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Analysis of First Grade High School Biology Textbooks Merdeka Curriculum Based on Environmental Literacy Aspects

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ABSTRACT

The research is motivated by environmental problems due to low environmental literacy as evidenced through various studies. Various solutions are sought to instill environmental literacy, for example learning by implementing an merdeka curriculum in textbooks. The aim of the study was to determine the percentage and level of environmental literacy suitability for first grade science textbooks in the merdeka curriculum. This type of quantitative descriptive research uses biology textbook material for first grade high school science published by the Ministry of Education and Culture Research and Technology 2021. Observation data collection techniques use observation sheet instruments. Data were analyzed descriptively quantitatively by calculating percentages and conducting Focus Group Discussions. The results of the study show that the percentage of environmental literacy is different. Material Viruses and Their Role (Chapter 2) with a score of 61.66%, Material Diversity of Living Things, Interactions, and Their Role in Nature (Chapter 7) with a value of 80.92%, and Material Global Warming: Concepts and Solutions with a value of 100%. The three chapters are categorized as "appropriate" in reflecting environmental literacy. However, it still needs to improve environmental literacy aspects, especially in Chapters 2 and Chapter 7.

Keywords: environmental literacy, textbooks, merdeka curriculum, biology

INTRODUCTION

Throughout 2020, the National Disaster Management Agency (BNPB) recorded 4,977 cases of natural disasters in Indonesia, making Indonesia the country with the highest number of natural disaster intensity in the world, after the United States (Firdaus & Sofro, 2022). BAPPENAS in Hayati (2020) said that there are three factors that can cause natural damage, namely the choice of technology, institutional structure, and human activities. The environmental damage caused by human activities includes garbage disposal, pollution,

deforestation, and various other things that cause global warming. These damages occur as a result of low environmental literacy.

Santoso et al. (2021), in their research, stated that people's environmental literacy skills are still very low and can be seen from the survey data of 12 provinces conducted in 2012 by the Ministry of Environment which showed an average of 0.57. Suryawati et al. (2020) described the ability of junior high school students to identify, analyze problems, and make planning actions to the practice of solving environmental problems is also still low. In addition, research conducted by Igbokwe (2016) also obtained low environmental literacy study results, namely only 29.3% of students who were considered to have met environmental literacy standards and the other 70.7% were still below standard.

According to Kusumaningrum (2018), environmental literacy can be interpreted as the ability of individuals to understand and interpret environmental conditions so that they can decide on appropriate actions to maintain, restore, and improve environmental conditions. Kristyowati & Purwanto (2019), mentioned that utilizing the environment as a learning resource is part of science literacy which is included in one of the literacies that must be fulfilled by students according to the provisions of the merdeka curriculum. Based on this, environmental literacy can help the realization of science literacy and the implementation of an merdeka curriculum.

Anggraena et al. (2021) explained that the merdeka curriculum is a curriculum that provides flexibility, namely educators can simplify and reduce the density of content through the separation between the curriculum framework and the operational curriculum. The merdeka curriculum has 6 basic literacy skills that are demanded competencies, namely literacy in reading and writing, numeracy literacy, digital literacy, financial literacy, cultural and civic literacy, and science literacy. According to Anjarsari (2014) science literacy helps students to be responsive and care about the state of nature. In addition, students can also think more critically and creatively in planning to solve problems that exist in the surrounding nature. Based on this, it is known that environmental literacy is part of science literacy, both of which lead to a caring attitude towards the environment.

According to Ahmadi (2022), the environment helps students to learn in a real way that can be realized in textbooks. Therefore, one of the efforts to instill aspects of environmental literacy is by adding environmental literacy values to textbooks. Sukerni (2014) defines textbooks as learning materials or materials that are arranged systematically, describe instructional objectives to be achieved, motivate students, anticipate learning difficulties that are generally oriented to students. Textbooks are used by teachers to assist the learning process and are expected to improve students' literacy skills.

The environmental literacy component can be realized in textbooks from various subjects, one of which is biology. This is because biology subjects are closely related to living things and the environment and its problems. For example, in one branch of biology, namely

ecology, which studies the interaction between organisms and the environment (Munir, 2016).

Marianingsih et al. (2021) in their research stated that the emergence of environmental literacy aspects has been found in the material in biology textbooks but with an unbalanced proportion because there are several chapters in the textbook that do not contain environmental literacy aspects. A similar thing was also found in a study conducted by (Rachmawati et al., 2021) where the content in junior high school science textbooks also had the same analysis results, namely the distribution of environmental literacy components in the book was uneven. Based on this, it is very necessary to analyze the material in other published textbooks so that it is known whether the textbook is able to support aspects of environmental literacy.

UNESCO in the 1977 Tbilisi Declaration categorized environmental literacy into 5 objectives. The five objectives are (1) awareness and sensitivity to the total environment and related issues. (2) knowledge related to various experiences and basic understanding of the environment and its problems. (3) attitude in the form of a set of values and feelings of concern for the environment and motivation to actively participate in environmental improvement and protection. (4) skills to identify and solve environmental problems. (5) action in the form of active involvement at all levels in efforts to solve environmental problems (McBride et al., 2013). The five categories are a reference from the analysis of research that has been done

The Tbilisi Declaration was the first conference organized between countries with the theme of environmental education (Hoffmann, 1978). According to Herlanti (2016), the five objectives outlined by UNESCO in the Tblisi declaration are easy to integrate in teacher books or student books and support the environmental education curriculum. The ease of integration is a consideration and is considered flexible enough when applied to the learning process. The above is the reason for choosing the five objectives as a reference for the research analysis. The environmental literacy content will be analyzed in first grade high school biology textbooks, namely the Natural Science book published by the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia (KEMDIKBUD RISTEK) in 2021. This book was chosen because it is the main handbook by schools that implement the merdeka curriculum.

The textbook used for the first grade merdeka curriculum is a combination of physics, chemistry, and biology subjects so it is referred to as a science book. This is because in the merdeka curriculum, the specialization program is replaced by a subject selection system that will be carried out in phase F in 2nd grades and 3rd grades. Meanwhile, 1st grade is still in phase E. According to Puspaningsih et al. (2021), the ultimate goal in phase E is that students are expected to have the ability to be more responsive to global issues and have an active role in solving problems.

The 1st grade science textbook contains physics subjects consisting of material on Measurement in Scientific Work (Chapter 1) and Renewable Energy (Chapter 6). Chemistry subjects consist of Green Chemistry in Sustainable Development 2030 (Chapter 3), Basic Laws Around Us (Chapter 4), and Atomic Structure-Advantages of Nanomaterials (Chapter 5). Meanwhile, biology subjects include Viruses and Their Role (Chapter 2), and Diversity of Living Things, Interactions, and Their Role in Nature (Chapter 7). As for the material Global Warming: Concepts and Solutions (Chapter 8) is a combined material from Physics, Chemistry, and Biology subjects (Puspaningsih et al., 2021). The material analyzed in this study is Biology material, namely Chapter 2, Chapter 7, and Chapter 8 in accordance with the field of science pursued by the researcher.

This study aims to analyze the average percentage of depth of environmental literacy planting and analyze the level of suitability of the category of biological material in 1st grade science textbooks in reflecting each aspect of environmental literacy based on the description of the background of the problem above, the researchers are interested in analyzing the content of environmental literacy aspects in biological material in 1st grade high school science textbooks, so that it is known to what extent the textbooks used facilitate the implementation of environmental literacy-based learning in biology learning.

METHOD

This research is a type of quantitative descriptive research. The object is biology material in first grade high school science textbooks of the merdeka curriculum published by the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia in 2021. Selection of research objects using purposive sampling technique. 1st grade high school science books are handbooks used by high schools that implement the merdeka curriculum.

The data collection technique used is observation with an observation sheet instrument that refers to the 1977 UNESCO Tblisi Declaration which categorizes environmental literacy in 5 categories, namely awareness, knowledge, attitudes, skills, and actions (McBride et al., 2013). The rating scale on this instrument uses a Guttman scale, which is a yes/no option. The instrument has been validated by two validators, namely two lecturers of Biology Education FKIP UAD who are competent according to the research theme.

