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Science assessment design based on environmental damage issues to strengthen students' literacy and numeracy competencies

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ABSTRACT

Strengthening literacy and numeracy is a mandate of national education policy, as stipulated in Government Regulation No. 57 of 2021 and implemented through the Minimum Competency Assessment (AKM). However, science assessments in schools are still dominated by memorization-based questions that do not integrate real-world contexts and data representation. This study aims to develop and formatively validate a science assessment design for environmental change material based on Environmental Damage Issues to integrate literacy and numeracy contextually and ensure its feasibility and acceptability by junior high school students. The study used an educational design research approach with the Tessmer formative evaluation model. Data were collected through expert validation and student responses in one-to-one, small group, and field test stages, then analyzed descriptively and qualitatively. The results showed that 25 items were deemed feasible and acceptable. The integration of narrative text, graphs, tables, and diagrams encouraged data interpretation and contextual problem-solving.

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INTRODUCTION

21st-century learning demands the integration of knowledge, higher-order thinking skills, literacy, and numerical abilities to solve real-world problems (OECD, 2025; Yanuarto, 2024). In the context of science education, scientific literacy is no longer defined simply as mastery of concepts, but rather as the ability to explain scientific phenomena, evaluate evidence, and make data-based decisions. Meanwhile, numeracy refers to the capacity to interpret quantitative information, analyze graphs and tables, and apply mathematical reasoning in various life contexts

(OECD, 2025; Pratiwi, 2025). Therefore, science learning assessments need to be designed not only to measure concept retention but also to activate data interpretation, scientific reasoning, and contextual problem-solving skills (Vlachopoulos, 2024).

The urgency of strengthening literacy and numeracy is not only highlighted in global discourses such as PISA but is also emphasized in national policies. The government states in Government Regulation Number 57 of 2021 concerning National Education Standards, Article 6 Paragraph (1), that competency standards in Elementary Education Units focus on character development in accordance with Pancasila values and strengthening students' literacy and numeracy competencies. This regulatory affirmation demonstrates that literacy and numeracy are not merely academic demands, but rather policy mandates that must be integrated into learning and assessment practices in schools.

In line with this policy, the Minimum Competency Assessment (AKM) is designed to measure literacy and numeracy skills based on real-life contexts (Ministry of Education and Culture, 2020; Pratiwi, 2025). However, our preliminary study and observations at Muhammadiyah 4 Prambon Middle School revealed a gap between policy demands and classroom assessment practices. The questions used by teachers in both formative and summative assessments still did not incorporate the context of the surrounding environment. Furthermore, these questions did not present data and facts in the form of narrative text, graphs, tables, or diagrams that could encourage in-depth interpretation of the information. As a result, students' thinking activities in solving problems are more focused on memorization than analysis, data interpretation, or contextual problem-solving. This condition indicates that science assessment practices in the field have not fully accommodated the strengthening of literacy and numeracy as mandated by national policies and international assessment frameworks (OECD, 2025; Kumar, Choudhary & Singh, 2023).

One relevant approach to bridging this gap is the use of Environmental Damage Issues as an assessment context. Environmental damage issues such as pollution, deforestation, biodiversity decline, and climate change represent complex phenomena that integrate scientific concepts, numerical data, and social and ethical dimensions. The literature shows that environmental socio-scientific issues (ESSIs) are effective in developing students' scientific literacy and argumentative skills because they require them to analyze evidence, interpret graphs, and draw data-based conclusions (Kumar, Choudhary & Singh, 2023; Hamel, 2024). The integration of environmental issues also encourages situated cognition, namely learning rooted in the realities of students' lives, thereby increasing the relevance and meaning of the learning process (Widyastuti, 2025).

Although several studies have developed instruments based on socio-scientific issues to improve science literacy (Diantari, 2025; Ramadhani, 2025), most of these studies have not explicitly focused on designing science assessments that integrate literacy and numeracy within the context of Environmental Damage Issues and have been tested for acceptability and practicality by school users. Thus, there is a clear research gap in developing science assessment designs based on environmental damage issues that conceptually integrate literacy and numeracy and are validated through a formative evaluation approach to ensure their feasibility and acceptability in the junior high school context.

