



## Integration of naturalistic to optimize biology learning outcomes: A literature review

**Ulisa Ararolita Limbong \*, Ardiah, Ayu Isnaini Nor Muslimin, Bobby Hanggoro Yogi Santika, Muhammad Jolianda Saputra Dalambide, Muhammad Rizky**

Department of Biology Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Banjarmasin, South Kalimantan, Indonesia, 70123

\*Corresponding Author Email: [2210119320017@mhs.ulm.ac.id](mailto:2210119320017@mhs.ulm.ac.id)

**Abstract.** Biology education emphasizes the importance of integrating multiple intelligences to optimize learning outcomes and foster meaningful learning experiences. Among these, naturalistic intelligence plays a key role in helping students connect biological concepts with real-world natural phenomena. This study aims to explore how naturalistic intelligence has been integrated into biology learning and its impact on students' understanding, attitudes, and learning achievements. A literature review was conducted using 1.780 research articles published between 2019 and 2024 from databases such as Google Scholar. Based on inclusion exclusion criteria, 10 articles were selected for in-depth analysis. The results indicate that learning strategies integrating naturalistic intelligence such as outdoor learning, contextual field exploration, and environment-based project learning enhance students' conceptual understanding, environmental awareness, and motivation. Most studies applied qualitative or mixed-method approaches, highlighting the importance of authentic experiences in strengthening biology learning outcomes. This study concludes that incorporating naturalistic intelligence supports holistic education by linking cognitive and affective domains, and recommends further research on technology-based and culturally contextualized applications of naturalistic intelligence in biology education.

*Abstrak. Pendidikan biologi abad ke-21 menekankan pentingnya integrasi berbagai kecerdasan untuk mengoptimalkan hasil belajar dan menciptakan pengalaman belajar yang bermakna. Di antara berbagai kecerdasan tersebut, kecerdasan naturalistik berperan penting dalam membantu peserta didik mengaitkan konsep biologi dengan fenomena alam di kehidupan nyata. Penelitian ini bertujuan untuk menelaah bagaimana kecerdasan naturalistik diintegrasikan dalam pembelajaran biologi serta dampaknya terhadap pemahaman, sikap, dan hasil belajar siswa. Kajian pustaka dilakukan terhadap 856 artikel penelitian yang terbit antara tahun 2019–2024 dari basis data Google Scholar. Berdasarkan kriteria inklusi eksklusif, diperoleh 10 artikel yang dianalisis secara mendalam. Hasil menunjukkan bahwa strategi pembelajaran yang mengintegrasikan kecerdasan naturalistik seperti pembelajaran luar ruangan, eksplorasi lapangan kontekstual, dan pembelajaran berbasis proyek lingkungan dapat meningkatkan pemahaman konsep, kepedulian lingkungan, dan motivasi belajar siswa. Sebagian besar penelitian menggunakan pendekatan kualitatif atau campuran, yang menegaskan pentingnya pengalaman otentik dalam memperkuat hasil belajar biologi. Kajian ini menyimpulkan bahwa integrasi kecerdasan naturalistik mendukung pendidikan holistik dengan menghubungkan ranah kognitif dan afektif, serta merekomendasikan penelitian lanjutan terkait penerapan berbasis teknologi dan konteks budaya dalam pembelajaran biologi.*

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## Introduction

Globalization and advances in digital technology are now rapidly expanding access to information and learning resources for biology, so that teachers and students can access a variety of creative, innovative, and in-depth learning resources (Rose et al. 2024). 21st century education requires students to have higher order thinking skills, as well as mastering learning and innovation skills, media and information literacy skills, and technological skills in supporting the learning process that is relevant to the challenges of the times (Banarsari et al., 2023). The appropriate use of technology can create a more inclusive, interactive, and effective educational environment in stimulating various types of student intelligence, including naturalistic intelligence (Tamyiz et al., 2025).

