International Journal of Sustainable Development and Planning
Vol. 21, No. 1, January, 2026, pp. 71-79
Journal homepage: http://iieta.org/journals/ijsdp

# Geopark Conservation Using Eco-Literacy: A Systematic Literature Review

Anggi Tias Pratama[1*], Rio Christy Handziko[1], Suhartini[1], Binari Manurung[2], Agung Setia Batubara[2], Yudiana Dewi Prihandini[3,4], Sri Wartini[3], Bayu Rahmat Setiadi[5,6], Nurul Bahiyah Abd Wahid[7]

[1] Department of Biology Education, Universitas Negeri Yogyakarta, Yogyakarta 55281, Indonesia
[2] Department of Biology, Universitas Negeri Medan, Medan 20221, Indonesia
[3] Department of Doctoral Program in Law, Universitas Islam Indonesia, Sleman 55584, Indonesia
[4] Department of Law, Universitas Negeri Yogyakarta, Yogyakarta 55281, Indonesia
[5] Department of Mechanical Engineering Education, Universitas Negeri Yogyakarta, Yogyakarta 55281, Indonesia
[6] Center for Eco-material Engineering and Manufacturing, Universitas Negeri Yogyakarta, Yogyakarta 55281, Indonesia
[7] Department of Biology, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Tanjong Malim 35900, Malaysia

Corresponding Author Email: anggitias@uny.ac.id



https://doi.org/10.18280/ijsdp.210107

**Received:** 23 July 2025
**Revised:** 12 October 2025
**Accepted:** 25 January 2026
**Available online:** 31 January 2026

***Keywords:***
*conservation, ecology, ecological ecosystem, ecological literacy, eco-literacy, geopark*

**ABSTRACT**

Geoparks were represented as areas of geological heritage that required effective conservation strategies centralized on community engagement and sustainable education. However, a systematic understanding of how eco-literacy had been applied to foster conservation knowledge and participation in these sites remained fragmented. The need for a comprehensive synthesis of the research landscape concerning eco-literacy adoption in geopark conservation was addressed by this study. The trends, geographic distribution, methodological characteristics, and thematic applications of eco-literacy studies in the context of global geopark conservation and development were aimed to be mapped by this Systematic Literature Review (SLR). The PRISMA 2020 guidelines were strictly followed by the review. A systematic search was conducted in the Scopus database, covering all years up to 5 May 2025. The search string was focused on 'Geopark', 'Eco-literacy'/'Ecological literacy', and 'Conservation'/'Education'. Inclusion criteria were based on the PICO framework (e.g., studies explicitly linking eco-literacy to geopark conservation or education). A total of 100 records were screened for eligibility, resulting in 35 articles being included for synthesis. A significant quantitative growth was revealed by the synthesis of 35 included studies, with a 74.28% increase in publications being noted between 2020 and 2025 compared to previous periods. Geographically, research was heavily dominated by contributions from Southeast Asian countries (Indonesia and Malaysia). Four main clusters of eco-literacy application were identified by the thematic analysis: Technology, Ecotourism, Applied Geo-education, and Scientific/Cultural Heritage integration. The majority of the studies were employed with qualitative (case study) or mixed-methods designs. Eco-literacy was established as a critical, multi-faceted approach to enhancing conservation awareness and community participation in geoparks. The exponential growth in research was warranted for the development of standardized, place-based instructional design models for eco-literacy. Future research was suggested to focus on quantifying the long-term impact of these interventions on successful geopark management and sustainability.

## 1. INTRODUCTION

A geopark was defined as an area with geological heritage (geo-site) and high-value landscapes, including geology, biodiversity, and cultural variety. Tremendous geological diversity and rarity were featured by geoparks. Geopark landscapes were also dwelled around by 20-25% of the world's population, the majority of whom relied upon their groundwater resources [1]. Distinct surface and subsurface reliefs were created by the combination of ecological niches, climate, and edaphic differences. Interactions were allowed to generate an ecosystem by an open landscape, which led to the endemicity of biodiversity, including a variety of plant and animal life [2, 3]. Geoparks were based on three fundamental pillars: education, conservation, and sustainable local economic development, all of which were identified by the presence of geological heritage and geo-sites inside them [4].

An important role was played globally by geoparks due to their diverse geological and ecological features. Their major objectives, primarily the protection and enhancement of biodiversity, were strategically paired with educational and Sustainable Development Goals, particularly through the

meaningful incorporation of local populations [5]. Geoparks, particularly those recognized as UNESCO Global Geoparks (UGGp), were represented as vital global geological heritage sites and functioned as living laboratories for sustainable development. The mandate of a Geopark was extended beyond mere geo-conservation; it was inherently involved with the integration of geology, biology, culture, and the socio-economic development of the local communities. The success of these conservation initiatives critically depended upon the active participation and in-depth understanding of the communities that directly interacted with the site. Consequently, the primary challenge in Geopark management was identified as designing and implementing effective educational strategies so that a robust sense of ownership and long-term conservation responsibility could be cultivated among these communities.

Geoparks confirmed as UGGp were reflected as an integrated effort in which the protection of geological heritage was integrated with the promotion of sustainable development [6-8]. Geopark research has evolved significantly over the last few decades, with the shift being made from basic geomorphological investigations to a more holistic approach that was encompassed by ecosystems, biodiversity protection, as well as socio-cultural and educational components of the surrounding community [9].

