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**Research Artikel**

# *DEVELOPMENT OF STEM-BASED E-LKPD TO IMPROVE SCIENTIFIC LITERACY CAPABILITIES ON ENVIRONMENTAL CHANGE MATERIAL*

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***Abstract***

*The problem of low science literacy needs to be used as a reference by the government in improving the learning system in Indonesia. This research aims to produce teaching materials in the form of STEM-Based Electronic Student Worksheets (E-LKPD) to Improve Science Literacy Skills in Environmental Change Materials. The method used is Research and Development (R&D) with a 4-D development model (Define, Design, Develop, and Disseminate). The development process goes through a validity test of 2 experts, a readability test of 15 students, and a field trial by 1 biology teacher and 35 students. Pretests and posttests were conducted using multiple-choice test instruments consisting of the same 10 questions. The results of the research showed that the developed E-LKPD had an average validity percentage of 85.2% with very feasible criteria. In the readability test, the average percentage of E-LKPD reached 86.2% with very feasible criteria. While in the field trial, the responses of teachers and students showed very feasible criteria with percentages of 81.25% and 82.25%. There was an increase in the average scientific literacy skills measured through the test instrument. The average result of scientific literacy skills before the implementation of E-LKPD was 57.3 while after the implementation of E-LKPD it increased to 79.6 with an N-Gain of 0.50 in the moderate category. Based on these results, it can be concluded that E-LKPD is very feasible to use in learning activities and there is an increase in scientific literacy skills after the use of E-LKPD in the learning process.*

***Keywords***: *Electronic Student Worksheets; Environmental Change Material; Learning Approach; STEM; Science Literacy Skills.*

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## INTRODUCTION

Scientific literacy is one of the life skills of the 21st century to improve the quality of human resources and improve the standard of living so that it determines the progress of a nation (Ahmadi & Ibda, 2018). Scientific literacy views the importance of thinking and acting skills which involve mastering thinking and using scientific thinking in recognizing and responding to social issues. Therefore, measuring scientific literacy is important to determine the level of scientific literacy of students in order to achieve high or good scientific literacy so that the quality of education in Indonesia can increase and be able to compete with other countries (Pratiwi et al., 2019). In fact, scientific literacy in Indonesia has a score below the international average. The 2022 PISA results stated that the international average score reached 485 points. Meanwhile, the scientific literacy abilities of Indonesian students only have an average score of 383 points.

The problem of low scientific literacy needs to be used as a reference by the government in improving the learning system in Indonesia. One of the factors that must be considered to improve students' scientific literacy is teaching materials that are adapted to the needs of the 21st century. These teaching materials have aspects of scientific literacy and materials that are in accordance with the competencies and needs analysis of students. Therefore, teachers strive to develop teaching materials that make students active as a tool in the learning process and can be used as a learning resource (Fidiantara et al., 2020). One of the teaching materials that teachers can use to create active and independent learning is by using Student Worksheets (LKPD) (Aini et al., 2019). Along with advances in technology, LKPD can be accessed via electronic media so that now it can be called an Electronic Student Worksheet (E-LKPD) (Arnidha et al., 2023).

Another effort that can be made to improve students' scientific literacy skills is to use a student-centered approach. Apart from that, the learning approach used also includes several scientific disciplines in order to increase students' understanding of concepts. One approach that can be used is the Science, Technology, Engineering, Mathematics (STEM) approach (Putri, R.M. et al., 2022). The next effort to improve scientific literacy skills is choosing a learning model. PBL models can be integrated with STEM approaches. Previous research also examined STEM-PBL as innovative learning to increase students' scientific literacy in the industrial era 4.0. (Suyidno et al., 2022).

This research aims to produce teaching materials in the form of STEM-based Electronic Student Worksheets (E-LKPD) to improve scientific literacy skills on environmental change material. Thus, researchers conducted research entitled "Development of STEM-Based E-LKPD to Improve Scientific Literacy Capabilities on Environmental Change Material".