Intelligence is a person's ability to solve problems, adapt to new situations, and take lessons from the experience gained (Fitria, 2020). Gardner in the theory of Multiple Intelligences explains that humans have eight types of intelligence, one of which is naturalistic intelligence, which is the ability to understand, appreciate, and utilize nature effectively to expand knowledge about the surrounding world (Ayuningrum, 2020). Characteristics of individuals with high naturalistic intelligence include having a love for the environment, being able to recognize the nature and behavior of animals and plants, and enjoying outdoor activities.

Practices that involve nature can develop self-knowledge, and increase sensitivity to the environment (Chase, 2011). Each child has different potentials and development of naturalistic intelligence, so the role of educators is important in choosing strategies that suit the characteristics of students. Wulandari et al. (2024) emphasized that the development of naturalistic intelligence can be carried out through various methods, depending on the ability, interests, and learning facilities available.

Research by Fakaubun and Rahanra (2023) shows that 2% of students have very high naturalistic intelligence, 71% high, and 27% moderate. These results show that most learners have naturalistic potential that can be optimized through appropriate learning approaches. Furthermore, Usman et al. (2022) explained that the level of naturalistic intelligence affects students' understanding, which can be measured through summative assessments to determine the correlation between intelligence and biology learning outcomes. Research by Rahmiyati and Fuadiyah (2023) revealed that the level of naturalistic intelligence of phase E students at SMAN 4 West Sumatra is still in the medium category. This condition shows that naturalistic intelligence is influenced by various factors, one of which is the learning strategy used by teachers. Therefore, this finding is important because it can be used as a basis for designing the right learning strategies to optimize the potential of students' naturalistic intelligence.

In general, the naturalistic intelligence of students varies, but most of them are in the high category and have the potential to be developed through the right learning strategies. Therefore, educators need to design appropriate learning and assessments to optimize the potential of students, especially for students who are still in the medium category. One of the approaches that is considered most appropriate for the context of naturalistic intelligence is *inquiry-based learning* (Lestari et al., 2023), where students are invited to discover concepts through the process of observation, exploration, and direct experimentation in nature. The cultivation of naturalistic intelligence from an early age also has high urgency, because the lack of guidance in developing this intelligence can have an impact on the behavior of children who tend to ignore the environment and lack a sense of ecological responsibility (Rahayu & Sitorus, 2024).

Naturalistic intelligence has a close relationship with nature (Irmawanty, 2022). Individuals with this intelligence are able to recognize, understand, and group natural phenomena and utilize the environment effectively in daily life (Ayuningrum, 2020). In biology learning, naturalistic intelligence is very relevant because biology studies living things and their environment. The integration of naturalistic intelligence can help students understand concepts more deeply, improve observation skills, and foster concern and sustainable ecological values (Yuhatriati et al., 2021).

The environment-based approach makes a significant contribution to the formation of ecological character, through direct experience, students are encouraged to cultivate an attitude of caring for the environment, empathy for living beings, and awareness to preserve nature. Rahmiyati and Fuadiyah (2023) stated that learning strategies can be designed from the results of naturalistic intelligence levels. Yuhatriati et al., (2021) emphasized that the application of media and learning strategies that stimulate naturalistic intelligence is able to improve the affective and moral aspects of students more deeply than conventional learning methods, so that the integration of naturalistic intelligence not only has an impact on the cognitive realm, but also affects the formation of sustainable ecological character and values.

In a pedagogical perspective, the application of naturalistic intelligence directs educators to create learning situations that are student-centered, experience-based, and oriented towards real problem-solving. Through project-based learning (PjBL), problem-based learning (PBL), inquiry learning, and discovery learning, students not only learn biological concepts, but also develop scientific competencies and 21st century skills. Recent research shows that these models are effective in improving biology learning outcomes, especially when combined with field activities and the use of technologies such as AR that visualize natural phenomena in an interactive and engaging way.

Several studies examine the role of naturalistic intelligence in biology learning, which focuses on measuring the level of student intelligence and its impact on learning outcomes, without reviewing effective learning strategies implemented, in addition to that there are still limited studies that map the latest research trends, main findings, and scientific contributions from research on the integration of naturalistic intelligence. Therefore, this study is important to provide a systematic overview of research developments, the direction of further research, and recommendations in improving biology learning outcomes with naturalistic intelligence. Based on the description above, this study aims to systematically examine the integration of naturalistic intelligence, to optimize biology learning outcomes.

