Biodiversity literacy level of students in a senior high school

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Indonesia is one of the countries experiencing a decline in biodiversity due to climate change and human activities, whereas biodiversity has an important value to meet the basic needs of humans and other living things so it is very important to be preserved. Therefore, the awareness of each individual is needed to preserve biodiversity so that it remains sustainable so that the needs of life on earth remain stable. Knowledge that must be possessed by students on the topic of biodiversity include: the level of biodiversity, the role of biodiversity, actions that can reduce biodiversity and efforts to prevent and preserve biodiversity. Issues or problems about biodiversity need to be known and learned by students so that students are able to solve problems related to biodiversity in everyday life. Biodiversity literacy skills possessed by students are expected to be able to make a positive contribution in the community environment to maintain the sustainability of biodiversity in the future. Based on the above, the purpose of this study is to determine the level of biodiversity literacy of high school students. The population of this study were 70 high school students in class X semester 2 of the 2023-2024 school year. The technique of collecting data on the level of biodiversity literacy of high school students uses a multiple choice research instrument of 40 questions that refer to the World Wildlife Fund's biodiversity education framework. The results of the investigation showed the level of biodiversity literacy of high school students at the level of functional literacy, structural literacy and nominal literacy, but no students were found to have a level of biodiversity literacy in multidimensional literacy. So that learning is needed that can bring out and improve biodiversity literacy in students.

Abstrak. Indonesia merupakan salah satu negara yang mengalami penurunan biodiversitas akibat perubahan iklim dan aktivitas manusia, padahal biodiversitas memiliki nilai penting untuk memenuhi kebutuhan dasar manusia dan makhluk hidup lainnya, sehingga sangat penting untuk dijaga kelestariannya. Karena itu diperlukan kesadaran setiap individu untuk menjaga kelestarian biodiversitas agar tetap lestari sehingga kebutuhan hidup di bumi tetap stabil. Pengetahuan yang harus dimiliki oleh mahasiswa pada topik biodiversitas antara lain: tingkat biodiversitas, peran biodiversitas, tindakan yang dapat mengurangi biodiversitas dan upaya pencegahan dan pelestarian biodiversitas. Isu-isu atau permasalahan tentang biodiversitas perlu diketahui dan dipelajari oleh siswa agar siswa mampu memecahkan masalah yang berkaitan dengan biodiversitas dalam kehidupan sehari-hari. Kemampuan literasi biodiversitas yang dimiliki oleh siswa diharapkan mampu memberikan kontribusi positif di lingkungan masyarakat untuk menjaga keberlangsungan biodiversitas di masa yang akan datang. Berdasarkan hal di atas, tujuan dari penelitian ini adalah untuk mengetahui tingkat literasi biodiversitas siswa SMA. Populasi penelitian ini adalah siswa SMA kelas X semester 2 tahun ajaran 2023-2024 sebanyak 70 orang. Teknik pengumpulan data tingkat literasi biodiversitas siswa SMA menggunakan instrumen penelitian pilihan ganda sebanyak 40 soal yang mengacu pada kerangka kerja pendidikan biodiversitas World Wildlife Fund. Hasil investigasi menunjukkan tingkat literasi biodiversitas siswa SMA pada tingkat literasi fungsional, literasi struktural dan literasi nominal, namun tidak ditemukan siswa yang memiliki tingkat literasi biodiversitas pada literasi multidimensional. Sehingga diperlukan pembelajaran yang dapat memunculkan dan meningkatkan literasi biodiversitas pada siswa.

A. Introduction

Indonesia is known as an archipelagic country and is one of the countries with the highest megadiversity. LIPI data on the Status of Indonesia's Biodiversity of Indonesia's Plant and Fungal Species in 2017 showed 31,750 species consisting of 2,273 types of fungi, 2,722 types of mosses, 512 types of crust moses, 1,611 types of pteridophyta and 24,632 types of spermatophytes (Retnowati et al., 2019). Indonesia has a high number of endemic species (Rintelen et al., 2017). Biodiversity has an important value to meet the basic needs of humans and other living things, so it is very important to maintain its sustainability in the present and future. Plant biodiversity is used by humans to fulfill daily life. The use of plants by humans such as utilizing leaves, stems, fruits, seeds, bulbs, flowers as medicine and food (Darmastuti et al., 2024).

