

Biological literacy skills of senior high school student using local potential-based biodiversity question sets

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Abstract: One of the efforts to improve the quality of education in Indonesia is through learning by integrating environmental culture. Environmental culture can be packaged in more meaningful learning through biological literacy. This study aims to assess the biological literacy skills of high school students using local potential-based biodiversity question sets. This study includes research with quantitative descriptive methods that aim to describe the biological literacy skills of high school tenth grade students. Biological literacy research data consists of 4 indicators, namely nominal, conceptual, multidimensional and functional. The number of participants was 60 high school students. The initial stage used expert judgment for content validation which was tested by 3 expert validators. Construct validation was carried out based on data collection with the results of 12 question sets that were declared valid. Data analysis of the percentage of students who answered correctly on biological literacy indicators were all at a high level, namely on nominal indicators of 69.37%, conceptual indicators of 70%, functional indicators of 66.87%, and multidimensional indicators of 70%. It is concluded that the local wisdom-based biodiversity question set can be used to measure students' biological literacy skills in schools.

Keywords: biological diversity; literacy; local potential

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Article history:

Received: 5 August 2024

Revised: 2 September 2024

Accepted: 17 September 2024

Published: 27 October 2024

 10.22219/jpbi.v10i3.35571

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p-ISSN: 2442-3750

e-ISSN: 2537-6204

How to cite:

Hidayat, A.E., W., I. (2024). Biological literacy skills of senior high school student using local potential-based biodiversity question sets. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 10(3), 724-734. <https://doi.org/10.22219/jpbi.v10i3.35571>

Introduction

Literacy is a valuable skill associated with achieving young people's academic, vocational and social goals (Merga, 2021). Literacy is a person's ability to use potential and skills in processing and understanding information when doing reading and writing activities. Through literacy skills, a person not only gains knowledge but can also use his knowledge and experience to serve as a reference in the future. The form of future orientation depends on certain ideas, actions and literacy (Mangnus *et al.*, 2021). However, in reality, the literacy skills of students in Indonesia based on the PISA score in 2023 ranked 68th out of 79 countries with a reading score of 371. In the 3 components of the PISA assessment, namely reading literacy, mathematics literacy, and science literacy, it tends to increase 12 points compared to the results achieved in 2022 with a reading score of 359.

Science literacy is the ability to understand science, communicate, and apply science skills to solve problems. Students' science literacy before the application of guided inquiry in public junior high school students in Taiwan showed low results. (Wen *et al.*, 2020). Based on research conducted by Sutrisna (2021). It is known that the average value of scientific literacy of Class high school students in Sungai Penuh City is 31.58 with a low category. The low scientific literacy ability of students is influenced by several factors, namely low interest in reading, evaluation tools that have not led to the development of scientific literacy, and lack of teacher knowledge about scientific literacy. The causes of low interest and reading habits include lack of access, especially in remote areas. This is one of the findings from the Ministry of Education and Culture's Reading Literacy Activity Index (Alibaca) (Fuadi *et al.*, 2020).

There are many kinds of science literacy, one of which is biological literacy which focuses on understanding the surrounding environment. Biological literacy requires an understanding of the nature

of science. This literacy can help learners in understanding content, especially biology. Biological literacy is the ability to use scientific inquiry to understand and recognize biological issues in society and integrate these ideas into decision making and communicate the results to others (McBride et al., 2013). UNESCO (2022), has been working towards realizing the vision of literacy for all since 1946 in the belief that acquiring and improving literacy skills throughout life is an intrinsic part of the right to education and brings with it enormous empowerment and benefits.

Biological literacy is a problem experienced by Indonesia and abroad. The results of research conducted by Wen et al (2020) stated that the science literacy of students in Taiwan is low, while currently science literacy is emphasized in science education standards globally and locally. This low achievement of student science literacy indicates that biology learning in the classroom has not been implemented optimally. This is supported by research that shows students' science literacy skills in Indonesia are low. The profile of students' literacy skills in one of the districts in the Special Region of Yogyakarta in a study by Nugraheni et al (2017), that the literacy skills of tenth grade students of public high schools in Gunungkidul Regency in biology subjects show an average in the low category. According to Ahyadi et al., (2018), the low level of biological literacy in students is due to several obstacles or problems that occur in learning biology, namely students tend to only listen to the material delivered by the teacher and do not try to actively seek their own information and the lack of students' reading interest in biology subjects causes low student understanding of material or concepts.