A significant impact on people's behavior was had by education, and thus individual development was contributed to. The community's awareness and appreciation of the heritage value of the resources through education was considered one of the key success factors for long-term geopark conservation [10]. An educational approach was based on the geopark area's potential and values, including geological, biological, cultural, and socio-economic factors that were integrated into efforts so that sustainable development could be achieved. Geopark education was involved with not only introducing people to natural and cultural wealth but also with the development of critical awareness, systemic thinking skills, and ecological responsibility in environmental preservation [11]. Ecological literacy, which was emphasized as a thorough understanding of ecosystems and their interactions with human life, was considered a particular approach for raising environmental consciousness. In the context of geoparks, the eco-literacy of organisms was a crucial feature because this region contained within unique biodiversity that had to be maintained and used sustainably [12].

Ecological literacy was defined as a critical understanding of ecological principles and the ability to apply them in the context of sustainable human-environmental interactions, particularly in geoparks. A declining environmental quality, biodiversity loss, and threats to the long-term viability of local life support systems could result from a lack of understanding and application [13]. The protection of geological, hydrological, and biological components in a unified system was included in geopark conservation [14]. In this context, ecological literacy was considered a key basis in which conservation success was attained, including the strengthening of environmental education, the increasing of stakeholder participation, and the implementation of environmentally benign and adaptable land use practices [15]. The crucial role of scientific knowledge and ecological thinking in identifying causal links in socio-environmental systems was emphasized by ecological literacy, thereby allowing for more informed decision-making. A conscious society was allowed to make decisions or act on environmental issues [16]. In the context of Geopark conservation education, existing studies had been traditionally centered on Geo-education, which was primarily focused on geological narratives, the identification of site heritage, and the promotion of geo-tourism. While important, this approach often failed to bridge the understanding of geological diversity with the broader ecological systems and the ethical implications of sustainability.

This was precisely where the relevance of ecological literacy (Eco-literacy) emerged as a holistic framework. Eco-literacy was defined as a deep understanding of the principles of nature's organization—such as interconnectedness, cycles, and partnership—that led to pro-environmental behavioral change and ethical action. The potential to integrate geological, biodiversity, and socio-cultural aspects into a single, cohesive educational lens were offered by this framework.

Despite the significant potential of eco-literacy, a noticeable research gap was revealed by a review of the current literature. To date, no comprehensive Systematic Literature Review (SLR) that explicitly mapped the research landscape between Eco-literacy and Geopark Conservation had been conducted. Existing literature was highly fragmented, presenting individual case studies without a structured synthesis regarding global trends, geographical distribution, or the most effective thematic application models of eco-literacy. Efforts to standardize or replicate proven eco-literacy instructional designs across various international geoparks were hindered by this fundamental gap.

This study was therefore positioned to fill this knowledge gap. Utilizing a rigorous SLR methodology was aligned with the PRISMA 2020 guidelines, and the relevant literature was aimed to be both quantitatively analyzed and qualitatively synthesized. The primary novelty of this study was laid in providing a state-of-the-art overview that identified the thematic domains where Eco-literacy was most effectively applied (e.g., in Technology, Ecotourism, or applied Geo-education) and mapped the evolution of these studies over several decades. The findings from this SLR were intended to serve as the empirical foundation for which an adaptable Eco-literacy-based theoretical framework and instructional design were formulated to support the educational and conservation pillars of Geoparks on a global scale.

A lack of understanding and application of ecological literacy was identified as a strategic approach to effective and long-term geopark conservation. A declining environmental quality, biodiversity loss, and threats to the long-term viability of local life support systems could result from a lack of a balanced approach to understanding geoparks in education. This study was intended to disclose the breadth of geopark research trends and the application of eco-literacy in various nations.

## 2. METHOD

### 2.1 Study area

The research area referred to the UNESCO Geopark data in 2024, which totaled at 213 geoparks spread across 48 countries [17]. The focus of the research was placed on how eco-literacy might be used to manage and develop geoparks. The outcomes of past research that were related to the research topic, as well as those published in international journals, conferences, and

book reviews, were included in the study data. The study area was encompassed by two important aspects: geoparks and literacy, as well as educational approaches that were aimed at bringing eco-literacy closer to knowledge, socialization, and awareness. The study field was limited to two things: an abstract of research results and tendencies in the role of overcoming geopark conservation through eco-literacy.

### 2.2 Data collection and analysis

The SLR approach was used to collect and analyze data. This approach was considered appropriate for addressing the impact of eco-literacy on geopark conservation processes across multiple countries. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) technique was utilized by the SLR [18], systematic and structured, and based on indexation-based credible data sources.

The role of eco-literacy in geopark conservation was investigated by this study using the SLR approach. Materials were obtained from 2009 to 2025, and database coverage was gained from Scopus-indexed journals, conference proceedings, and book reviews. The arrangement, distribution, and filtering of the topics were decided upon by the researcher based on their suitability with the content required for the SLR study.

Table 1 was the researcher's database for further investigation of the content of publications directly connected to the research topic. To deepen and filter more strictly, criteria for inclusion and exclusion were developed by the researcher, with content screening being based on six guiding questions, as shown in Table 2.

The determination of which articles were to be included or excluded was determined as described in Table 2. In short, the included articles were simply compiled based on keywords, English language usage, and relevance to the study topic. The exclusion process was also necessitated to check for duplicate articles in different study subtopics, articles with completely unrelated content, and difficulties in gaining access to the full paper. For example, searches were also limited to whether the paper might be downloaded or not, so that all the information could be studied by researchers to find new things in someone else's research. To gradually filter, a search string containing the keyword "literacy" or its synonyms, such as "knowledge" and "learning," was run, yielding the following results. (1) "Geopark" AND "Eco-literacy"; (2) "Geopark" AND "Knowledge"; (3) "Geopark" AND "Literacy"; and (4) "Geopark" AND "Learning." The initial procedure of finding strings and articles that were irrelevant and difficult to examine was summarized in Table 1.