Indonesia is one of the countries experiencing a decline in biodiversity due to climate change and human activities. Based on the Indonesian Biodiversity Strategy and Action Plan IBSAP 2025-2045 that Indonesia is experiencing a crisis of biodiversity loss in a decade, it is estimated that around 1 million species of plants and animals are facing the threat of extinction globally and it is predicted that Indonesia will experience a reduction in habitat area from 80.30% in 2000 to 49.70% in 2045 (Kementerian Perencanaan Pembangunan Nasional, 2024). The decline in biodiversity in Indonesia is caused by forest loss due to tree felling, forest fires and forest conversion (deforestation) (Setiawan, 2022). Human activities that can cause a decrease in biodiversity such as taking a certain number of individuals of certain species, either for their own consumption or for trading through activities illegal hunting, illegal fishing and illegal logging (Diaz et al., 2019). Based on the report World Wildlife Fund The main threats to biodiversity loss in Asia Pacific are land use and sea change including habitat loss and degradation (43%), overexploitation of species (27%), invasive species and disease (14%), pollution (11%) and climate change (5%) (Almond et al., 2021). Problems arising from the decline in plant biodiversity include a decrease in the population of useful plant species, a decrease in local knowledge and the loss of local technology in utilizing plant resources (Sujarwo, 2023).

Based on the IUCN Red List, there are 128,918 species of which 35,765 (28%) are threatened with extinction, including amphibians (41%), sharks (31%) and corals (33%) and the latest data includes IUCN Red List is Kalimantan Mango *(Mangifera casturi)* endangered in their natural habitat (IUCN, 2020). Plant biodiversity in Indonesia consists of 3,393 species of Indonesia plants with 674 endemic species and 683 species must update their conservation status to anticipate extinction and as an appropriate plant rescue and protection effort (Kusumadewi et al.,

2020). Therefore, the awareness of each individual is needed to maintain the preservation of biodiversity so that the needs of life on Earth remain stable. According to Yuan et al. (2022) Students' awareness of sustainability needs to be increased and needs to be strengthened related to real issues and problems in the community, because according to Obrecht et al. (2021) by incorporating sustainability that focuses on biodiversity protection and environmental management into school curricula, extracurricular programs and school initiatives with communities and educational institutions can form a generation that cares about sustainability.

Learning related to the topic of biodiversity is studied in phase E including elements of understanding Biology and process skills. The element of understanding Biology is that students have the ability to create solutions to problems based on local, national or global issues related to understanding the diversity of living things and their roles, viruses and their roles, biological technology innovations, ecosystem components and interactions between components and environmental changes. Meanwhile, the process skill elements consist of observing, questioning and predicting, planning and conducting investigations, processing, analyzing data and information, evaluating and reflecting, and communicating results (Kemendikbudristek, 2022).

Learning on the topic of biodiversity must be able to generate knowledge that can later be implemented as an effort to protect biodiversity such as protecting the preservation of plants, animals and the environment. Real-world problems and future challenges on biodiversity issues in learning make students participate and play an active role in the scientific research process related to biodiversity conservation and are able to strengthen students' self-efficacy and sense of responsibility related to biodiversity issues (Schneiderhan-Opel & Bogner, 2020). Learning that implements pro-biodiversity activities is able to create changes in student behavior so that they are able to take actions related to the biodiversity problems found (Kurniasih, 2018). The formation of pro-environmental and biodiversity behavior is an important part of the learning process carried out in learning so that it is expected to make a real contribution to the wider community (Aripin et al., 2021). Actions that students can take at school to create a green school such as: managing the school garden, each class is given the responsibility to maintain and care for the garden near the class, inviting students to dispose of sampang by sorting waste into organic and inorganic waste and processing it into compost, making hydroponic installations to grow vegetable plants, and doing community service work at the school (Widodo et al., 2023).