## METHOD

This research was carried out at MAN 1 Bekasi City, West Java in the even semester of the 2023/2024 academic year. The subjects of this research were 35 students of class X-1. The subjects of this research were taken based on 1 sample from the total class X. This research includes research using the Research and Development (R&D) method. The development model used in this research is the 4-D model. This model consists of 4 stages, namely the definition stage, design stage, development stage and disseminate stage. In this research, researchers only implemented it up to the development stage without the disseminate stage due to time and cost limitations.

The development process goes through a validity test of 2 experts, a readability test of 15 students, and a field trial by 1 biology teacher and 35 students. Pretests and posttests were conducted using multiple-choice test instruments consisting of the same 10 questions. The pretest was carried out before the learning of Environmental Change material began, while the posttest was carried out after the learning of Environmental Change material was completed. The test questions were analyzed through the formulation of learning objective indicators and scientific literacy competency indicators adopted from PISA 2015. The researcher used the PISA 2015 indicators

because in 2018 and 2022 the PISA assessment referred to these indicators.

The data processing technique in this research uses a Likert scale. The results of each expert's validation are processed to obtain agreement between assessors using the following formula:

$$PS = \frac{S}{N} \times 100\%$$

Information:
PS = Percentage
S = Number of respondents' answers in 1 item
N = The number of ideal values in an item

The eligibility criteria for the validation sheet instrument can be seen in Table 3 below.

Table 3. Eligibility Criteria

| Scale | Criteria |
|---|---|
| 81% - 100% | Very Worthy |
| 61% - 80% | Worthy |
| 41% - 60% | Decent Enough |
| 20% - 40% | Not Worthy |
| ≤ 20% | Totally Not Worth It |

(Astuti & Ismail, 2021)

The E-LKPD effectiveness test was analyzed using normalized gain (N-gain). Below is the N-gain test formula:

$$N - Gain = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score}$$

Normalized Gain (N-gain) criteria can be seen in Table 4 below.

Table 4. *N-gain* Criteria

| Score | Alternative Answers |
|---|---|
| *N-Gain* ≥ 0.70 | High |
| 0.30 – 0.70 | Medium |
| 0.00 – 0.29 | Low |

(Supriadi, 2021)

## RESULTS AND DISCUSSION

This research aims to develop a STEM-based Electronic Student Worksheet (E-LKPD) to try to improve scientific literacy skills in environmental change material. Interviews with students were conducted to continue the needs analysis from the students' perspective. Based on the results of student interviews, there is a conclusion that biology teachers have never used experimental learning methods in class X. Therefore, researchers intend to apply experimental learning methods in the E-LKPD that will be developed. All the speakers also had an interest in this matter. After conducting interviews with teachers and students, then analysis of concepts, tasks and formulation of learning objectives is carried out.

The second stage of the 4-D development model is the design stage. At this stage, several activities are carried out, namely preparing test standards, selecting media and formats, and creating an initial design. The preparation of test standards was carried out with the aim of improving scientific literacy skills in environmental change material. In accordance with the name of the teaching material developed, namely Electronic Student Worksheet (E-LKPD), the choice of media used is electronic media. E-LKPD can simplify and narrow down space and time so that learning becomes effective and can be used as an interesting tool when students' interest in learning decreases (Putri, G.D. et al., 2023).

The medium for designing and compiling E-LKPD used by researchers is the Canva application. Apart from that, the media for distributing E-LKPD and collecting assignments in this research uses the WhatsApp application. In choosing the format, the file form that will be used in developing this E-LKPD is Portable Document Format (PDF). Later, this file will also be included on the flipbook website so that students can see the E-LKPD visualization like a printed book. After choosing the media and format, then create an initial design. This E-LKPD product is designed with 3 parts, namely the introduction, contents and closing. This product is also designed according to PBL syntax in each activity. The results of the initial E-LKPD design can be seen in the image below.