**Table 1.** Search strings related to geopark conservation through eco-literacy

| Search String | Articles Retrieved | Articles Reduced | Articles Used to Analysis |
|---|---|---|---|
| “Geopark” AND "Eco-literacy" OR "Eco-literacy" OR "Eco literacy" OR "Ecology literacy" or "Ecological literacy" | 0 | 0 | 0 |
| “Geopark” AND “Knowledge” | 241 | 181 | 60 |
| "Geopark" AND "Literacy" | 5 | 2 | 3 |
| "Geopark” AND “Learning” | 74 | 37 | 37 |
| Total | 320 | 220 | 100 |

**Table 2.** Include and exclude criteria in making decisions on the use of articles

| Criteria | Decision |
|---|---|
| Partial or full availability of keywords | Include |
| The article is fully written in English | Include |
| Review of articles related to geoparks, eco-literacy, literacy, ecology, learning, and knowledge | Include |
| Articles duplicated in other sections | Exclude |
| The review is not related to eco-literacy and its relevance to geoparks | Exclude |
| Articles are difficult to access in fullpaper | Exclude |

The SLR data collection for the database that was still active in Scopus was depicted in Table 1. Out of the 320 articles, 100 were to be evaluated in greater detail later. The 100 data points were used for screening so that whether the 320 articles contained complete full papers could be determined. The collected data, as presented in Figure 1, showed that 220 articles were not used because they only contained abstracts. Filtering was considered essential when defining the data used, with the following stages: (1) the main database was selected, (2) keywords were determined, (3) abstracts were studied deeper, (4) screening was performed on easily accessible databases, and (5) PICO (Problem, Intervention, Comparison, and Outcome) processes were used. Standardized data was sought to be obtained by the PICO technique based on the relevance of the "title," "abstract," and "keywords" [19]. Keywords were defined as strings by researchers and included geoparks, eco-literacy, literacy, ecology, learning, and knowledge. The selection of these keywords was corresponded to each synonym of related words so that more relevant articles might be caught.

The factors mentioned in Table 2 were used to help the researcher decide whether or not the publications were to be used. The PICO (problem, intervention, comparison, and measurements) thinking idea was considered by researchers for constructing the PRISMA filtering flow. How the PICO thinking idea was organized by the researcher was shown in Table 3.

**Table 3.** Thinking concept of PICO

| Problem (P) | Intervention (I) | Comparison (C) | Outcome (O) |
|---|---|---|---|
| Geopark | Eco-literacy | Literacy | Conservation |
| Geopark | Eco-literacy | Knowledge | Learning |
| Geopark | Eco-literacy | Ecological | Tourism |

The filtering formulation in Table 3 of PICO was taken from the PRISMA schematic diagram in Figure 1.

It was indicated by the PRISMA scheme in Figure 1 that 35 papers were resulted from the included articles. The articles were strictly selected based on their relevance to eco-literacy and its derivatives in education, particularly in geopark areas. The synthesis was enhanced with artificial intelligence-based synthesis methods and was recorded in Microsoft Excel. The study was validated by experts, and the conclusions of each synthesis were certified for use in SLR article processing.

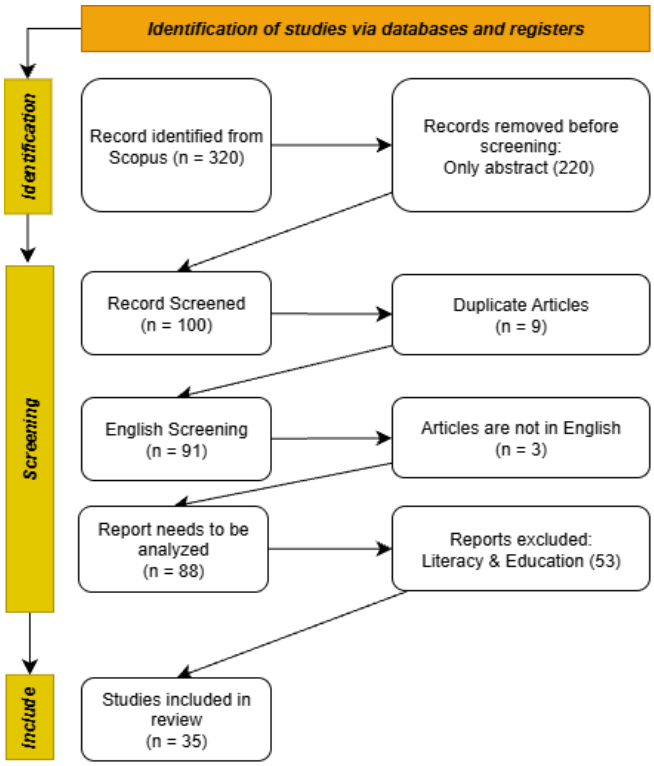


**Figure 1.** Scopus database filtering results using PRISMA technique

## 3. RESULTS

### 3.1 The articles bibliography

The development of eco-literacy research, specifically on geoparks, was extremely low. A total of 35 relevant articles was yielded when the PRISMA approach was used for literacy and educational filtering.

The extent to which the growth of eco-literacy in geoparks could be tracked year after year was determined in order to inform other researchers about the research's challenges and trends. The year of the search was defined as the year of publication, not the year in which data was collected and processed by other researchers. This was carried out so that various published and related articles could be connected, thereby allowing them to be tracked as needed. Based on data collection from Scopus, the development of eco-literacy research trends in geopark areas as a conservation effort was presented in Figure 2.

