



## Analysis of Sustainable Awareness of Junior High School Students on Biotechnology Material

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**Abstract:** SDGs are a UN program that covers many important world issues, including education. Integrating science learning with Education for Sustainable Development (ESD) aims to increase students' understanding of (SDGs) and foster sustainability awareness so that they can be implemented in life. The purpose of this study was to collect preliminary information about the profile of sustainability awareness on SDG 6 and SDG 12 of junior high school students in grade IX related to Biotechnology material. This research used a descriptive qualitative method; the sample consisted of 71 students who were given a closed questionnaire of 20 statements. The sustainability awareness profile studied consists of three categories: behavioral and attitudinal awareness, emotional awareness, and sustainability practice awareness. The results showed that students have a level of sustainability awareness of SDGs with an average score of 2.9 out of 4, so it is included in the high criteria. Other results show that students' sustainability awareness of SDG 6 is higher than SDG 12, with an average ratio of 3.1 and 2.9. Meanwhile, sustainability awareness of the SDGs for female students is relatively higher than for male students, with a percentage ratio of 87.8% and 79.3%. It can be concluded that, in general, students have a high level of sustainability awareness. The results of this preliminary research on the level of sustainability awareness are expected to be a reference for the author in designing and developing ESD-based teaching materials on biotechnology to improve students' understanding of SDGs.

**Keywords:** green governance, local wisdom, TNBTS

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### INTRODUCTION

Population growth and energy needs that continue to increase yearly cause various problems, one of which impacts environmental problems. This condition causes many parties to realize that the earth needs wiser action to manage the environment. This is so the environment can provide sustainable life support for future generations. Sustainable Development Goals (SDGs) are also known as global goals, adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030, all people will enjoy peace and prosperity. The SDGs are a set of goals that countries want to achieve by countries of the world to make human life better and our environment healthier. The SDGs have 17 main goals to achieve together. This means all countries are working together to achieve these goals. Sustainable development is a way of economic growth that utilizes resources to meet human needs by protecting the environment so that humans can meet their needs for the next generation (Njoku et al., 2019). The SDGs also cover more issues, such as environmental protection, climate change, gender equality, and responsible consumption. One of the actions echoed internationally is the United Nations (UN) setting an international development agenda known as the Sustainability Development Goals (SDGs), the Sustainable Development Goal. This agenda aims to benefit humans and the Earth until 2030. Indonesia is tasked with implementing the Sustainable Development Goals (SDGs) program, which consists of 17 goals and 169 measurable achievements. A significant framework for development aimed at promoting progress in a global setting is the Sustainable Development Goals (SDGs) (Akanle, 2022). The Sustainable Development Goals (SDGs), or SDGs, is a global development plan that aims to end poverty, promote prosperity, and protect the planet by achieving seventeen goals by 2030.

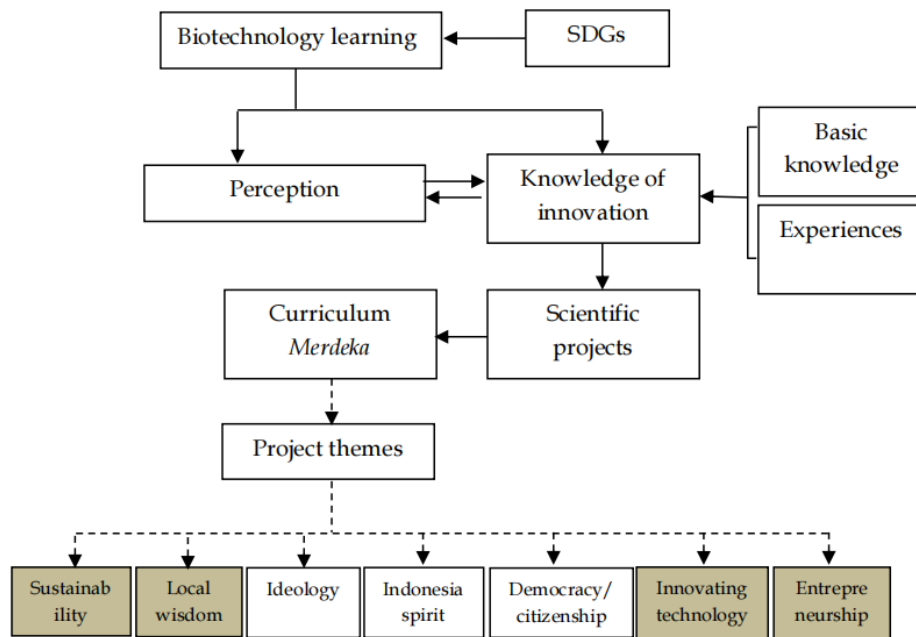
The seventeen goals are as follows: No Poverty; No Hunger; Healthy and Prosperous Lives; Quality Education; Gender Equality; Clean Water and Sanitation; Clean and Affordable Energy; Decent Work and Economic Growth; Industry, Innovation and Infrastructure; Reducing inequalities; Sustainable Cities and Settlements; Responsible Consumption and Production; and Addressing Environmental Change, Marine Ecosystems; Terrestrial Ecosystems; Peace, justice and resilient institutions; Partnerships for the goals. All of the SDGs are grouped into three dimensions of development, namely, the economic development dimension, social development, and environmental development dimensions. These three dimensions are interconnected and closely related (Ogunmakinde et al., 2022; Pauw et al., 2015; Wilujeng et al., 2019). To effectively achieve the SDGs, the agenda provides action guidance for all social actors, from governments to the private sector and

civil society (D'Amato et al., 2019). The principle thing in the implementation of the SDGs program is "No One Left Behind" in the sense that everyone is expected to play a role in the success of achieving the SDGs by 2030. All parties in question include the government and parliament, academics and experts, philanthropy and businesses, organizations, civil society, and the media (Badaru & Adu, 2021). Education for Sustainable Development (ESD), or education for sustainable development, is the fourth goal of the SDGs. Education for Sustainable Development (ESD) is defined as learning to make decisions that look to the long-term future of the economy, environment, and well-being of every society (Oe et al., 2022). According to the United Nations' concept of sustainable development, education plays an important role in supporting the success of a sustainable world. Education can play a significant role in achieving sustainable development goals (SDGs) in the context of sustainable development (Sterling, 2016). The education agenda in the SDGs not only sets targets to ensure that all students enroll and complete school but also to realize quality education for learners so that it can encourage them to think quickly and intuitively when making decisions. This will improve the quality of life, which will affect sustainable development in society (Nazar et al., 2018). ESD should be implemented in formal education to allow students to contribute to real problems facing society (Wals & Kieft, 2010; Hoffmann & Siege, 2018).