The data were analyzed using percentage analysis to calculate the value of environmental literacy for each aspect using the formula of Marianingsih et al. (2021), namely:

$$Score = \frac{\text{number of scores obtained for each aspect of environmental literacy}}{\text{maximum number of scores for each aspect of environmental literacy}} \times 100\%$$

Meanwhile, to calculate the fulfillment of all aspects of environmental literacy, it is obtained through the average score obtained, using the formula:

$$Average = \frac{\text{number of scores obtained for each aspect of environmental literacy}}{\text{number of environmental literacy aspect}}$$

The suitability category of environmental literacy according to Sugiyono (2016) on Table 1.

Table 1. Suitability category of environmental literacy

Value (100%)	Description
51 - 100	Aligned
0 - 50	Not yet appropriate

Before analyzing the data with the formula above. The data were first analyzed using the Focus Group Discussion (FGD) technique. In carrying out FGDs, the authors were assisted by biology teachers and peers who already had an understanding of the research topic.

RESULT AND DISCUSSION

This study has five aspects that are used as benchmarks in conducting the analysis, namely; awareness, knowledge, attitudes, skills, and actions. The results of the analysis show that chapter 8 has the highest percentage, followed by chapter 7, and the least is chapter 2.

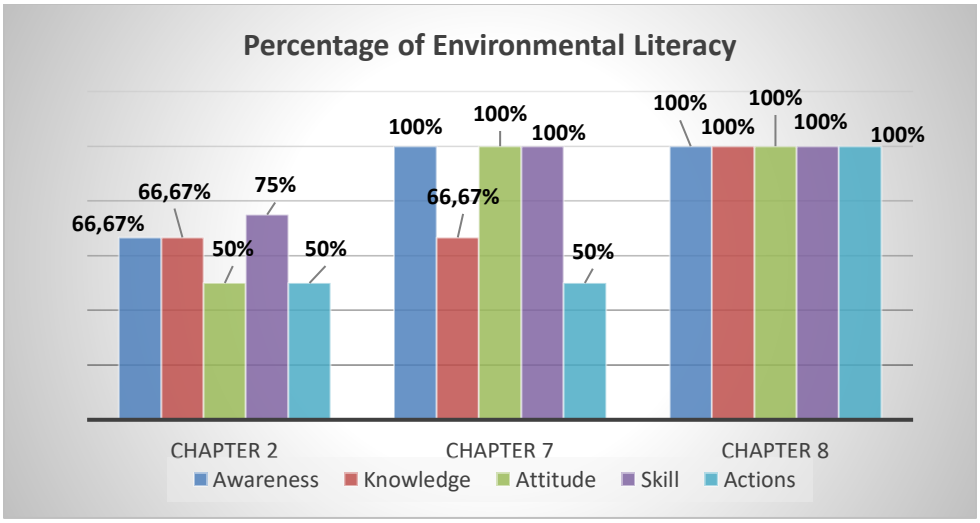


Figure 1. Histogram of environmental literacy achievement of three chapters of biology materials

The following is a description of the results of the analysis of percentage calculations and Focus Group Discussions on three chapters of biology material in first grade high school science textbooks.

Environmental Literacy Embedded in Chapter 2 of Viruses and Their Roles
Awareness aspect

There are 2 objects from the aspect of consciousness in chapter 2. The score obtained for the awareness aspect in this chapter is 66.67% with the criteria "suitable". This value was obtained because two of the three awareness indicators were met in this chapter, namely awareness of environmental problems and stimulation of commitment to protecting the environment. Page 32 contains indicators of awareness of environmental problems shown through project activities where students are invited to identify virus cases in the surrounding environment. Indirectly, the activities carried out can provide awareness that cases of viral disease can be found in the surrounding environment and are included in environmental problems.

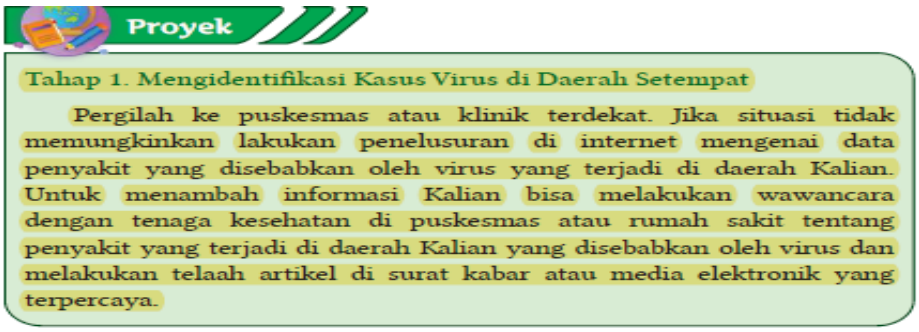


Figure 2. Project phase 1 identifying virus cases

According to LIPI microbiologist Sugiyono Saputra, environmental problems are the reason for the emergence of various diseases. About 60 per cent of these diseases come from animals (zoonis), and the rest come from wildlife. A number of new diseases have emerged from human activities against nature, such as encroachment into wild forest areas. Therefore, maintaining and preserving the environment is the key to preventing outbreaks caused by viruses (Agang, 2020).

Environmental awareness itself is a state of a person who has in-depth knowledge related to things that affect their environment seen from the way they behave and their attitudes. Someone who has environmental awareness will be seen through the knowledge they have, how to respond and behaviour towards the environment (Amos in Sugiarto & Gabriella, 2020). Through the explanation above, the researcher emphasises that the project activity of identifying virus cases can provide "knowledge that helps students be aware of environmental problems".

There is one indicator that has not been met in this chapter. The indicator is awareness of protecting the environment. The researcher suggests integrating environmental awareness

behaviour in virus material to create an environment that is kept clean and free from the spread of dangerous viruses.

Knowledge aspect

There are 4 knowledge aspect objects found in chapter 2. The score obtained for the awareness aspect in this chapter is 66.67% with the criteria of "appropriate". A total of four out of six indicators of knowledge aspects. These indicators are experience or basic understanding of protecting the environment, knowledge related to ecology, appropriate actions to overcome environmental problems, and information on environmental issues.

On page 42, there is an indicator of experience or basic understanding of protecting the environment shown by the material about biopesticides from viruses as an alternative to environmentally friendly agriculture. The statement from the material indirectly provides an understanding to protect the environment through the use of biopesticides.

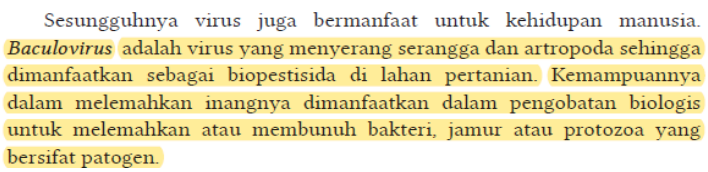
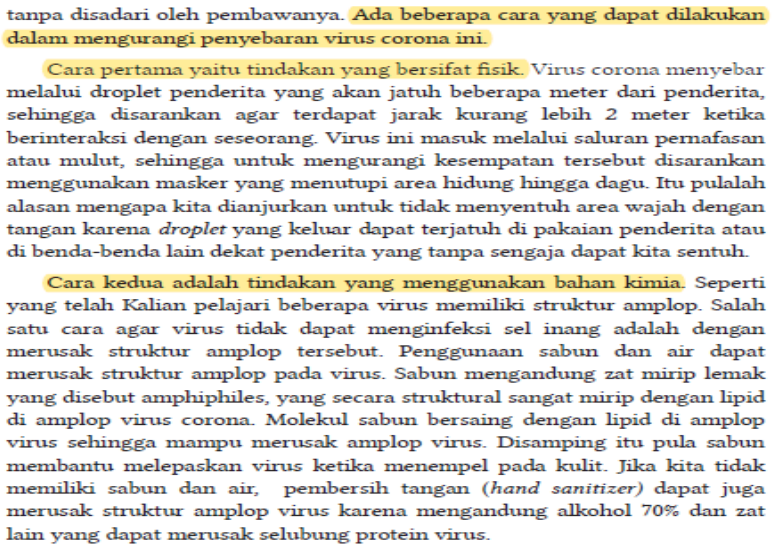

Sesungguhnya virus juga bermanfaat untuk kehidupan manusia. *Baculovirus* adalah virus yang menyerang serangga dan artropoda sehingga dimanfaatkan sebagai biopestisida di lahan pertanian. Kemampuannya dalam melemahkan inangnya dimanfaatkan dalam pengobatan biologis untuk melemahkan atau membunuh bakteri, jamur atau protozoa yang bersifat patogen.