According to Figure 2, a significant increase was experienced by the trend and issue of eco-literacy, specifically for geoparks, over the last five years (2020-2025), being reached significantly compared to the previous year. Whereas in 2019 and earlier, in-depth articles discussing eco-literacy in geoparks were very limited, with a maximum of two articles, starting in 2020, articles discussing this topic were increased sharply, with the number being ranged from four to more. A significant twofold increase was represented by this from 2020 to the present. This surge was increased as various countries were registered for geopark sites with UNESCO, and researchers were attracted who were interested in studying eco-literacy as a geopark conservation effort. The biggest number of eco-literacy research was conducted in 2024, and it was expected to increase in 2025. This growing trend was indicated as a topic that would be developed by researchers in all countries with geoparks under conservation. This challenge needed to be grasped quickly so that simple eco-literacy could be disseminated on a wide scale for geopark conservation issues.

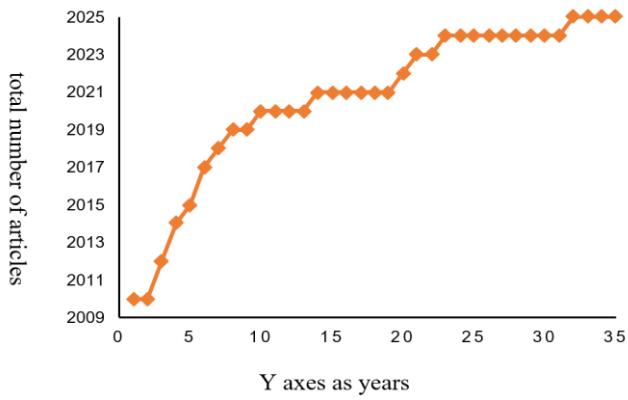


**Figure 2.** Number of articles based on the published year

The seriousness with which environmentalists around the world were beginning to mobilize their resources to consider eco-literacy in geopark management was demonstrated by the line in Figure 2. To determine the extent to which each country was involved in the application of eco-literacy for geopark conservation, the distribution of other researchers' study objects was analyzed in the infographic in Figure 3.


**Figure 3.** Distribution of eco-literacy-related research in geoparks around the world

According to the results of the mapping, Indonesia was identified as the country that placed the greatest emphasis on eco-literacy in geopark conservation. According to Figure 3, five UNESCO-recognized geoparks, distributed across several regions, were held by Indonesia. This high quantity, together with the increasing interest of academics in Indonesian geopark sites, has led to the use of eco-literacy in a variety of concepts for learning, ecotourism, community empowerment, and ecosystem-based geopark conservation. When seen on a regional scale, this study was dominated by Southeast Asia,

with geopark contributions being made by Indonesia and Malaysia. At the continental level, the highest eco-literacy study was found in Asia compared to the other continents. This data was not generalizable because much more data was still needed based on the capacity to access articles, the correctness of researchers, and a variety of other characteristics that served as the baseline for which publications were filtered. Thus, the trend of eco-literacy was increased again since geoparks became the focus of global conservation, indicating that they had to be maintained properly and sustainably, with the life of the ecosystem within them being taken into account in accordance with the ecocentrism principle.

### 3.2 Eco-Literacy adaptation in geopark research trend

Numerous adaptations were undergone by the evolution of eco-literacy research. Several findings were demonstrated regarding how the application of eco-literacy was disseminated using various methods, particularly among those studying in the world's Geoparks. The aspects of adaptation that had been implemented to strengthen eco-literacy in the geopark area are shown in Table 4.

**Table 4.** Karst sustainability view in ecocentrism

| Eco-literacy Adaptation Aspects | Description | Refs. |
|---|---|---|
| Technology in Strengthening Geopark Eco-literacy | Use of technology for learning and reinforcement in literacy | [10, 20-24] |
| | Assistive technology for hands-on Geopark exploration as a tool to introduce the diverse resources inside the Geopark | [25-27] |
| Ecotourism Community | Eco-literacy learning obtained through an ecotourism travel package in the Geopark area. | [28, 29] |
| | Improving the community's Geopark literacy by empowering tourism quality. | [30, 31] |
| | Variety of learning that is carried out in the Geopark area as an autonomous learning object that is directly interwoven with real-world experience. | [32-35] |
| Applied Geoeducational | Developing eco-literacy through direct interaction with concerns and challenges in the Geopark area. | [36-39] |
| | Education units that carry out eco-literacy development and assessment related to the Geopark | [8, 40-42] |
| Science and Cultural Heritage | Studying Geoparks promotes eco-literacy among academics, scientists, and policymakers. | [43-45] |
| | Geoparks as a beneficial cultural heritage to raise awareness of caring for and safeguarding unique global heritage. | [15, 46-48] |

The phenomenon of internalizing the variety of geoparks into eco-literacy was divided into the characteristics listed in Table 4. These features were demonstrated to show that the presence of eco-literacy was considered extremely crucial to investigate [49], the information was utilized as a genuine conservation endeavor utilizing Geopark information from various angles. Based on the results of the analysis of 35 articles related to eco-literacy in geoparks, the distribution of each aspect is shown in Figure 4 below.