In addition, UNESCO (1992) stated that the realm of education is an important part of introducing the SDGs into all aspects of education. This is related to Education and sustainable issues (ESD). To achieve this, one way is to integrate the values of the SDGs into the learning process. One of the indicators in the implementation of the ESD program is sustainability awareness. Sustainability awareness is a sustainable awareness that helps achieve specific goals. Sustainability awareness in the practice of sustainable lifestyles in everyday life can contribute indirectly to the achievement of the 17 SDGs, namely to maintain and appreciate the surrounding environment by considering future impacts in terms of social, economic, and environmental (Al-Naqbi & Alshannag, 2018). The development of sustainable development issues has resulted in various studies on aspects of students' sustainability knowledge, attitudes, and behavior. Environmental education has an effect on students' sustainable development awareness (Munawar et al., 2019), showing a positive influence on sustainable development awareness in students who study environmental education at school. The same thing was also reported: students' sustainable awareness was in the high category, and there were differences between female and male students (Ridwan et al., 2021).

The sustainability issues echoed by the UN in the SDGs program are also closely related to various fields of science, including biotechnology. Environmental issues are prominent in biotechnology because of their significance in improving the quality of human life, which depends on sustainability and emphasizes social and natural aspects. Various research and innovations in the biotechnology field will be beneficial in fulfilling various human needs in the future (Cornelissen et al., 2021). Biotechnology is the application of biological agents to improve the quality of human existence. One of the primary goals for 2020 is to use biotechnology to produce a range of sustainable goods (Alias et al., 2014). Integrating the SDGs components into classroom learning, especially in biotechnology materials, will produce a strong understanding of knowledge, attitudes, and awareness of the problems around our environment (Hogan & O'Flaherty, 2021).

A flowchart that explains the relationship between biotechnology science learning and the application of SDGs in the school environment. The shaded boxes are project themes in the independent curriculum aligned with the SDGs program's development. Many compatibilities in biotechnology materials can be applied when introducing SDGs to students. According to the reasoning given above, learning biotechnology improves students' perceptions and understanding, enabling them to innovate in science and produce scientific projects that promote the School Curriculum (Curriculum Merdeka). Most students believe that biotechnology education is related to food and health concerns, although producing goods or services receives a lower perception score (Purnomo et al., 2023).



**Figure 1.** Linkage of learning biotechnology material with the SDGs program  
Source: Purnomo et al. (2023)

In terms of sustainability, we can find links between biotechnology material and SDGs in the application of everyday life, including SDGs 6 and SDGs 12. SDG-12 (responsible consumption and production) to ensure globally sustainable consumption and production patterns, with a focus on resource efficiency, waste reduction, and promotion of environmentally friendly production practices. The goal is responsible consumption and production by reducing food waste and waste worldwide and reducing per capita food loss by 50% by 2030. Another goal is to reduce waste generated by society towards a state of zero waste through appropriate processing activities (Purwaningrum et al., 2024; Capah et al., 2023). Food loss and food waste, also known as FLW, is a food loss and waste that currently puts food security and the global economy in significant danger (Ishangulyyev et al., 2019). As a result, governments and industries involved in the food supply and production chain and society as a whole, including academia, must make efforts to prevent food loss and waste. Education is the initial foundation for producing agents of change who can guide society to achieve sustainable development goals (Badaru & Adu, 2021). Another sustainable development goal is clean water and proper sanitation, SDG's goal point 6. Universal access to proper sanitation is a basic need and human right. One of the points in the sustainable development goals or SDGs in the environmental sector is to ensure that people achieve universal access to clean water and sanitation. One of the goals in 2030 is to achieve access to adequate and equitable sanitation and hygiene for all people. The success of sustainable development goals in SDGs 6 and 12 cannot be separated from the role of the world of education by introducing and implementing classroom learning. Learning innovations are needed, especially in environmental education (Ichsan et al., 2020). It is also the responsibility of academics to realize the ideals of sustainable development. Utilizing natural resources for a better life without compromising future generations.

This study aims to obtain preliminary information by describing and categorizing the sustainability awareness profile of ninth-grade junior high school students towards SDG 6 and SDG 12. In addition, this study aims to describe gender differences in sustainability awareness profiles based on three categories, namely (1) behavior and attitude awareness, (2) emotional awareness, and (3) practical sustainability awareness (Hasan et al., 2010; Muthia et al., 2021). Practice awareness is a conscious practice that continuously applies the SDGs theory in everyday life. This condition usually occurs when students understand the concept of SDGs well, so it is easy to practice it in life, such as getting used to throwing garbage in its place every day. Behavioral and attitude awareness is an attitude and behavior that is shown as a concern for the environment and the concept of SDGs in everyday life. This category relates to students' perspectives and understanding of the concept of SDGs, such as students' understanding that littering can cause environmental pollution. The emotional awareness category is an overflow of feelings that develop or students' psychological reactions to environmental problems around them. This emotional outburst can be in the form of joy, sadness, disappointment, love, and others. This condition exemplifies students feeling disappointed with air pollution from vehicle fumes (Clarisa et al., 2020; Kurupparachchi et al., 2021).