The knowledge that students must have on the topic of biodiversity includes: the level of biodiversity, the role of biodiversity, actions that can reduce biodiversity and efforts to prevent and preserve biodiversity. Literacy is one of the life skills and must be mastered in facing the challenges of the 21st century, research results by Nudiati & Sudiapermana (2020) found that literacy is not directly proportional to the implementation carried out. Biodiversity literacy is the ability of a person to understand biodiversity, sensitivity to every change that occurs in the environment and the ability to find solutions to problems related to biodiversity (Katili et al., 2022). The findings of the study show that the level of biodiversity literacy of junior high school students has a high attitude towards biodiversity but the level of knowledge about biodiversity is low (Hulya & Rifat, 2022). Meanwhile, the findings of the study Berame et al. (2022), high school students have a vague understanding of the use of the natural environment well but they understand that the natural environment is very important to protect. Milkisso (2020) state that students' knowledge of biodiversity is still low, this is because students do not carry out activities such as field trips, experiments in the laboratory and outside the laboratory, and outdoor activities to teach environmental problems. Issues or problems about biodiversity need to be known and studied by students as a form of knowledge so that it is hoped that students will be able to solve problems related to biodiversity in daily life. In addition, students are required to have biodiversity literacy skills because in their daily lives they use plants directly, but sometimes they do not realize that they already have knowledge about the use of biodiversity.

When students have an understanding including knowledge, skills, attitudes and actions about biodiversity, it is hoped that students will be able to solve problems in daily life related to biodiversity. Understanding biodiversity in students sometimes has misconceptions about the concept of biodiversity because they are able to explain well about the genetic variation of species but are wrong in choosing phenomena related to the level of biodiversity (Pratomo et al., 2021). So that the biodiversity literacy skills possessed by students are expected to be able to make a positive contribution to the community to maintain the sustainability of biodiversity in the future.

Based on the explanation above, the main purpose of this study is focused on investigating the achievement of biodiversity literacy in each indicator and the level of biodiversity literacy of high school students in learning biology of biodiversity material and its role in phase E.

B. Material and method

This research is a type of qualitative research. The population in this study is high school students in class X or phase E who have learning outcomes to understand biology students have the ability to create solutions to problems based on local, national or global issues related to understanding the diversity of living things and their roles and process skills according to Kemendikbudristek (2022) including:

1) Observing
2) Questioning and predicting
3) Planning and conducting investigations
4) Processing, analyzing data and information
5) Evaluating and reflecting
6) Communicating

The research was conducted at SMAN 1 Mande as many as 70 students for the 2023-2024 school year. The technique of collecting data on the level of biodiversity literacy of high school students uses research instruments in the form of 40 multiple-choice questions referring to the biodiversity education framework World Wildlife Fund (World Wildlife Fund, 1996). The biodiversity literacy instruments used have been validated by experts, tested, and analyzed using the ANATES 4.0 application. The results of the analysis of the biodiversity literacy instrument have validity in the moderate, high, and very high categories with a reliability of 0.93, including in the very high category and the difficulty level of the questions in the easy, medium, and difficult categories. Biodiversity literacy questions in this study include: nine questions about the level of biodiversity, six questions about factors that affect biodiversity, eight questions about the value of biodiversity for humans, six questions about science and technology, four questions about strategies that have been used to investigate biodiversity problems and issues and seven questions about appropriate action strategies for the prevention of biodiversity loss. Student biodiversity literacy data was obtained through written tests (paper and pencil test), Then the score is calculated using the Formula 1.

$$V = \frac{x}{y} \times 100 \dots\dots\dots\dots\dots\dots\text{Formula 1}$$

Description:
V   = Biodiversity literacy score
x   = Score obtained
y   = Maximum score

The scores obtained by students are then interpreted based on the level of biodiversity literacy by adapted from Aripin et al. (2021) shown in Table 1. The explenation for each biodiversity literacy category is in Table 2.