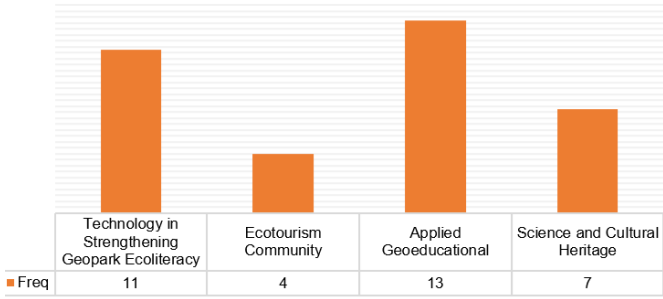


**Figure 4.** Distribution of eco-literacy implementation aspect

It was shown in Figure 4 that the highest level of eco-literacy was associated with the advancement of earth-related sciences such as geology, geodesy, geomorphology, and other education-based sciences. Meanwhile, an interesting issue was paid attention to, regarding how eco-literacy could be combined with ecotourism as a tour package so that geoparks could become known and learned about as a source of applied science for tourists.

## 4. DISCUSSION

Advantages for education, research, culture, and social development were provided by geoparks. Ecological literacy was improved, environmental consciousness was created, and sustainable activities were promoted among students when geoparks were integrated into educational frameworks [50]. Geoparks were worked as dynamic educational platforms that were encouraged for conservation. Hands-on learning opportunities were offered by Geoparks that were enhanced by knowledge of natural systems and conservation [51]. A holistic conservation strategy was adopted by Geoparks, with all aspects of natural and cultural heritage being valued, conserved, and promoted as part of their geopark status. Since their formation in 2000, UGGp have grown from simply conservation sites to vibrant educational spaces where geoscience teaching and community interaction were incorporated [52].

A low level of knowledge and awareness towards geoparks was led to by the community's low ecological literacy about geoparks; clearly, more education and outreach help was needed to deliver the message to the community regarding geopark development and protection [53]. It was suggested by the study's findings that additional awareness-raising programs, dialogues, and workshops might be arranged by relevant authorities to foster a better understanding of the geopark idea and to stimulate local engagement in geopark-based activities [54].

It was suggested by the data that education and communication initiatives involving communities were not coordinated, probably due to a lack of resources and manpower for non-formal education and training [55]. Furthermore, little general information was accessible to the public. While programs and materials were required to raise public awareness about the community, effective community communication was necessitated by a long-term commitment in staff and resources so that direct interaction with the intended audience could be achieved. A needs analysis of the target population was also ensured to make certain that any

public education initiatives were as effective as possible and that the program and resources spent yielded the best results. Integration of geo-education in geoparks was served by the United Nations Sustainable Development Goals (SDGs), particularly in encouraging quality education and environmental stewardship [8]. More than 177 geoparks worldwide were currently functioned as outdoor classrooms, and the practical value of education programs in encouraging ecological literacy and sustainable tourism was emphasized by them [56].

Issues in designing educational materials that were effectively targeted to a wide range of literacy and ecological levels, as well as assessing the current state of ecological understanding among geopark visitors and communities, were presented by Geopark conservation. Gaps in public awareness and involvement were uncovered by existing research, with some stakeholders being demonstrated to have an insufficient grasp of the geopark idea and their role in conservation [57]. The most effective ecological literacy approaches were combined with formal school curricula with non-formal and informal learning strategies in geoparks. Geo-world sites were used as experiential learning environments by geo-education to raise knowledge of geological processes, biodiversity, and human-environmental connections [26].

While significant platforms for environmental education, conservation consciousness, and sustainable development had been established by several countries, the efficacy of their teaching materials and activities was unknown. Ecological literacy was considered an inherent aspect of environmental education, particularly in geoparks with high ecological, cultural, and geological importance. Collaboration was considered crucial for the successful integration of ecological literacy in education among schools, Geopark management, communities, and research organizations [58].

## 5. CONCLUSION

According to the study's findings, the trend of geopark and eco-literacy research was increased by 74.28% in the last five years (2020-2025). Most of the research on this topic was conducted on the Asian continent, particularly in Southeast Asia, which was dominated in this study by contributions from geoparks in Indonesia and Malaysia. Geopark preservation was considered important in eco-literacy because the use of technology in geoparks and ecotourism communities and the application of geoparks in education, society, and culture were strengthened by it.

The ecocentrism tendency in geopark environmental management was resurfaced following the ruthless anthropocentrism of exploiting karst natural resource riches. This finding was supported by a growing number of papers that examined ecocentrism and its relationship to the karst environment. Ecocentrism was considered a dignified worldview for which the karst ecosystem could be restored to its mandate. Various studies had found that the strength of karst management was dependent on the individual involved. Legislation, educational measures, exploration, and other features that affected the future conditions of the geopark to be either advantageous or a natural disaster for organisms in it were constructed by humans. The landscape heritage owned by each country and recognized by UNESCO was the responsibility and obligation of both biotic and abiotic individuals within or outside the environment. Because holistic deep ecology was required by ecocentrism, all people involved with the geopark region had to follow the laws of harmony with nature and sustainable development. Suggestions for future research were included for the development of instructional design through eco-literacy-based learning delivered to the community to protect the Geopark.

## ACKNOWLEDGEMENT

This research was funded by the Indonesian LPTK Collaborative Research in 2025 according to contract number T/1045/UN34.9/PT.01.03/2025 dated April 24, 2025.

## REFERENCES

[1] Martínez-Martín, J.E., Ester Mariñoso, P., Rosado-González, E.M., Sá, A.A. (2023). Prospective study on geosciences on-line education: UNESCO global geoparks in Spain and Portugal. Geosciences, 13(2): 22. https://doi.org/10.3390/geosciences13020022

[2] Surtikanti, H.K., Bahabazi, U. (2013). Studi tentang ekologi dan habitat planaria, Sp. di subang: Kelimpahan dan biomassa merupakan indikator kualitas air bersih. Majalah Ilmiah Biologi BIOSFERA: A Scientific Journal, 30(2): 66-72.