## METHODS

This research used a descriptive method with a qualitative approach. Descriptive studies look for independent variable values without comparing or relating them to other variables. Meanwhile, according to [Sudjana and Ibrahim \(2004\)](#), descriptive research is defined as research that seeks to describe a symptom, event, or incident that occurs at this time. The qualitative descriptive method is a research step whose output is descriptive data in the form of words from documents or notes that describe the state of the field under study. The descriptive method aims to see a clear picture or description of specific circumstances or symptoms. This research prioritizes the process based on real phenomena and circumstances in the field.

Sustainability Awareness or sustainability awareness observed is related to SDG 6, namely clean water and proper sanitation, and SDG 12, namely responsible consumption and production. Students' sustainability awareness includes three categories: awareness of behavioral attitudes, emotions, and sustainability practices. There are 20 statements to survey students' perceptions of sustainability practices and values in daily life. Most of the statement items were selected from the journals ([Hassan et al., 2010](#); [Al-Naqbi & Alshannag, 2018](#)), and the researcher developed other items based on SDG 6 and SDG 12. The data required was obtained from junior high school students in grade IX in the Bogor Regency area in qualitative form, then quantified in percentage form. The instrument was distributed to 3 classes in different schools, and the sample used was 71 students using a simple random sampling technique. Descriptive statistical analysis was used in this study because the author only wanted to describe the sample data and did not want to make conclusions that applied to the population from which the sample was taken. In this study, the authors wanted to know the profile of sustainability awareness of junior high school students in grade IX related to SDGs 6 and 12 on Biotechnology material. The questionnaire consisted of 20 statements written in positive and negative sentences to see how consistent the respondents are in answering them. The statements given were developed from the journal ([Rini et al., 2022](#)) to determine students' sustainability awareness, which consists of 3 categories: behavioral and attitude awareness, emotional awareness, and sustainability practice awareness.

**Table 1.** Grouping of Statements Based on 17 SDGs Development Goals

Objective Aspect	Item number	
	Positive	Negative
SDG 6 (Clean Water and Proper Sanitation)	2,13,15,16	8,10,17,18,20
SDG 12 (Responsible Consumption and Production)	1,3,5,6,7,9	4,11,12,14,19

The statements were arranged randomly and the grouping of statements given to respondents based on the three categories of Sustainability Awareness is presented in [Table 2](#) below;

**Table 2.** Grouping Statements Based on Sustainability Awareness Categories

Objective Aspect	Item number	
	Positive	Negative
<i>Behavioral and attitude awareness</i>	1,3,7,12,16	8,11
<i>Emotional awareness</i>	4,6,9,10,13	14,19
<i>Sustainability practice awareness</i>	2,5,15	17,18,20

In the next stage, the data was processed using a Likert scale with four rating options for each answer: Score 4 indicates strongly agree, score 3 agree, score 2 disagree, and score 4 strongly disagree. The data obtained were then analyzed using the mean and percentage concerning the sustainable awareness level, as seen in [Table 3](#).

**Table 3.** Level of Sustainability Awareness  
([Rini et al., 2022](#))

Mean	Category
1,00 - 2,00	low awareness
2,01 - 3,00	medium consciousness
3,01- 4,00	high awareness

The data obtained is then displayed in percentage form using the percentage formula which is obtained from the total of the values obtained divided by the maximum value and multiplied by 100. Then, the percentage results of statements from respondents were classified based on criteria adopted by Hasan (2010), as shown in [Table 4](#).

**Table 4.** Categories of Sustainability Awareness (Hassan et al., 2010)

Sustainability Awareness (%)	Description
0,0%-39,9%	Practices that seldom or dislike to be done
4,00%–69,9%	Practices that are done/happened moderate/medium
70,0% - 100	Practices/feelings that are most likely one/happened

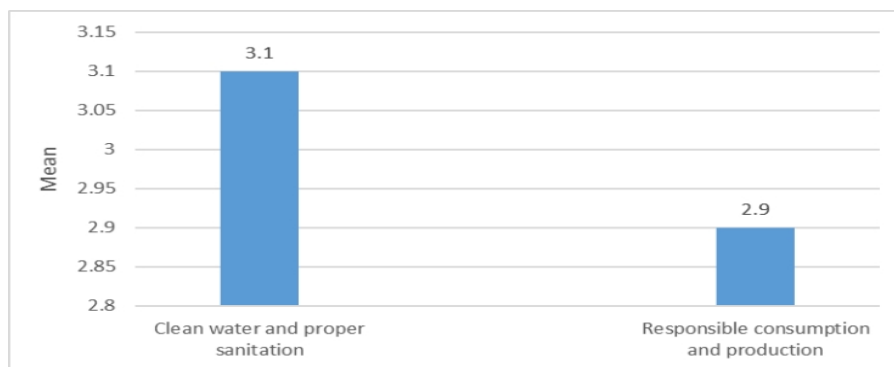
## RESULT AND DISCUSSION

Building a society with consistent environmental awareness and impact is one of the most efficient approaches to building an eco-friendly society. Schools, especially students, aim to build a sustainability awareness culture (Firmanshah et al., 2023). Environmental problems related to the Sustainable Development Goals (SDG 6) on clean water and proper sanitation and SDG 12 on responsible consumption and production are common in the school environment. The data analysis of respondents in Table 5 shows that students in their daily lives have high sustainability awareness on SDG 6 (average 3.1) and moderate sustainability awareness on SDG 12 (average 2.9). This condition means that all students can carry out the behavior listed in the questionnaire. The same results were also found by Arshad (2020), who stated that a very high level of environmental awareness and environmental behavior was identified among students in Pakistan.

