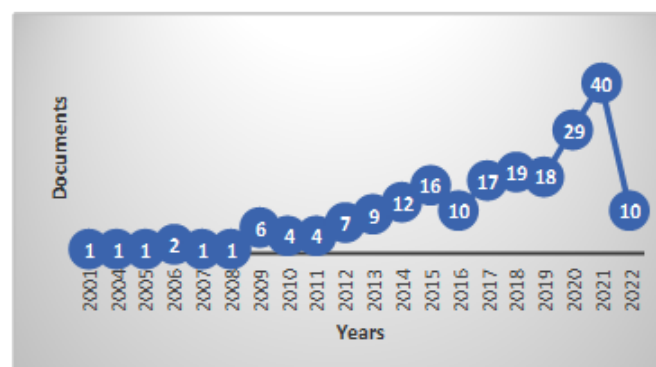


Figure 2. Publication trend

The first article, which included the keyword search for child education and artisanal mining, was published by [Veiga et al.](#) (2001) and was entitled "Mining with Communities." This article has 106 or 84th percentile citations in Scopus and a 40-view count since 2013. This article contains several cases of potential challenges in achieving a sustainable mining community with the need to adhere to the principles of ecological sustainability, economic vitality, and social equality. The author suggests the role of community consultation

and capacity building. Meanwhile, recent studies discuss the nature of ASM activities, the environmental consequences, public health, social, and economic issues (Balogun et al., 2022; Kyaw & Sakakibara, 2022; Taux et al., 2022), and the increasing problem of ASM and child labor due to poverty. Thus, it is necessary to formalize ASM to improve mining working conditions (Lambon-Quayefio & Owoo, 2021; Owusu et al., 2021), increase the elimination of ASM mines (Baddianaah et al., 2022), and impact the livelihoods and future of young people (Osei et al., 2021).

The most productive author on the issue of child education and ASM published in the Scopus Journal is Hilson G., who produced 15 documents. The second is Veiga M.M., which has 10 publications. For the highest number of document citations, Hilson G. with a total of 1,052 citations, followed by Wang J. (832 citations) even though the number of documents was 3, and Chen H. with 809 citations from one publication. Veiga M.M. is in seventh position with a total of 613 citations. Gavin Hilson is a prolific author. This is because of his position as a professor and chair of sustainability in business at the Surrey Business School, University of Surrey, United Kingdom. His work has been widely cited, considering he is also an Editor-in-Chief of the well-known journal The Extractive Industries and Society, ranked Q-1 Scopus. Marcello Veiga is a Professor Emeritus at The University of British Columbia. His research focused on mining and sustainable mining communities. He was a Chief Technical Advisor of the GEF/UNDP/UNIDO Global Mercury Project for the United Nations Industrial Development Organization, Vienna, from 2002 to 2008.

There are several influential countries in the publication of child education and ASM. Of 67 countries, 16 fulfill the thresholds with a minimum limitation of 5 documents from each country. The United Kingdom, Canada, and China occupy the top three positions as the countries where the author comes from whose publications have the most citations (see Table 1.). Meanwhile, the country of origin of the author who produced the most publications was the United Kingdom (54 documents), followed by the United States (41 documents) and Canada (30 documents). The United Kingdom has become a popular country for producing publications, which is supported by the productivity of well-known authors such as Galvin Hilson, Samuel Spiegel, Sadia Mohammed Banchirigah, and others. Canada has Marcello M. Veiga, Jonathan Gamu, Philippe Le Billon, and others. China is supported by the work of Haiyang Chen, Yanguo Teng, Sijin Lu, and others. Authors in the United Kingdom network with various countries, such as the United States, Canada, Ghana, Tanzania, Sweden, Germany, Netherlands, South Africa, Spain, Nigeria, and China. However, authors from Brazil only network with Canada. Likewise, authors from Australia only work with the United States and Ghana.