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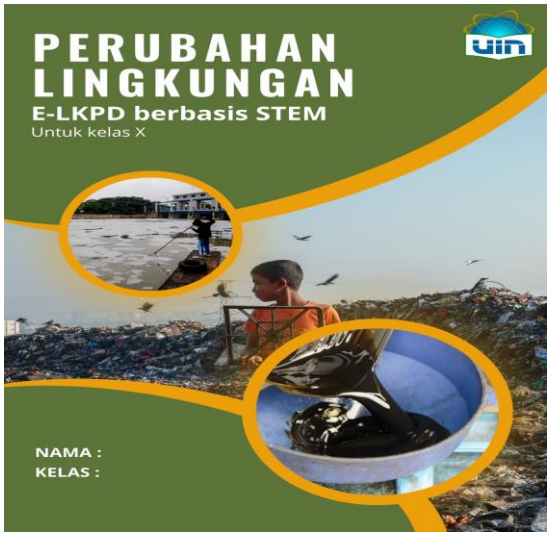
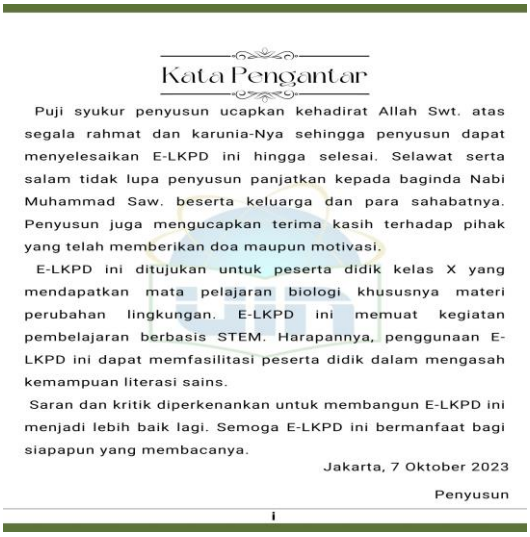



Figure 1. Front cover of E-LKPD



## Kata Pengantar

Puji syukur penyusun ucapkan kehadirat Allah Swt. atas segala rahmat dan karunia-Nya sehingga penyusun dapat menyelesaikan E-LKPD ini hingga selesai. Selawat serta salam tidak lupa penyusun panjatkan kepada baginda Nabi Muhammad Saw. beserta keluarga dan para sahabatnya. Penyusun juga mengucapkan terima kasih terhadap pihak yang telah memberikan doa maupun motivasi.

E-LKPD ini ditujukan untuk peserta didik kelas X yang mendapatkan mata pelajaran biologi khususnya materi perubahan lingkungan. E-LKPD ini memuat kegiatan pembelajaran berbasis STEM. Harapannya, penggunaan E-LKPD ini dapat memfasilitasi peserta didik dalam mengasah kemampuan literasi sains.

Saran dan kritik diperkenankan untuk membangun E-LKPD ini menjadi lebih baik lagi. Semoga E-LKPD ini bermanfaat bagi siapapun yang membacanya.

Jakarta, 7 Oktober 2023

Penyusun

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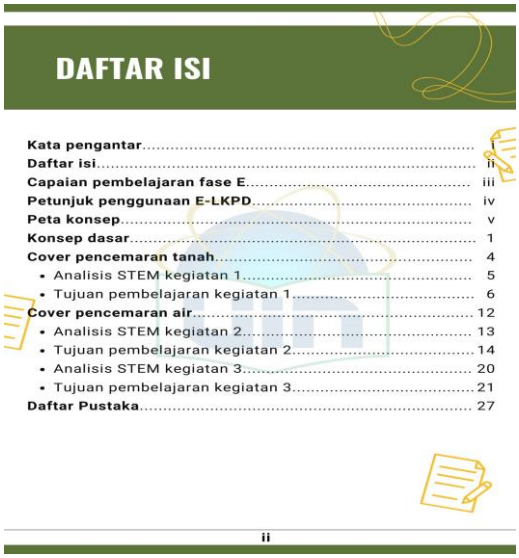
Figure 2. Foreword



