

# Evaluating the scientific accuracy and pedagogical approaches in biodiversity content of secondary school textbooks: A cross-publisher study

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## Abstract

This study analyzes how biodiversity is represented in secondary school biology textbooks from both government and private publishers. The focus of the research is on evaluating their alignment with the national curriculum, the scientific accuracy of biodiversity concepts, and their ability to foster critical thinking. The research employs a descriptive content analysis approach using the Four Steps Teaching Material Development (4S TMD) method, limited to the selection stage. The sample consists of one government-published and one private-published biology textbook commonly used in Grade X of Secondary School, selected from a survey of 45 schools in Bogor Regency. The results show key differences: government textbooks provide a more accurate, comprehensive view of biodiversity and are better aligned with the curriculum, offering real-world ecological examples. They also promote inquiry-based learning and critical thinking. On the other hand, private textbooks offer more superficial coverage with conceptual errors, focusing on rote memorization and theoretical knowledge. These findings suggest that government textbooks are better suited for fostering a deep understanding of biodiversity, while private textbooks may limit students' ability to engage with the topic. The study calls for improved quality of textbook biodiversity content better to support students' learning and awareness of ecological issues. Future research could explore the impact of these textbook differences on student outcomes.

**Abstrak.** Penelitian ini menganalisis bagaimana keanekaragaman hayati diwakili dalam buku teks biologi sekolah menengah atas yang diterbitkan oleh penerbit pemerintah dan swasta. Fokus penelitian ini adalah mengevaluasi kesesuaiannya dengan kurikulum nasional, akurasi ilmiah konsep keanekaragaman hayati, dan kemampuannya dalam mengembangkan pemikiran kritis. Penelitian ini menggunakan pendekatan analisis konten deskriptif dengan metode Four Steps Teaching Material Development (4S TMD), yang dibatasi pada tahap seleksi. Sampel terdiri dari satu buku teks biologi yang diterbitkan oleh pemerintah dan satu buku teks yang diterbitkan oleh penerbit swasta, yang umum digunakan di Kelas X Sekolah Menengah Atas, dipilih dari survei 45 sekolah di Kabupaten Bogor. Hasil menunjukkan perbedaan signifikan: buku teks pemerintah memberikan gambaran yang lebih akurat dan komprehensif tentang keanekaragaman hayati, serta lebih selaras dengan kurikulum, dengan contoh-contoh ekologi dunia nyata. Mereka juga mendorong pembelajaran berbasis penemuan dan pemikiran kritis. Di sisi lain, buku teks swasta menawarkan cakupan yang lebih permukaan dengan kesalahan konseptual, berfokus pada hafalan dan pengetahuan teoretis. Temuan ini menyarankan bahwa buku teks pemerintah lebih cocok untuk mengembangkan pemahaman mendalam tentang keanekaragaman hayati, sementara buku teks swasta mungkin membatasi kemampuan siswa untuk terlibat dengan topik tersebut. Studi ini menyerukan peningkatan kualitas konten keanekaragaman hayati dalam buku teks untuk mendukung pembelajaran dan kesadaran siswa terhadap isu-isu ekologi. Penelitian masa depan dapat mengeksplorasi dampak perbedaan buku teks ini terhadap hasil belajar siswa.

## A. Introduction

Biodiversity represents a fundamental aspect of biological sciences, serving as the basis for understanding the diversity of life forms and the intricate relationships between organisms and their environments. As a critical topic within biology education, biodiversity encompasses ecological and evolutionary dimensions with profound implications for conservation and natural resource management. (Qomariyah et al., 2019). Consequently, how biodiversity content is portrayed in biology textbooks is pivotal in influencing students' comprehension of its significance and its role in sustaining ecosystem balance (Labobar & Kapojos, 2023). This study emphasizes that the way textbooks frame biodiversity will directly shape students' scientific literacy and environmental awareness.