Table 1. Top 5 co-author's countries by number of citations

Country by co-authors	Number of articles (A)	Number of citations (C)	Average (C/A)	Total link strength
United Kingdom	54	2.109	39,06	20
Canada	30	1.029	34,30	28
China	10	980	98,00	12
United States	41	632	15,41	30
Ghana	22	293	13,32	11

Citation analysis is a subfield of informetrics (Rousseau et al., 2018). This analysis deals with the frequency and pattern of giving references and receiving citations (cited). A quote can be a link in the future because it shows the connection between the past and the present. Quotations are one measure of the progress of science. Citation of scientific publications is the primary means of communication between authors and a form of appreciation of thoughts. Citation analysis serves as a powerful tool for understanding how knowledge evolves. By examining how often and in what patterns scientific works are referenced, researchers can uncover influential studies, track emerging trends, and identify key contributors in a field. This approach not only fosters collaboration and innovation but also serves as a way for scholars to acknowledge and build upon the ideas of others, ultimately advancing scientific progress. The author established a minimum threshold of 50 citations per document out of 208, with only 23 meeting this standard. Chen et al. (2015) emerged as the most cited work with 809 citations, yet surprisingly, it lacks network connections. This suggests that the authors who cited Chen's work either did so fewer than 50 times or published it outside the Scopus database. Meanwhile, Bebbington et al. (2008) secured 332 citations and successfully formed two network connections, one with Gamu et al. (2015) and another with Bebbington et al. (2018). The most substantial network ties were observed in Hilson (2009) and Banchirigah and Hilson (2010), each with six links, demonstrating their active role in the research community. This pattern reveals how citation analysis can uncover the depth of collaboration and influence within a scholarly network.

In terms of citation documents, Veiga (2014) only networked with Spiegel and Veiga (2010) and Hilson (2006). This suggests that other authors did not cite him, or his citations were less than 50. He is one of the authors whose work is important in ASM issues. For almost two decades, he has researched the social and

interrelated environmental impacts of ASM in developing countries, mostly in West Africa. He has produced more than 150 papers, book chapters, and reports on the subject (Hilson, 2016a). This shows that there is a positive relationship among the author's social status, the productivity of scientific works, the journal he is aiming for, the author's country of origin, as well as the level of citation.

VOSviewer helps rank the 10 most frequently cited publication titles (see Table 2.). The work of [Chen et al. \(2015\)](#), the most cited "Contamination Features and Health Risk of Soil Heavy Metals in China" (809 citations), was published in the *Journal Science of the Total Environment*. He discusses the significant increase in heavy metal pollution and the risk of its exposure to vulnerable populations of children and women in China, along with the rapid development of industry and agriculture over the last three decades. The issue of mercury contamination or pollution is a common topic of study in ASM studies, in addition to poverty, agriculture, and labor-intensive issues. Furthermore, the work of [Bebbington et al. \(2008\)](#), "Contention and Ambiguity Mining and the Possibilities of Development" in the *Journal of Development and Change* was cited 332 times. The article describes the debates and conflicts related to increasing mining activity in developing countries over the last three decades. Debates about the resource curse and the possibility of extraction towards development, various types of resistance, and social mobilization have changed the relationship between mining and political economy.

Galvin Hilson, the most prolific and influential author, discusses various issues surrounding artisanal and small-scale gold mining in sub-Saharan Africa. It analyzes the dynamics of ASM, the complexity of the labor hierarchy, the unique forms of production, and the informal assistance system ([Hilson, 2009](#)). He suggested a more pragmatic bottom-up approach to mercury education and its alternatives ([Hilson, 2006](#)). Artisanal and small-scale mining has become indispensable and potentially most important in rural economic activity over the last two decades but has failed to change the perceptions of donors and policymakers ([Hilson & Mcquilken, 2014](#)). ASM has long been regarded as a nuisance, so it is not considered an integral part of regional economic development and strategic poverty alleviation plans. Hence, a radical change in policy "mindset" is needed. He also shows that ASM and agriculture are inseparable ([Hilson & Garforth, 2013](#)); therefore, they must be seen and treated in policy circles and rural development ([Hilson, 2016](#)).