However, previous studies have rarely integrated literacy and numeracy simultaneously within an Environmental Damage Issues-based assessment design that is systematically validated through formative evaluation. This study addresses this gap. Based on this background, this study aims to develop and formatively validate a science assessment design on environmental change based on Environmental Damage Issues that integrates literacy and numeracy contextually and is feasible and acceptable to junior high school teachers and students. This research positions itself as a conceptual

and practical contribution to bridging the gap between literacy-numeracy policy mandates and science assessment practices in schools.

RESEARCH METHODS

Research Design

This study employed an Educational Design Research (EDR) approach using the formative evaluation model proposed by Tessmer (1993). This approach was selected because the primary objective of the study was to develop and refine a science assessment design based on Environmental Damage Issues through iterative evaluation stages. The research focused on producing a valid and practical assessment instrument through two main phases: the preliminary stage (analysis and design) and the formative evaluation stage (self-evaluation, expert review, one-to-one, small group, and field test). In addition, a descriptive qualitative approach was used to analyze data obtained from expert feedback and student responses. This approach did not function as a separate research design (Rukajat, 2018) but rather as a data analysis strategy to interpret the feasibility, readability, and practicality of the developed assessment instrument during the formative evaluation process.

Population and Samples

This research was conducted from December 30, 2024, to May 9, 2025, at Muhammadiyah 4 Prambon Junior High School, Nganjuk Regency, East Java. This research was conducted to obtain test questions suitable for use by seventh-grade junior high school students. The sample was taken from 13 seventh-grade students.

Instruments

Data collection was obtained from the results of the FGDs, as well as input and suggestions from teachers, written on the question feasibility sheet. The FGD form was validated by two experts: an assessment expert and a science learning expert. The validation score reached 88.2, indicating that the instrument was valid and could be used for data collection. Other supporting data sources included one-to-one and small group sheets completed by students during the one-to-one and small group research stages.

Procedures

The development research model used in this study refers to Tessmer (1993). Tessmer's research stages are divided into two development stages: preliminary (preparation and design) and formative evaluation (self-evaluation, expert reviews, one-on-one, revision, small group, revision, and field testing).

1. Preparation Stage
   The preparation stage was conducted on December 30, 2024, with permission from the principal of the research location. This was followed by initial analysis through interviews with subject teachers.
2. Design Stage
   This stage was conducted from January 2-29, 2025, with discussions with the supervising lecturer and subject teachers to develop a test outline tailored to the preparation stage.
3. Expert Review Stage
   This stage was conducted on February 6, 2025, using a Focus Group Discussion (FGD) via Zoom. This phase was attended by subject teachers as field practitioners, expert lecturers in assessment, expert lecturers in content, and supervisors. The purpose of this phase was to

provide suggestions, responses, and input on the questions that had been created so that the questions could be deemed appropriate in terms of their material and construction.

4. One-to-One Phase
   This phase was conducted on February 13, 2025. Three students participated in this phase. They worked on the questions that had been previously created and revised. The purpose of this phase was to determine the readability of the questions and the students' difficulties in understanding the questions.
5. Small Group Phase
   This phase was conducted on February 15, 2025. Six students participated in this phase. The purpose of this phase was to obtain student input and suggestions regarding the practicality of the questions.
6. Field Test Phase
   This phase was conducted on May 8, 2025, and was conducted at the school with 13 students participating. Students work on revised questions from the previous stages for 80 minutes, or two class hours. The purpose of this stage is to identify any difficulties students experience while working on the questions. The sample size of 13 students is consistent with the principles of formative evaluation in the Tessmer model, which emphasizes iterative refinement and usability testing rather than statistical generalization. Therefore, a relatively small sample is considered appropriate to identify readability, practicality, and usability issues before wider implementation.

Data Analysis

The data generated in the research is in the form of a design description followed by suggestions for improvement from science assessment experts, media experts, and practitioners (preliminary stage, self-evaluation, prototyping (expert review), as well as student response (one-to-one stage, small group, and field test. Therefore, the data generated is in the form of a design for improvement and recommendations for improvement. Therefore, the data is analyzed descriptively by providing justification from the results of relevant previous research.