Secondary school biology textbooks are primary educational resources that align with the curriculum and national education policies. Nonetheless, notable discrepancies exist in the scope and presentation of biodiversity topics between textbooks published by governmental bodies and those produced by private publishers. These variations may significantly impact students' understanding, particularly concerning the interrelations among species, ecosystems, and evolutionary processes (Hanifah, 2021). Such differences highlight the theoretical importance of comparing government and private publishers, since publishing policies, review procedures, and pedagogical orientations may influence the accuracy and depth of textbook content.

Several previous studies have highlighted disparities in the representation of biodiversity in secondary school biology textbooks from various publishers (Hanifah, 2021). Moreover, government-issued textbooks tend to present more structured fundamental concepts, adhering to established national standards. In contrast, textbooks from private publishers often adopt a more flexible approach, incorporating recent research trends and providing more contextual case studies (Mulia & Zulyusri, 2021). However, variations in content delivery may lead to differences in how students grasp biodiversity principles, especially if there is no continuity in the fundamental concepts taught (Praja & Prastiwi, 2021). This reinforces the need for a comparative study that not only identifies these gaps but also evaluates their educational implications.

Although research has been conducted on the differences in biodiversity content coverage in textbooks from various publishers, systematic comparative studies between government-issued and privately published textbooks remain limited. Further analysis is required to evaluate how these differences impact students' comprehension quality and teaching effectiveness. Additionally, no existing approach integrates science-based teaching material development models to assess the appropriateness of

biodiversity content in secondary school biology textbooks (Virdarani, 2023). This study specifically addresses this gap by applying the Four Steps Teaching Material Development (4S TMD) method to compare government and private textbooks.

One approach that can be used to evaluate the quality of textbook biodiversity content is the Four Steps Teaching Material Development (4S TMD) method, which consists of four stages: selection, structuring, characterization, and reduction (Anwar, 2023). The selection stage involves assessing the alignment of topic coverage with the curriculum, the scientific accuracy of concepts, and the development of substantive and pedagogical contexts in learning. Structuring focuses on how the material is systematically organized according to scientific principles and didactic aspects that enhance students' comprehension (Lubis et al., 2024). Meanwhile, the characterization and reduction stages emphasize the relevance of the material to students' psychological and cognitive development, as well as the identification of essential concepts necessary for meaningful learning (Usher & Maroun, 2018). However, in this research the focus is limited to the selection stage to ensure depth of analysis.

This study aims to systematically compare and analyze the representation of biodiversity in secondary school biology textbooks published by the government and private publishers using the 4S TMD method. The research questions are: (1) How do government and private textbooks align with the curriculum? (2) How accurate are the biodiversity concepts presented? (3) To what extent do the textbooks support critical thinking and pedagogical contexts as reflected in the presence of inquiry-based activities, field projects, and higher-order questions embedded in the material? Consequently, the findings of this study are expected to provide insights into how improving textbook quality can contribute to more effective and conceptually accurate biology education.

## B. Material and methods

This study employs a descriptive qualitative approach with a documentary research design, focusing on content analysis in Secondary school biology textbooks (Grade X of Secondary school). The research object consists of two teaching material manuscripts: one government-published and one private-published textbook on biodiversity, both commonly used in Grade X of Secondary school. This textbook was selected based on a survey of textbook usage in 45 public of Secondary school in Bogor Regency. This study aims to evaluate the representation of biodiversity concepts in the examined textbook using the Four Steps Teaching Material Development (4S TMD) approach, although the analysis is limited to the

selection stage for methodological precision (Anwar, 2023).

In this study, content evaluation is conducted based on the selection stage of the 4S TMD method. The selection stage aims to assess whether the content presented in the textbook meets specific criteria regarding curriculum alignment, scientific accuracy, and the development of substantive and pedagogical contexts. Within this research context, only three main aspects of the selection stage are analyzed: (1) alignment with the curriculum, (2) scientific accuracy of concepts, and (3) relevance to substantive and pedagogical contexts. The other stages of 4S TMD (structuring, characterization, and reduction) were not applied because the focus of this research is comparative evaluation rather than full teaching material development.