Table 2. Top 10 influential documents

Documents	Title	Citations	Links	Document Type
Chen H. (2015)	Contamination Features and Health Risks of Soil Heavy Metals in China	809	0	Article
Bebbington A. (2008)	Contention and ambiguity mining and the possibilities of development	332	2	Article
Telmer K.H. (2009)	World emission of mercury from artisanal and small-scale gold mining	177	0	Book Chapter
Hilson G. (2014)	Four decades of support for artisanal and small-scale mining in Sub-Saharan Africa - A critical review	148	5	Article
Hilson G. (2009)	Small-scale mining, poverty and economic development in Sub-Saharan Africa: An overview	147	6	Article
Banchirigah S.M. (2010)	De-agrarianization re-agrarianization & local economic development: Re-orientating livelihoods in African artisanal mining communities	138	6	Article
Hilson G. (2016)	Farming, small-scale mining, and rural livelihoods in Sub-Saharan Africa - A critical overview	108	4	Article
Veiga M.M. (2001)	Mining with communities	106	0	Article
Hilson G. (2006)	Abatement of mercury pollution in the small-scale gold mining industry restructuring the policy and research agendas	100	2	Article
Gamu J. (2015)	Extractive industries and poverty: A review of recent findings and linkage mechanisms	92	3	Article

Bibliographic coupling presents documents that have the same reference. This shows the closeness of the study between documents. We limited a minimum of 50 citations per document. Of the 208 documents, 23 of them fulfilled the thresholds (see Fig. 3.). [Banchirigah and Hilson \(2010\)](#) have the highest total link strength (112 links), followed by [Hilson \(2016\)](#) (104 links). [Veiga et al. \(2001\)](#) only have references in common with [Hilson \(2006\)](#). Although [Chen et al. \(2015\)](#) have the highest citation (809), it does not have the same reference

as the displayed data, and the reference similarity is less than 50 citations per document. The dominant reference visualization used 45.574 authors; 16 met a minimum limit of 50 citations per author. The most widely used reference is Hilson G's, cited along with 492 other articles with a total link strength of 6.151. In second place is Veiga, M.M., with 297 citations and a link strength of 5,038. Both of them far outperform other authors in terms of the dominant references. This again shows that Hilson G. and Veiga M.M. are influential authors on this issue.

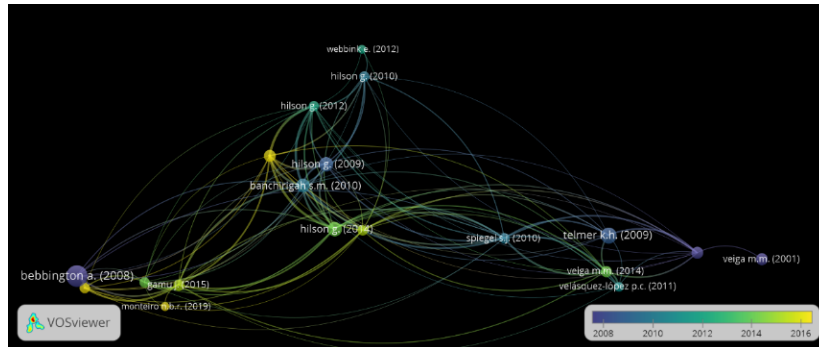


Figure 3. Overlay visualization bibliographic coupling by documents

The authors rank 10 influential journals based on the most articles (see Table 3.). These are included in the Quartile 1 (Q-1) category in the SJR (Scimago Journal Ranking) parameter, which means that the journals indexed by Scopus have the greatest influence regarding the average weighted citations per article published in a journal. *Journal of Extractive Industries and Society* is the largest journal with the keyword "child education and artisanal mining" (11 articles), followed by *Journal Resources Policy* (10 articles) and the *International Journal of Environmental Research and Public Health* (8 articles). Meanwhile, the highest number of citations was in the *Journal of Science of The Total Environment* (930 citations), the *Journal of Extractive Industries and Society* (509 citations), and the *Journal of Development and Change* (411 citations).