Table 1 Biodiversity literacy levels

Value range	Levels of biodiversity
0-25	Nominal literacy
26-50	Functional literacy
51-75	Structural literacy
76-100	Multidimensional literacy

Table 2 Biodiversity literacy category

Biodiversity literacy level	Explanation
Nominal literacy	1. Understand basic terms related to biodiversity and be able to communicate them. 2. There are misconceptions in providing explanations about biodiversity. 3. Awareness and sensitivity to biodiversity are beginning to emerge. 4. The ability to identify biodiversity problems and efforts to.
Functional literacy	1. Understand the definition of contextual biodiversity and use it correctly. 2. Able to communicate information on problems related to biodiversity issues. 3. Sensitivity to biodiversity emerges. 4. Individually, awareness and commitment to maintaining biodiversity emerge.
Structural literacy	1. Have extensive knowledge of biodiversity 2. Understanding the role and function of biodiversity in everyday life 3. Able to explain the concept and problems of biodiversity in their own words 4. Demonstrate responsible attitudes and actions in the use of biodiversity
Multidimensional literacy	1. Able to connect biodiversity issues based on local, national, and global issues 2. Regularly and independently dig up various information related to biodiversity issues 3. Able to synthesize various information related to biodiversity and take concrete actions for biodiversity conservation. 4. Applying responsible attitudes and actions in the use of biodiversity in daily life.

C. Results and discussion

Percentage of Biodiversity Literacy Achievement in Each Indicator

Percentage of biodiversity literacy achievement based on World Wildlife Fund (1996) indicators shown in Figure 1.
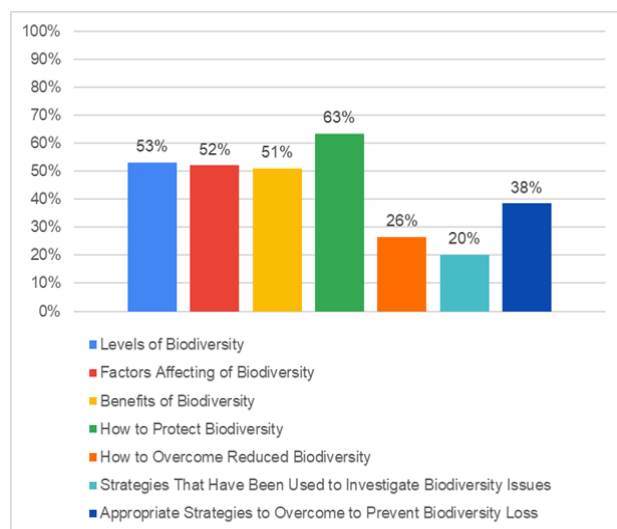

Figure 1
Percentage of biodiversity literacy in each indicator

Figure 1 shows the percentage of biodiversity literacy achievement for each indicator. The achievement of biodiversity literacy indicators that have a percentage above 50% is levels of biodiversity, factors affecting biodiversity, benefits of biodiversity, and how to protect biodiversity, while the achievement of biodiversity literacy indicators that have a percentage below 50% is how to overcome reduced biodiversity, strategies that have been used to investigate biodiversity issues, and appropriate strategies to overcome to prevent biodiversity loss.

Based on Figure 1, it can be seen that the indicator "strategies that have been used to investigate biodiversity issues" has the lowest percentage of biodiversity literacy achievement at 20%. It turns out that students do not know the use of biodiversity as a bioindicator in an area, such as using the existence of lichen populations to find out the air quality in an area, broom fish *(Hypostomus plecostomus)* to find out the quality of river waters. In addition, it can be through monitoring the use of plants by the community in an area. Furthermore, on the indicator "how to overcome reduced biodiversity" with an achievement of 26%. The findings that occurred turned out to be foreign to each student with the term invasive species, this caused students not to know how to overcome the problems in biodiversity caused by invasive species such as that there are types of plants that can cause the decline of other species such as acacia *(Acacia nilotica),* african wood *(Maesopsis eminii),* kaliandra *(Calliandra calothyrsus),* kirinyuh *(Chromolaena odorata,*and mantangan *(Merremia peltata).*