## DAFTAR ISI



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Figure 3. List of contents

## Capaian Pembelajaran Fase E

| Elemen | Fase E |
|---|---|
| **Pemahaman Biologi** | Pada akhir fase E, peserta didik memiliki kemampuan menciptakan solusi atas permasalahan-permasalahan berdasarkan isu lokal atau global dari pemahamannya tentang keanekaragaman mahkluk hidup dan peranannya, virus dan peranannya, penerapan bioteknologi, komponen ekosistem dan interaksi antar komponen serta **perubahan lingkungan.** |
| **Keterampilan Proses** | Keterampilan saintifik yang mencakup<br>(1) mengamati,<br>(2) mempertanyakan dan memprediksi,<br>(3) merencanakan dan melakukan penyelidikan,<br>(4) memproses dan menganalisis data dan informasi,<br>(5) mengevaluasi dan merefleksi, dan<br>(6) mengomunikasikan hasil. |

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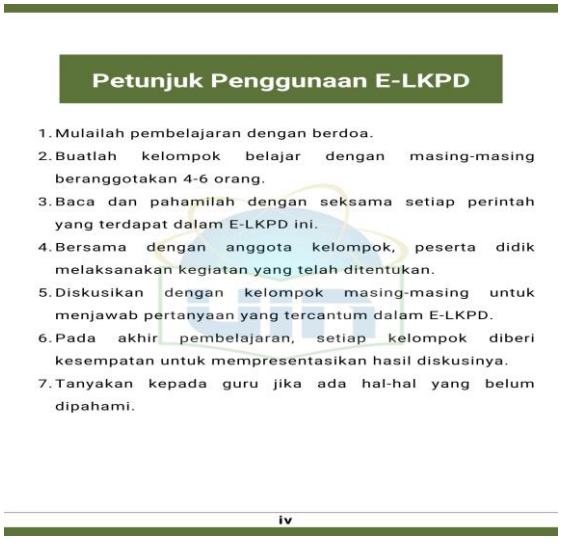
Figure 4. Phase E learning outcomes



## Petunjuk Penggunaan E-LKPD

1. Mulailah pembelajaran dengan berdoa.
2. Buatlah kelompok belajar dengan masing-masing beranggotakan 4-6 orang.
3. Baca dan pahamilah dengan seksama setiap perintah yang terdapat dalam E-LKPD ini.
4. Bersama dengan anggota kelompok, peserta didik melaksanakan kegiatan yang telah ditentukan.
5. Diskusikan dengan kelompok masing-masing untuk menjawab pertanyaan yang tercantum dalam E-LKPD.
6. Pada akhir pembelajaran, setiap kelompok diberi kesempatan untuk mempresentasikan hasil diskusinya.
7. Tanyakan kepada guru jika ada hal-hal yang belum dipahami.

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Figure 5. Instructions for using E-LKPD