**Table 5.** Sustainability awareness score based on sustainable development goals (SDGs)

Category	Score		Note
	Average (mean)	Percentage	
SDG - 6	3.1	74	Clean water and proper sanitation
SDG - 12	2.9	72	Responsible consumption and production

In the category of SDGs, goal point 6 (mean 3.1) is categorized as having high awareness. Students understand the importance of saving water and prefer using organic detergents to preserve the environment and tumblers (drinking water bottles) when doing activities outside the home to reduce waste. Concern for the availability of clean water and proper sanitation for the surrounding environment is also high, such as not throwing garbage into the river and keeping the bathroom clean. However, this concern needs to be demonstrated more by a genuine attitude to utilizing household liquid waste (reuse) to reduce pollution; this can be seen with the lowest percentage of 53% in SDG 6. This high sustainability awareness can be influenced by several circumstances, such as knowledge about the environment obtained in Environmental Education (EE) learning during schooling at the previous level. Strengthening environmental knowledge can also be obtained in science learning at school from media coverage and the influence of positive habituation in the family environment, so this sustainability awareness needs to be strengthened again with a structured and sustainable understanding of the SDGs concept both from the school environment and the family environment at home. The SDGs concept needs to be applied to various institutions' knowledge, attitudes, and skills so that people become accustomed to implementing the SDGs in their daily lives. Hasan (2010) also presented similar research results. Hasan found that students have a high attitude of awareness of sustainable development. However, they need to clearly understand the relationship between sustainable development issues and the interaction between its components. So, there is still a very weak relationship between students' understanding of sustainable development concepts and sustainability practices in everyday life. Hassan et al. (2010) suggest that scientific values and noble attitudes are goals in science learning provided at school. In this case, science learning integrated with SDG values is a noble attitude in understanding students' concern for the environment, such as the condition of clean water and proper sanitation they find in the environment, analyzing problems and finding solutions using scientific steps.



**Figure 2.** Average student sustainability awareness of SDG 6 and SDG 12

In the SDG 12 category on responsible consumption and production, the analysis results show the level of sustainability awareness in the high category (mean 2.9), which means that most students have been able to do it. The highest average, with a percentage of 86%, in the statement, "I understand that ginger, lemongrass, turmeric plants can be made into processed drinks for body health," which means that students already understand good consumption and production for health, such as consuming or producing ginger, lemongrass, turmeric plants can be made into processed drinks for body health. Students are also aware of sustainability practices, among others, utilizing kitchen waste such as fruits and vegetables to be composted with a percentage of 80%, namely in the statement, "I understand that kitchen waste such as fruits and vegetables can be used as compost." This follows one of the success indicators of SDG 12: by 2030, it will substantially reduce waste production through prevention, reduction, recycling, and reuse. Hammami et al. (2018) conclude that, in general, students understand or have knowledge about the dangers of plastic waste for the environment, but their average score on environmental knowledge is low. The solution that can be done is for the government to provide support for the implementation of environmental education in schools.

The lowest percentage in SDG 12 is in the statement "I understand pickled fruits or vegetables cannot make food last longer," with a percentage of 56% and "I believe making fertilizer from fruit waste is not practical because we can buy it at the store" with an average of 66%. This shows that students moderately understand applying the 3Rs (reduce, reuse, and recycle) for responsible consumption and production to reduce waste. It can be concluded that students need to understand the technology of utilizing organisms to produce a new product (biotechnology). Purnomo et al. (2023), in his research, finds that learning biotechnology materials can improve understanding of the sustainability of human life. Students better understand sustainability issues by doing it in project-based learning and producing several scientific projects such as food nutrition, pest control, and water quality control. Students are generally accustomed to practicing sustainable living in their daily lives. This can be due to good habituation instilled in families or schools since childhood. However, students' knowledge needs to improve, such as food processing using conventional biotechnology foods such as tempeh, yogurt, and nata de coco, which is part of SDG 12. Likewise with SDG 6, throwing garbage in its place, turning off the water tap, and saving water use are good habits in the family. However, students do not understand the application of biotechnology in supporting the goal of SDG 6, for example, the utilization of lerak (*Sapindus rarak* DC) plants for organic detergents that are environmentally friendly because they can reduce water pollution. The results are divided into three domains: behavior and attitude awareness, emotional awareness, and sustainability practice awareness. Values showing the average score and total percentage (agree and disagree) of student responses for each statement based on the three categories can be observed in Table 6.

**Table 6.** Sustainability awareness scores Sustainability awareness scores are based on behavioral and attitude awareness, emotional awareness, and sustainability practice awareness.