Figure 3. Biopesticide utilisation of viruses

According to Laba et al. (2014), the use of synthetic pesticides should be avoided and replaced with biopesticides. Biopesticides consist of botanical pesticides made from plants and zoological pesticides from viruses, bacteria or fungi. Biopesticides are known to be safe and can reduce pollution, improve soil fertility and biodiversity, and do not harm the environment.

Another component of the knowledge aspect is the right action to overcome environmental problems found on page 46. The material on this page describes the various ways that can be done to reduce the spread of viruses with physical and chemical actions. The environment is closely related to biotic components, one of which is disease-causing microorganisms such as viruses. So that indirectly by reducing the spread of viruses, it can overcome environmental problems.



tanpa disadari oleh pembawanya. Ada beberapa cara yang dapat dilakukan dalam mengurangi penyebaran virus corona ini.

Cara pertama yaitu tindakan yang bersifat fisik. Virus corona menyebar melalui droplet penderita yang akan jatuh beberapa meter dari penderita, sehingga disarankan agar terdapat jarak kurang lebih 2 meter ketika berinteraksi dengan seseorang. Virus ini masuk melalui saluran pernafasan atau mulut, sehingga untuk mengurangi kesempatan tersebut disarankan menggunakan masker yang menutupi area hidung hingga dagu. Itu pulalah alasan mengapa kita dianjurkan untuk tidak menyentuh area wajah dengan tangan karena *droplet* yang keluar dapat terjatuh di pakaian penderita atau di benda-benda lain dekat penderita yang tanpa sengaja dapat kita sentuh.

Cara kedua adalah tindakan yang menggunakan bahan kimia. Seperti yang telah Kalian pelajari beberapa virus memiliki struktur amplop. Salah satu cara agar virus tidak dapat menginfeksi sel inang adalah dengan merusak struktur amplop tersebut. Penggunaan sabun dan air dapat merusak struktur amplop pada virus. Sabun mengandung zat mirip lemak yang disebut amphiphiles, yang secara struktural sangat mirip dengan lipid di amplop virus corona. Molekul sabun bersaing dengan lipid di amplop virus sehingga mampu merusak amplop virus. Disamping itu pula sabun membantu melepaskan virus ketika menempel pada kulit. Jika kita tidak memiliki sabun dan air, pembersih tangan (*hand sanitizer)* dapat juga merusak struktur amplop virus karena mengandung alkohol 70% dan zat lain yang dapat merusak selubung protein virus.

Figure 4. How to reduce the spread of coronavirus

The physical and chemical actions described in Figure 3 are applications of the Clean and Healthy Lifestyle Programme (PHBS). This is in accordance with the statement of Patmawati et al. (2021), who said that during the Covid-19 pandemic, the easiest application of PHBS was washing hands with soap, wearing masks, and maintaining distance. The implementation of Clean and Healthy Living Behaviour is the best step to prevent the spread of the virus and overcome environmental problems.

The explanation of the use of biopesticides and how to reduce the spread of the virus is categorised in the environmental knowledge aspect. This is in accordance with Lee's statement in Rini et al. (2017), that environmental knowledge is the basic knowledge that exists in a person regarding everything that can be done and attempted to help protect the environment. Researchers see that the use of biopesticides is related to "basic knowledge" and reducing the spread of viruses is included in "things that can be done to help protect the environment" so that it fits the definition of environmental knowledge defined by Lee in Rini et al. (2017).

There are two indicators that have not been met in this chapter. These indicators are government policies on the environment or environmental issues and information on social cultural systems that protect or damage the environment. Researchers suggest integrating the two indicators in virus material to increase knowledge related to government policies and social cultural systems that can affect the increase or decrease in virus populations in the surrounding environment.

Attitude aspect

2 object aspects of attitude are found in chapter 2. The score obtained for the awareness aspect in this chapter is 50% with the criteria of "not appropriate". There are two out of four indicators in the attitude aspect that are fulfilled. These indicators are increasing interest in learning about the environment and providing motivation to participate in preserving or protecting the environment.

Page 41 contains an indicator of increasing interest in learning about the environment. On that page, there is an activity where students are asked to find the benefits of viruses for life related to humans, animals, plants, and ecosystems. The activity can increase students' interest in studying the environment through the benefits of the virus they find.

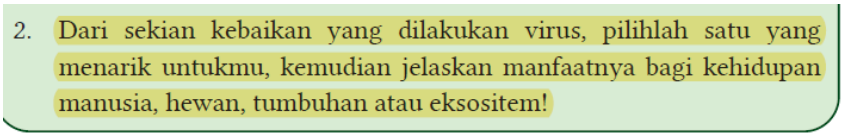

2. Dari sekian kebaikan yang dilakukan virus, pilihlah satu yang menarik untukmu, kemudian jelaskan manfaatnya bagi kehidupan manusia, hewan, tumbuhan atau eksositem!

Figure 5. Virus benefits search activity

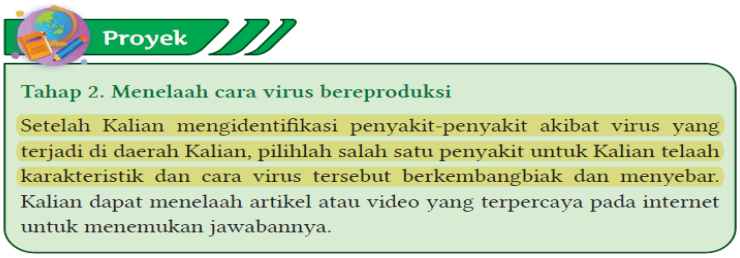
The activity in Figure 4 is included in the attitude aspect. According to Sumarsono & Giyatno (2012), environmental attitude is a tendency that occurs and is formed or learned when responding consistently to environmental conditions in the form of likes and dislikes according to three things: perception and knowledge of environmental problems (cognitive component), emotions or feelings that arise related to the environment (affective component), and the tendency to behave or act for the environment (conative component). The researcher emphasises that the activity of looking for the benefits of viruses for humans, animals, plants, or ecosystems above is included in the environmental attitude described by Sumarsono & Giyatno (2012) because it can "provide feelings in the form of interest in studying the environment (affective component)".

There are two indicators that have not been fulfilled, namely fostering a caring attitude towards the environment and increasing an attitude of responsibility for environmental balance. The researcher suggested integrating the two indicators in the virus material. The integration is very useful to increase the sense of care and responsibility to protect the environment and reduce the possibility of spreading the virus.

Skill aspect

The 4 skill aspect objects are found in chapter 2. The score obtained for the skill aspect in this chapter is 75% with the category "appropriate". Three out of four skill aspect indicators were fulfilled in this chapter. These indicators include stimulating students to investigate environmental issues, stimulating students to analyse the suitability of solution plans for environmental problems, and stimulating students to create solutions to environmental problems.

On page 40, the book contains an indicator of stimulating students to investigate environmental issues. The page asks students to work on a project, namely tracing data on diseases caused by viruses through the way viruses multiply and spread. The data obtained by students can be related to the environment because viruses can spread through dirty environments so that students can find environmental issues as a result of the search.


Proyek

Tahap 2. Menelaah cara virus bereproduksi

Setelah Kalian mengidentifikasi penyakit-penyakit akibat virus yang terjadi di daerah Kalian, pilihlah salah satu penyakit untuk Kalian telaah karakteristik dan cara virus tersebut berkembangbiak dan menyebar. Kalian dapat menelaah artikel atau video yang terpercaya pada internet untuk menemukan jawabannya.

Figure 6. Phase 2 project investigating viral diseases

According to Purnama (2016), many environment-based diseases are caused by viruses, such as ARI, tuberculosis, diarrhoea, polio, measles, and helminthiasis. Public health experts agree that the health of the environment is one of the factors that contribute greatly to the desired health outcomes. The environment can be both a support and a transmission medium that aggravates existing diseases. A dirty environment will help the virus to grow quickly. Through the search, students get many facts related to the environment and can conduct various investigations on environmental issues.