Table 3. Top 10 influential journals based on the number of articles

Name of Journal	Q	H-index	Number of Articles (A)	Number of Citations (C)	Average (C/A)	Total Link
Extractive Industries and Society	Q1	37	11	509	46.27	753
Resources Policy	Q1	80	10	298	29.80	514
International Journal of Environmental Research and Public Health	Q1	138	8	150	18.75	281
Journal of Cleaner Production	Q1	232	7	344	49.14	529
Environmental Research	Q1	149	5	111	22.20	293
Environment International	Q1	210	4	52	13.00	114
Science of The Total Environment	Q1	275	4	930	232.50	99
World Development	Q1	192	4	157	39.25	134
Disability and Society	Q1	80	3	26	8.67	0
Geoforum	Q1	125	3	87	29.00	164

Bibliometric analysis based on keywords is useful for summarizing the main content of a document and making it easier to know the objectives, methods, perspectives, and results obtained. The authors identify co-occurrences and author keywords. The data shows 564 keywords used by the author. Then, at least two occurrences were obtained, and 79 keywords met the threshold. The keyword "artisanal and small-scale mining (ASM)" was most dominantly used (41 occurrences) with a total link strength of 92. We used a thesaurus to organize the data. The keywords artisanal mining, small-scale mining, and artisanal and small-scale mining are combined into "artisanal and small-scale mining." However, we did not combine the terms "artisanal and small-scale gold mining" (23 occurrences) and "gold" (7 occurrences) because these specifically referred to the type of gold mining. The hope is to find other types of artisanal mining, such as oil, tin, coal, or others. However, the keywords were not found. It is possible that the study is not available yet or the number is still less than two events. The following most popular keywords are "mercury pollution" (27 occurrences) and "Ghana" (20 occurrences) (see Fig. 4.).

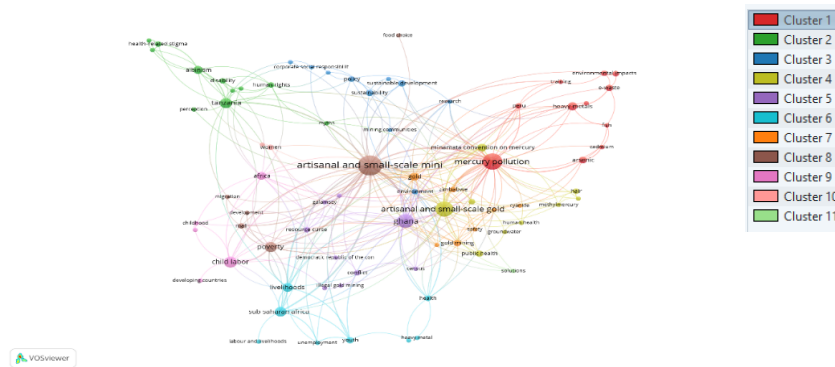


Figure 4. Authors' keywords network visualization

The network visualization of the author's keywords shows 11 keyword clusters. The keyword with the highest citation is in the brown cluster with the dominant topic "artisanal and small-scale mining," followed by the red cluster, "mercury pollution," and the yellow cluster, "artisanal and small-scale gold mining" (see Fig. 4.). Overall, the keyword "artisanal and small-scale mining" dominates the keywords in the publication. In addition, issues generally relate to artisanal gold mining, as shown by studies in sub-Saharan Africa. We found that during a search for the keyword "artisanal mining" in the Scopus database, there was a similarity or correlation between influential authors and dominant keywords (Sununianti & Nugroho, 2023a, 2023b). On the other hand, this opens up opportunities for further studies to raise the issue of other types of ASM in developing countries. The largest nodes with the keyword "artisanal and small-scale mining" indicate that the topic was mostly discussed around 2016. Around 2014, the common topics discussed were "poverty, Mali, development, migration, environment, environmental justice, policy, research, training, developing countries." Meanwhile, around 2022, start discussing "galamsey and food choice."