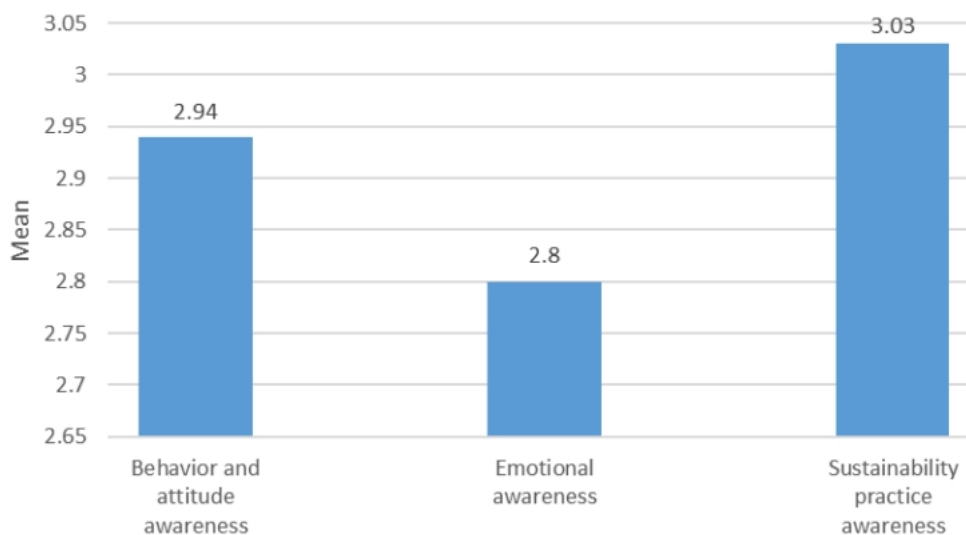
Item	Statement	Mean	%	Note
<i>Behavior And Attitude Awareness</i>				
1	I understand that ginger, lemongrass, and turmeric can be made into processed drinks for health.	3.5	86	Agree
3	I read about environmental issues in mass media or social media.	3.1	77	Agree
7	I understand kitchen waste, such as fruits and vegetables, can be used as compost.	3.2	80	Agree
8	I do not feel the need to conserve clean water because I believe that water sources will always be available.	3.0	76	Disagree
1	I believe that making fertilizer from fruit waste is not practical because we can buy it at stores.	2.7	66	Disagree
12	I understand pickled fruits and vegetables cannot make food last longer.	2.2	56	Disagree
16	I understand that using organic detergent from plant materials can reduce water pollution.	2.9	74	Agree
<i>Emotional Awareness</i>				
4	I believe that mukbang (consuming large amounts of food) content is beneficial because it can entertain viewers and earn income.	2.7	67	Agree
6	I enjoy making healthy drink creations such as kunyit asem and beras kencur instead of buying instant drinks.	3.0	75	Agree
9	I feel concerned about the environment by recycling waste into useful items.	2.7	69	Agree
10	I do not care if my neighbors litter the river because it is none of my business.	3.1	79	Disagree
13	I believe buying refillable packaging products (refill) is an example of caring	2.8	70	Agree

	for the environment.			
14	I do not care about health reasons, and I still buy junk food because it is delicious.	2.7	64	Disagree
19	I do not care when my friends leave food on their plates because it is none of my business.	2.6	64	Disagree
<i>Sustainability Practice Awareness</i>				
2	I carry a tumbler with me when I go out.	2.9	73	Agree
5	I carry a tote bag when shopping at the supermarket instead of using plastic bags.	3.5	86	Agree
15	I understand I can reuse the water left over from washing rice to make it into plant fertilizer.	2.6	53	Agree
17	I do not usually clean the bathroom at home because I feel disgusted.	3.2	79	Disagree
18	I do not participate in community service to clean the sewers and prefer to pay someone else to do it.	3.2	80	Disagree
20	The school water tap was broken, and the water overflowed; I did not fix it because it was not my obligation.	2.9	73	Disagree
The overall mean of the Sustainability Awareness category		2.9	71	

Table 6 above shows that the value of students' sustainable awareness is generally classified as high (mean 2.9 and percentage 71%). These results are similar to [Ridwan et al. \(2021\)](#) and [Rini \(2022\)](#). [Ridwan et al. \(2021\)](#) find that students' sustainability awareness, with an average score of 0.77, is at high criteria. Meanwhile, [Rini et al. \(2022\)](#) reports that students' sustainability awareness, with a mean score of 3.33 out of 4, is included in the high criteria. This result shows that respondents understand and believe that sustainability awareness is needed in a balanced manner regarding social, economic, and environmental aspects. The highest level of sustainability awareness was found in the practice of carrying tote bags when shopping at the supermarket instead of using plastic bags. In addition, students also understand that ginger, lemongrass, and turmeric plants can be made into processed drinks for health as a form of implementation of responsible consumption and production. Both items have the same percentage of 86%, which means they are often and always done. [Bozoglu et al. \(2016\)](#) also shows a high level of environmental sustainability awareness among students. Important factors that influence environmental awareness are environmental education and information factors.

Meanwhile, the student response with the lowest percentage is "I prefer to reuse the remaining rice washing to water the plants," with an average percentage of 53%. This states that students still lack understanding and knowledge about using biotechnology concepts in everyday life to support sustainability awareness, especially SDG 6. In accordance with the definition of biotechnology, Biotechnology is a technology that utilizes biological systems, living organisms, or parts thereof to develop or create different products ([Glick & Pasternak, 2022](#); [Campbell et al., 2017](#)). One of the efforts to reduce liquid waste is using biotechnology using household waste as fertilizer, so students' sustainability awareness on this issue is still not optimal. In the categories of behavior and attitude, emotional attitude, and sustainability practice awareness, the analysis of each category can be seen in [Figure 2](#).

[Pribadi \(2017\)](#) looks at the implementation of SDGs to improve the quality of education in Papua through improving the quality of students and teachers. All parties must be committed to implementing the Sustainable Development Goals (SDGs) in order to improve the quality of education in the future. Relevant parties include families, schools, and the government in determining SDG implementation policies. Another point is the importance of instilling environmental education from an early age to support the successful implementation of the SDGs in the community ([Lestari et al., 2024](#)). Another important factor in increasing students' sustainability awareness of environmental issues is quality education, such as lesson planning that contains methods, media, and learning models that align with the SDGs ([Hidayah & Nugraheni, 2024](#)).