The first criterion in the selection stage is curriculum alignment, evaluated through a systematic analysis of the integration of textbook content with the Learning Outcomes (CP) and Learning Objective Flow (ATP). The initial step in this analysis involves matching the textbook's concepts with the applicable national curriculum. Competency Achievement Indicators (IPK) are developed based on the CP established in the curriculum. Subsequently, Concept Labels (LK) are formulated to identify key concepts that must be included in biodiversity learning materials. This process ensures that textbook content is structured according to national educational standards and facilitates systematic learning (Sahra & Sahra, 2024). Table 1 presents the alignment criteria applied in this stage for clarity.

**Table 1 Alignment criteria applied in selection stage of 4S TMD method**

| Criterion                         | Description                                                                                                                                         | Source                                         |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Curriculum Alignment              | Matching content with CP, ATP, and IPK, and identifying concept labels (LK)                                                                         | (Sahra & Sahra, 2024)                          |
| Scientific Accuracy               | Systematically reviewing the analysis of biology textbooks                                                                                          | (Vydra & Kováčik, 2025)                        |
| Substantive & Pedagogical Context | Ecology textbooks connect theory and data, shaping the understanding of future scientists, but they still lack diversity and present complex facts. | (Ansari & Landin, 2022; Richards et al., 2025) |

The second criterion is the scientific accuracy of the concepts presented in the textbook. To evaluate this aspect, a comparative analysis is conducted between the concepts in the textbook and standard concepts derived from international academic sources, such as *Life: The Science of Biology* and *Campbell Biology*. Scientific accuracy is fundamentally concerned with the alignment of ideas to the prevailing scientific consensus, which is derived from rigorous peer-reviewed research and a collective body of knowledge across disciplines (Bray, 2010).

The final criterion in the selection stage is the development of substantive and pedagogical contexts, which aims to assess the extent to which the textbook connects biodiversity topics with real-world phenomena and how the material is presented in the learning process. Substantive context in this study includes how textbook content is linked to biological phenomena, scientific facts, ecological data, and practical applications in various fields (Richards et al., 2025). The evaluation of substantive context is carried out by analyzing how concepts in the textbook are explained in relation to real-life examples and applications.

Meanwhile, the pedagogical context is analyzed to determine whether the textbook serves as a medium for fostering students' critical thinking skills, problem-solving abilities, and scientific attitudes. A practical textbook should provide definitions and descriptions of concepts and encourage students to explore these concepts through interactive learning activities. This analysis provides insight into whether each textbook

supports inquiry-based learning or relies primarily on rote memorization.

The biodiversity concepts examined in this study include genetic diversity, species diversity, ecosystem diversity, Indonesia's biodiversity, the benefits of biodiversity, biodiversity conservation in Indonesia, classification of living organisms, classification of living organisms by experts, grouping of living organisms and their roles, organisms in ecosystems, and interactions among ecosystem components. These concepts were used as the basis for comparing the two types of textbooks systematically.

Data analysis is conducted qualitatively using content analysis, a method used to identify, categorize, and evaluate the quality of material presentation in textbooks. The study examines each textbook section related to biodiversity and compares it with established scientific and pedagogical standards. Systematically investigate biology textbooks, revealing trends and gaps in coverage across various topics, informing potential improvements in educational content (Vydra & Kováčik, 2025). The accuracy and depth of concepts are evaluated using a three-level rating scale: superficial (1), intermediate (2), and in-depth (3). Additionally, content analysis is performed to identify potential misconceptions in concept presentation, which may impact students' understanding. Figure 1 illustrates the evaluation framework applied, showing the flow of analysis from curriculum alignment, scientific accuracy, and pedagogical context into the final evaluation outcome.