1. What is the research trend regarding the integration of naturalistic intelligence to optimize biology learning outcomes, in the last five years?
2. What are the main findings of the literature review obtained regarding the integration of naturalistic intelligence to optimize biology learning outcomes?
3. What is the scientific impact of research on the integration of naturalistic intelligence to optimize biology learning outcomes?

## Research Methods

### 1) Type

This study uses *the Systematic Literature Review* (SLR) research type to identify, evaluate, and synthesize relevant research results regarding the integration of naturalistic intelligence in biology learning. The SLR approach was chosen because it is able to provide a comprehensive picture of how naturalistic intelligence is applied, its learning strategies, and its impact on student learning outcomes. This method is carried out through a systematic article search process based on the inclusion and exclusion criteria that have been set, this type of research refers to the literature review approach described by Banarsari et al. (2023) with stages including identification, selection, evaluation, and synthesis of previous research results. This study aims to examine the latest research trends, find research gaps, and identify the most effective approach in optimizing biology learning outcomes through the integration of naturalistic intelligence.

**Table 1 Inclusion and exclusion criteria**

| Inclusion Criteria                                                                                                                                                                                                                                                                                                   | Exclusion Criteria                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Articles that discuss naturalistic intelligence, biology learning outcomes, or lam-based learning strategies.<br>Published in the 2019-2024 period.<br>Studies by empirical, experimental, correlational, or developmental methods.<br>Full access to articles.<br>Publication in national proceedings and journals. | Articles that are not related to the context of biology learning.<br>Articles published before 2019.<br>Non-empirical studies such as opinion or theoretical studies.<br>Articles are only available in abstract form or are not fully accessible.<br>Publications in languages other than English/Indonesian. |

### 2) Data Sources and Time

The data sources in this study come from various scientific articles that have been published and accessed through the main database, namely Google Scholar. Through this data-based program, it was chosen because it provides credible scientific literature, has gone through a peer-review process, and has a wide scope in the fields of education and biology. The articles taken are focused on research that discusses the integration of naturalistic intelligence in the context of biology learning, both from the perspective of learning model development, implementation strategies, and its influence on student learning outcomes.

The literature search process was conducted on August 5, 2025, using several keyword combinations to expand the search reach and ensure comprehensive data coverage. The keywords used include "Naturalistic intelligence in biology learning", "Naturalistic intelligence biology education", "Multiple intelligences in biology learning", and "Integration of naturalistic intelligence". The search was carried out by adjusting the publication filter to only include articles in the period 2019 to 2024, so that the results of the study represent the latest developments in 21st century educational research, especially related to the application of multiple intelligence in biology learning, the selection of articles also considers the completeness of the data, methodological validity, and relevance to the research focus so that the results of this literature review are representative and of high quality.

### 3) Data collection techniques

Data collection in this study was carried out through a systematic literature search process on the Google Scholar database. The search focus is directed at scientific articles relevant to the theme of naturalistic intelligence in biology learning, which are published in the time range of 2019 to 2024, this time limit is set to ensure that the literature sources used reflect recent developments in the application of the theory of multiple intelligence in the context of biology

learning. In the framework of a systematic review based on the PRISMA model on the Systematic Literature Review (SLR) method, articles published less than one year before the search time are generally not recommended for analysis due to the limited number of citations and unstable publication status, such as the possibility of revision or withdrawal of articles, the article selection process is carried out in stages of identification, screening, feasibility, and inclusion. This criterion is logical to maintain the stability of evidence in synthesis, similar to the local practice in the Indonesian thesis guidelines which limit publication to the last 5-10 years to focus on mature evidence. However, the 12-month limit has been criticized as a rigid "one-size-fits-all", as complex SLRs rarely change significantly from new studies, and strict exceptions could hinder the publication of ambitious reviews (Stokes et al., 2023). As illustrated in Figure 1, to ensure the accuracy and credibility of the data used in this study.