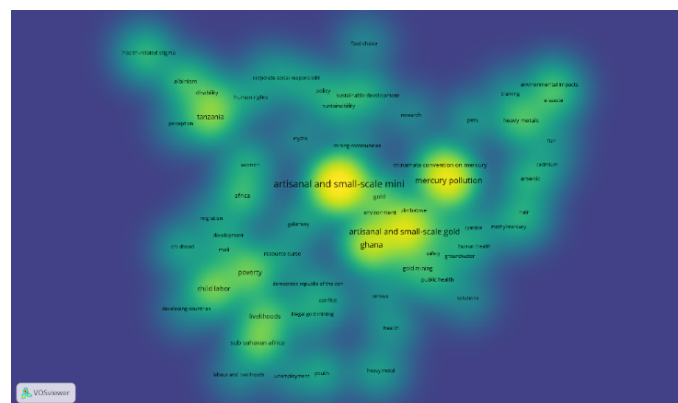


Figure 5. Authors' keywords density visualization

Density visualization aims to get an overview of a map by paying attention to the most important areas. The lighter the density, the more frequently the authors discuss the topic. In addition, Fig. 5. helps map out several research topics regarding child education and artisanal mining that are rarely discussed. Topics that still have the opportunity to be further researched, such as "Developing Countries on Child Education in Artisanal Mining," "Child Education on Artisanal Mining," "Children or Childhood in Artisanal Mining," "Labor and Livelihood on child education in artisanal mining," "land degradation in artisanal mining," "census on child education in artisanal mining," or "solutions on child education in artisanal mining." The keyword "child labor" has networked with ASM, gold, poverty, livelihood, sub-Saharan Africa, developing countries, and child education if explored further. The keyword "child education" is not very dominant and only relates to child labor, illegal mining, and Ghana. Likewise, the keyword "education" only relates to women. The limited network of keywords is an opportunity for further publications to analyze the relationship between child education and children's rights, improving families' socioeconomic status, or other types of ASM.

This study introduces several novel aspects compared to previous research on child education and artisanal small-scale mining (ASM). While much of the existing literature has focused primarily on the link between health (Dewi et al., 2013; Gyamfi, 2020; Riaz, 2018; Schwartz et al., 2021), child labor, poverty, and ASM (Bansah & Adonteng-Kissi, 2025; Faber et al., 2017; Hilson, 2010; Maconachie & Hilson, 2016), this study distinguishes itself by addressing how children's education can be improved without involving them in hazardous work. This critical shift in focus aims to break the cycle of child labor, which has been largely unexplored in prior studies. The novelty lies in integrating socioeconomic changes in the livelihoods of mining communities and

improving children's education without further exploiting their labor. Previous studies have primarily concentrated on the harmful impacts of child labor on education, yet they have not sufficiently examined the possibilities for improving education systems and livelihoods in tandem. Recent works by [Owusu et al. \(2021\)](#), [Ahlerup et al. \(2016\)](#), [Mihigo et al. \(2024\)](#), and [Takyi \(2024\)](#) have emphasized this gap in addressing both the education and economic challenges faced by children in ASM areas, which this study aims to fill. [Morante-Carballo et al.'s \(2022\)](#) bibliometric study was the nearest methodologically. However, their findings emphasized social factors, environmental impacts, mercury contamination, and ASM as a livelihood and identified geotourism in artisanal mining areas as an important trend supporting geological heritage conservation and sustainable ASM development.

Additionally, this study leverages bibliometric data to map research trends, networks, and geographical distribution related to child education and ASM, applying a quantitative approach rarely used in this context. The bibliometric analysis not only offers a visual representation of the growth of this research field but also identifies significant emerging topics, influential authors, and potential gaps in the existing literature. This method provides a more holistic and data-driven view of the study's evolution, contributing to the body of knowledge in a way that previous studies have not. [Takyi \(2024\)](#) and [Jonah \(2018\)](#) highlight the need for such data-driven methods to explore complex issues such as child labor, poverty, and educational access in ASM regions. This approach allows researchers to better understand the core ideas shaping this field by uncovering key collaboration patterns and highlighting the most influential works. It also equips policymakers and stakeholders with valuable insights to develop more targeted and effective strategies that address the educational challenges faced by children in ASM communities. The impact of this study is evident in its potential to influence policy-making and intervention strategies in ASM communities. By elucidating the connections between poverty, socioeconomic development, and children's education, this study provides critical insights that can guide the formulation of policies and interventions to break the poverty and child labor cycle. [Takyi \(2024\)](#) argues that the development of effective education programs in mining regions must go hand-in-hand with improvements in household livelihoods, which this study explicitly addresses. Furthermore, the research highlights the need for multi-dimensional approaches integrating educational reforms and socioeconomic support to create sustainable change in ASM communities. Focusing on these interconnected areas, the study advocates for a holistic approach that empowers families and children, ultimately fostering long-term social and economic development.