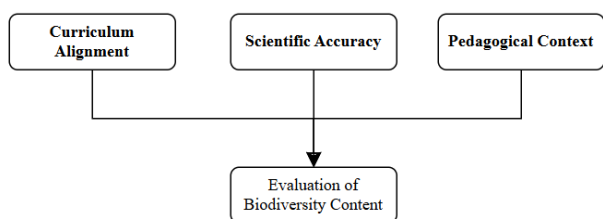


Figure 1 Illustrates the evaluation framework

## C. Results and discussion

This section presents the results of the analysis regarding the alignment of biology textbooks, particularly concerning biodiversity topics, with the curriculum. As outlined in the previous sections, the data indicate significant differences between textbooks published by government and private publishers. These differences pertain to the scope and depth of biodiversity coverage, the accuracy of the concepts, the inclusion of real-world applications, and the pedagogical approaches used. The analysis is based on several key factors, including the extent of coverage of biodiversity concepts, the accuracy of those concepts, and the effectiveness of the pedagogical strategies in fostering critical thinking and environmental awareness among students. As summarized in Tables 2 and 3, government textbooks

consistently align more closely with curriculum expectations and provide deeper real-world applications, while private textbooks often remain superficial.

### *Scope of content alignment with the curriculum*

The alignment of the textbook content with the national curriculum plays a critical role in ensuring that students acquire the necessary competencies in biology, particularly in understanding biodiversity and its relevance to ecological and environmental studies. As shown in Table 1, the analysis of the curriculum alignment reveals that the government-published textbooks present a more comprehensive approach to biodiversity topics. These textbooks thoroughly cover key concepts such as the various levels of biodiversity (genetic, species, and ecosystem), biodiversity benefits, and the importance of conservation efforts. In contrast, privately published textbooks typically provide a more superficial examination of biodiversity, often concentrating solely on definitions or general overviews. They frequently lack the depth of analysis necessary to connect concepts to real-world ecological challenges. For instance, as seen in Table 3, private textbooks omit systematic treatment of ecosystem diversity, which limits students' grasp of interconnected ecological processes.

Table 2 The analysis of the curriculum

| Competency                     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic competency</b>        | <b>Understanding:</b> Students are expected to create solutions for local, national, or global problems related to biodiversity, viruses, biotechnology, ecosystems, and environmental changes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Course learning outcome</b> | <b>Process skills:</b> Includes scientific steps from observation to communication of results.<br><b>Identifying levels of biodiversity:</b> <ul style="list-style-type: none"> <li>- Genetic biodiversity</li> <li>- Species biodiversity</li> <li>- Ecosystem biodiversity</li> </ul> <b>Observation,</b> Select the appropriate tools for measurement and observation.<br><b>Questioning and predicting,</b> identify questions and problems that can be scientifically investigated.<br><b>Planning and conducting investigation,</b> develop a scientific plan and collect data systematically.<br><b>Processing, analyzing data and information,</b> Interpret and analyze data using appropriate tools.<br><b>Evaluating and reflecting,</b> Evaluate conclusions and methodology.<br><b>Communicating results,</b> Present investigation results in an appropriate and systematic manner. |
| <b>Concept labels</b>          | <ol style="list-style-type: none"> <li>1. Biodiversity</li> <li>2. Biodiversity in Indonesia</li> <li>3. Benefits of Biodiversity</li> <li>4. Conservation of Biodiversity in Indonesia</li> <li>5. Classification of Living Organisms</li> <li>6. Grouping Living Organisms and Their Roles</li> <li>7. Living Organisms in Ecosystems</li> <li>8. Interactions Among Ecosystem Components</li> <li>9. Conservation of Biodiversity</li> <li>10. Grouping Living Organisms According to Experts</li> <li>11. Formulating Efforts to Conserve Biodiversity</li> </ol>                                                                                                                                                                                                                                                                                                                             |

### *Conceptual accuracy and depth of biodiversity content*

A crucial aspect of the analysis was the conceptual accuracy of the biodiversity content presented in the textbooks. As detailed in Figures 1 and 2, the results showed notable differences between the textbooks regarding the scientific accuracy and depth of the information. Government-published textbooks generally offer reliable and scientifically accurate information, including up-to-date research and widely accepted scientific frameworks. These textbooks accurately describe the interactions between species, the functions of ecosystems, and the principles of biodiversity conservation (Guan et al., 2019). In contrast, privately published textbooks exhibited several conceptual inaccuracies. For example, some textbooks oversimplify ecological relationships and

misrepresent species interactions, which could lead to misconceptions among students. The absence of comprehensive ecological models and real-world examples further limited students' ability to relate textbook knowledge to real-world scenarios. As illustrated in Figure 1 (scientific accuracy) and Figure 2 (depth of concepts), the government textbooks provide higher ratings, while private textbooks remain at the superficial to intermediate levels. Moreover, an International textbook publisher provided the most accurate and in-depth coverage of biodiversity topics, supported by extensive empirical data and research. The textbook also connected biodiversity concepts to environmental challenges, such as climate change and global conservation efforts.