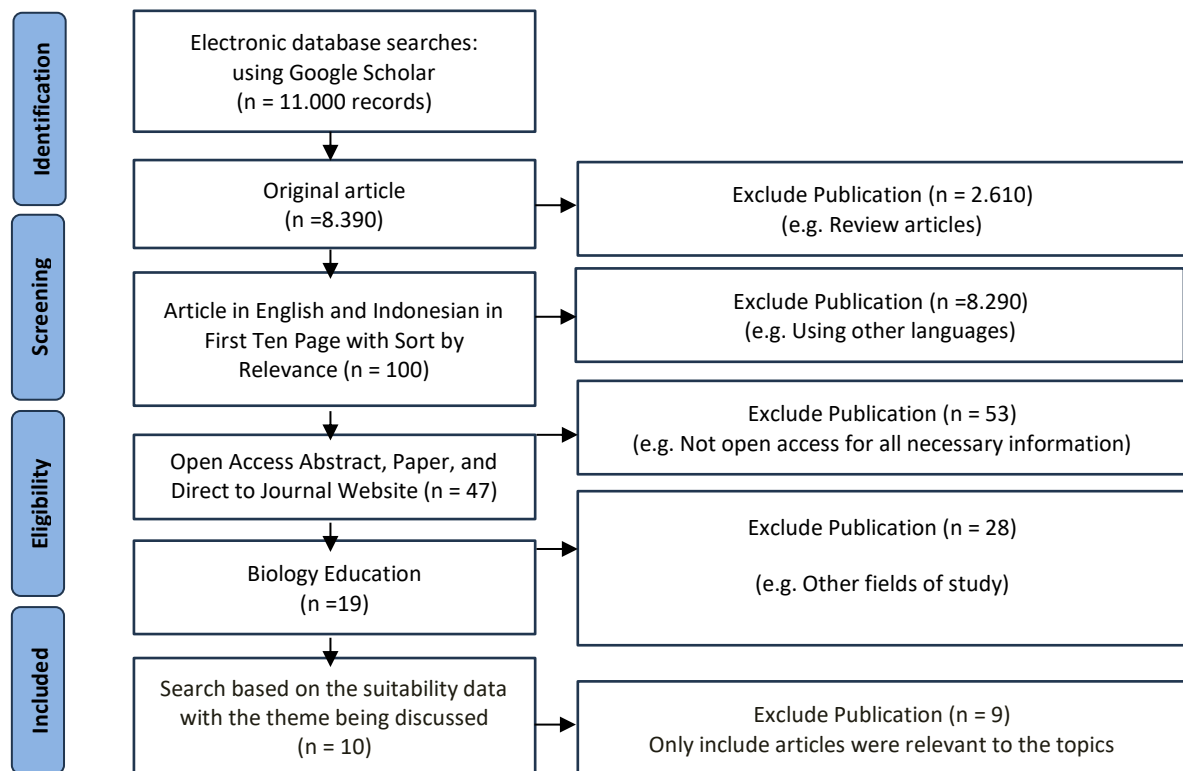


Figure 1 The process of selecting articles in SLR studies using the PRISMA model

Based on the PRISMA diagram in the image above, the article selection process began at the identification stage through an electronic search using Google Scholar which yielded 1,780 articles. Furthermore, an initial screening was carried out by excluding articles in the form of review articles, so that there were 183 original research articles.

At the screening stage, articles are then selected based on language, namely relevant English and Indonesian articles on the first page of the search, so that 100 articles are obtained. Of these, 18 articles that did not provide open access or could not be fully accessed were issued, leaving 82 articles.

The *eligibility* stage is carried out by selecting articles based on the suitability of the field of study, namely biology education. At this stage, a total of 52 articles from other fields of study were issued, resulting in 30 articles that were in accordance with the focus of the research. Furthermore, a feasibility assessment was carried out based on the suitability of the topic with the research objectives. From this stage, as many as 20 articles were removed because they were not substantially relevant to the research topic. Thus, 10 articles were obtained that met all inclusion criteria and were further analyzed at the included stage.