RESULTS

The results of this research are the design of numeracy literacy questions on Environmental Change to strengthen junior high school students' literacy and numeracy competencies based on environmental damage. Question development was carried out in four stages: preliminary, self-evaluation, prototyping (expert review, one-to-one, small group), and field testing. Each stage is explained below.

Preparation Stage

Techniques such as interviews and observations were used to gather insights into students' learning preferences and challenges (Nishonov, 2022). This stage involved selecting a school to serve as the research location. After selecting a research location, the curriculum used in the school was reviewed, materials were selected, teaching materials were analyzed, science teachers were interviewed, and subjects were determined. Based on interviews with subject teachers and material adjustments, the subjects selected were seventh-grade students.

Self-Evaluation StageThe self-evaluation stage is the initial stage in formative evaluation according to Tessmer, where developers independently assess the initial design of a product or instrument before testing it with experts or users. At this stage, researchers assess the design's suitability for its objectives, conduct a needs analysis, and revise the product based on personal

reflection before moving on to the next stage (Nugraha, Meika, & Yunitasari, 2024). After identifying the material to be selected for question development, researchers reviewed the CP and TP discussed with the science teacher. After determining the CP and TP, researchers created a question grid in the form of a table containing learning objectives, question indicators, question texts, answer keys, and scoring for each question number. The questions were designed in a variety of formats. These included multiple-choice, complex multiple-choice, short answer, essay, and true-false questions. Based on this grid, prototype I, consisting of 25 question scripts, was ready to be developed.

Expert Review Stage

Prototype I, a test script for Environmental Change, was produced in the previous stage. It was then validated by experts, taking into account content, construction, and language. The results of the first expert review are shown in the table below.

Table 1. Criticism, feedback, and assessment experts

No	Description
1.	The suggested level used is the question level, not the level of the learning objective indicator.
2.	Question scoring is adjusted to the cognitive level.
3.	One learning objective can have more than one question.
4.	Questions created must take into account the learning objective.

Previously, the cognitive level was focused on the question indicator level. After the expert review stage, the level used was the question level, as each question has a different level that will affect the scoring. Furthermore, before each question was scored equally, the expert provided input that the scoring for each question be adjusted to the predetermined question level. The higher the question level, the higher the score, especially for essay-type questions. Furthermore, more than one question can be created for a learning objective so that invalid questions can be replaced with others that still meet the same learning objective. If a single question achieves the learning objective, it is not necessary to give all the questions in a single lesson to students.

Figure 1. Initial question design that still does not reflect the principles of writing questions well (right) and after revision (left). Improved questions, questions with a higher cognitive level, should also have a higher correct answer score.

Figure 1 shows only one multiple-choice question on numeracy, specifically the magnitude of the orangutan decline. After receiving input from an expert, two questions were added, with the second being a descriptive question that requires students to think about the causes of the orangutan decline. Scoring also differs between questions one and two due to the different cognitive levels achieved. For question one, a student's correct answer is a score of 1, while the maximum score for question two is 3. Further criticism, suggestions, and input from the second expert can be seen in Table 2.

Table 2. Criticism, suggestions, and responses from experts in the subject matter

No.	Description
1.	Questions are designed to emphasize case studies through problem-solving.
2.	More than one question can be created for each case.
3.	Adding questions related to numeracy cases.

The second validator's suggestion and input was that the questions could be emphasized on case studies through problem-solving to strengthen the competency dimension. Previously, researchers created questions based solely on stimuli, with answers contained within the stimuli, which did not strengthen students' problem-solving skills. Then, the study added questions that emphasize students' problem-solving skills. The following is an example of a problem-solving question in the context of a forest destruction case. Students are asked to explain how to prevent and address forest destruction. Further input is to add questions related to numeracy case studies, where multiple questions can be created for a single case.

Perhatikan berita tentang hutan Indonesia berikut!