The material on page 50 of the textbook is included in the indicators of other attitudinal aspects, namely stimulating students to create solutions to environmental problems. The sentence on that page indirectly asks students to make solutions to environmental problems. This is because viruses can spread through air and dirty environments so that they are included in environmental problems.

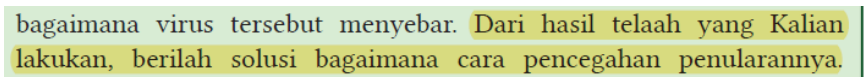

bagaimana virus tersebut menyebar. Dari hasil telaah yang Kalian lakukan, berilah solusi bagaimana cara pencegahan penularannya.

Figure 7. Providing Solutions on How to Prevent Virus Transmission

As one example, the transmission of the Covid-19 virus can occur through close contact with patients, objects or environments contaminated with the virus, airbone particles, and airway droplets. The solution that can be provided is to create a clean and healthy environment. Starting with maintaining personal hygiene, for example washing hands using soap so that the chain of microorganisms that are the source of infection can be interrupted (Khariri, 2020).

The two examples above include aspects of environmental skills. This is in accordance with the opinion of McBride et al. (2013), namely environmental skills that must be fulfilled are identifying and solving environmental problems through the solutions provided. The researcher here emphasises that investigating diseases caused by viruses is included in "identifying environmental problems" while providing solutions to prevent virus transmission is "solving environmental problems", both of which are included in the opinion of McBride et al. (2013) on environmental skills.

There is one indicator of the skill aspect that has not been fulfilled in this chapter. The indicator is stimulating students to analyse the causes of environmental problems. The researcher suggests integrating the indicator of stimulating students to analyse the causes of environmental problems in the virus material in order to improve students' skills to analyse the causes of environmental problems through the spread of viruses.

Action aspect

There are 2 action aspect objects in chapter 2. The score obtained for the action aspect in this chapter is 50% with the category "not appropriate". Two of the four action indicators are fulfilled in this chapter. These indicators are an invitation to behave in an environmentally friendly manner and an invitation to be actively involved in solving environmental problems.

On page 50, the material in the book contains an indicator, namely an invitation to behave in an environmentally friendly manner. The activity on that page asks students to campaign for the project results of solutions to prevent virus transmission. One of the solutions to prevent virus transmission is to behave in an environmentally friendly manner.

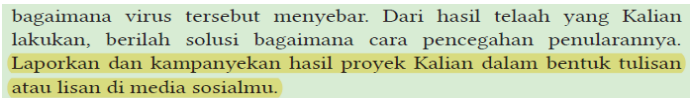

bagaimana virus tersebut menyebar. Dari hasil telaah yang Kalian lakukan, berilah solusi bagaimana cara pencegahan penularannya. Laporkan dan kampanyekan hasil proyek Kalian dalam bentuk tulisan atau lisan di media sosialmu.

Figure 8. Virus transmission prevention campaign activities

Sugiarto & Gabriella (2020) define environmentally friendly behaviour as behaviour that pays special attention to the environment in everyday life, for example by protecting the environment and nurturing life. The task above means that students are invited to campaign for environmentally friendly behaviour as a solution to prevent virus transmission. The activity is also in accordance with the statement of McBride et al. (2013), who said that environmental literacy actions can be in the form of active involvement of all levels in efforts to solve environmental problems. The researcher emphasised that the campaign activities carried out by students caused students to be "actively involved in solving environmental problems" so that they corresponded to the intention of the action component defined by McBride et al. (2013).

There are two of the four indicators of the action aspect that have not been fulfilled. These indicators are the call to action to preserve the environment and the call to manage

waste. The researcher suggested integrating these two indicators in the virus material to increase students' real actions to preserve the environment and manage waste to minimise the spread of the virus.

Environmental Literacy Content in Chapter 7 on Diversity of Living Things, Interactions, and Their Role in Nature

Awareness aspect

There are 5 objects from the awareness aspect in chapter 7. The score obtained for the awareness aspect in this chapter is 100% with the category "appropriate" because all indicators are met. These indicators are awareness of protecting the environment, awareness of environmental problems, and stimulation of commitment to protecting the environment.

On page 175, the book contains an indicator of awareness of protecting the environment. The activity is a reflection activity with a sentence that asks how to behave towards other living things. The answer to the question can make students aware of the importance of protecting the environment for the survival of other living things.

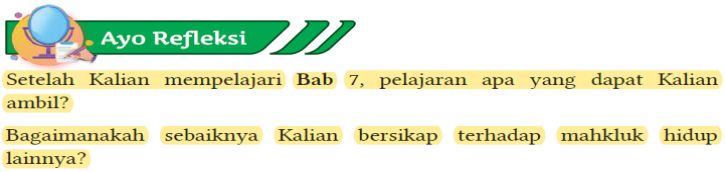


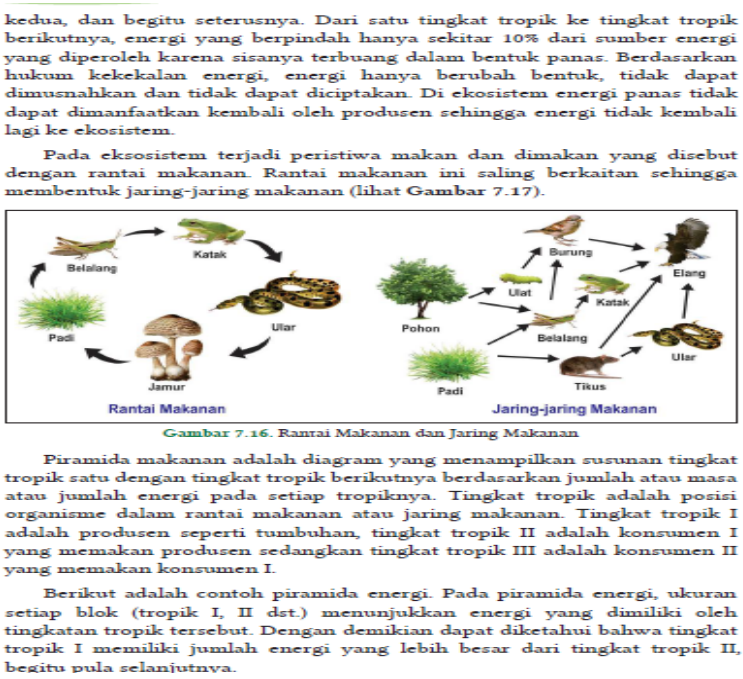
Figure 9. Students' awareness question for reflection

According to Amos in Sugiarto & Gabriella (2020), environmental awareness is the state of a person who has in-depth knowledge related to things that affect his environment seen from the way he behaves and his attitude. A person who has environmental awareness will be seen through the knowledge they have, how to respond and behaviour towards the environment. The researcher emphasises the answer to the question of project activities that will provide "awareness of how to respond and behave" so that the environment is maintained in accordance with the definition of environmental awareness according to Amos in Sugiarto & Gabriella, (2020).

Knowledge aspect

The 13 knowledge aspect objects are found in chapter 7. The score obtained for the awareness aspect in this chapter is 66.67% with the category "appropriate". Four out of six knowledge indicators are fulfilled in this chapter. These indicators include experience or basic understanding of protecting the environment, knowledge related to ecology, appropriate actions to overcome environmental problems, and information on environmental issues.

The most indicators of knowledge aspects found in chapter 7 are knowledge related to ecology. This is because in that chapter there is its own material that discusses living things in ecosystems and is found on page 169 to page 173. In addition, on other pages there is also material related to ecology. According to Chen (2013), environmental knowledge can be defined as the ecological knowledge possessed regarding the environment. The researcher emphasises the aspect of environmental knowledge as "ecological knowledge" in accordance with the definition proposed by Chen (2013). Here is one example of ecological material found on page 171 related to food chains.



kedua, dan begitu seterusnya. Dari satu tingkat tropik ke tingkat tropik berikutnya, energi yang berpindah hanya sekitar 10% dari sumber energi yang diperoleh karena sisanya terbuang dalam bentuk panas. Berdasarkan hukum kekekalan energi, energi hanya berubah bentuk, tidak dapat dimusnahkan dan tidak dapat diciptakan. Di ekosistem energi panas tidak dapat dimanfaatkan kembali oleh produsen sehingga energi tidak kembali lagi ke ekosistem.