Figure 2 Comparison of scientific accuracy in government, private, and international textbooks



Figure 3 Depth of biodiversity concept coverage across textbooks

*Real-world applications of biodiversity concepts.*

One of the significant findings of the analysis was the incorporation (or lack thereof) of real-world examples and applications within the biodiversity content of the textbooks. Table 3 compares how the textbooks relate their biodiversity content to real-World phenomena include environmental issues, conservation strategies, and ecological challenges. Government-published textbooks excelled in linking biodiversity topics to local and global environmental problems, using case studies and empirical data to demonstrate the relevance of biodiversity in real-world contexts. As seen in Table 3, government textbooks included specific references to Indonesian national parks and ex situ conservation strategies, whereas private

textbooks did not provide any practical conservation examples.

In contrast, privately published textbooks provided minimal contextualization of biodiversity topics. For instance, they often failed to include concrete examples of species conservation or ecological restoration efforts, which limited students' ability to connect their learning to current environmental problems. The absence of case studies or environmental data made it difficult for students to appreciate the urgency of biodiversity preservation, leaving them with only a theoretical understanding of the topic. The Biology Campbell textbook stood out by integrating global case studies and empirical data, thereby providing students with a clear perspective on biodiversity's importance in global conservation.

**Table 3 Comparison of biodiversity content and real-world relevance in textbooks**

| Material category                                | Private publisher textbook                 | Government publisher textbook                                            | International publishers' textbook                                  |
|--------------------------------------------------|--------------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------------------|
| <b>Genetic diversity</b>                         | (Discussed, but lacks real-world examples) | (Related to genetic variation and biotechnology)                         | (Connected to modern genetics and research data)                    |
| <b>Species diversity</b>                         | (Examples are less varied)                 | (Related to speciation and geographical distribution)                    | (Connected to evolutionary data and species adaptation)             |
| <b>Ecosystem diversity</b>                       | (Definition is unclear, few examples)      | (Related to real ecosystems and their impact)                            | (Connected to global ecology and climate change)                    |
| <b>Biodiversity in Indonesia</b>                 | (Descriptive only, lacks specific data)    | (Related to Indonesian biogeography and endemic species)                 | (Connected to biodiversity research and conservation)               |
| <b>Benefits of biodiversity</b>                  | (Discussed but lacks depth)                | (Explained with applications in agriculture, health, and industry)       | (Connected to economic data and ecosystems)                         |
| <b>Biodiversity conservation</b>                 | (No real conservation examples)            | (Related to national parks, ex situ conservation, and legal regulations) | (Connected to global case studies and environmental policies)       |
| <b>Classification of living organisms</b>        | (No systematic approach)                   | (Related to phylogeny and the development of taxonomy)                   | (Connected to DNA technology and cladistics)                        |
| <b>Grouping living organisms by experts</b>      | (No expert references)                     | (Related to theories from various scientists)                            | (Connected to taxonomy research and the history of classification)  |
| <b>Grouping living organisms and their roles</b> | (Under-discussed)                          | (Related to ecosystems and food chains)                                  | (Connected to ecological relationships and specific organism roles) |
| <b>Living organisms in ecosystems</b>            | (Not discussed)                            | (Related to ecosystem change phenomena)                                  | (Connected to population research and ecosystem dynamics)           |
| <b>Interactions among ecosystem components</b>   | (Not discussed)                            | (Related to natural phenomena like competition and predation)            | (Connected to empirical data and ecological interaction models)     |

*Pedagogical context and their impact on student skills*

The pedagogical strategies employed in the textbooks were another critical area of analysis, particularly in how they foster students' critical thinking, investigative skills, and ability to apply biodiversity concepts. Table 3 compares the pedagogical context of the three types of textbooks. Government-published textbooks provided more structured learning opportunities that engaged students in critical thinking and scientific inquiry. As summarized in Table 4, government textbooks consistently incorporate field projects, inquiry-based tasks, and exploration of local

ecosystems, while private textbooks rarely extend beyond descriptive tasks.