Auriga Nusantara Ungkap 4 Konsesi Penyebab Utama Kerusakan Hutan Indonesia

https://images.app.goo.gl/CQ4UtQ85vcCMBkL49

Kabar mengejutkan datang dari organisasi non-pemerintah yang bergerak di bidang pelestarian lingkungan dan sumber daya alam, Auriga Nusantara. Auriga Nusantara mengungkapkan bahwa lebih dari separuh deforestasi di Indonesia sepanjang tahun 2024 terjadi di area konsesi. Berdasarkan perhitungan Auriga Nusantara, total deforestasi di Indonesia mencapai 261.575 hektare pada tahun 2024. Dari jumlah tersebut, 59% atau seluas 153.498 hektare terjadi di area konsesi. Ketua Auriga Nusantara, Timer Manurung, mengatakan, temuan ini mengindikasikan adanya deforestasi legal. Pasalnya, penghilangan tutupan hutan alam di area konsesi memang diperbolehkan. "Deforestasi legal menjadi masalah terbesar kita," kata Timer dalam tayangan YouTube Auriga Nusantara, Senin 3 Februari 2025. Auriga Nusantara mencatat ada empat jenis konsesi yang menyumbang deforestasi terbesar di Indonesia sepanjang tahun 2024, yaitu, logging seluas 36.068 hektare, kebun Kayu 41.332 hektare, tambang 36.615 hektare dan sawit 37.483 hektare. Timer Manurung menambahkan bahwa pemerintah memberikan izin atau membangun proyek strategis nasional (PSN) yang menyebabkan hutan alam dibabat secara legal. "Selama ini kita kerap mendengar bahwa masyarakat lokal atau kemiskinan disalahkan sebagai penyebab deforestasi di indonesia. Tapi, angka-angka deforestasi atau tempat kejadian deforestasi membantah itu semua," jelas Timer. Di samping itu, belum ada payung hukum yang melindungi kawasan hutan alam selain kawasan konservasi. "Kami berani menyimpulkan hanya 3 persen deforestasi yang terjadi pada 2024 sebagai ilegal. Selebihnya sangat mungkin legal karena dibolehkan, diberikan izin, karena aturan tidak melindungi hutan alam," papar Timer.

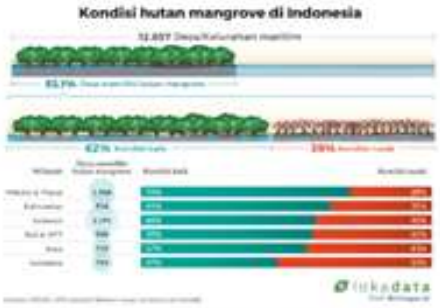
Sumber: https://www.sawitku.id/konservasi/81414475200/auriga-nusantara-ungkap-4-konsesi-penyebab-utama-kerusakan-hutan-indonesia

25. Berdasarkan uraian di atas, jelaskan 5 upaya yang dapat dilakukan untuk mencegah dan mengatasi kerusakan hutan!

Figure 3. Example of an assessment question that addresses the causes of forest destruction in Indonesia. The question is problem-solving in nature.

Perhatikan gambar mengenai kondisi hutan mangrove di Indonesia di bawah ini!

Kondisi Hutan Mangrove di Indonesia



Sumber : https://images.app.goo.gl/dsmBNuF6TwzVm3sD7

Hutan mangrove merupakan salah satu cara mencegah abrasi di laut. Berdasarkan data tersebut, tentukan pernyataan di bawah ini benar atau salah!

Pernyataan	B/S
Desa di wilayah Maluku & Papua yang memiliki hutan mangrove sebanyak 1.536	
Kondisi hutan mangrove yang baik di wilayah Jawa sebesar 43%	
Desa di wilayah Sulawesi memiliki hutan mangrove seluas 2.991	
Kondisi hutan yang rusak mangrove di wilayah Kalimantan sebesar 35%	

Figure 4. Example of a numeracy case study question

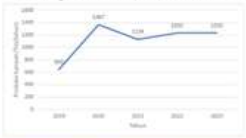
As can be seen from Figure 4, questions containing numeracy case studies can be presented in the form of stimulus diagrams so that students can also learn to read diagrams. Questions are made in the form of statements. Students are asked to answer the questions with the options B (true) or S (false). Furthermore, criticism, input, and suggestions from science teachers can be seen in the following table. Furthermore, criticism, input, and suggestions from science teachers can be seen in the following table (Table 3).

Table 3. Critic, input, and suggestions from practitioners

No.	Description
1.	Added questions containing graphic stimuli
2.	More detailed explanation of scoring for each question

Perhatikan grafik di bawah ini!