#### 4) Data Analysis Techniques

Data analysis in this study was carried out using *the Content Analysis* technique, which aims to identify, organize, and interpret the content of the article systematically based on themes and meanings relevant to the focus of the research, namely the integration of naturalistic intelligence in biology learning. According to Krippendorff (2019), content analysis is a research method that produces replicable and valid inferences from text data into the context of its use. The analysis process is carried out through several stages.

First, the researcher identifies the main content and focus of each selected article. Second, the researcher found key themes that emerged, such as the application of multiple intelligence theory, nature-based learning strategies, and its relationship with improving biology learning outcomes. Third, the findings were then grouped into certain categories,

for example (a) learning approaches that integrate naturalistic intelligence, (b) the impact of such integration on students' motivation and learning outcomes, and (c) the relationship between naturalistic intelligence-based learning and environmental awareness and contextual values.

Next, the researchers compiled a summary of each theme obtained to provide a comprehensive picture of how the integration of naturalistic intelligence can optimize biology learning outcomes. The results of this analysis are expected to be able to show general patterns, research trends, and strategic recommendations for the development of a more holistic and contextual biology learning model.

## Results and Discussion

Based on the number of relevant documents has increased significantly from year to year, as shown in the following graph which records the total documents from 2019 to 2024.

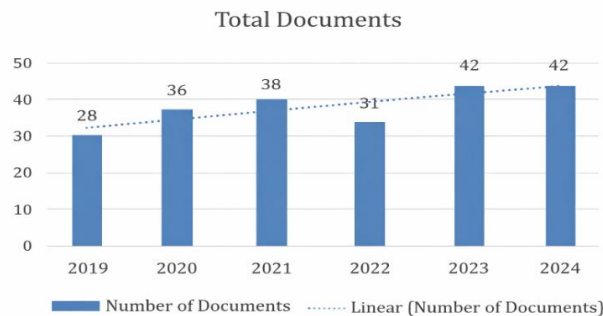


Figure 2 Graph of the distribution of the number of documents from 2019 to 2024

Based on the distribution chart of the number of documents from 2019 to 2024 above, the trend in the graph shows that the publication of articles on naturalistic intelligence will increase significantly in 2023, before declining again in 2024. This increase is in line with the growing focus of research in the field of 21st century education, which emphasizes technological integration, learning innovation, and strengthening ecological competence. Banarsari et al., (2023) emphasized that the use of educational technology in the 21st century encourages the emergence of new learning media that allows for the exploration of environmental concepts in a more interactive manner, thereby expanding research interests on naturalistic intelligence.

In addition, many studies in 2019–2024 describe the positive relationship between naturalistic intelligence and various aspects of Biology learning outcomes, such as learning motivation and science process skills (Fakaubun & Rahanra, 2023), environmental literacy (Irmawanty, 2022), and summative assessment of Biology (Rahmiyeti & Fuadiyah, 2023). The surge in publications in 2023 is also strengthened by the increase in research examining the influence of inquiry learning strategies on the understanding of plant diversity (Lestari et al., 2023) and the improvement of naturalistic intelligence in early childhood (Rahayu & Sitorus, 2024; Wulandari et al., 2024). Meanwhile, studies that focus on innovative media, such as quiet books for naturalistic intelligence stimulation (Yuhasriati et al., 2021), as well as the study of naturalistic intelligence profiles based on the revised Bloom taxonomic perspective (Usman et al., 2022), also enrich the theoretical basis of the research. Overall, the graphs presented show consistency with the literature trends. This trend indicates that the peak of research interest in naturalistic intelligence occurs when ecological issues, learning technologies, and pedagogical innovations receive high academic attention.