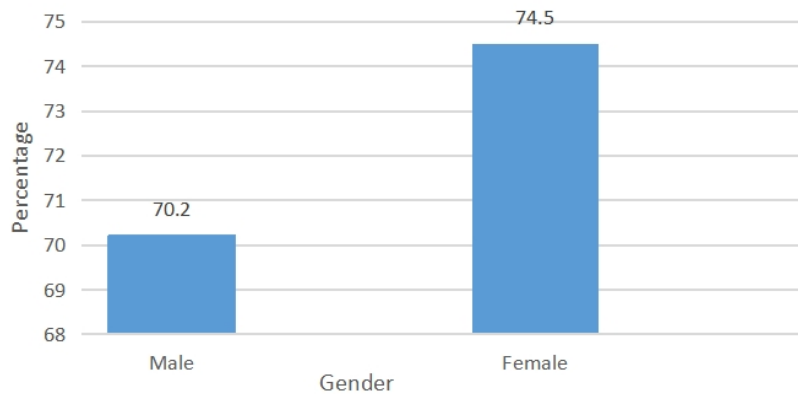
**Figure 3.** Sustainability Awareness based on the categories of attitudes, emotions, and sustainable living practices

Figure 3 shows that the average level of behavior and attitude awareness of sustainability is 2.94, which means that it has a high level of sustainability awareness. Respondents understand awareness and concern about responsible consumption and production in everyday life, such as efficient use of natural resources and sustainable consumption and production patterns (SDG 12). One example is that students understand the utilization of natural resources of herbal plants such as ginger, lemongrass, and turmeric to be made into body health drinks (jamu). Students understand that kitchen waste, such as fruit or vegetables, can be used as compost to minimize the amount of waste produced daily (zero waste). Marchal et al. (2022) reported that environmental education started early in France. Even with early education, children can develop a basic understanding of the decomposition of organic waste in the composting process.

In addition to sustainability awareness on SDG 12, students are highly aware of SDG 6, such as caring about saving clean water, understanding that using organic detergents from plant materials can reduce water pollution, and reading about environmental issues in mass/social media. So, this category shows that students have high attitudes and behaviors towards sustainable development challenges. Kuruppuarachchi et al. (2021), in his research, found that a person's attitude will help him have behavioral awareness of the environment in the long run. The second category, namely emotional awareness of the environment (emotional awareness), shows the lowest results compared to other categories; in this category, the average on all statement items is 2.8. Thus, emotionally, students have a relatively high concern for their environment, but not on all statement items. Students have emotional concern for the environment in the attitude of disagreeing with neighbors who litter the river (SDG 6). However, students still have low concerns such as "I do not care about health reasons and still buy junk food because it is delicious" and "I do not care when friends leave their food on the plate because it is not my business." These statements indicate low emotional awareness of SDG 12 goal of responsible consumption and production with consumptive lifestyles (excessive consumption of products). This average result contradicts previous research by Rini et al. (2022), which states that emotional awareness is the category that has the highest percentage among other aspects.

The third category of sustainability practice awareness, with a mean value of 3.03, is the highest among other categories. This situation shows that students have a high awareness of practices or actions to preserve the environment, such as the statement, "I bring a tumbler (drinking container) when doing activities outside the home," then the statement, "Students are used to bringing tote bags when shopping at supermarkets instead of using plastic bags." These actions are a form of students' sustainable awareness in reducing waste that pollutes the environment (SDG 12). In addition, other forms of awareness in sustainable practices that are often also shown by the habit of cleaning the bathroom, community service to clean the gutters of the house, and spontaneous actions in repairing damaged school water taps show sustainable awareness in the SDG 6 goal of clean water and proper sanitation. However, these results contradict previous research by Ridwan et al. (2021), which find that knowledge of sustainability practices was the lowest in the category compared to other components. This may occur due to different research locations and samples.





**Figure 4.** Average percentage of Sustainability Awareness by gender

The figure above shows that male students have an awareness level of 70.2%, while female students have an awareness level of 74.5%. These results indicate that female students are more aware of behavioral attitudes, emotions, and sustainable living practices than male students. Several studies also reported similar results (Rini et al., 2022; Al-Naqbi & Alshannag, 2018; Dlamini, 2021). Rini found that female students' sustainability awareness was relatively higher than male students with a percentage ratio of 87.8% and 79.3%. Similarly, Al-Naqbi & Alshannag, 2018 (2018) reports that female students have higher ESD knowledge than male students, and Dlamini (2021) stated that gender factors affect environmental awareness behavior. However, this result differs from previous findings (Levine & Strube, 2012), which report that female students have lower ESD levels than male students. So, it can be concluded, in general, that there are differences in sustainability awareness based on gender factors.

In conclusion, respondents have a high level of sustainability awareness in all categories of sustainability awareness. Students mostly agreed with the statement, "I understand that ginger, lemongrass, and turmeric plants can be made into processed drinks for body health." with a percentage of 86%. The statement "I understand that I can reuse the remaining rice washing into fertilizer for watering plants" is the lowest percentage of 53%, so it can be concluded that students have limited knowledge of the use of biotechnology in everyday life. So that the results of this study can be developed to prepare science learning tools on biotechnology material integrated with ESD. These results align with Anggraini and Karyanto (2018), who state that students have low knowledge and attitudes about the environment, which the lack of increased competence in the school curriculum may cause.

Findings reveal that biotechnology is very relevant to the issue of sustainable living in the SDGs program (Purnomo et al., 2023). Teachers can design contextual learning about daily environmental problems in the school environment because contextual learning can improve students' problem-solving skills. This is an example of handling school waste related to SDG 6 regarding clean water and proper sanitation. For this reason, teachers can innovate by designing the right learning model and teaching materials (Eliyawati et al., 2022), revealing the importance of the carrying capacity of teaching materials in the successful implementation of ESD in schools. Teaching materials with ESD content do not start from elementary school (SD) but are mostly developed at the secondary school level. Another conclusion is that the developed teaching books are more knowledge-oriented and minimal-oriented to real action (sustainability practices). Another finding in this study is the need for more knowledge of students and teachers regarding sustainable development goals (SDGs). Most participants did not have sufficient knowledge about the SDGs and their interrelationships, or they did not know about the SDGs and their urgency in life. Similar findings were also revealed by Seva-Larrosa et al. (2023) about the low environmental awareness among university students in Spain. To foster sustainability awareness, the main thing needed is knowledge and understanding of the meaning of sustainability, as described in the SDGs. Organizing sustainable education will lead students to sustainable attitudes and behaviors. As well as implementing it (practicing sustainability) in everyday life. This study shows the results of students' sustainability awareness at a moderate to high level in three categories: sustainability attitudes and behaviors, emotional awareness, and sustainability awareness practices. Ekamilasari & Pursitasari (2021) shows a percentage of 37.95%, 70.63%, and 86.92% of the level of sustainability, behavior, and attitudes of students, respectively, at a moderate level. Therefore, efforts need to be made to improve students' sustainability awareness practices. The results of this study are expected to be used as a further reference for the author in designing and developing quality ESD-based science teaching materials on biotechnology material. Because quality teaching materials in SDGs can help accelerate the achievement of SDGs.