In the indicator "appropriate strategies to overcome to prevent biodiversity loss", this indicator has an achievement of 38%. Biodiversity knowledge in this indicator includes appropriate actions taken by

individuals to prevent the reduction or loss of biodiversity in an area, such as the role of students to maintain biodiversity in the school environment, as a community to maintain biodiversity in an area, and as visitors to tourist attractions to maintain biodiversity in the area. Furthermore, the "benefits of biodiversity" indicator in this indicator has an achievement of 51%, this can be influenced by students' initial knowledge about the use of biodiversity in daily life, such as in the fields of food, clothing, boards, medicine, oxygen, and aesthetics. According to Katili & Rahmat (2020) that through the utilization of biodiversity potential in learning, it can be used as an effort to grow the character of biodiversity conservation and instill the ethical value of human relations with nature in an integrative manner.

The "factors affecting of biodiversity" indicator in this indicator has an achievement of 52%. Knowledge in this indicator includes knowledge of factors caused by humans and nature to biodiversity, such as human actions that affect biodiversity in an area, natural disasters that affect biodiversity in a region, and the existence of plant or animal species that affect biodiversity in an area. The "level of biodiversity" indicator in this indicator has an achievement of 53%. Students' knowledge of the level of biodiversity is obtained from initial knowledge through science learning in elementary and junior high schools. Students are already able to understand basic terms related to biodiversity such as the definition of biodiversity at the genetic level, species level, and ecosystem level and provide examples that can be found in the surrounding environment. However, students are not able to apply knowledge about the level of biodiversity, such as how to obtain plant species based on crossbreeding based on the characteristics of each species and how the condition of biodiversity in an area is known if the plant species in a region are known.

The "how to protect biodiversity" indicator is the highest achievement of 63%. Knowledge on this indicator includes how individuals can protect biodiversity when they find plant species that are included in the Red List of Endangered Plants of the International Union for Conservation of Nature (IUCN) such as finding carrion flowers *(Amorphophallus titanum),* the role of individuals as students to protect biodiversity in the school environment, and the role of individuals as a community to protect biodiversity in the surrounding area. When viewed from the achievement of each biodiversity literacy indicator, it can be seen that students already have knowledge related to biodivarist, but the knowledge possessed by students is still low, this is shown by the achievement in each indicator as a whole only in the range of 20-60%.

According to Khairani et al. (2020) Students have high knowledge and positive attitudes towards biodiversity, but understanding of the impact of invasive species on biodiversity is still low, in line with research results Coracero et al. (2022) Demonstrate low students' knowledge and awareness of laws, projects and policies on biodiversity conservation and protection. The results of the study show that students do not yet have an understanding of the aesthetic value of biodiversity, so learning that provides direct experience or is involved in sustainable conservation and conservation activities is needed (Talens, 2024). Katili et al. (2021) argued that the character of biodiversity conservation in students can be brought up through learning that utilizes the potential of ecosystems and biodiversity in the surrounding environment. In line with the opinion Istiqomah et al. (2020) Attitude formation is the result of socialization and interaction with the environment which is the embodiment of a person's thoughts, feelings, and assessments of objects of knowledge, understanding, opinions, and beliefs so as to produce a tendency to act.

Biodiversity Literacy Levels
Based on the results of research and analysis of data obtained regarding the level of biodiversity literacy of high school students as shown in Figure 2.
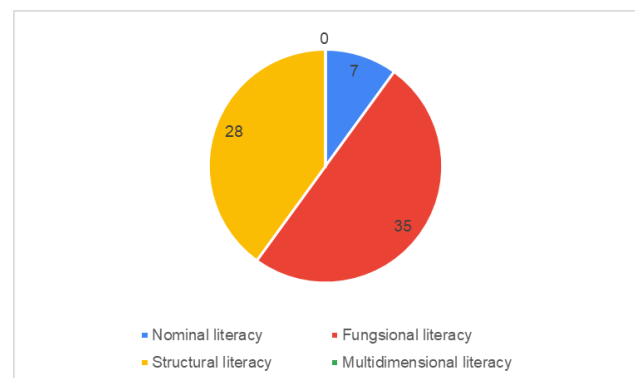