[3] Costa, D.D.A., Dolbeth, M., Christoffersen, M.L., Zúñiga-Upegui, P.T., Venâncio, M., de Lucena, R.F.P. (2023). An overview of rhodoliths: Ecological importance and conservation emergency. Life, 13(7): 1556. https://doi.org/10.3390/life13071556

[4] Marlina, E., Herawan, T. (2020). Geotourism concept development in the basis of environment sustainability, socioculture, and natural science wealth: A case study in Indonesia. Journal of Environmental Management & Tourism, 11(1(41)): 145-158. https://doi.org/10.14505/jemt.11.1(41).17

[5] Avelar, S., Mansur, K.L., Anjos, S.C., Vasconcelos, G.F. (2015). Community perceptions for geoconservation of a coastal area in Rio de Janeiro, Brazil. Geoheritage, 7(3): 275-283. https://doi.org/10.1007/s12371-014-0130-z

[6] Modrej, D., Štrucl, S.F., Hartmann, G. (2018). Results of the geointerpretation research in the frame of the Danube GeoTour project. Geologija, 61(1): 101-110. https://doi.org/10.5474/geologija.2018.007

[7] Justice, S.C. (2023). Leveraging earth science research for effective sustainability policy and territorial management in the Chablais UNESCO global geopark (France). Geological Society, London, Special Publications, 530(1): 277-288. https://doi.org/10.1144/SP530-2022-125

[8] Setiawan, I.F., Rohaendi, N., Harmoko, A.A. (2025). Assessment of geoeducational value of geosites in UNESCO Global Geopark Ciletuh-Palabuhanratu based on school students. IOP Conference Series: Earth and Environmental Science, 1451(1): 012013. https://doi.org/10.1088/1755-1315/1451/1/012013

[9] Stoffelen, A. (2020). Where is the community in geoparks? A systematic literature review and call for attention to the societal embedding of geoparks. Area, 52(1): 97-104. https://doi.org/10.1111/area.12549

[10] Sas, A. (2024). Implementation of information

technology learning media to improve geoparks literacy in maros-pangkep geopark area through the Geological Information Center. IOP Conference Series: Earth and Environmental Science, 1424(1): 012033. https://doi.org/10.1088/1755-1315/1424/1/012033

[11] Azmi, E., Che Rose, R.A., Awang, A., Abas, A. (2023). Innovative and competitive: A systematic literature review on new tourism destinations and products for tourism supply. Sustainability, 15(2): 1187. https://doi.org/10.3390/su15021187

[12] Khoshkam, M., Jaafar, M. (2016). A community-based geotourism entrepreneurship: A case of Kilim Geopark, Malaysia. International Journal of Social Ecology and Sustainable Development (IJSESD), 7(4): 47-58. https://doi.org/10.4018/IJSESD.2016100104

[13] Bethel, B.J., Buravleva, Y., Tang, D. (2021). Blue economy and blue activities: Opportunities, challenges, and recommendations for the Bahamas. Water, 13(10): 1399. https://doi.org/10.3390/w13101399

[14] Syaharuddin, S. (2024). Integrating artificial intelligence in learning environments: A comprehensive review of current practices and impacts. Seminar Nasional Paedagoria, 4(1): 14-23. https://journal.ummat.ac.id/index.php/fkip/article/view/25544.

[15] Azman, N., Halim, S.A., Liu, O.P., Saidin, S., Komoo, I. (2010). Public education in heritage conservation for geopark community. Procedia-Social and Behavioral Sciences, 7: 504-511. https://doi.org/10.1016/j.sbspro.2010.10.068

[16] Pratama, A.T., Limiansi, K., Anazifa, R.D. (2020). Penggunaan STEM (Science, technology, engineering, and mathematics) terintegrasi pembelajaran berbasis proyek untuk mahasiswa. Jurnal Biology Science & Education, 9(2): 115-121.

[17] Pérez-Romero, M.E., Álvarez-García, J., Flores-Romero, M.B., Jiménez-Islas, D. (2023). UNESCO global geoparks 22 years after their creation: Analysis of scientific production. Land, 12(3): 671. https://doi.org/10.3390/land12030671

[18] Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. Bmj, 372. https://doi.org/10.1136/bmj.n71

[19] Cumpston, M.S., McKenzie, J.E., Thomas, J., Brennan, S.E. (2021). The use of 'PICO for synthesis' and methods for synthesis without meta-analysis: Protocol for a survey of current practice in systematic reviews of health interventions. F1000Research, 9: 678. https://doi.org/10.12688/f1000research.24469.2

[20] Emafri, W., Sari, D.P., Rifai, H. (2020). Design of edupark physics book with project based learning based on Ngarai Sianok National Geopark, Indonesia. Journal of Physics: Conference Series, 1481(1): 012100. https://doi.org/10.1088/1742-6596/1481/1/012100

[21] Ummah, K., Rifai, H. (2020). Preliminary analysis learning media based on Edupark Science with scientific methods in the national geopark of Ranah Minang Silokek of Sijunjung. Journal of Physics: Conference Series, 1481(1): 012065. https://doi.org/10.1088/1742-6596/1481/1/012065

[22] Ummah, K., Rifai, H. (2021). Validity of science edupark e-book based on scientific approach on the national geopark of Ranah Minang Silokek, Indonesia. Journal of Physics: Conference Series, 1876(1): 012058. https://doi.org/10.1088/1742-6596/1876/1/012058