Pada eksosistem terjadi peristiwa makan dan dimakan yang disebut dengan rantai makanan. Rantai makanan ini saling berkaitan sehingga membentuk jaring-jaring makanan (lihat Gambar 7.17).

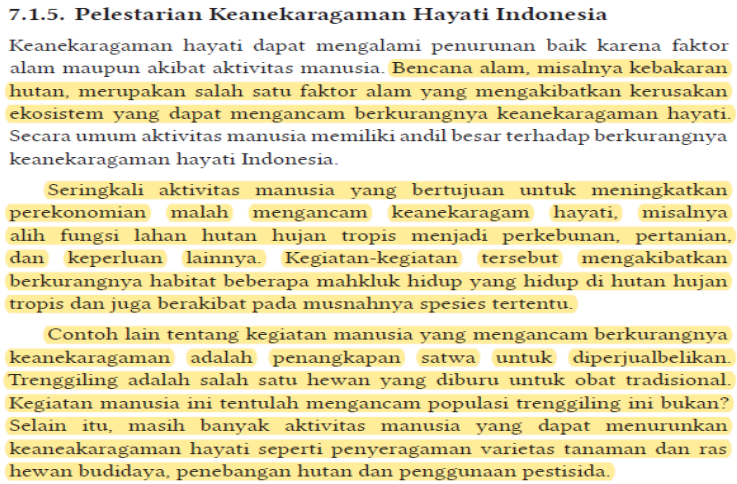
Gambar 7.16. Rantai Makanan dan Jaring Makanan

Piramida makanan adalah diagram yang menampilkan susunan tingkat tropik satu dengan tingkat tropik berikutnya berdasarkan jumlah atau masa atau jumlah energi pada setiap tropiknya. Tingkat tropik adalah posisi organisme dalam rantai makanan atau jaring makanan. Tingkat tropik I adalah produsen seperti tumbuhan, tingkat tropik II adalah konsumen I yang memakan produsen sedangkan tingkat tropik III adalah konsumen II yang memakan konsumen I.

Berikut adalah contoh piramida energi. Pada piramida energi, ukuran setiap blok (tropik I, II dst.) menunjukkan energi yang dimiliki oleh tingkatan tropik tersebut. Dengan demikian dapat diketahui bahwa tingkat tropik I memiliki jumlah energi yang lebih besar dari tingkat tropik II, begitu pula selanjutnya.

Figure 10. Food chains and food webs

The textbook material in chapter 7 page 160 also contains indicators of other aspects of environmental knowledge, namely information related to environmental issues. The material in the book alludes to environmental issues that occur such as forest fires, land conversion, and reduced biodiversity.



7.1.5. Pelestarian Keanekaragaman Hayati Indonesia

Keanekaragaman hayati dapat mengalami penurunan baik karena faktor alam maupun akibat aktivitas manusia. Bencana alam, misalnya kebakaran hutan, merupakan salah satu faktor alam yang mengakibatkan kerusakan ekosistem yang dapat mengancam berkurangnya keanekaragaman hayati. Secara umum aktivitas manusia memiliki andil besar terhadap berkurangnya keanekaragaman hayati Indonesia.

Seringkali aktivitas manusia yang bertujuan untuk meningkatkan perekonomian malah mengancam keanekaragam hayati, misalnya alih fungsi lahan hutan hujan tropis menjadi perkebunan, pertanian, dan keperluan lainnya. Kegiatan-kegiatan tersebut mengakibatkan berkurangnya habitat beberapa mahkluk hidup yang hidup di hutan hujan tropis dan juga berakibat pada musnahnya spesies tertentu.

Contoh lain tentang kegiatan manusia yang mengancam berkurangnya keanekaragaman adalah penangkapan satwa untuk diperjualbelikan. Trenggiling adalah salah satu hewan yang diburu untuk obat tradisional. Kegiatan manusia ini tentulah mengancam populasi trenggiling ini bukan? Selain itu, masih banyak aktivitas manusia yang dapat menurunkan keaneakaragaman hayati seperti penyeragaman varietas tanaman dan ras hewan budidaya, penebangan hutan dan penggunaan pestisida.

Figure 11. Material on environmental issues

The material in the image above describes the many environmental issues that occur. According to Chen (2013), environmental knowledge is also defined as the amount of knowledge possessed regarding environmental issues. Based on Chen's (2013) explanation, researchers emphasize the definition of environmental knowledge which can be "a certain amount of knowledge related to environmental issues".

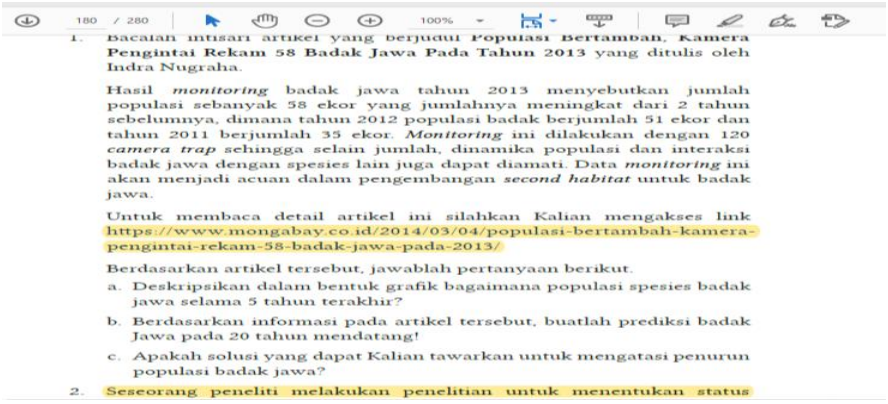
There are two indicators that have not been met in this chapter. These indicators are government policies regarding the environment or environmental problems and information on social cultural systems that protect or damage the environment. Researchers suggest integrating the two indicators in the material on the diversity of living things. This integration is very useful for increasing knowledge regarding government policies and social cultural systems related to living things.

Attitude aspect

The attitude aspect in chapter 7 found 6 objects. The value obtained for the attitude aspect in this chapter is 100% in the "appropriate" category because all indicators are met. These indicators are increasing interest in studying the environment, providing motivation to participate in protecting or protecting the environment, fostering a caring attitude towards the environment, and increasing an attitude of responsibility towards environmental balance.

Indicators of motivation to participate in protecting or protecting the environment can be found on page 162. According to McBride et al. (2013), environmental literacy attitudes consist of a series of values and feelings of concern for the environment and motivation to actively participate in improving and protecting the environment. Researchers emphasize the words "motivation to actively participate" as a definition of environmental literacy attitudes according to McBride et al. (2013). On this page there is a news link which contains information on rhino conservation efforts to save the environment. This news can motivate

students to participate in preserving or protecting the environment through preserving the Javan rhino.


1. Bacalah intisari artikel yang berjudul **Populasi Bertambah, Kamera Pengintai Rekam 58 Badak Jawa Pada Tahun 2013** yang ditulis oleh Indra Nugraha.

Hasil *monitoring* badak jawa tahun 2013 menyebutkan jumlah populasi sebanyak 58 ekor yang jumlahnya meningkat dari 2 tahun sebelumnya, dimana tahun 2012 populasi badak berjumlah 51 ekor dan tahun 2011 berjumlah 35 ekor. *Monitoring* ini dilakukan dengan 120 *camera trap* sehingga selain jumlah, dinamika populasi dan interaksi badak jawa dengan spesies lain juga dapat diamati. Data *monitoring* ini akan menjadi acuan dalam pengembangan *second habitat* untuk badak jawa.

Untuk membaca detail artikel ini silahkan Kalian mengakses link https://www.mongabay.co.id/2014/03/04/populasi-bertambah-kamera-pengintai-rekam-58-badak-jawa-pada-2013/

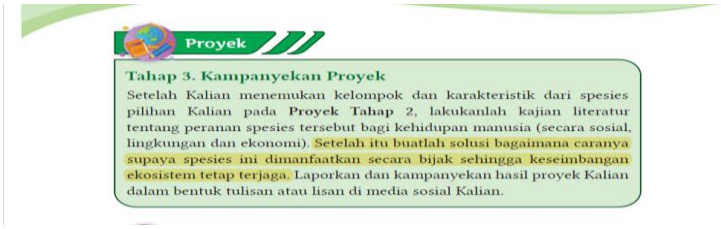
Berdasarkan artikel tersebut, jawablah pertanyaan berikut.

a. Deskripsikan dalam bentuk grafik bagaimana populasi spesies badak jawa selama 5 tahun terakhir?
b. Berdasarkan informasi pada artikel tersebut, buatlah prediksi badak Jawa pada 20 tahun mendatang!
c. Apakah solusi yang dapat Kalian tawarkan untuk mengatasi penurun populasi badak jawa?