## CONCLUSION

Based on the research that has been conducted, the level of sustainability awareness of junior high school students related to SDG 6 and SDG 12 is generally high. This result shows that students have a fairly high awareness and concern for sustainable development. However, students also have low knowledge and awareness of certain sustainability challenges, such as waste and waste management through 3R activities (reuse, reduce, and recycle). Sustainability awareness in the sustainability practice awareness category shows the highest results compared to behavior and emotional awareness. Concerning sustainability awareness based on gender, both female and male students have positive sustainability awareness. However, the level of sustainability awareness of female students is better than that of male students. This study has limitations because the conclusions drawn are based on respondents in 3 schools only, so the findings are not necessarily the same for all junior high school students. This research can only reflect the sustainable awareness of junior high school students.

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## REFERENCES

- Akanle, O., Kayode, D., & Abolade, I. (2022). Sustainable development goals (SDGs) and remittances in Africa. *Cogent Social Sciences*, 8(1).
- Al-Naqbi, A. K., & Alshannag, Q. (2018). The status of education for sustainable development and sustainability knowledge, attitudes, and behaviors of UAE University students. *International Journal of Sustainability in Higher Education*, 19(3), 566–588.
- Alias, N., DeWitt, D., & Siraj, S. (2014). An evaluation of gas law webquest based on active learning style in a secondary school in Malaysia. *Eurasia Journal of Mathematics, Science and Technology Education*, 10(3), 175–184.
- Anggraini, W., & Karyanto, P. (2018, September). The environmental knowledge and attitude of middle-school students in five prominent green schools in Indonesia. In *International Conference on Teacher Training and Education 2018 (ICTTE 2018)* (pp. 18-22). Atlantis Press.
- Badaru, K. A., & Adu, E. (2021). Education and Community Development: Catalysts for Attaining Post-2015 Sustainable Development Agenda in Developing Countries. *Journal of Sociology and Social Anthropology*, 12(October), 74–91.
- Bozoglu, M., Bilgic, A., Topuz, B. K., & Ardali, Y. (2016). Factors affecting the students' environmental awareness, attitudes and behaviors in Ondokuz Mayıs University, Turkey. *Fresenius Environmental Bulletin*, 25(4), 1243-1257.
- Campbell, B. M., Beare, D. J., Bennett, E. M., Hall-Spencer, J. M., Ingram, J. S., Jaramillo, F., ... & Shindell, D. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and society*, 22(4).
- Capah, B. M., Rachim, H. A., & Raharjo, S. T. (2023). Implementasi SDGs-12 melalui Pengembangan Komunitas. *Social Work Journal*, 13(1), 150–161.
- Clarisa, G., Danawan, A., Muslim, M., & Wijaya, A. F. C. (2020). Penerapan Flipped Classroom dalam Konteks ESD untuk Meningkatkan Kemampuan Kognitif dan Membangun Sustainability Awareness Siswa. *Journal of Natural Science and Integration*, 3(1), 13.
- Cornelissen, M., Małyska, A., Nanda, A. K., Lankhorst, R. K., Parry, M. A. J., Saltenis, V. R., Pribil, M., Nacry, P., Inzé, D., & Baekelandt, A. (2021). Biotechnology for Tomorrow's World: Scenarios to Guide Directions for Future Innovation. *Trends in Biotechnology*, 39(5), 438–444.
- Dlamini, N. J. (2021). Gender-based violence, twin pandemic to COVID-19. *Critical Sociology*, 47(4-5), 583-590.