A major contribution of this research is its exploration of the intersection between socioeconomic development and children's education in ASM communities. Rather than merely highlighting the challenges, this study presents potential solutions for improving family income and reducing the need for children to engage in labor. This interdisciplinary approach provides new insights into how education, poverty alleviation, and economic diversification can work together to create sustainable pathways for children's educational success in ASM regions. In line with recent findings by [Faber et al. \(2017\)](#), [Kennedy et al. \(2020\)](#), and [Osei et al. \(2021\)](#), this study underscores the importance of providing alternative livelihoods that do not involve children in labor, thus allowing them to access education. Moreover, this research contributes to the global discourse on child rights and the right to education. Previous studies have shown that child labor in mining is often justified as a means to improve family income, but the resulting educational deprivation creates long-term negative effects for children and communities ([Lambon-Quayefio & Owoo, 2021](#); [Owusu et al., 2021](#)). By focusing on systemic improvements in education and livelihoods, the study offers solutions that can help eliminate the need for children to work, contributing to global education goals and aligning with international labor conventions. The study highlights how improving education systems in ASM areas is key to breaking the cycle of poverty and labor exploitation. The bibliometric analysis provides further contributions by identifying key underexplored research areas, particularly the intersection of education, gender, and cultural norms in ASM communities. Future research should focus on these unexplored areas to further enhance our understanding of how social and cultural factors influence children's access to education in ASM regions. This study encourages future research to investigate the social structures and cultural norms that contribute to the perpetuation of child labor, offering new avenues for exploration that can lead to more comprehensive interventions. Through this approach, researchers can gain deeper insights into the social dynamics and structural inequalities that limit children's access to education in ASM communities. More sustainable and culturally relevant educational programs can be developed by embracing local wisdom and engaging communities in the process. Ultimately, this strategy improves the effectiveness of policy interventions and empowers local communities to take an active role in shaping the future of education for their children.

CONCLUSION

This bibliometric study comprehensively analyzes the research trends related to child education and artisanal small-scale mining (ASM) over the past two decades. The analysis revealed that Galvin Hilson is the most prolific and influential author in this field, with the United Kingdom leading in publication output and

citation volume, followed by Canada and China. The Journal of Extractive Industries and Society is the most prominent in publishing articles related to this topic, while the Journal of Science of the Total Environment stands out for its high citation impact. One of the key findings of this study is the identification of a research gap, where most existing studies have primarily focused on the links between child labor, poverty, and health risks in ASM, particularly in Sub-Saharan Africa. In contrast, the potential for improving children's education through socioeconomic changes in mining communities remains underexplored. The most cited article, "Contamination Features and Health Risk of Soil Heavy Metals in China" by Chen et al., underscores the environmental risks associated with ASM but does not address the systemic issues impacting children's education in these areas. The impact of this research is multifaceted. First, it highlights the importance of integrating socioeconomic development with educational improvements to break the cycle of child labor and poverty in ASM communities. By identifying key authors, journals, and research gaps, the study provides a foundation for future research to improve policy-making and interventions that simultaneously address the economic challenges and the educational needs of children in these regions. The findings suggest that household income and access to education improvements are interconnected and should be targeted together in policy frameworks. This study can potentially guide the development of more effective educational programs and alternative livelihood solutions for mining communities, thus ensuring that children can access education without being exploited for labor. In this way, the study contributes not only to the academic literature but also to practical interventions that could significantly impact the well-being and future prospects of children in artisanal mining regions.

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