2. Seseorang peneliti melakukan penelitian untuk menentukan status

Figure 12. Link to news about the Javan rhinoceros

Page 174 in chapter 7 has another attitudinal aspect component, namely increasing an attitude of responsibility towards environmental balance. On this page, there are activities in the form of project campaigns. Students are asked to come up with solutions for how to use their chosen species wisely to maintain ecosystem balance.


Proyek

Tahap 3. Kampanyekan Proyek

Setelah Kalian menemukan kelompok dan karakteristik dari spesies pilihan Kalian pada **Proyek Tahap 2**, lakukanlah kajian literatur tentang peranan spesies tersebut bagi kehidupan manusia (secara sosial, lingkungan dan ekonomi). Setelah itu buatlah solusi bagaimana caranya supaya spesies ini dimanfaatkan secara bijak sehingga keseimbangan ekosistem tetap terjaga. Laporkan dan kampanyekan hasil proyek Kalian dalam bentuk tulisan atau lisan di media sosial Kalian.

Figure 13. Project campaign activities

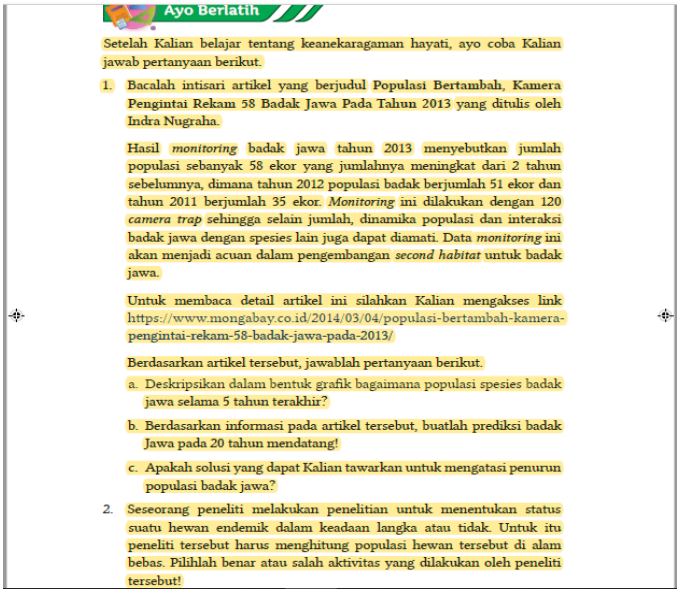
The activities in Figure 12 will indirectly increase students' sense of responsibility for environmental balance. According to Chen (2013), having a positive attitude towards environmental issues can have an impact on ecological responsibility in carrying out pro-environmental behavior. Based on Chen's (2013) explanation, researchers emphasize "ecological responsibility resulting from a positive attitude towards environmental issues" including the aspect of environmental literacy attitudes.

Skill aspect

There are 6 objects from the skill aspect in chapter 7. The value obtained for the attitude aspect in this chapter is 100% in the "appropriate" category because all indicators are met. These indicators are stimulating students to analyze the causes of environmental problems, stimulating students to investigate environmental issues, stimulating students to

analyze the suitability of solution plans for environmental problems, and stimulating students to create solutions to environmental problems.

On page 162 there are indicators that stimulate students to analyze the causes of environmental problems as stated in the let's practice activity where students are given the opportunity to study and analyze articles related to the Javan rhino. From this article, students will describe the essence regarding the Javan rhino population.



Ayo Berlatih

Setelah Kalian belajar tentang keanekaragaman hayati, ayo coba Kalian jawab pertanyaan berikut.

1. Bacalah intisari artikel yang berjudul Populasi Bertambah, Kamera Pengintai Rekam 58 Badak Jawa Pada Tahun 2013 yang ditulis oleh Indra Nugraha.

   Hasil *monitoring* badak jawa tahun 2013 menyebutkan jumlah populasi sebanyak 58 ekor yang jumlahnya meningkat dari 2 tahun sebelumnya, dimana tahun 2012 populasi badak berjumlah 51 ekor dan tahun 2011 berjumlah 35 ekor. *Monitoring* ini dilakukan dengan 120 *camera trap* sehingga selain jumlah, dinamika populasi dan interaksi badak jawa dengan spesies lain juga dapat diamati. Data *monitoring* ini akan menjadi acuan dalam pengembangan *second habitat* untuk badak jawa.

   Untuk membaca detail artikel ini silahkan Kalian mengakses link https://www.mongabay.co.id/2014/03/04/populasi-bertambah-kamera-pengintai-rekam-58-badak-jawa-pada-2013/

   Berdasarkan artikel tersebut, jawablah pertanyaan berikut.

   a. Deskripsikan dalam bentuk grafik bagaimana populasi spesies badak jawa selama 5 tahun terakhir?

   b. Berdasarkan informasi pada artikel tersebut, buatlah prediksi badak Jawa pada 20 tahun mendatang!

   c. Apakah solusi yang dapat Kalian tawarkan untuk mengatasi penurun populasi badak jawa?

2. Seseorang peneliti melakukan penelitian untuk menentukan status suatu hewan endemik dalam keadaan langka atau tidak. Untuk itu peneliti tersebut harus menghitung populasi hewan tersebut di alam bebas. Pilihlah benar atau salah aktivitas yang dilakukan oleh peneliti tersebut!

Figure 14. Let's Practice Activity

The decline in the Javan rhino population is an environmental problem related to the balance of the ecosystem. According to McBride et al. (2013), environmental literacy skills are skills for identifying and solving environmental problems. Based on the explanation from McBride et al. (2013), researchers emphasize that this analysis is part of "identification of environmental problems" which is included in environmental literacy skills.

Action aspect

There are 2 action aspect objects in chapter 7. The value obtained for the action aspect in this chapter is 50% in the "not appropriate" category. A total of two of the four action aspect indicators are met in this chapter. These indicators include an invitation to be actively involved in solving environmental problems and a call to action to preserve the environment.

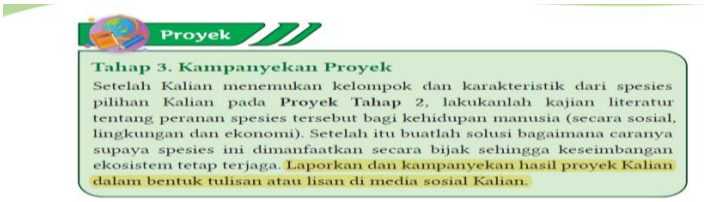


Figure 15. Project Phase 3 of the Environmental Conservation Action Campaign

The image on page 174 above contains indicators of a call to action to preserve the environment. According to McBride et al. (2013), environmental literacy actions can take the form of active involvement at all levels in efforts to resolve environmental problems. Based on the description of McBride et al. (2013), researchers emphasize "active involvement in solving environmental problems" which can be implemented by encouraging environmental conservation. This can be seen from stage 3 project activities where students are asked to campaign for project results related to solutions for wise use of species for ecosystem balance. Campaigns for solutions are included in the indicators of calls for action to preserve the environment.

There are two indicators of the action aspect that have not been fulfilled in this chapter, namely the invitation to behave in an environmentally friendly manner and the invitation to manage waste. Researchers suggest integrating these two indicators into the diversity of living things. The integration of indicators into the material is very useful for supporting students' real actions in maintaining the sustainability of living things through a protected environment.

Environmental Literacy Content in Chapter 8 on Global Warming: Concepts and Solutions

Awareness aspect

Found 7 objects from the aspect of consciousness in chapter 8. The value obtained for the awareness aspect in this chapter is 100% in the "appropriate" category because all indicators are met. These indicators are awareness of protecting the environment, awareness of environmental problems, and stimulation of commitment to protecting the environment.