On the other hand, privately published textbooks tended to focus on rote memorization and theoretical knowledge, with limited opportunities for students to explore or investigate biodiversity concepts actively. This approach was criticized for not promoting the development of essentials. Scientific skills like data analysis or hypothesis testing are crucial for understanding and addressing real-world biodiversity issues. The lack of inquiry-based learning in private textbooks limits students' ability to

develop investigative skills and reduces the potential for deeper engagement with the subject matter. In contrast, Biology Campbell excelled in fostering students' analytical and investigative skills. The

textbook included numerous case studies, data analysis exercises, and interactive activities, encouraging students to explore biodiversity topics actively.

**Table 4 Government textbooks consistently incorporate field projects, inquiry-based tasks**

| Material category                                | Private publisher textbook                 | Government publisher textbook                                                | International publishers' textbook                                                    |
|--------------------------------------------------|--------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Genetic diversity</b>                         | (Concepts only, no skills developed)       | (Exploration-based learning is present, but lacks in-depth activities)       | (Encourages analytical skills with genetic case studies)                              |
| <b>Species diversity</b>                         | (Descriptive only)                         | (Encourages critical thinking with real-life examples)                       | (Trains investigative skills with species data)                                       |
| <b>Ecosystem diversity</b>                       | (No exploration activities)                | (Involves field projects and ecosystem observation)                          | (Includes applicable ecological research methods)                                     |
| <b>Biodiversity in Indonesia</b>                 | (Memorization only)                        | (Discussion and exploration-based activities of the surrounding environment) | (Develops scientific thinking and biogeographical analysis skills)                    |
| <b>Benefits of biodiversity</b>                  | (Not connected to practical skills)        | (Encourages understanding of conservation and utilization of biodiversity)   | (Develops scientific attitudes through case studies in economics and the environment) |
| <b>Biodiversity conservation</b>                 | (Lacks environmental awareness)            | (Encourages active participation in school conservation programs)            | (Includes policy analysis and its impact on society)                                  |
| <b>Classification of living organisms</b>        | (Theory only with no analysis or practice) | (Grouping activities are present, but still limited)                         | (Trains systematic thinking skills using phylogenetic methods)                        |
| <b>Grouping living organisms by experts</b>      | (No skills developed)                      | (Trains critical thinking by comparing the theories of experts)              | (Encourages independent research in taxonomy)                                         |
| <b>Grouping living organisms and their roles</b> | (No skill exploration)                     | (Connected to ecological roles but not very applicable)                      | (Encourages skills in analyzing organism interactions)                                |
| <b>Living organisms in ecosystems</b>            | (No exploratory activities)                | (Connected to simple experiments and environmental projects)                 | (Encourages skills in ecological system analysis with simulations)                    |
| <b>Interactions among ecosystem components</b>   | (Descriptive only)                         | (Includes exploration activities on ecological relationships)                | (Develops experimental and ecological modeling skills)                                |

The findings from this study offer significant insights into the alignment of biodiversity content in biology textbooks published by governmental and private publishers, and the extent to which these textbooks meet curriculum standards and pedagogical requirements. The study demonstrates notable differences in the depth of scientific concepts, curriculum alignment, and pedagogical context (i.e., learning tasks that position students to practice inquiry and reasoning) between textbooks produced by government and private publishers. Following textbook evaluation perspectives on knowledge selection and epistemic quality, these differences are interpreted as variation in how scientific knowledge is selected, justified, and translated into learnable classroom experiences (Kloser, 2013; Makaon, 2021; Reinisch & Fricke, 2022). This discussion not only situates these findings within the existing literature but also frames them through curriculum studies and textbook evaluation theory, highlighting implications for improving science education. The study's findings reveal that government-published textbooks