Biological literacy can be trained to students by integrating the environment around students so that learning is more meaningful. The relevance of the current education curriculum to the global environmental situation and its influence on sociocultural and economic aspects, is a challenge for science education in the 21st century. Education is not only learning about theories related to subjects but the integration of local values that exist in an area is an essential thing that needs to be learned. According to UNESCO (2022), states that the integration of biodiversity in education programs is very important to support the use of biodiversity and its conservation in a fair and sustainable manner. Indonesia as the second megabiodiversity country in the world, has been known to have a very high natural wealth, flora and fauna. The erosion of biodiversity in Indonesia can threaten the local potential that exists in each region.

Local potential can be utilized as a knowledge base in innovating biology learning in schools. In addition, local potential can also be used as a source of learning biology (Alimah, 2019). By applying this approach, it is expected that students will find it easier to understand biology material and get more meaningful learning. However, in reality, education in Indonesia has not integrated local potential in learning, especially in the preparation of assessments. The integration of local potential into learning is still limited, and the utilization of the real environment has not been widely implemented (Sari et al., 2024). Lack of awareness of local potential and the importance of biodiversity is common. The integration of local potential in learning can be done through various ways both in learning activities and assessments.

Assessment in biology learning generally only uses the basic concepts of each material without integrating local potential in biodiversity material. Whereas with the integration of local potential can introduce students to be more concerned and maintain the biodiversity they have. Research conducted by Alti et al (2021), with the title "science literacy-based assessment instruments on biodiversity material", in this study did not show any local potential used in the components of making assessments. The preparation of assessments contains various components that require students to have good literacy and numeracy skills. Biological literacy can be assessed by utilizing local potential-oriented assessments.

One of the local potentials spread across Indonesia is the diversity of medicinal plants or known as toga plants (family medicinal plants). The use of medicinal plants has become part of cultural heritage and local wisdom that needs to be maintained. It is important for students to have biological literacy skills oriented to local potential as a provision in solving problems in everyday life and fostering awareness about the biodiversity around them that needs to be preserved. Concern for nature conservation is still relatively low due to the pressure of needs and lack of education (Suryaningsih, 2020).

Previous research on local potential integrated in learning was conducted by Utari et al (2024), In this study, showed that the development of the minimum numeracy competency assessment questionnaire of the PISA model showed results that were classified in the good category. Some of the research that has been done before, only highlights the local potential that is integrated in assessment activities, while in this study focuses on biodiversity that is integrated in learning assessments. The renewal in this study is the application of a local potential-based question set to support biology learning to be more meaningful. Students' ability to understand learning materials can be obtained from experiences about the use and conservation of biodiversity around them. The results of this study can be a reference for future researchers to integrate local potential in learning assessments in other subjects, so that it can foster students' awareness to continue to maintain the diversity of flora and fauna in Indonesia from the threat of extinction both due to exploitation and community indifference to their natural resources. The purpose of this study was to describe the initial ability of biological literacy of high school tenth grade

students using biodiversity assessments oriented to local potential. This research is expected to be a guideline for developing diverse assessments to support the assessment of students' biological literacy skills.

Based on the background that has been described, it is necessary to develop a biodiversity questionnaire based on local potential to assess students' biological literacy skills. The purpose of the research is to describe the biological literacy skills of tenth grade high school students through biodiversity assessment based on local potential.

Method

This research is a quantitative descriptive method that aims to describe the biological literacy skills of tenth grade high school students. By using biological literacy as an assessment reference, the biological literacy assessed in the study includes nominal, functional, conceptual, and multidimensional. The procedure of this research includes developing local potential-oriented question sets, validation tests to determine the feasibility of assessment, data collection, data analysis, and determination of biological literacy skills.

Problem Set Development

This research phase begins with the development stage of question sets using biodiversity question sets that include multiple choice tests to access biological literacy on biodiversity content. The question set was developed through a validity test with a biserial point correlation approach (Rahayu & Djazari, 2016). Biological literacy assessed in this study includes nominal, conceptual, multidimensional, and functional with limitations according to those compiled by Ratumanan & Lauren (2013), presented in Table 1.

Table 1. Indicator answers based on the literacy scale

No.	Indicator	Description
1.	Multidimensional	Answers incorporate an understanding of science that goes beyond disciplinary concepts and scientific investigation procedures. Includes philosophical, historical and social dimensions of science and technology. Answers develop some understanding and appreciation of science and technology in relation to their everyday lives. More specifically, they begin to make connections within the discipline between science, technology and major issues in society.
2.	Conceptual	Answers developed some understanding of key conceptual schemes and linked schemes to their general understanding of science. Answers also demonstrated procedural skills and an understanding of the process of scientific inquiry and technology design.
3.	Functional	The answer explains the concept correctly, but the answer shows only a limited understanding.
4.	Nominal	Answer recognizes or mentions a concept related to science, answer may also explain a particular understanding but shows a misconception.