Pages 201 and 202 in the book contain indicators of incentives to commit to protecting the environment. Questions in the let's reflect activity indirectly help students commit to protecting the environment. This is because this activity can make students reflect and think about the increasingly deteriorating condition of the earth.

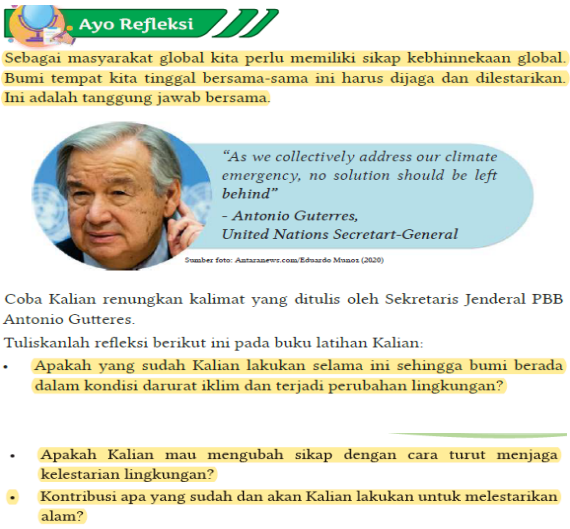


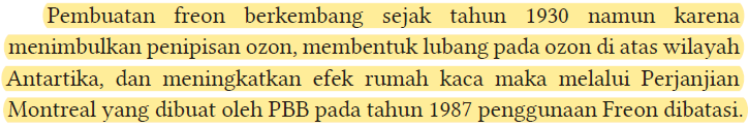
Figure 16. Let's Reflect Activity

According to Amos in Sugiarto & Gabriella (2020) environmental awareness is the state of a person who has in-depth knowledge regarding things that influence their environment, seen from the way they behave and their attitude. Someone who has environmental awareness will be seen through the knowledge they have, their way of responding and their behavior towards the environment. Researchers assess that this awareness will help in committing to protecting the environment which can be seen from "knowledge, ways of behaving and behaving towards the environment" in accordance with the description of environmental awareness according to Amos in Sugiarto & Gabriella (2020).

Knowledge aspect

There are 20 objects from the knowledge aspect found in chapter 8. Value The result obtained for the awareness aspect in this chapter is 100% in the "appropriate" category because all indicators are met. These indicators are experience or basic understanding of protecting the environment, knowledge related to ecology, government policies regarding the environment or environmental problems, appropriate actions to overcome environmental problems, information on environmental issues, and information on social cultural systems that protect or damage the environment.

On page 192 in chapter 8 contains indicators of government policy regarding the environment or environmental problems. This can be seen from the material on the page which touches on making freon. The use of freon has been proven to cause ozone depletion so that through the Montreal Agreement by the UN the use of freon was limited.

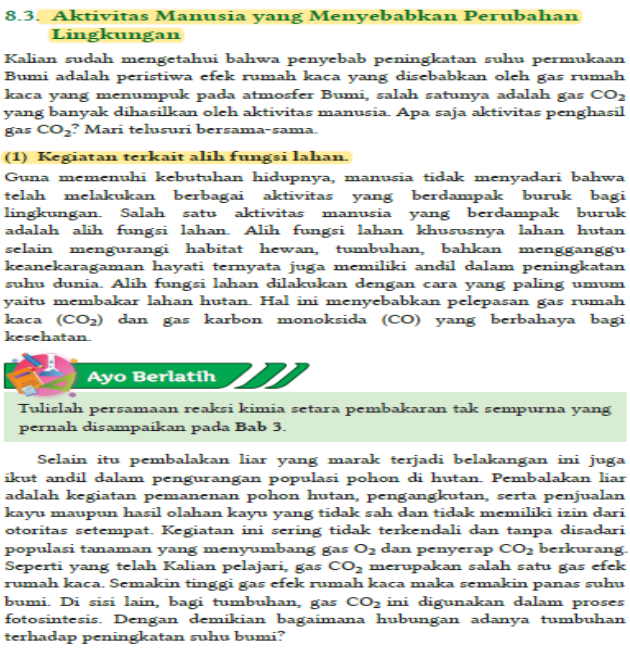


Pembuatan freon berkembang sejak tahun 1930 namun karena menimbulkan penipisan ozon, membentuk lubang pada ozon di atas wilayah Antartika, dan meningkatkan efek rumah kaca maka melalui Perjanjian Montreal yang dibuat oleh PBB pada tahun 1987 penggunaan Freon dibatasi.

Figure 17. Restrictions on the Use of Freon by the United Nations

The example above is part of the environmental knowledge aspect. According to Othman in Dewi & Atika Anggraini (2022), environmental knowledge can be demonstrated by sectoring's ability to understand environmental problems, the causes and consequences of the problems, including the facts and concepts needed in the explanation. Researchers emphasize "sectoring abilities in knowing environmental problems" according to the definition of environmental knowledge according to Othman in Dewi & Atika Anggraini (2022). This sectoring capability was applied by the government to create a policy to reduce the use of freon after realizing the dangers of freon itself.

Indicators of other aspects of knowledge, namely information on social cultural systems that protect or damage the environment, can be found on pages 187, 190, 191, 192, 193. On these pages several activities are described that have become habits for society. However, unfortunately, these habits are destructive habits. environment.



8.3. **Aktivitas Manusia yang Menyebabkan Perubahan Lingkungan**

Kalian sudah mengetahui bahwa penyebab peningkatan suhu permukaan Bumi adalah peristiwa efek rumah kaca yang disebabkan oleh gas rumah kaca yang menumpuk pada atmosfer Bumi, salah satunya adalah gas CO_2 yang banyak dihasilkan oleh aktivitas manusia. Apa saja aktivitas penghasil gas CO_2? Mari telusuri bersama-sama.

(1) Kegiatan terkait alih fungsi lahan.

Guna memenuhi kebutuhan hidupnya, manusia tidak menyadari bahwa telah melakukan berbagai aktivitas yang berdampak buruk bagi lingkungan. Salah satu aktivitas manusia yang berdampak buruk adalah alih fungsi lahan. Alih fungsi lahan khususnya lahan hutan selain mengurangi habitat hewan, tumbuhan, bahkan mengganggu keanekaragaman hayati ternyata juga memiliki andil dalam peningkatan suhu dunia. Alih fungsi lahan dilakukan dengan cara yang paling umum yaitu membakar lahan hutan. Hal ini menyebabkan pelepasan gas rumah kaca (CO_2) dan gas karbon monoksida (CO) yang berbahaya bagi kesehatan.

Ayo Berlatih

Tulislah persamaan reaksi kimia setara pembakaran tak sempurna yang pernah disampaikan pada Bab 3.

Selain itu pembalakan liar yang marak terjadi belakangan ini juga ikut andil dalam pengurangan populasi pohon di hutan. Pembalakan liar adalah kegiatan pemanenan pohon hutan, pengangkutan, serta penjualan kayu maupun hasil olahan kayu yang tidak sah dan tidak memiliki izin dari otoritas setempat. Kegiatan ini sering tidak terkendali dan tanpa disadari populasi tanaman yang menyumbang gas O_2 dan penyerap CO_2 berkurang. Seperti yang telah Kalian pelajari, gas CO_2 merupakan salah satu gas efek rumah kaca. Semakin tinggi gas efek rumah kaca maka semakin panas suhu bumi. Di sisi lain, bagi tumbuhan, gas CO_2 ini digunakan dalam proses fotosintesis. Dengan demikian bagaimana hubungan adanya tumbuhan terhadap peningkatan suhu bumi?

Figure 18. One example of a habit that damages the environment

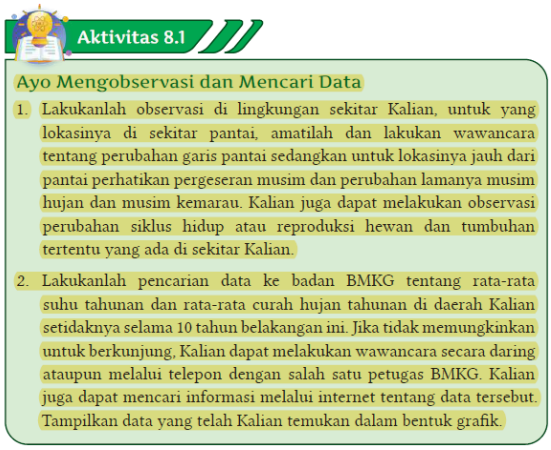
According to Dewi & Atika Anggraini (2022), knowledge regarding entrenched social habits, even though they have a negative impact on the environment, is important.