- D'Amato, D., Korhonen, J., & Toppinen, A. (2019). Circular, Green, and Bio-Economy: How Do Companies in Land-Use Intensive Sectors Align with Sustainability Concepts? *Ecological Economics*, 158(April 2018), 116–133.
- Ekamilasari, E., & Pursitasari, I. D. (2021). Students' critical thinking skills and sustainability awareness in science learning for implementation education for sustainable development. *Indonesian Journal of Multidisciplinary Research*, 1(1), 121-124.
- Eliyawati, E., Widodo, A., Kaniawati, I., & Fujii, H. (2023). Effectiveness of Teacher Training on Environmental Education: Challenges and Strategy for Future Training Program. *Jurnal Penelitian Pendidikan IPA*, 9(8), 6056-6066.
- Firmanshah, M. I., Abdullah, N., & Fariduddin, M. N. (2023). The Relationship of School Students' Environmental Knowledge, Attitude, Behavior, and Awareness toward the Environment: A Systematic Review. *International Journal of Academic Research in Progressive Education and Development*, 12(1), 432–449.
- Glick, B. R., & Patten, C. L. (2022). *Molecular biotechnology: principles and applications of recombinant DNA*. John Wiley & Sons.
- Hammami, M., Negra, Y., Billaut, F., Hermassi, S., Shephard, R. J., & Chelly, M. S. (2018). Effects of Lower-Limb Strength Training on Agility, Repeated Sprinting With Changes of Direction, Leg Peak Power, and Neuromuscular Adaptations of Soccer Players. *Journal of strength and conditioning research*, 32(1), 37–47.
- Hassan, A., Noordin, T. A., & Sulaiman, S. (2010). The status of the level of environmental awareness in the concept of sustainable development amongst secondary school students. *Procedia - Social and Behavioral Sciences*, 2(2), 1276–1280.
- Hidayah, B. N., & Nugraheni, N. (2024). Peran Pembelajaran Abad 21 dalam Mewujudkan Sustainable Development Goals (SDGs). *Jurnal Citra Pendidikan*, 4(2), 1666–1677.
- Hoffmann, T., & Siege, H. (2018). What is Education for Sustainable Development (ESD)? *Human Development*, 1(8), 1–6.
- Hogan, D., & O'Flaherty, J. (2021). Addressing education for sustainable development in the teaching of science: the case of a biological sciences teacher education program. *Sustainability (Switzerland)*, 13(21).
- Ichsan, I. Z., Sigit, D. V., Miarsyah, M., Ali, A., Suwandi, T., & Titin. (2020). Implementation supplementary book of green consumerism: Improving students' HOTS in environmental learning. *European Journal of Educational Research*, 9(1), 227–237.
- Ishangulyyev, R., Kim, S., & Lee, S. H. (2019). Understanding food loss and waste-why are we losing and wasting food? *Foods*, 8(8).
- Kurupparachchi, J., Sayakkarage, V., & Madurapperuma, B. (2021). Environmental literacy level comparison of undergraduates in the conventional and ODLs universities in Sri Lanka. *Sustainability (Switzerland)*, 13(3), 1–16.
- Lestari, B. B., Nugraheni, N., Husain, F., Semarang, U. N., Tinggi, S., & Pati, T. (2024). Penerapan Edukasi SDGs di Lingkungan Sekolah Guna Mendukung Terwujudnya Kesejahteraan Pendidikan. *Jurnal Penelitian Ilmu-Ilmu Sosial*, 1(10), 67–72.
- Levine, D. S., & Strube, M. J. (2012). Environmental attitudes, knowledge, intentions and behaviors among college students. *The Journal of social psychology*, 152(3), 308-326.
- Marchal, C., Singh, N., Batz, Z., Advani, J., Jaeger, C., Corso-Díaz, X., & Swaroop, A. (2022). High-resolution genome topology of human retina uncovers super enhancer-promoter interactions at tissue-specific and multifactorial disease loci. *Nature communications*, 13(1), 5827.
- Munawar, S., Heryanti, E., & Miarsyah, M. (2019). Hubungan Pengetahuan Lingkungan Hidup dengan Kesadaran Lingkungan pada Siswa Sekolah Adiwiyata. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, 9(1), 22–29.
- Muthia, A. E., Nugraha, M. G., & Chandra, A. F. (2021). Pengembangan Instrumen Sustainability Awareness dalam Materi Getaran Harmonik Sederhana untuk Siswa SMA. *WaPFI (Wahana Pendidikan Fisika)*, 6(2), 204–210.

- Nazar, R., Chaudhry, I. S., Ali, S., & Faheem, M. (2018). Role of Quality Education for Sustainable Development Goals (SDGs). *PEOPLE: International Journal of Social Sciences*, 4(2), 486–501.
- Njoku, E., Ruël, H., Rowlands, H., Evans, L., & Murdoch, M. (2019). An Analysis of the Contribution of e-HRM to Sustaining Business Performance. *Advanced Series in Management*, 23(May), 21–39.
- Oe, H., Yamaoka, Y., & Duda, K. (2022). How to Sustain Businesses in the Post-COVID-19 Era: A Focus on Innovation, Sustainability and Leadership. *Business Ethics and Leadership*, 6(4), 1–9.
- Ogunmakinde, O. E., Egbelakin, T., & Sher, W. (2022). Contributions of the circular economy to the UN sustainable development goals through sustainable construction. *Resources, Conservation and Recycling*, 178, 106023.
- Pauw, J. B. de, Gericke, N., Olsson, D., & Berglund, T. (2015). The effectiveness of education for sustainable development. *Sustainability (Switzerland)*, 7(11), 15693–15717.
- Pribadi, B. A. (2017). *Media & teknologi dalam pembelajaran*. Prenada Media.
- Purnomo, A. R., Yulianto, B., Mahdiannur, M. A., & Subekti, H. (2023). Embedding Sustainable Development Goals to Support Curriculum Merdeka Using Projects in Biotechnology. *International Journal of Learning, Teaching and Educational Research*, 22(1), 406–433.
- Purwaningrum, P., Yanidar, R., & Yulinawati, H. (2024). Budi Daya Maggot Sebagai Upaya Pemrosesan Food Loss dan Food Waste (FLW). 5(3), 5173–5177.
- Ridwan, I. M., Kaniawati, I., Suhandi, A., Samsudin, A., & Rizal, R. (2021). Level of sustainability awareness: Where are the students' positions? *Journal of Physics: Conference Series*, 1806(1).
- Rini, N. W., & Nuroso, H. (2022). Profil Sustainability Awareness Siswa SMA/SMK pada Materi Suhu dan Energi. *Environment*, 51(2), 68–76.
- Seva-Larrosa, P., Marco-Lajara, B., Úbeda-García, M., Zaragoza-Sáez, P., Rienda-García, L., García-Lillo, F., ... & Martínez-Falcó, J. (2023). Students' perception of sustainable development goals (SDGs) and the benefits for companies derived from their implementation. *Economic research-Ekonomska istraživanja*, 36(1).
- Sterling, S. (2016). A Commentary on Education and Sustainable Development Goals. *Journal of Education for Sustainable Development*, 10(2), 208–213.
- Sudjana, N. & Ibrahim. (2004). *Dasar-dasar Proses Belajar Mengajar*. Sinar Baru Algensido Offset.
- Wals, A. E. J., & Kieft, G. (2010) *Education for Sustainable Development, Research Overview*. Sida Review.
- Wilujeng, I., Dwandaru, W. S. B., & Rauf, R. A. B. A. (2019). The effectiveness of education for environmental sustainable development to enhance environmental literacy in science education: A case study of hydropower. *Jurnal Pendidikan IPA Indonesia*, 8(4), 521–528.