The validity of the questions was tested on 15 items. If $r_{count} > r_{table}$ the conditions are met then the question items are considered valid. Analysis of the validity of test questions by material experts. The validator of the material expert test questions gave a score for each item with the answers very suitable (4), suitable (3), quite suitable (2), less suitable (1), and not suitable (0), then added up the total score of each validator and found the average validity with the formula. The validity of each question is determined based on the validity criteria in Table 2 (Riyani et al., 2017).

Table 2. Criteria for categorizing the validity of questions by material experts

Score interval	Validation criteria
$3 \leq VR \leq 4$	Very valid
$2 \leq VR < 3$	Valid
$1 \leq VR < 2$	Less valid
$0 \leq VR < 1$	Invalid

Data Collection

The research participants consisted of 60 students of MA Unggulan Amanatul Ummah Surabaya. Random determination in class A amounted to 30 students and class B amounted to 30 students. The test was conducted in April 2024 involving 60 students of class MA Unggulan Amanatul Ummah Surabaya. Students involved as participants in this study were determined randomly from four existing classes. The test was conducted in 30 minutes.

Data analysis

Data were analyzed using simple analysis in the form of averages and percentages. Biological literacy skills are determined based on the correct answers from each indicator, namely nominal, functional, multidimensional and conceptual. Furthermore, the percentage was calculated and the category was determined based on [Table 3 \(Chasanah et al., 2022\)](#).

Table 3. Biological literacy categories

Percentage	Category
$80 < P \leq 100\%$	Very high
$60 < P \leq 80\%$	High
$40 < P \leq 60\%$	High enough
$20 < P \leq 40\%$	Less feasible
$0 < P \leq 20\%$	Not worth it

Results and Discussion

Validity of question sets

The results of the question validation assessment show the average validator score with a very valid category. This shows consistency in the validator's assessment of the quality of the questions. Thus, the validity assessment based on expert judgment is able to measure biological literacy accurately. The highest average validity assessment score was 3.8 while the lowest average score was 3.2. follow in [Table 4](#).

Table 4. Results of validity assessment of each item based on expert judgment

No.	Aspects	Validator score		
		V1	V2	V3
Stimulus material				
1.	The material / stimulus contains a phenomenon that is interesting, renewable and in accordance with everyday life	3.87	3.67	3.80
2.	The stimulus used is contextual (text, images/graphics, and visualizations are in line with the real world)	3.80	3.53	3.47
3.	The stimulus contains information that learners can use to understand and answer the question.	3.93	3.53	3.33
4.	Stimulus is presented clearly and easily understood	3.80	3.60	3.33
Item construction				
5.	The instructions for working on the questions are clear	3.87	3.67	3.47
6.	The question items are in accordance with the indicators of biodiversity	3.93	3.87	3.27
7.	Item contains local potential of the region	3.93	3.87	3.40
8.	Item contains aspects of biological literacy	3.93	3.40	3.27
9.	Proportional composition of answer choices	3.67	3.47	2.73

No.	Aspects	Validator score		
		V1	V2	V3
10.	Answer options in the form of numbers in order from the smallest to the largest.	3.80	3.53	2.80
11.	Answer options do not use the statement "all answers are right/wrong" and the like	3.80	3.93	2.80
12.	The subject matter does not give clues to the answer key	3.87	3.80	2.80
13.	Item does not depend on the answer to the previous question	3.87	3.27	3.47
14.	There is a reference source in the quoted text and image	4.00	3.27	3.20
Language				
15.	Use of sentences according to PUEBI	3.87	3.33	3.13
16.	The sentences presented do not cause double meanings	3.47	3.80	3.00
17.	Scientific / foreign words are written in italic / italic fonts	3.60	3.67	3.07
18.	The context/stimulus/question must be formulated clearly, firmly, and logically using good Indonesian language and not contain elements of SARAPPPK (ethnicity, religion, race, intergroup, pornography, politics, propaganda, and violence).	3.47	3.53	3.27
Average		3.80 (highly valid)	3.60 (highly valid)	3.20 (highly valid)

The question set that has been tested for validity through expert judgment with 3 expert validators shows a valid value in Table 4. The validity assessment based on expert judgment is consulted with experts to determine the validity of the question device in terms of its content (Setiawan, 2019). Expert judgment is used as an intuitive approach to organizing ideas or thoughts among experts to discuss (solve problems). The level of validity of this expert judgment shows that the questions are feasible and able to be used to measure students' biological literacy skills.