demonstrate a higher level of alignment with the national curriculum when compared to those published by private publishers. This finding supports the arguments of previous studies, which suggest that governmental textbooks are more systematically designed to meet curriculum expectations and educational standards (Scott & Husain, 2021). A plausible explanation is that government textbooks are typically produced under more centralized review and accountability structures, making curriculum mapping and competency coverage more explicit. Government textbooks are tailored to cover the required competencies, including an in-depth understanding of biodiversity at various levels (genetic, species, and ecosystem), and offer a comprehensive treatment of conservation strategies, which are critical curriculum components. Additionally, they provide students with opportunities to engage in scientific practices, thus fostering a holistic approach to biology education (Unger, 2023; Wahono et al., 2023). For practice, this suggests government textbooks can function as a baseline "opportunity to learn," while private textbooks

should be checked against the same competency targets before adoption. This reinforces curriculum alignment theory, which emphasizes that consistent national standards enhance equity in science education.

In contrast, textbooks from private publishers often prioritize superficial coverage of topics, focusing more on definitions and conceptual descriptions without delving into the underlying scientific principles or their real-world applications. This trend aligns with the findings of (Wernick et al. (2014), who noted that private publishers frequently emphasize marketability and visual appeal over scientific accuracy and curriculum adherence. This “coverage-first” orientation may occur when space limitations and layout priorities compress explanation, evidence, and connections among concepts. The superficial content in private textbooks may lead to gaps in students’ understanding of complex ecological concepts, limiting their ability to engage with the subject matter critically. This reflects textbook analysis theory, which warns that content simplification can undermine conceptual learning and critical engagement. Therefore, although popular for their engaging format, these textbooks are less likely to facilitate a deep, rigorous understanding of biodiversity than their government counterparts.

Regarding the accuracy of scientific concepts, the study found that textbooks from government publishers were generally more scientifically accurate than those from private publishers. This result is consistent with the literature, which highlights that books published by government bodies tend to follow established scientific frameworks and are regularly reviewed by experts to ensure accuracy (Akçay et al., 2023; Yilmaz et al., 2017). From an epistemic-quality lens, accuracy is not only factual correctness but also how well explanations make the underlying scientific rationale visible to learners (Kloser, 2013). The government textbooks in this study adhered to contemporary scientific research, aligning closely with global standards in the study of biodiversity. They provided precise explanations of ecological interactions, species classification, and evolutionary processes, ensuring students understood these critical concepts. This finding suggests that rigorous review processes directly strengthen the validity of educational resources.

On the other hand, private publisher textbooks were found to contain some misconceptions or incomplete explanations, particularly in ecology and species classification topics. For instance, several textbooks inaccurately portrayed ecological relationships, such as predator-prey dynamics or symbiotic interactions, which are central to understanding ecosystems (Akçay et al., 2023; Li et al., 2021; Partini & Ekananda, 2023). These inaccuracies are problematic because they may mislead students, preventing them from forming a correct conceptual

framework for understanding ecological processes. Furthermore, insufficient depth in these textbooks can contribute to a fragmented understanding of biodiversity, as students may struggle to grasp the interconnectedness of species and ecosystems (Zukswert et al., 2019). This aligns with conceptual-change arguments that incomplete or overly simplified explanations can stabilize misconceptions unless instructional materials explicitly support revision of prior ideas (Babou et al., 2023; Mello, 2019). Such misconceptions highlight the importance of applying science education frameworks that emphasize conceptual change and correction of students’ prior misunderstandings.

One of the most striking differences between government-published and private-published textbooks was their relevance to real-world contexts. The government textbooks excelled in relating biodiversity concepts to environmental issues, particularly in local and global ecosystems. As noted in previous studies, including real-world examples is essential for fostering meaningful learning experiences and promoting environmental awareness (Stillman, 2016). For example, government textbooks discussed the biodiversity of Indonesia’s unique ecosystems and species, linking these discussions to global conservation efforts and policy decisions. They also incorporated case studies on the impact of climate change on biodiversity, providing students with practical examples that illustrate the urgency of conservation. This contextualization is consistent with place-based and socio-scientific issue perspectives, where local cases and public issues make biodiversity learning more meaningful and decision-oriented (Cavadas, 2017; Mesaoud et al., 2018). This finding supports the role of contextual learning theory, which stresses that connecting content to students’ lived realities enhances motivation and comprehension.