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Figure 6. Concept maps


Figure 7. Basic concepts

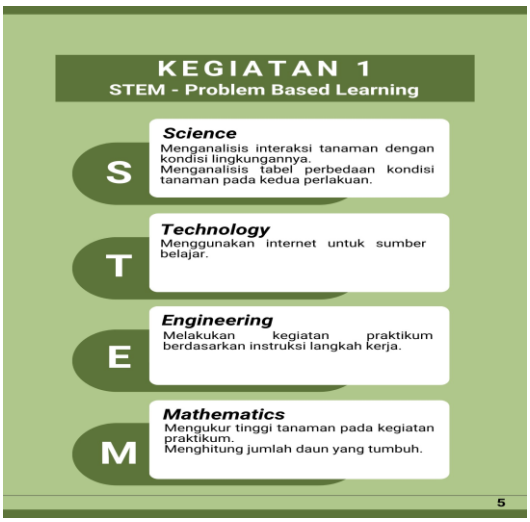


Figure 8. STEM analysis

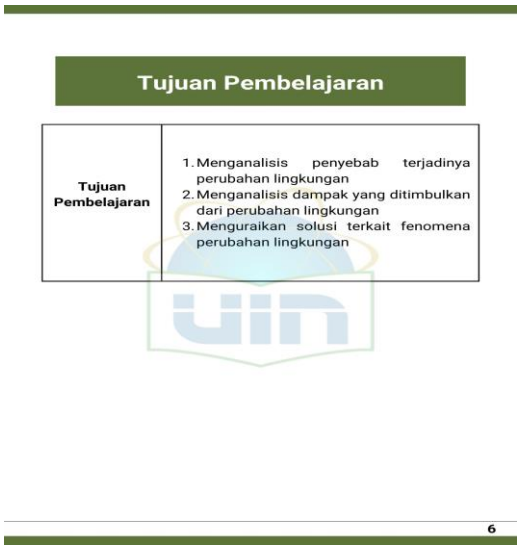


Figure 9. Learning objectives


Figure 10. Core activities

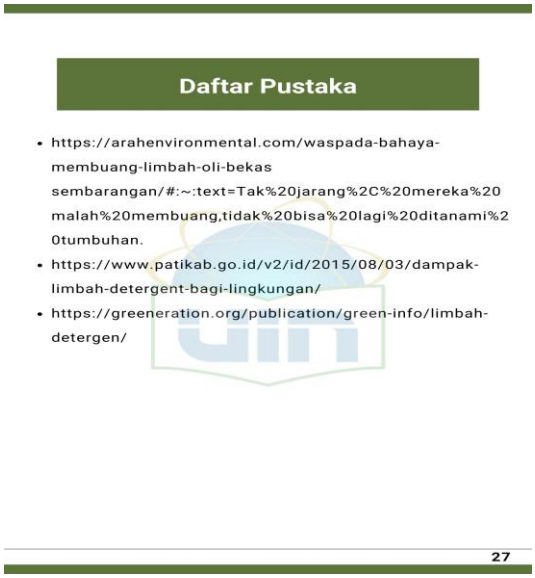


Figure 11. Bibliography

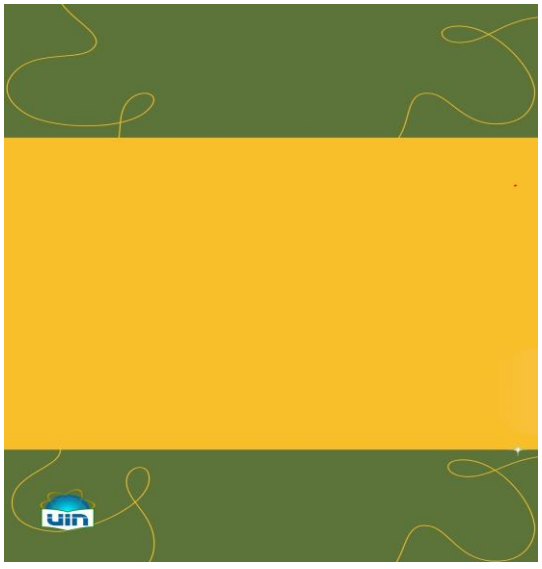

Figure 12. Back cover of E-LKPD


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The third stage of the 4-D development model is the development stage. This stage is the final stage in this research because the dissemination stage was not carried out. This stage consists of expert assessments and development trials. The expert assessment process is carried out by validating the E-LKPD product that has been previously designed through a validity test instrument by experts appropriate to their field. The expert assessment process in this research involved material experts as well as media and design experts. The material expert consists of 2 validators, namely a biology lecturer and a biology teacher. The media and design expert consists of 1 validator, namely a biology lecturer. If the expert assessments are totaled as a whole, then the results of the validity test can be seen in Table 5 below.

Table 5. Total Expert Rating

| Expert | Percentage | Criteria |
|---|---|---|
| Material | 85% | Very worthy |
| Design dan media | 85.5% | Very worthy |
| **Average** | 85.2% | **Very worthy** |

Based on Table 5, the average number of expert assessments of the E-LKPD product being developed reached 85.2% with very feasible criteria.

After an assessment has been carried out by experts, the next step is to carry out the trial phase. Before being tested on a large group, the E-LKPD was first tested for readability on a small group. Small groups consisting of 15 students were taken from the research subjects. There are 3 aspects that can be tested in the readability test, including graphic aspects, appropriateness of content, and linguistics. The recapitulation of the results of this analysis can be seen in Table 6 below.