The results of the validity test of questions with correlation $r_{count} > r_{table}$ with a significant level of 5%, showed 12 questions in the valid category and 3 questions showed invalid in Table 4. Invalid questions include question number 2 ($0.173 > 0.482$); question number 10 ($0.405 > 0.482$); question number 12 ($0.480 > 0.482$). These three questions access biological literacy multidimensional indicators. Thus from 12 valid questions, only one question can be used to access multidimensional indicators. Empirical validity of biodiversity questions based on local potential, can be seen in Table 5.

Table 5. Empirical validity of biodiversity questions based on local potential

Question number	Calculated r value	Table r value	Category
1	0.794	0.482	Valid
2	0.173	0.482	Invalid
3	0.721	0.482	Valid
4	0.539	0.482	Valid
5	0.974	0.482	Valid
6	0.855	0.482	Valid
7	0.639	0.482	Valid
8	0.600	0.482	Valid
9	0.682	0.482	Valid
10	0.405	0.482	Invalid
11	0.789	0.482	Valid
12	0.480	0.482	Invalid
13	0.989	0.482	Valid
14	0.882	0.482	Valid
15	0.816	0.482	Valid

Through empirical validity testing of each item in [Table 5](#), there are 12 questions in the valid category and 3 questions in the invalid category. Valid category questions can be interpreted in their presentation as having elements that can improve thinking skills, problem-solving abilities, and contain a renewable phenomenon in accordance with everyday life. Questions are also given stimulus development in the form of text, images, and visualization of life ([Muhajir et al., 2021](#)). As for the questions with invalid categories totaling 3 based on [Table 5](#), it can be interpreted that through the presentation of the question there are sentences that cause double meaning, so it is not easily understood by students. Learning contexts that are easily understood by students must use clear vocabulary, terms, and symbols ([Oktavia, 2020](#)). The validation results were then improved and revised through the suggestions given by the validator until they obtained the "very valid" category in the expert judgment assessment.

Local Potential-based question sets

The question set consists of 12 questions with details of 4 questions: nominal indicators, 4 questions: functional indicators, 1 question: multidimensional indicators, and 3 questions: conceptual indicators. The question set is integrated with local potential in the form of plant species, animals and natural diversity around. The local potential used in the questions is the diversity of clover leaves that have different sizes, clover is a local potential from Surabaya which is often used as a traditional food typical of Surabaya. The variety of bananas used in the question set is a local potential that is often found throughout Indonesia. Bananas are known as a type of fruit with a very varied shape for example questions on the topic of biodiversity of genes and species. Examples of local potential-based biodiversity question sets are listed in [Table 6](#) which contains local potential from various regions.

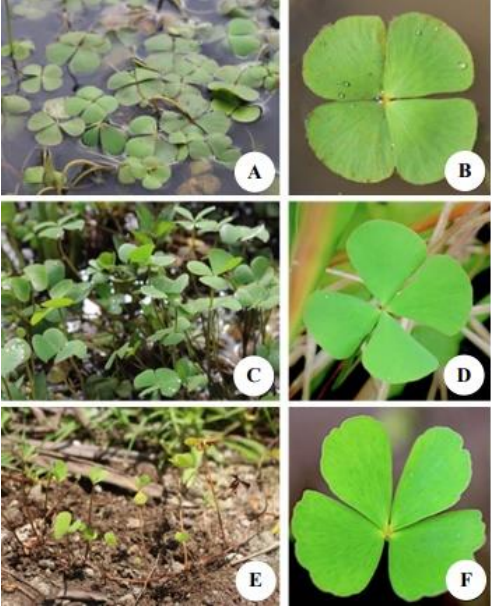

Table 6. List of local potentials used in question sets

Biodiversity topic	Local potential
Factors affecting Biodiversity	<ul style="list-style-type: none"> Variations of clover leaf shapes. Clover is a plant that is used for traditional food for the people of Surabaya. Variations of monstera leaves. Monstera is an ornamental plant
Gene and species diversity	<ul style="list-style-type: none"> Variations of <i>duku</i> and <i>langsep</i> fruit. Both plants are fruit-bearing species native to Indonesia. Variations of banana fruit. Plants that are widely found in Indonesia Variations of coconut, palm and <i>salak</i> trees. These three species are popular plants in Indonesia, especially the coconut tree.
Biodiversity around the environment	<ul style="list-style-type: none"> Color variations in roses (red and white roses) Baluran national park Bawean island nature reserve Rice field ecosystem in Mojokerto
Species-level biodiversity	<ul style="list-style-type: none"> Growth of peppers in Indonesia Variations of chicken as the most widely cultivated livestock in Indonesia