Figure 2
Percentage of biodiversity literacy level of high school students

Figure 2 shows that the level of biodiversity literacy of high school students consists of functional literacy of 50%, structural literacy of 40%, nominal literacy of 40% and multidimensional literacy of 0%. Based on Figure 2, it can be seen that the highest level of student literacy in the functional literacy category means that they have indicator achievements: understand the definition of contextual biodiversity and use it correctly, able to communicate information on problems related to biodiversity issues, sensitivity to biodiversity emerges, and individually, awareness and commitment to maintaining biodiversity emerge. Meanwhile, there are no students who are included in the multidimensional literacy category who have indicator achievements: able to connect biodiversity issues based on local, national, and global issues, regularly and independently dig up various information related to biodiversity issues, able to

synthesize various information related to biodiversity and take concrete actions for biodiversity conservation, and applying responsible attitudes and actions in the use of biodiversity in daily life.

One of the learnings that can be applied in learning biodiversity topics is mini research learning because students are directly involved in learning. Mini-learning research based on local wisdom is able to increase awareness of biodiversity conservation (Leksono, 2017). In addition, learning that can be applied to biodiversity topics includes inquiry learning because students can make direct observations of biodiversity in the surrounding environment. Inquiry learning can facilitate students to increase their curiosity and creativity in seeing problems in the topic being studied, but it still needs to be modified to further maximize the potential that students have (Cahyaningrum et al., 2023). In addition, the application of the learning model can affect the biodiversity literacy skills possessed by students. Learning model *Project Based Learning* Able to develop students' biodiversity literacy skills including defining biodiversity at the gene, species and ecosystem levels, communicating and making solutions to problems related to biodiversity, and defining the use of biodiversity (Hiola et al., 2023). In addition, learning methods about biodiversity can be adjusted to the conditions of students and teaching materials. Inquiry-based learning can be applied because it provides students with direct experience about biodiversity and can be combined with project methods that directly utilize the surrounding environment so that it can increase students' environmental awareness.

D. Conclusion

Based on the results of the biodiversity literacy survey of high school students, it can be seen that the achievement of biodiversity literacy is the lowest in the indicator "strategies that have been used to investigate biodiversity issues" while the highest in the indicator "nature impact on biodiversity" and the level of biodiversity literacy of high school students is at the level of functional literacy, structural literacy, nominal literacy, and there are no students who have a level of biodiversity literacy multidimensional literacy. Based on this, it is necessary to implement learning that is able to improve biodiversity literacy skills to the level of multidimensional literacy, such as the use of learning models, learning methods, learning resources and student worksheets that are tailored to student conditions and teaching materials.

E. References

Almond, R. E. A., Grooten, M., & Petersen, T. (2021). Living planet report 2020-bending the curve of biodiversity loss. *Natural Resources & Environment*, *35*(3), 62-62. Retrieved from https://search.proquest.com/openview/ae4fe2c3d0b9bcb38681066eee8de02d

Aripin, I., Hidayat, T., & Rustaman, N. (2021). Pengembangan program perkuliahan biologi konservasi berbasis citizen science project. *J. Pedagogi Hayati*, *5*(1), 1-9. DOI: https://doi.org/10.31629/ph.v5i1.3590

Berame, J. S., Lumaban, N. W., Delima, S. B., Mercado, R. L., Bulay, M. L., Morano, A. B., & Parohinog, C. D. M. G. (2022). Attitude and behavior of senior high school students toward environmental conservation. *Biodiversitas Journal of Biological Diversity*, *23*(10), 5267-5277. DOI: https://doi.org/.13057/biodiv/d231036

Cahyaningrum, M. N., Rochintaniawati, D., & Kusnadi, K. (2023). Survey pelaksanaan pembelajaran inkuiri di SMA. *JIIP - Jurnal Ilmiah Ilmu Pendidikan*, *6*(11), 9134–9142. DOI: https://doi.org/10.54371/jiip.v6i11.2393

Coracero, E. E., Facun, M. C. T., Gallego, R. B. J., Lingon, M. G., Lolong, K. M., Lugayan, M. M., ... & Suniega, M. J. A. (2022). Knowledge and perspective of students towards biodiversity and its conservation and protection. *Asian Journal of University Education*, *18*(1), 118-131. DOI: https://doi.org/10.24191/ajue.v18i1.17178