[23] Kneć, A., Zgłobicki, W. (2025). Mobile applications as a tool for tourism management in Geoparks (Case study: Potential Geopark małopolski przełom wisły, E poland). Land, 14(4): 676. https://doi.org/10.3390/land14040676

[24] Agastya, I.B.O., Paripurno, E.T., Prastistho, B., Murwanto, H., Prasetya, J.D., Nugraho, A.R.B. (2024). Model media learning for disaster risk reduction in the Batur UNESCO Global Geopark. International Journal of Geoheritage and Parks, 12(3): 353-366. https://doi.org/10.1016/j.ijgeop.2024.04.005

[25] Zheng, S., Zhu, L., Weng, L., Gu, X. (2024). The more advanced, the better? A comparative analysis of interpretation effectiveness of different media on environmental education in a Global Geopark. Land, 13(12): 2005. https://doi.org/10.3390/land13122005

[26] Sari, D.P., Rifai, H. (2019). Preliminary analysis of edupark fluid learning tool in Mifan water park in Padang Panjang city. Journal of Physics: Conference Series, 1185(1): 012091. https://doi.org/10.1088/1742-6596/1185/1/012091

[27] Kim, H.S., Lim, C. (2019). Developing a geologic 3D panoramic virtual geological field trip for Mudeung UNESCO global geopark, South Korea. Episodes Journal of International Geoscience, 42(3): 235-244. https://doi.org/10.18814/epiiugs/2019/019019

[28] Li, G., Xu, D. (2023). Learning by doing: Educational tourism at Mount Danxiashan. Tourism Cases, (2023): tourism202300043. https://doi.org/10.1079/tourism.2023.0043

[29] Santangelo, N., Amato, V., Ascione, A., Russo Ermolli, E., Valente, E. (2020). Geotourism as a tool for learning: A geoitinerary in the Cilento, Vallo di Diano and Alburni Geopark (Southern Italy). Resources, 9(6): 67. https://doi.org/10.3390/resources9060067

[30] Long, C., Lu, S., Zhu, Y. (2022). Research on popular science tourism based on SWOT-AHP model: A case study of Koktokay World Geopark in China. Sustainability, 14(15): 8974. https://doi.org/10.3390/su14158974

[31] Fernandes, G.P., Castro, E., Gomes, H., Fernandes, M. (2021). New training contexts for geoeducation and tourism: Action and education strategies in the qualification of Estrela Geopark communities in Portugal. In Handbook of Research on Human Capital and People Management in the Tourism Industry, pp. 329-349. https://doi.org/10.4018/978-1-7998-4318-4.ch016

[32] Briggs, A., Dowling, R., Newsome, D. (2023). Geoparks-learnings from Australia. Journal of Tourism Futures, 9(3): 351-365. https://doi.org/10.1108/JTF-11-2020-0204

[33] Buhay, D.N., Best, L.A. (2015). Informal learning at Stonehammer and English Riviera geoparks. Geoheritage, 7(2): 165-175. https://doi.org/10.1007/s12371-014-0125-9

[34] Harangi, S., Korbély, B. (2023). The basaltic monogenetic volcanic field of the Bakony-Balaton UNESCO Global Geopark, Hungary: From science to geoeducation and geotourism. Geoconservation Research, 6(1): 70-97. https://doi.org/10.30486/gcr.2023.1981579.1125