Table 2 The 10 most important articles

| Code | Peneliti (Year)        | Problem                                                                                                                                                                                   | Method                   | Findings                                                                                                                                 |
|------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | Utari & Mahrawi (2019) | The relationship between naturalistic intelligence and the New Environmental Paradigm (NEP) in biology education students in the study course of kebabantenan (natural resource concept). | Qualitative descriptive. | There is a positive and significant relationship between naturalistic intelligence and The New Environmental Paradigm (NEP) of students. |

| Code | Peneliti (Year)             | Problem                                                                                                                          | Method                          | Findings                                                                                                                                   |
|------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| A2   | Nurlia & Anggo (2020)       | The learning outcomes of biology of high school students are still low and the role of naturalistic intelligence is not optimal. | Quantitative correlation.       | There is a positive relationship between naturalistic intelligence and learning interest in biology learning outcomes.                     |
| A3   | Yuhasriati et al. (2021)    | Research and development (R&D).                                                                                                  | Research and development (R&D). | Quiet Book Media is effective in stimulating and increasing the naturalistic intelligence of early childhood.                              |
| A4   | Irmawanty (2022)            | Low environmental literacy of students in biology learning.                                                                      | Quantitative correlation.       | Naturalistic intelligence has a significant relationship with the level of environmental literacy of students.                             |
| A5   | Usman et al. (2022)         | The profile of students' naturalistic intelligence in the context of Bloom's revised taxonomy has not been well mapped.          | Qualitative descriptive.        | Most learners are at the level of understanding and analyzing in naturalistic intelligence.                                                |
| A6   | Fakaubun & Rahanra (2023)   | Lack of motivation to learn and develop naturalistic intelligence that has an impact on biology learning outcomes.               | Quantitative associative.       | Learning motivation and naturalistic intelligence have a significant positive effect on biology learning outcomes.                         |
| A7   | Rahmiyati & Fuadiyah (2023) | Biological assessments do not reflect the naturalistic intelligence of students as a whole.                                      | Descriptive quantitative.       | Naturalistic intelligence correlates with the achievement of students' biological summative assessments.                                   |
| A8   | Lestari et al. (2023)       | Learning strategies have not been able to maximize biology learning outcomes.                                                    | Quasi-experiments.              | The inquiry learning strategy significantly improves student learning outcomes, in line with the development of naturalistic intelligence. |
| A9   | Rahayu & Sitorus (2024)     | The development of early childhood naturalistic intelligence through inquiry learning is not optimal.                            | Quasi-experiments.              | Inquiry strategies are effective in improving early childhood naturalistic intelligence.                                                   |
| A10  | Wulandari et al. (2024)     | Early childhood naturalistic intelligence has not been facilitated by the right methods.                                         | Descriptive qualitative.        | Exploration-based and naturalistic learning innovations can improve engagement and learning outcomes.                                      |

Based on Table 2, it can be seen that the use and integration of naturalistic intelligence in biology learning has been increasingly studied in the last five years, with diverse approaches and results that show a positive impact on student learning outcomes. Conceptually, researchers define naturalistic intelligence as *a person's ability to recognize, categorize, and understand the relationship between living beings and their environment consciously and systematically* (Rahmawati & Yusuf, 2020; Arifin & Sulastri, 2022). In the context of biology learning, this intelligence is not only the skill of observing nature, but also concerns the ability to think ecologically, develop empathy for the environment, and foster awareness to maintain ecosystem balance (Nuraini et al., 2024).

In general, researchers conceptualize the role of naturalistic intelligence as a means to bridge abstract biology learning with real experiences in nature. By involving learners in exploratory activities, such as ecosystem observation, identification of local flora-fauna, or environment-based experiments, biology learning becomes more meaningful and contextual. Research by Putra & Handayani (2021) and Wulandari et al. (2021) shows that the use of environment-based media is able to deepen the understanding of biological concepts that were previously difficult to explain theoretically, such as food chains, adaptation, or biodiversity. This approach also encourages learners to associate scientific knowledge with social and moral responsibility towards nature.