Darmastuti, S. A., Nazar, I. A., & Setyawan, A. D. (2024). Plant diversity and its use in javanese urban home garden: An ethnobotanical study in Central Java, Indonesia. *Asian Journal of Ethnobiology*, *7*(1), 32–42. DOI: https://doi.org/10.13057/asianjethnobiol/y070104

Diaz, S., Settele, J., Eduardo, B., Hein, T., & Maximillen, G. (2019). *The global assessment report on biodiversity and ecosystem service*. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Retrieved from https://files.ipbes.net/ipbes-web-prod-public-files/inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf

Hiola, Z. W., Katili, A. S., & Husain, I. H. (2023). Biodiversity literacy skills in problem-based science lectures: A grounded theory research. *Jurnal Pendidikan MIPA*, *24*(1), 50–58. DOI: https://doi.org/10.23960/jpmipa/v24i1.pp50-58

Hulya, A. E., & Rifat, E. (2022). An investigation of secondary school students' biodiversity literacy level. *Dinamika Ilmu*, *22*(2), 393–410. DOI: https://doi.org/10.21093/di.v22i2.5046

Istiqomah, I., Suwondo, S., & Firdaus, L. N. (2020). Environmental education in forming attitudes of environmental care for students. *Journal of Educational Sciences*, *4*(1), 200-211. DOI: https://doi.org/10.31258/jes.4.1.p.200-211

IUCN. (2020). *IUCN Red List 2017-2020 Report*. Retrieved from https://nc.iucnredlist.org/redlist/resources/files/1630480997-IUCN_RED_LIST_QUADRENNIAL_REPORT_2017-2020.pdf

Katili, A. S., & Rahmat, A. (2020). Biodiversity literacy in science education for biodiversity conservation. *International Journal of Innovations in Engineering Research and Technology [IJIERT]*, *7*(5), 31–35. Retrieved from https://repo.ijiert.org/index.php/ijiert/article/view/388

Katili, A. S., Utina, R., Yusuf, F. M., & Pikoli, M. (2022). *Literasi biodiversitas dan pembelajarannya*. Gorontalo: Ideas Publishing.

Katili, A. S., Utina, R., Yusuf, F. M., Pikoli, M., & Dama, L. (2021, July). Biodiversity literacy in science education. In *Journal of Physics: Conference Series* (Vol. 1968, No. 1, p. 012024). IOP Publishing. DOI: https://doi.org/10.1088/1742-6596/1968/1/012024

Kemendikbudristek. (2022). *Capaian pembelajaran pada pendidikan anak usia dini, jenjang pendidikan dasar, dan jenjang pendidikan menengah pada kurikulum merdeka.* Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi.

Kementerian Perencanaan Pembangunan Nasional. (2024). *Indonesian biodiversity strategy and action plan IBSAP 2025-2045*. Kementerian Perencanaan Pembanguanan Nasional/Badan Perencanaan Pembangunan Nasioanl.

Khairani, A. Z., Kipli, M., & Shamsuddin, H. (2020). High school students' knowledge and its influence on attitude towards biodiversity at waterfront cities in Malaysia. *Universal Journal of Educational Research*, *8*(1), 83–88. DOI: https://doi.org/10.13189/ujer.2020.080109

Kurniasih, M. D. (2018). Menumbuhkan karakter konservasi biodiversitas melalui penerapan species identification and response software. *Edu Sains: Jurnal Pendidikan Sains & Matematika*, *6*(2), 30-41. DOI: https://doi.org/10.23971/eds.v6i2. 991

Kusumadewi, Y., Wardani, W., Sudarmonowati, E., Partomihardjo, T., Shomat, F., Primajati, M., Randi, A., Hamidi, A., Pratama, B. A., Robiansyah, I., Purwaningsih, P., & Kalima, T. (2020). *Daftar merah tumbuhan Indonesia 1: 50 jenis pohon kayu komersial* (E. Sudarmonowati, Y. Kusumadewi, T. Partomihardjo, & W. Wardani, Eds.). Jakarta: LIPI Press. DOI: https://doi.org/10.14203/press.310