[35] Ferdowsi, S., Tavana, M., Heydari, R., Štrba, Ľ. (2025). Geoeducation: The key to geoheritage conservation in tourism destinations. International Geology Review, 67(13): 1674-1696. https://doi.org/10.1080/00206814.2025.2466028
[36] Martínez-Frías, J., Mederos, E.M., Lunar, R. (2017). The scientific and educational significance of geoparks as planetary analogues: The example of Lanzarote and Chinijo Islands UNESCO Global Geopark. Episodes Journal of International Geoscience, 40(4): 343-347. https://doi.org/10.18814/epiiugs/2017/v40i4/017035
[37] Muzambiq, S., Walid, H., Ganie, T.H., Hermawan, H. (2021). The importance of public education and interpretation in the conservation of Toba Caldera Geoheritage. Geoheritage, 13(1): 3. https://doi.org/10.1007/s12371-020-00523-x
[38] Zgłobicki, W., Nowak, I., Baran-Zgłobicka, B., Głuszek, A. (2024). The use of geosites in education-A case study in central Poland. Resources, 13(1): 15. https://doi.org/10.3390/resources13010015
[39] Zgłobicki, W., Kołodyńska-Gawrysiak, R., Gawrysiak, L. (2015). Gully erosion as a natural hazard: The educational role of geotourism. Natural Hazards, 79(Suppl 1): 159-181. https://doi.org/10.1007/s11069-014-1505-9
[40] Nazaruddin, D.A., Ab Manaf, N. (2024). Assessment of geoeducation program for indigenous students in Kenyir Geopark, Terengganu, Malaysia. Geoconservation Research, 7(1): 22-38, https://doi.org/10.57647/j.gcr.2024.0701.02
[41] Martínez-Martín, J.E., Mariñoso, P.E., Rosado-González, E.M., Paz, A., Sá, A.A. (2024). Assessment of educational potential in Arouca and Estrela UNESCO Global Geoparks (Portugal) for multi-level students and teachers. International Journal of Geoheritage and Parks, 12(4): 517-530. https://doi.org/10.1016/j.ijgeop.2024.11.002
[42] Mammadova, A. (2021). Integrating Japanese local government and communities into the educational curriculum on regional sustainability inside the UNESCO's biosphere reserves and geoparks. Sustainability, 13(5): 2497. https://doi.org/10.3390/su13052497
[43] dos Santos Pinto, D.G., de Araujo Andrade, Y.L., de Souza Rédua, L., da Silva Marinho, T. (2021). Geoconservation: A regional didactic experience in triângulo mineiro context (Minas Gerais state, Brazil). Geoheritage, 13(2): 49. https://doi.org/10.1007/s12371-021-00575-7
[44] Ferraro, F.X., Schilling, M.E., Baeza, S., Oms, O., Sá, A.A. (2020). Bottom-up strategy for the use of geological heritage by local communities: Approach in the "Litoral del Biobío" Mining Geopark project (Chile). Proceedings of the Geologists' Association, 131(5): 500-510. https://doi.org/10.1016/j.pgeola.2020.06.001
[45] Fang, S., Guo, X. (2010). Chinese Geoparks' construction and the sustainable utilization of geological heritage resources. In 2010 2nd International Conference on Information Engineering and Computer Science, Wuhan, China, pp. 1-4. https://doi.org/10.1109/ICIECS.2010.5678383
[46] Zecha, S., Regelous, A. (2018). Promoting geodiversity education by using earthcaching in National Geoparks. Geoheritage, 10(4): 637-643. https://doi.org/10.1007/s12371-018-0280-5
[47] Sarwoprasodjo, S., Kinseng, R.A., Sunarminto, T., Mijiarto, J., Hidayati, R.K., Syifa, F.A., Dzar, A.A., Syah, M.R.A.A., Muthmainnah, H.S., Santoso, Z.F. (2025). Fostering ecosystem resilience through targeted communication: A cluster analysis of Ijen Geopark Communities. BIO Web of Conferences, 175: 04003. https://doi.org/10.1051/bioconf/202517504003
[48] Henriques, M.H., Tomaz, C., Sá, A.A. (2012). The Arouca Geopark (Portugal) as an educational resource: A case study. Episodes Journal of International Geoscience, 35(4): 481-488. https://doi.org/10.18814/epiiugs/2012/v35i4/004
[49] Prihandini, Y.D., Sefriani, S.B. (2025). Karst environment sustainability in ecocentrism ideology: A systematic literature review. International Journal of Sustainable Development and Planning, 20(2): 893-899. https://doi.org/10.18280/ijsdp.200237
[50] Williams, M.A., Tronti, G., Peruzzo, R.S., García-Rodríguez, M., Fazio, E., Zucali, M., Bollati, I.M. (2025). Geoscience popularisation in Geoparks: A common workflow for digital outcrop modelling. Computers & Geosciences, 105945. https://doi.org/10.1016/j.cageo.2025.105945
[51] Brilha, J., Gray, M., Pereira, D.I., Pereira, P. (2018). Geodiversity: An integrative review as a contribution to the sustainable management of the whole of nature. Environmental Science & Policy, 86: 19-28. https://doi.org/10.1016/j.envsci.2018.05.001
[52] García-Cala, L.J., Vega-Angarita, L.C., Ríos-Reyes, C.A., Viviescas-Beltrán, L.S. (2025). Discovering the Earth: Design and implementation of geoeducation strategies and their social impact in rural areas of Chicamocha Canyon: Case study at Instituto Valle del Río de Oro, Piedecuesta (Colombia). International Journal of Geoheritage and Parks, 13(4): 506-519. https://doi.org/10.1016/j.ijgeop.2025.01.005
[53] Mejía, V.L.V., Grados, J.E., Núñez, F.R.B., Ticona, I.L.Q. (2024). Education for sustainability: A valuative perspective on learning and knowledge technologies by Graduates. Clío. Revista de Historia, Ciencias Humanas y Pensamiento Crítico, 9(5): 267-288. https://doi.org/10.5281/zenodo.14559327
[54] Irfan, M., Afzal, A., Bali, B.S., Topal, S., Naik, S., Ahmad, N., Bashir, A. (2025). Exploring the geoheritage, cultural geomorphology, and geotourism potential of the Kashmir region, Northwest Himalaya, India. Geoheritage, 17(2): 85. https://doi.org/10.1007/s12371-025-01117-1
[55] Carrion-Mero, P., Soto-Navarrete, L., Apolo-Masache, B., Mata-Perello, J., Herrera-Franco, G., Briones-Bitar, J. (2025). Environmental assessment and tourism carrying capacity in Geosites of the Ruta del Oro Geopark Project. Geoheritage, 17(1): 1-22. https://doi.org/10.1007/s12371-025-01084-7
[56] Dang, K.B., Pham, T.T., Phan, T.T.H., Nguyen, M.H., Pham, T.P.N., Hoang, T.T., Hoang, T.H.N., Nguyen, T.H.T., Nguyen, T.H., Le, Q.D., Tran, N.B.V., Tran, T.K.B. (2025). Bayesian belief network for assessing conservation and tourism development in UNESCO Geoparks. Geoheritage, 17(1): 36. https://doi.org/10.1007/s12371-025-01083-8
[57] Santos, D.S., Mansur, K.L. (2024). The educational importance of geosites representing geodiversity-

biodiversity relationships: A thematic inventory proposal. Geoheritage, 16(4): 99. https://doi.org/10.1007/s12371-024-01000-5

[58] Adrianda, R.S., Sahara, R., Gusti, U.K. (2025). The geodiversity site of Geopark Ranah Minang Silokek, Indonesia: Promoting geo-education and geotourism through geosite assessment. International Journal of Geoheritage and Parks, 13(2): 239-249. https://doi.org/10.1016/j.ijgeop.2024.11.012