Grafik Volume Produksi Sampah Harian (Ton) di Daerah Istimewa Yogyakarta



https://images.app.goo.gl/9uUdPBhnWCd7XytT6

Yogyakarta, yang dikenal sebagai kota pelajar dan destinasi wisata budaya, kini menghadapi masalah besar terkait pengelolaan sampah. Permasalahan ini terlihat khususnya di Tempat Pembuangan Akhir (TPA) Piyungan yang sering kali menampung sampah melebihi kapasitas yang ditentukan. TPA Piyungan dirancang untuk menampung 650 ton sampah per hari, namun volume sampah dari Yogyakarta, Bantul, dan Sleman sering kali melebihi angka tersebut. Data tahun 2022 menunjukkan bahwa volume sampah mencapai rata-rata 747 ton per hari. Sumber : https://perkim.id/perkotaan/yogyakarta-di-bawah-bayang-bayang-gunungan-sampah/

24. Berdasarkan grafik di atas, produksi sampah terendah dan tertinggi terjadi pada tahun...
    a. Produksi sampah terendah pada tahun 2019
    b. Produksi sampah terendah pada tahun 2021
    c. Produksi sampah tertinggi pada tahun 2023
    d. Produksi sampah tertinggi pada tahun 2020

(Jawaban lebih dari 1)

Figure 5. Question with a graphical stimulus. It includes a contextual title and facts in the form of data in the form of a graph about the volume of daily waste production.

Previously, there were no questions with graphic stimuli. After receiving input from the science teacher, the researcher added a graphic problem using the example of waste in a particular area. This additional problem was used to strengthen students' graphic reading skills, as the teacher's assessment indicated that students at the school were still relatively low in graphic reading. Furthermore, the scoring for each problem was further detailed, from a score of one to the highest. The revised Prototype I results in Prototype II, which will then be used in the one-to-one phase.

One-to-One Phase

In the one-to-one phase, three students with low, medium, and high proficiency were given Prototype I and asked to work on the problems within the allotted time. After completing the problems, students were asked to complete a one-to-one questionnaire to assess their understanding of the sentences, images, and stimuli from the problems. Three students wrote that the size of the images contained writing that was too small and difficult to read clearly. Furthermore, one student wrote many abbreviations, such as "Kep." (Kep). Students provided feedback to avoid using unfamiliar abbreviations.

Furthermore, one student experienced difficulty understanding the questions. Upon further investigation, it turned out that the student was having difficulty answering the questions, not understanding them. Researchers understood this because the students' numeracy competency levels varied. According to Nurhayati et al. (2022), the order of numeracy competency levels, from lowest to highest, is: requires special intervention, basic, proficient, and advanced.

Small Group Stage

The revised results, based on input from the validator and three students, were then tested on six students with high, medium, and low ability (two students each). As in the previous stage, in this stage, students were given a question sheet and an assessment sheet to gauge their responses to the questions. On this assessment sheet, students recorded their time efficiency, the use of the questions, and the practicality of the questions. During this process, students were able to complete the questions well, but they took longer than the allotted time. The results of this stage, called prototype III, will be tested in the field test.

Field Test Stage

In this stage, 13 seventh-grade students were given revised questions from the previous stages. This stage was conducted once on May 8, 2025. Students were given 80 minutes, or two class hours, to answer 25 numeracy literacy questions in various formats. After 80 minutes, students collected their completed questions. During the process, several students asked questions about the meaning of the questions, and after explanations, the students understood the meaning. The following is an example of a student's answer that aligns with the expected answer. The student's answer can be seen in Figure 6 below.