Leksono, S. M. (2017, May). Pengaruh pembelajaran mini riset berbasis kearifan lokal terhadap kesadaran konservasi keanekaragaman hayati. In *Prosiding Seminar Nasional Pendidikan FKIP* (Vol. 1, No. 2, pp. 1-10). Retrieved from https://jurnal.untirta.ac.id/index.php/psnp/article/view/1-10

Milkisso, K. P. (2020). Undergraduate university students' knowledge, attitude and behavior towards biodiversity. *Journal of Tropical Forestry and Environment, 10*(2), 39-50. Retrieved from http://journals.sjp.ac.lk/index.php/JTFE/article/view/4862

Nudiati, D., & Sudiapermana, E. (2020). Literasi sebagai kecakapan hidup abad 21 pada mahasiswa. *Indonesian Journal of Learning Education and Counseling*, *3*(1), 34-40. DOI: https://doi.org/10.31960/ijolec.v3i1.561

Obrecht, A., Pham-Truffert, M., Spehn, E. M., Payne, D., de Bremont, A., Altermatt, F., ... & Geschke, J. (2021). Achieving the SDGs with biodiversity. *Swiss Academies Factsheet*, *16*(1), 1-11. DOI: https://doi.org/10.5281/ZENODO.4457298

Pratomo, G. N. (2021, March). Student's misconception profile of first semester 10th grade on biology. In *6th International Seminar on Science Education (ISSE 2020)* (pp. 145-149). Atlantis Press. DOI: https://doi.org/10.2991/assehr.k.210326.020

Retnowati, A., Rugayah, R., Rahajoe, J. S., & LIPI Press (Eds.). (2019). *Status keanekaragaman hayati Indonesia: Kekayaan jenis tumbuhan dan jamur Indonesia* (Cetakan pertama). Jakarta: LIPI Press.

Rintelen, K., Arida, E., & Häuser, H. (2017). A review of biodiversity related issues and challenges in megadiverse Indonesia and other Southeast Asian Countries. *Research Ideas and Outcomes*, *3*, 1–16. DOI: https://doi.org/10.3897/rio.3.e20860

Schneiderhan-Opel, J., & Bogner, F. X. (2020). FutureForest: Promoting biodiversity literacy by implementing citizen science in the classroom. *The American Biology Teacher*, *82*(4), 234–240. DOI: https://doi.org/10.1525/abt.2020.82.4.234

Setiawan, A. (2022). Keanekaragaman hayati indonesia: masalah dan upaya konservasinya. *Indonesian Journal of Conservation*, *11(1)*, 13–21. DOI: https://doi.org/ 10.15294/ijc.v11i1.34532

Sujarwo, W. (2023). *Kekinian etnobotani indonesia: peran, potensi, tantangan, dan peluang dalam mendukung pemanfaatan sumber daya tumbuhan berkelanjutan*. Jakarta: Penerbit BRIN.

Talens, J. (2024). Exploring senior high school students' social representation of biodiversity. *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, *6*(8), 199–205. Retrieved from https://ijmrap.com/wp-content/uploads/2024/02/IJMRAP-V6N8P143Y24.pdf

Widodo, A., Riandi, R., Sriyati, S., Rochintaniawati, D., Solihat, R., & Siswandari, P. (2023). *Pengembangan nilai-nilai keberlanjutan melalui pelajaran sains*. Bandung: UPI Press.

World Wildlife Fund. (1996). *The development of a biodiversity literacy assessment instrument—Report to the national environmental education training foundation.* Washington, DC.: Wisconsin Center for Environmental Education, Stevens Point. Retrieved from https://eric.ed.gov/?id=ED406234

Yuan, X., Yu, L., Wu, H., She, H., Luo, J., & Li, X. (2022). Sustainable development goals (SDGs) priorities of senior high school students and global public: Recommendations for implementing education for sustainable development (ESD). *Education Research International*, *2022*(1), 2555168. DOI: https://doi.org/10.1155/2022/2555168