The question set used as a test of students' biological literacy is integrated with local potential by taking the big topic "Biodiversity". There are several biodiversity topics that are described and explored for their local potential ([Table 6](#)). This is related to the validity of the question device as a developer of students' thinking skills and measuring students' biological literacy skills. Local potential-based questions in science learning can deepen students' science concepts ([Fatimah et al., 2022](#)). This is supported by [Sriyati et al \(2021\)](#), which states that local wisdom-based question sets can improve science process skills, concern for existing natural resources and understanding of student learning concepts.

Biological literacy question sets are designed by integrating local potential which is the closest example to students' daily lives. The use of local potential is related to the concept of biodiversity in an applicative context and related to the reality of students. The local potential chosen is in the form of plants, animals and natural resources that are beneficial to society. One example is the clover plant, which is used economically by the people of Surabaya in the form of traditional food used in question number 4. Other plants used in the question set are *duku* and *langsep* fruits, which are native to Indonesia to test understanding of functional literacy. Baluran national park is a park commonly known by students to identify biodiversity in their surrounding environment. Some examples of questions in the biological literacy question set that are included in the biological literacy indicators are in [Table 7](#).

Table 7. Examples of local potential-based biological literacy question sets

Question number	About	Biological literacy indicators
3.	 <p style="text-align: center;">(Wisanti et al., 2021)</p> <p>Marsilea crenata or commonly known by the local name clover. It is a plant that is familiar to the people of Indonesia, especially in Surabaya, East Java. This plant is used as the main ingredient in the legendary culinary specialty of the city of heroes, pecel clover. From the three pictures above, there are differences in the size of the leaves that show the level of biodiversity?</p> <ol style="list-style-type: none"> Genes due to species variation are formed due to environmental influences. Genes due to species variation are formed due to differences in skin color. Genes that are formed due to differences in genes from the mating of two parents. Type because it is the variation found in various species within a genus. Types because there are different variations in various species within the same genus 	Conceptual
4.	 <p style="text-align: center;">(Hajar et al., 2021)</p> <p>"Similar but not the same" is an appropriate term for the three types of fruits above, Figure A is a member of the Meliaceae tribe. This plant, which is native to western Southeast Asia, is similar to the langsat fruit. The most famous cultivar of Figure A in Indonesia is the Palembang region, mainly because of its sweet taste and few seeds. Picture B fruit or is a fruit that is widely found in the Sumatra region. Factors that can increase the biodiversity of the above fruits are....</p>	Functional

Question number	About	Biological literacy indicators
	a. Adaptation b. Classification c. Domestication d. Inter-species mating e. Interaction of genes with the environment	
6.	Rice fields are found in the highlands and lowlands, one of the areas that has many rice fields is the Pacet Mojokerto area. The constituent components of the rice field ecosystem have various aspects of botanical and abiotic ecosystems. From several components such as rice, grass, locusts, soil, temperature and water. From this statement, why can agricultural systems threaten biodiversity? a. Rice fields are usually monoculture b. Excessive fertilization kills animals c. Pesticide use kills animals d. Pesticide use kills plants e. Excessive fertilization kills plants	Multidimensional
15.	The Bawean Island Nature Reserve, located in Gresik, East Java Province, is one of the government's efforts to preserve biodiversity in Indonesia. The correct statement about the conservation area is . a. Forest areas fostered and preserved for education b. Collection of rare plants and animals for science and recreation c. Nature conservation areas with certain characteristics, both on land and in water d. Natural forest areas usually located in mountainous areas that are conserved to protect the land from erosion. e. Nature reserve areas that protect and ensure the natural development of plant species that are unique to the place.	Nominal

Biological Literacy Skills

Table 8 shows that students' biological literacy skills are in the high category in all indicators, namely nominal, conceptual, functional, and multidimensional. This shows that there is consistency in students' understanding and ability in biological literacy. However, the nominal literacy indicator shows variations in the percentage of students who answered correctly, the highest 80% in question number 9 and the lowest 65% in questions 1 and 11. Students' nominal literacy is considered good enough to recognize and distinguish the basic characteristics of biodiversity. In addition, students are considered to have the ability to integrate various perspectives in identifying biodiversity (67.5%). This ability is an indicator of multidimensional literacy.