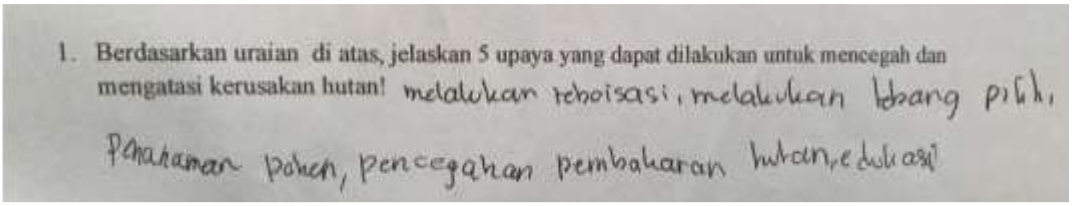
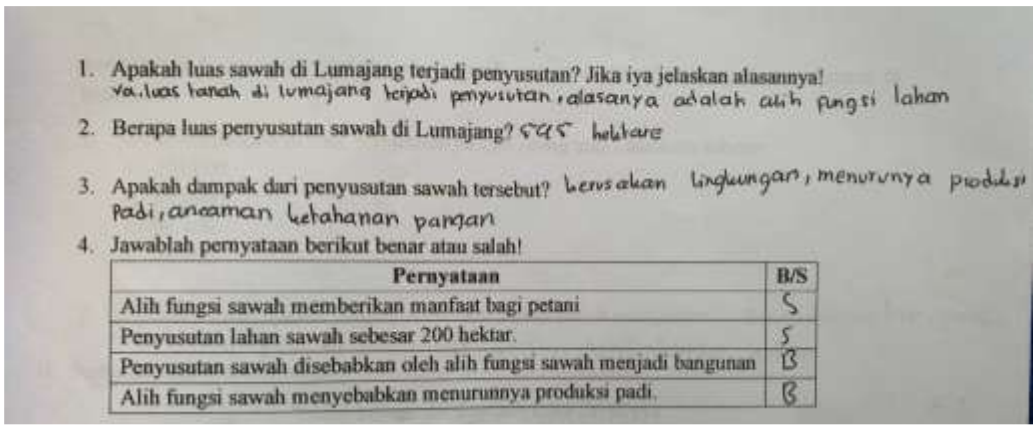

1. Berdasarkan uraian di atas, jelaskan 5 upaya yang dapat dilakukan untuk mencegah dan mengatasi kerusakan hutan! melakukan reboisasi, melakukan ibang pilh, Penanaman pohon, pencegahan pembakaran hutan, edukasi

Figure 6. Student Answers

Based on the image above, it can be seen that students understood the questions, as evidenced by their answers, which were consistent with the questions. Furthermore, the varied question

formats demonstrated that students were able to answer them accurately and correctly. Examples of questions and student answers can be seen in Figure 7.


1. Apakah luas sawah di Lumajang terjadi penyusutan? Jika iya jelaskan alasannya!
   Ya, luas lahan di lumajang terjadi penyusutan, alasanya adalah alih fungsi lahan
2. Berapa luas penyusutan sawah di Lumajang? 595 hektare
3. Apakah dampak dari penyusutan sawah tersebut? kerusakan lingkungan, menurunya produksi padi, ancaman ketahanan pangan
4. Jawablah pernyataan berikut benar atau salah!

Pernyataan	B/S
Alih fungsi sawah memberikan manfaat bagi petani	S
Penyusutan lahan sawah sebesar 200 hektar.	S
Penyusutan sawah disebabkan oleh alih fungsi sawah menjadi bangunan	B
Alih fungsi sawah menyebabkan menurunnya produksi padi.	B

Figure 7. Student Answers in Different Question Formats

As can be seen from the image above, students were able to correctly answer the questions given in various forms. The questions above are in the form of short essay questions, as well as true-false statements. All questions created contain factual stimuli. The development of fact-based questions has been proven to train students to think critically, analytically, and solve problems in the context of everyday life, so that they not only understand concepts theoretically but are also able to apply them practically (Juniar, 2025). The following is an example of a student's answer that demonstrates the ability to solve problems in the surrounding environment through practical solutions. The student's answer can be seen in Figure 8.

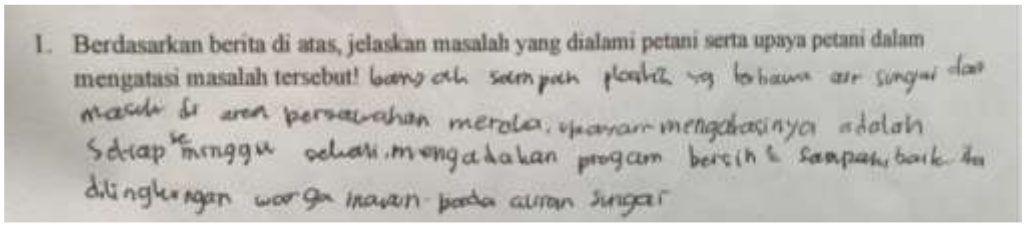

1. Berdasarkan berita di atas, jelaskan masalah yang dialami petani serta upaya petani dalam mengatasi masalah tersebut! banyak sampah plastik yg berbau asr sungai dan masuk di area persawahan merela upayanya mengatasinya adalah setiap minggu selasa mengadakan progam bersih & sampah, baik di lingkungan warga maupun pada aliran sungai

Figure 8. Student answers by providing practical solutions.