In terms of learning strategies, models, and approaches, these studies identified some of the most effective models in integrating naturalistic intelligence. *The Problem Based Learning (PBL)* and *Project Based Learning (PjBL)* models are the dominant choices because they encourage the active involvement of students in solving real problems based on the environment (Sari et al., 2020; Dewi et al., 2023). The *discovery learning* approach has also proven to be effective in building conceptual understanding and scientific thinking skills, as students are invited to



discover the principles of biology through direct observation in nature (Pratama & Laili, 2025). In addition, technology-based learning innovations such as *Augmented Reality* (AR) integrated with ecological contexts (Hidayat & Ramadhani, 2024) provide a new dimension to the learning experience, allowing learners to visualize complex biological phenomena without having to be in the field all the time.

Meanwhile, learning based on local potential also received great attention. Research by Lestari & Gunawan (2023) emphasizes that the integration of elements of local Kalimantan wisdom in ecosystem materials not only strengthens naturalistic intelligence, but also fosters a sense of ecological identity and pride in the environment of the region. This reinforces the view that the development of naturalistic intelligence should not be separated from the local socio-cultural context, so that students can understand biology not only as a science, but also as part of daily life and culture of the community.

From the results of the study, it can be concluded that the integration of naturalistic intelligence has a significant influence on biology learning outcomes in three main domains, namely cognitive, affective, and psychomotor. In the cognitive aspect, improvements occur in terms of concept understanding, analytical thinking skills, and mastery of ecosystem materials (Putra & Handayani, 2021; Pratama & Laili, 2025). In the affective aspect, students show a positive attitude towards nature, such as caring for the environment, ecological empathy, and higher learning motivation (Nuraini et al., 2024; Dewi et al., 2023). Meanwhile, in the psychomotor aspect, direct observation activities and field experiments have been proven to improve scientific skills such as recording data, identifying organisms, and analyzing relationships between ecosystem components (Nirmala & Santoso, 2022).

Overall, the findings of the 10 article confirm that biology learning integrated with naturalistic intelligence not only emphasizes knowledge transfer, but also prioritizes the formation of character and ecological awareness of students. This learning is in line with the 21st century education paradigm that emphasizes environmental literacy, creativity, and critical thinking skills. The integration of naturalistic intelligence also has great potential in supporting the achievement of *the Sustainable Development Goals* (SDGs), especially in the fourth (quality education) and fifteenth (life on land) goals. Thus, biological learning based on naturalistic intelligence can be a strategic foundation in forming a generation that is not only intellectually intelligent, but also ethical and responsible for the preservation of nature.

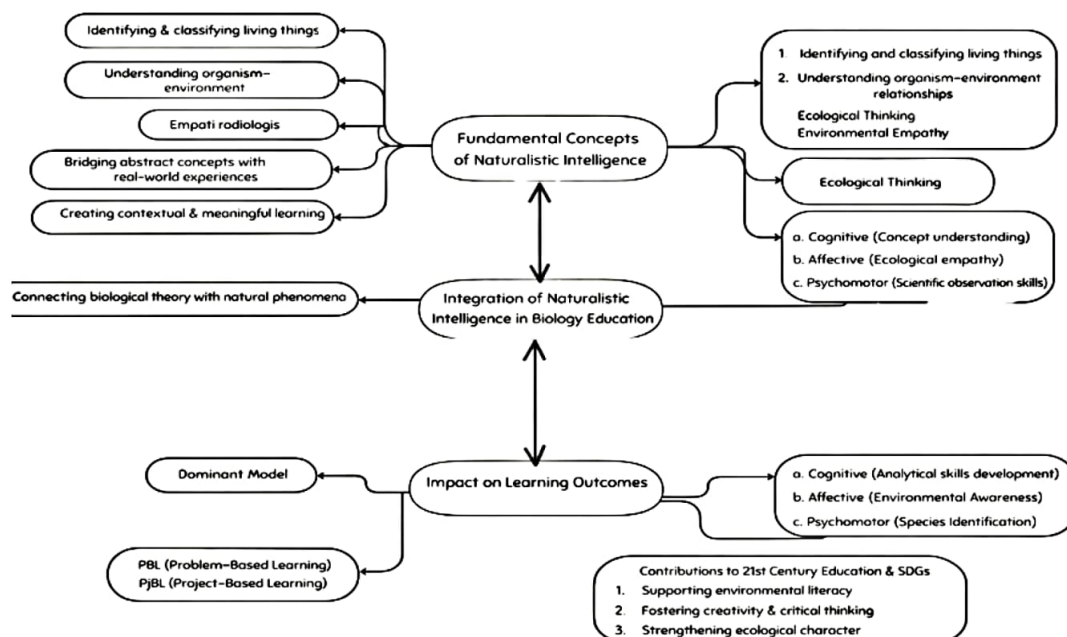


Figure 3 Scheme for the integration of naturalistic intelligence in biology learning