In contrast, textbooks from private publishers often lacked these connections to the real world. While they provided definitions and basic information, they generally failed to offer specific examples of biodiversity conservation or ecological restoration efforts. This absence of real-world context is a significant limitation because it reduces the potential for students to relate the knowledge gained from textbooks to the challenges they will encounter as future scientists, policymakers, or informed citizens (Simon et al., 2018). Without local cases or socio-scientific prompts, the text may inform but not mobilize students’ reasoning about conservation choices (Mesaoud et al., 2018). The failure to address current environmental issues like climate change, habitat destruction, and species extinction in private-published textbooks can also contribute to a lack of urgency among students regarding the importance of biodiversity conservation. This limitation has implications for practice, suggesting that teacher

supplementation of private textbooks with authentic case studies is essential to bridge the gap.

From a pedagogical standpoint, government-published textbooks offered more effective learning strategies than those from private publishers. They emphasized critical thinking and inquiry-based learning, encouraging students to engage in hands-on activities, fieldwork, and scientific investigations. In this study, this “pedagogical context” is evidenced by the presence of tasks (e.g., field projects and inquiry-based activities) that align with intended scientific practices and skills reported in the results (see Table 4). Textbooks that promote active learning and scientific inquiry are instrumental in developing students' problem-solving skills and scientific literacy (Yang & Liu, 2016). Government textbooks provided numerous opportunities for students to engage with biodiversity meaningfully, including activities that allowed them to collect data, observe ecosystems, and apply theoretical concepts to real-life situations. Private-published textbooks, however, predominantly focused on rote memorization and the presentation of facts. Although they included some basic activities, these were generally not designed to foster deeper exploration of biodiversity or challenge students to think critically about the environmental issues. This pattern can be read as a design choice: when tasks are minimal, the textbook functions more as an information source than as a guide for skill development. This lack of pedagogical rigor aligns with the findings (Wernick et al., 2014). The implication for practice is that policymakers should encourage textbook authors to integrate inquiry-based frameworks, ensuring textbooks function as tools for skill development rather than rote recall.

## D. Conclusion

This study provides a comprehensive comparison between the representation of biodiversity in government-published and private-published secondary school biology textbooks, offering valuable insights into the alignment of content with the national curriculum, scientific accuracy, and pedagogical strategies. The findings reveal that government-published textbooks tend to provide a more thorough and scientifically accurate treatment of biodiversity topics, aligning closely with curriculum standards and providing students with opportunities for critical thinking and inquiry-based learning. These textbooks also connect biodiversity concepts to real-world applications, particularly concerning conservation efforts and ecological challenges in Indonesia and beyond. In contrast, privately published textbooks often offer a more superficial coverage of biodiversity, focusing on general definitions and lacking real-world examples or in-depth exploration of ecological processes. The inaccuracies and limited context in these textbooks may lead to misconceptions, hindering students' understanding of biodiversity's complexities.

Additionally, the pedagogical approaches in privately published textbooks are less likely to foster critical thinking or investigative skills, emphasizing rote memorization instead of active engagement. The practical implication is that teachers should critically supplement private textbooks with authentic case studies and inquiry-based activities, while policymakers should encourage publishers to integrate national curriculum standards with real-world ecological challenges. This study contributes to the body of knowledge by highlighting the importance of textbook quality in biology education, particularly regarding biodiversity, and by suggesting improvements in the accuracy and real-world relevance of content could enhance students' understanding and environmental awareness. Future research could explore the impact of these textbooks on student performance and engagement in biodiversity-related subjects and the potential for integrating more interactive and inquiry-based learning methods into textbook design. Future research should also investigate how these textbook differences influence long-term student attitudes toward biodiversity conservation and sustainable practices.

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