DISCUSSION

This study demonstrates that the Environmental Damage Issues-based science assessment design produces a feasible and acceptable instrument for seventh-grade students. The primary focus of this study was not on quantitative testing of item quality, but rather on the instrument's acceptability, readability, and practicality through the formative evaluation stages of the Tessmer model. These results confirm that integrating the context of environmental damage issues into science assessments can be a strategic approach to strengthening students' literacy and numeracy in a contextual and meaningful manner.

1. Environmental Damage Issues as a Context for Literacy and Numeracy

Using environmental degradation as an assessment context presents complex phenomena that combine scientific concepts, numerical data, and social and ethical dimensions. The literature shows that environmental socio-scientific issues (ESSIs) are effective in developing scientific literacy because they require students to evaluate evidence, analyze information, and make data-based decisions (Kumar, Choudhary & Singh, 2023). This context aligns with the international scientific literacy framework, which emphasizes the ability to explain phenomena scientifically,

evaluate and design scientific investigations, and critically interpret data and evidence (OECD, 2025).

Various studies have shown that integrating socio-scientific issues into science learning and assessment can improve scientific argumentation and data-based reasoning skills (Anggi, Hernani & Solihat, 2019; Ismah, Haryadi & Antarnusa, 2024). Issues such as environmental pollution, deforestation, and climate change, for example, require students to read graphs, interpret numerical trends, and relate quantitative data to ecological impacts. This process directly activates the numeracy dimension, particularly in terms of data interpretation, estimation, and contextual problem solving.

Furthermore, the environmental context provides situated cognition, meaning learning rooted in real-world situations increases relevance and meaning for students (Widyastuti, 2025). When students are confronted with data on declining animal populations, graphs of waste volume, or comparisons of forest area, they don't simply memorize concepts but interpret, analyze, and evaluate—competencies that are core to 21st-century literacy and numeracy. National research also shows that environmental issue-based assessments can increase student engagement in data analysis and scientific problem-solving activities (Safira, 2020). Thus, Environmental Damage Issues serves not only as a contextual illustration but also as an epistemic framework that integrates scientific reading literacy, data literacy, and numeracy into a single, authentic assessment.

2. Cognitive Mechanisms in Strengthening Literacy and Numeracy

The developed instrument contains a variety of question formats, including complex multiple-choice, essay-based, graphic-based true-false, and numerical data-based questions. This variation enables the activation of several cognitive mechanisms. First, graphic-based and numerical data-based questions encourage students to translate and interpret quantitative information. This ability is an essential part of numeracy as defined in the PISA framework, namely the ability to use mathematical concepts to understand and solve problems in real-life contexts (OECD, 2025). Ramadhani's (2025) research shows that the context of waste management in science assessments significantly improves students' numeracy skills through the interpretation of quantitative data.

Second, case study-based and problem-solving questions stimulate analytical and evaluative thinking. Students not only answer based on explicit information but also must integrate concepts, data, and practical solutions to environmental problems. This activity aligns with the characteristics of 21st-century assessments, which emphasize measuring higher-order thinking skills and scientific reasoning (Putra, 2022).

Third, weighting scores based on cognitive level reflects an effort to assess the quality of the thinking process, not just the accuracy of the answers. This practice aligns with the principles of authentic assessment, which assess the complexity of thinking and the ability to apply concepts in real-world contexts (Kumar, Choudhary & Singh, 2023).