Table 8. Students' biological literacy skills on biodiversity material using local potential-based questions

Indicator	Biological literacy indicators	Question number	Students who answered correctly (%)	Category
Identify features of biodiversity	Nominal	1	65	High
		9	80	
		11	65	
		14	67.5	
		Average	69.37	
Diversity of genes, species, DNA,	Functional	4	62.5	High
		5	72.5	
		7	72.5	
		8	72.5	
		Average	70.00	
Biodiversity in the surrounding environment	Multidimensional	2	62.5	High
		6	67.5	
		10	65	

Indicator	Biological literacy indicators	Question number	Students who answered correctly (%)	Category
		12	72.5	
		Average	66.87	
Factors affecting biodiversity	Conceptual	3	70	High
		13	72.5	
		15	67.5	
		Average	70.00	

The research results of testing students' biological literacy skills using local potential-based biodiversity question sets (Table 8) show a high category in each indicator. In general, it can be seen that functional and conceptual biological literacy indicators have a higher percentage than other category indicators in student answers. Answers in functional indicators show that students have been able to remember concepts or information related to the problems given. Students are also able to recall information from several textbooks such as writing basic facts, but have not been able to justify their own opinions (Hadi et al., 2020). In this case, it relates to a problem set that is connected to local potential by presenting graphs, facts for the submission of interesting solutions in improving students' thinking skills.

In conceptual indicators, students are able to connect several concepts they have and then use them to solve problems and make decisions in everyday life. This can be driven by students' biological literacy skills through reading. Most of the students in class MA Unggulan Amanatul Ummah do not carry gadgets, so they can focus more and have a high interest in reading the text reading books provided. Generally, higher-level literacy skills are obtained from reading a lot from various sources (Khair et al., 2021). This conceptual literacy shows students' knowledge related to cause and effect (Ekasari & Zaini, 2020).

The level of literacy in the nominal indicator has a higher percentage than the multidimensional literacy indicator, in this nominal indicator the percentage figure is also close to the functional and conceptual indicators. It can be caused by the answers given by students to the problems or phenomena presented in the question set are only limited to statements of agreement or disagreement. Likewise, explanations are only limited to their own thoughts without understanding existing concepts and have not been able to provide examples. Students who have nominal literacy are able to recognize terms but do not have a clear understanding of their meaning (Ayuningtyas & Hayati, 2022). In the nominal indicator, students agree with other people's opinions without involving their own thoughts. So that through understanding a concept that students have not really mastered, it will make mistakes in understanding or misconceptions.

Analysis of answers on multidimensional biological literacy indicators showed the lowest percentage among other indicators. Through a percentage of 66.87%, it indicates that students have been able to apply the understanding gained from the relationship between concepts and daily events, but have experienced difficulties. The difficulties experienced by students may be from science literacy questions whose combination with daily life phenomena or local potential has not been reached by students' thinking. Explanation by Miftahurridlo & Hayati (2020), that students have difficulty in multidimensional indicators in understanding the phenomena given so that student thinking cannot develop. However, a large percentage in the indicator also does not answer the indication that students have difficulty in understanding the problem in their best answer. Added by Mutasam et al (2021), if students are lacking in multidimensional indicators there is a possibility that students are hesitant in using their concept knowledge and applying it in everyday life situations. Students only know a few facts and have not been able to find relationships between facts, making it difficult to communicate and apply their thinking (Isnaeni, 2022). Broadly speaking in this study, students have a fairly good ability in biology literacy on the topic of biodiversity based on local potential.

Conclusion

Based on the results of the study, it can be concluded that the local wisdom-based biodiversity question set is very valid and suitable for measuring students' biological literacy skills at school. This is supported by the overall average results of research validation which shows the validity of the question device of 3.5 with a very valid category. This is in line with the high biological literacy results of students with scores on each biological literacy indicator. Based on the results of the development research that has been carried out, the advice given is that research needs to be carried out on the application of local wisdom-based question devices in other regions and with other biological materials. Using measurable achievement results indicators and learning objectives to be achieved.

Acknowledgment

Respectful appreciation be upon Rector of Universitas Negeri Surabaya who has facilitated the research through an institutional policy.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

A. E. Hidayat: writing; **W. Wisanti:** data and writing review 1, and **I. Isnawati:** data and writing review 2

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