Perceptions and knowledge related to environmental problems are included in the cognitive component (environmental knowledge). Through this, it is hoped that it can have an impact in the form of a caring attitude towards the environment. Based on the explanation by Dewi & Atika Anggraini (2022), researchers emphasize "entrenched social habits which are one of the cognitive components" or aspects of environmental knowledge.

Attitude aspect

The attitude aspect in chapter 8 found 7 objects. The value obtained for the awareness aspect in this chapter is 100% in the "appropriate" category because all indicators are met. These indicators are increasing interest in studying the environment, providing motivation to participate in protecting or protecting the environment, fostering a caring attitude towards the environment, and increasing an attitude of responsibility towards environmental balance.

Page 185 in chapter 8 contains indicators for fostering an attitude of caring for the environment. Through activity 8.1 there are two activities where students are asked to observe and search for data. After carrying out these activities, it can create an environmentally caring response to the problems that occur.


Aktivitas 8.1

Ayo Mengobservasi dan Mencari Data

1. Lakukanlah observasi di lingkungan sekitar Kalian, untuk yang lokasinya di sekitar pantai, amatilah dan lakukan wawancara tentang perubahan garis pantai sedangkan untuk lokasinya jauh dari pantai perhatikan pergeseran musim dan perubahan lamanya musim hujan dan musim kemarau. Kalian juga dapat melakukan observasi perubahan siklus hidup atau reproduksi hewan dan tumbuhan tertentu yang ada di sekitar Kalian.
2. Lakukanlah pencarian data ke badan BMKG tentang rata-rata suhu tahunan dan rata-rata curah hujan tahunan di daerah Kalian setidaknya selama 10 tahun belakangan ini. Jika tidak memungkinkan untuk berkunjung, Kalian dapat melakukan wawancara secara daring ataupun melalui telepon dengan salah satu petugas BMKG. Kalian juga dapat mencari informasi melalui internet tentang data tersebut. Tampilkan data yang telah Kalian temukan dalam bentuk grafik.

Figure 19. Activities that increase environmental awareness

An environmentally caring attitude is an attitude that has a great influence on environmental preservation. According to Chen (2013), environmental concern is a global attitude that has an indirect effect on behavior. However, it can take the form of emotionality, factual knowledge, and will. Based on the explanation by Chen (2013), the researcher emphasizes the meaning of the attitude of "care for the environment" which is expressed indirectly in the activity in Figure 18.

Skill aspect

There are 12 objects from the skills aspect found in chapter 8. The value obtained for the awareness aspect in this chapter is 100% in the "appropriate" category. because all indicators are met. These indicators include stimulating students to analyze the causes of

environmental problems, stimulating students to investigate environmental issues, stimulating students to analyze the suitability of solution plans for environmental problems, and stimulating students to create solutions to environmental problems.

Page 196 in chapter 8 contains indicators for analyzing the suitability of planned solutions to environmental problems. This can be seen from the question sentence regarding how to reduce motor vehicle gas emissions. The initial solution offered was cycling and students were asked to discuss whether cycling could support reducing exhaust emissions from motorized vehicles.

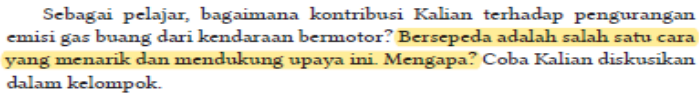

Sebagai pelajar, bagaimana kontribusi Kalian terhadap pengurangan emisi gas buang dari kendaraan bermotor? Bersepeda adalah salah satu cara yang menarik dan mendukung upaya ini. Mengapa? Coba Kalian diskusikan dalam kelompok.

Figure 20. Questions Showing Requests for Student Opinions on Proposed Solutions

Critical thinking skills are found in the sentence in figure 19. According to Subardiyono & Salamah (2015), in critical thinking students are subjects who are active in searching for, identifying, owning and deciding on the most appropriate alternative solutions for the problems they face. In addition, according to McBride et al. (2013), environmental literacy skills are skills for identifying and solving environmental problems. Researchers emphasize the phrase "deciding on alternative solutions and solving environmental problems" included in environmental skills as described by Subardiyono & Salamah (2015) and McBride et al. (2013).

Action aspect

There are 2 action aspect objects in chapter 8. The value obtained for the awareness aspect in this chapter is 100% in the "appropriate" category because all indicators are met. These indicators include calls for environmentally friendly behavior, calls for active involvement in solving environmental problems, calls for action to preserve the environment, and calls for waste management.

Page 186 in chapter 8 can be included as an invitation indicator to be actively involved in solving environmental problems. This can be seen from the sentence in the book which says that studying changes in the Earth's climate can predict global warming in the future. Indirectly, this sentence invites students to prevent or resolve global warming by studying climate change in the past.

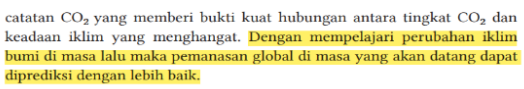
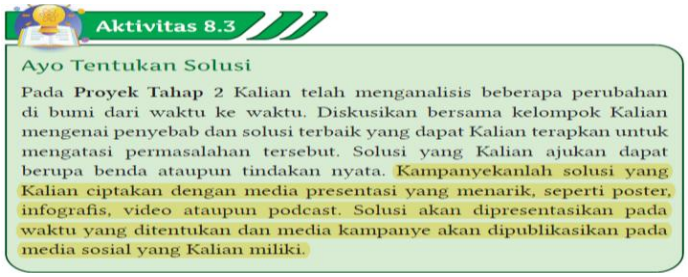

catatan CO_2 yang memberi bukti kuat hubungan antara tingkat CO_2 dan keadaan iklim yang menghangat. Dengan mempelajari perubahan iklim bumi di masa lalu maka pemanasan global di masa yang akan datang dapat diprediksi dengan lebih baik.

Figure 21. Material showing aspects of action

Apart from that, the action aspect can also be seen on page 198 which contains an invitation to manage waste. On this page there is an activity that students must carry out to find a solution to the analysis of changes occurring on earth. In addition, students are asked to publish solutions to their social media. One solution to deal with changes in the earth is to manage waste. So, students will indirectly campaign for environmental preservation through waste recycling or waste management activities.


Aktivitas 8.3

Ayo Tentukan Solusi

Pada **Proyek Tahap** 2 Kalian telah menganalisis beberapa perubahan di bumi dari waktu ke waktu. Diskusikan bersama kelompok Kalian mengenai penyebab dan solusi terbaik yang dapat Kalian terapkan untuk mengatasi permasalahan tersebut. Solusi yang Kalian ajukan dapat berupa benda ataupun tindakan nyata. Kampanyekanlah solusi yang Kalian ciptakan dengan media presentasi yang menarik, seperti poster, infografis, video ataupun podcast. Solusi akan dipresentasikan pada waktu yang ditentukan dan media kampanye akan dipublikasikan pada media sosial yang Kalian miliki.

Figure 22. Let's Determine the Solution Activity

The two examples above are included in environmental literacy actions. Environmental literacy action itself takes the form of active involvement at all levels in efforts to solve environmental problems (McBride et al., 2013). Like the definition of environmental literacy actions described by McBride et al. (2013), researchers emphasize the need for "active involvement at all levels to resolve environmental problems". Solving environmental problems can be solved by learning from changes in the earth's climate to predict future climate or by starting to manage waste to preserve the environment.

CONCLUSION

Based on the results of the study, it can be concluded that the average percentage of depth of planting environmental literacy in biology material is 61.66% for Chapter 2 on Viruses and their Role, 83.33% for Chapter 7 on the Diversity of Living Things, Interactions, and their Role in Nature, and 100% for Chapter 8 on Global Warming: Concepts and Solutions. The three chapters fall into the "appropriate" category to reflect environmental literacy in all aspects, both aspects of awareness, knowledge, attitudes, skills, and aspects of action.

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