3. Student Admission as an Indicator of Initial Eligibility

The results of the one-to-one, small group, and field test stages showed that students were able to understand the stimulus, read the graphs, and answer questions in a variety of formats provided. Although there were several technical inputs such as image size and use of abbreviations, the revisions made showed that the instrument met the aspects of readability and practicality. In the context of development research, student acceptance is an important indicator in the initial phase before further quantitative testing is conducted (Tessmer, 1998). Instruments that are not understood or accepted by students will be difficult to develop further. Therefore, the findings of this study provide a basis for the design of an environmental issue-based assessment has good implementation potential in science classes.

4. Implications for Science Teachers

These findings provide practical implications that science teachers can: (1) integrate environmental damage issues as an assessment context without significantly changing the curriculum structure, (2) use a variety of stimuli (text, graphics, numerical data) to strengthen students' scientific reading and numeracy literacy, (3) utilize case study-based questions as a diagnostic tool to identify students' weaknesses in data interpretation and problem solving, (4) national literature shows that Indonesian students' scientific literacy still needs to be improved to be able to respond to global challenges such as environmental issues (Sari, 2025). Therefore, contextual and real-phenomenon-based assessments are one of the relevant and applicable strategies.

5. Limitations and Directions for Further Research

This study focused on the instrument's feasibility and acceptability, rather than on quantitative analyses such as reliability, construct validity, or item analysis. Therefore, further research is needed to test the instrument's psychometric qualities in a larger sample (Putri, 2025). Such testing would strengthen the claim that the instrument is not only acceptable to students but also valid and reliable in measuring literacy and numeracy.

Environmental literacy is a crucial component of science education that emphasizes individuals' ability to understand and respond critically to environmental issues (Pertiwi et al., 2021). Furthermore, environmental literacy encompasses not only cognitive aspects but also affective and behavioral dimensions; therefore, learning must be designed comprehensively to foster awareness and real actions toward environmental problems. In this context, Problem-Based Learning (PBL) integrated with Socio-Scientific Issues (SSI) has been shown to enhance environmental literacy, particularly in understanding real-world contextual problems (Nurjanah et al., 2025). In addition, scientific literacy involves the ability to understand concepts, interpret data, and apply them in everyday life, enabling students not only to acquire knowledge but also to use it contextually (Adela et al., 2025). This development is further strengthened by numeracy literacy, which refers to the ability to understand, use, and interpret numerical data through a STEM approach, which essentially represents a contextual, issue-based learning approach aligned with SSI (Syamsuddin et al., 2024).

The SSI approach itself has been widely recognized as an effective framework for developing 21st-century competencies. The use of SSI in learning enhances environmental awareness, argumentation skills, and decision-making based on socio-scientific issues (Susilawati et al., 2021). Moreover, SSI functions as a primary approach in science education by introducing complex issues, such as pandemics, to foster students' argumentation skills, reasoning, and decision-making grounded in scientific knowledge and values (Smit et al., 2025). More broadly, SSI serves as an integrative framework that connects scientific, social, ethical, and environmental dimensions within learning contexts based on global issues such as climate change and energy, thereby promoting scientific literacy in a holistic manner (Sari et al., 2025). Thus, integrating SSI into science learning not only strengthens literacy and numeracy competencies but also fosters critical thinking and informed decision-making relevant to global challenges.

CONCLUSION

This study concludes that the developed science assessment design based on Environmental Damage Issues is feasible, practical, and acceptable for use in junior high school science learning. The assessment integrates contextual stimuli such as narrative texts, graphs, tables, and real-world environmental cases, enabling students to engage in data interpretation, scientific reasoning, and problem-solving. From a theoretical perspective, this study contributes to the development of

science assessment by demonstrating that Environmental Socio-Scientific Issues (ESSIs) can serve as an effective framework to integrate literacy and numeracy within a single assessment design. This integration supports the broader conceptualization of scientific literacy as the ability to interpret data, evaluate evidence, and make informed decisions in real-world contexts.

Practically, the findings provide a reference for science teachers to design more contextual and meaningful assessments by incorporating environmental issues and multiple forms of data representation. Such assessment practices can help shift classroom evaluation from memorization-based testing toward higher-order thinking and data-based reasoning. In terms of educational policy, this study supports the implementation of literacy and numeracy strengthening as mandated in the Minimum Competency Assessment (AKM). The developed assessment design offers an applicable model that aligns with national education standards and can be adapted to support competency-based assessment practices in schools.

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