Figure 3. describes how naturalistic intelligence is integrated and has an impact in Biology Learning. Basic Concepts of Naturalistic Intelligence This section, linked directly from the main box "Integration of Naturalistic Intelligence in Biological Learning", explains the basics of intelligence. Recognizing and grouping living things, understanding the organism-environment relationship, ecological thinking, and rheological empathy.

The relationship between the Basic Concept of Naturalistic Intelligence and the Integration of Naturalistic Intelligence in Biology Learning is conceptual-implemptive. The basic concept of naturalistic intelligence acts as a

theoretical foundation that explains the characteristics and indicators of naturalistic intelligence, such as the ability to recognize and group living things, understand the relationship between organisms and their environment, think ecologically, and have empathy for nature. The understanding of this concept is a reference in designing and integrating naturalistic intelligence into biology learning through the selection of contextual and environment-based learning strategies, models, and activities. Thus, the integration of naturalistic intelligence in biology learning is a form of real application of basic concepts that aim to create learning that is more meaningful and relevant to natural phenomena.

The relationship between the Integration of Naturalistic Intelligence in Biology Learning and the Impact on Learning Outcomes is causal. The integration of naturalistic intelligence in biology learning, which is realized through contextual learning, the use of the environment as a learning resource, and the application of models such as *Problem-Based Learning* and *Project-Based Learning*, plays a role as a factor that affects the improvement of student learning outcomes. Through this integration, students not only gain a deeper understanding of biological concepts (cognitive aspect), but also show caring and empathy for the environment (affective aspect) as well as scientific skills such as observation and identification of organisms (psychomotor aspect). Thus, the impact on learning outcomes is the output of the biology learning process that systematically integrates naturalistic intelligence.

The integration of Naturalistic Intelligence in Central Biology Learning refers to the ability of students to understand the natural world in the field of biology, especially on how students are able to apply their understanding of biology to natural phenomena that occur in the surrounding environment. Examples include observing organisms, recognizing natural patterns, and building relationships with the environment. When biology learning integrates this intelligence, theory is not taught in the abstract, but is directly linked to real observations in the environment. By connecting theory with natural phenomena, learners experience for themselves what they learn. This makes biological concepts not just memorize, but real experiences that leave their mark.

## Conclusion

This study concludes that the integration of naturalistic intelligence in Biology learning plays an important role in optimizing student learning outcomes in various cognitive, affective, and psychomotor domains. Through strengthening the ability to observe natural phenomena, ecological thinking skills, and empathy for the environment, naturalistic intelligence becomes a bridge between scientific knowledge and ecological awareness. The results of the review of ten articles show that inquiry-based learning strategies, project-based learning, and field observation are the most effective approaches to cultivate this intelligence comprehensively. In general, the application of naturalistic intelligence has been proven to be able to increase the understanding of abstract biological concepts, foster learning motivation, and build environmental care in students. However, this study still has limitations, including the relatively limited number of articles analyzed and the dominance of research with descriptive and correlational approaches, so the generalization of findings needs to be done carefully. This opens up opportunities for further research in the form of experimental, longitudinal studies, and the development of naturalistic intelligence-based learning models that are integrated with technology and local contexts. These findings are also in line with 21st century education that emphasizes science literacy, ecological character, and context-based learning. Therefore, future research and learning practices are recommended to expand the application of naturalistic intelligence by integrating it into the Biology curriculum more systematically, utilizing digital technology such as Augmented Reality or interactive multimedia, and instilling local wisdom values in the learning process to create a meaningful, sustainable, and environment-oriented learning experience.

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