Table 6. Recapitulation of Readability Test Analysis Results

| Aspect | Percentage | Criteria |
|---|---|---|
| Graphics | 84% | Very worthy |
| Content suitability | 86.6% | Very worthy |
| Linguistics | 88% | Very worthy |
| **Average** | 86.2% | **Very worthy** |

Based on Table 6 above, the linguistic aspect has the highest percentage of 88% with very appropriate criteria. The lowest percentage is in the graphic aspect of 84% with very feasible criteria. The average assessment of these 3 aspects reached 86.2% with very feasible criteria. In this readability test there are also suggestions for improvements to the E-LKPD product being developed.

E-LKPD products that have been applied to the learning process in the classroom will receive responses from teachers and students. Requests for responses were given to the class X biology teacher and all research subjects. Teacher and student response questionnaires have the same 4 aspects, namely practicality, appropriateness of content, graphics and language. The recapitulation of the results of this analysis can be seen in table 7 below.

Table 7. Recapitulation of Teacher Response Questionnaire Analysis Results

| Aspect | Percentage | Criteria |
|---|---|---|
| Practicality | 85% | Very worthy |
| Content suitability | 80% | Worthy |
| Graphics | 80% | Worthy |
| Linguistics | 80% | Worthy |
| **Average** | 81.25% | **Very worthy** |

Based on table 7 above, the highest percentage is in the practical aspect of 85% with very feasible criteria. Meanwhile, the feasibility aspects of content, graphics and language have the same percentage value of 80% with the appropriate criteria. The average assessment of these 4 aspects reached 81.25% with very feasible criteria. This indicates that E-LKPD is easy to use in the learning process. Instructions and work steps for use are systematic and easy to understand. Apart from that, the activities in E-LKPD are simple and easy to do. The average assessment of these 4 aspects reached 81.25% with very feasible criteria.

As many as 35 students were asked for student response questionnaires. Recapitulation of student response questionnaires analysis results can be seen in Table 8 below.

Table 8. Recapitulation of Student Response Questionnaire Analysis Results

| Aspect | Percentage | Criteria |
|---|---|---|
| Practicality | 82.2% | Very worthy |
| Content suitability | 8.4% | Very worthy |
| Graphics | 82% | Very worthy |
| Linguistics | 83.1% | Very worthy |
| **Average** | 82.25% | **Very worthy** |

Based on Table 8 above, the linguistic aspect has the highest percentage of 83,1% with very appropriate criteria. This aspect also occupies the highest percentage in the readability test. This indicates that the E-LKPD being developed uses sentences that are easy to understand, clear, and do not create double (ambiguous) meanings. The average assessment of these 4 aspects reached 82.25% with very feasible criteria. Based on this, it can be seen that the E-LKPD product received a positive response from both teachers and students.

The next stage is the implementation of E-LKPD. In addition to producing teaching material products, this product also seeks to improve literacy skills regarding environmental change material. For E-LKPD products that have passed the readability test, an effectiveness test is carried out which is analyzed using normalized gain or N-gain through pretest and posttest. N-gain analysis is a statistical method used to measure and categorize improvements in student learning outcomes between pretest and posttest (Nurjanah et al., 2024). All subjects of this research took the pretest and posttest. The pretest was conducted before learning the Environmental Change material began. Learning using E-LKPD began after the pretest for 3 meetings. For 1 meeting, the time allocation is 2 lesson hours, where 1 lesson hour lasts for 30 minutes. Then, the posttest was conducted after learning the Environmental Change material was completed.

In the learning process, students get an average score above the minimum completion criteria. Activities 1 and 2 got an average score of 79 while activity 3 got an average score of 73. There was a decrease in scores for activity 3, but in activities 1 and 2 students were able to maintain their scores. This can happen because this research has limited time conditions so that students' grades cannot improve in the learning process. The limited time conditions in this research also caused the N-gain index to have medium criteria. There were some students who did not experience an increase in learning outcomes in the posttest. However, the implementation of STEM-based E-LKPD products in learning has attempted to improve students' scientific literacy skills. This research was able to obtain an N-gain index with medium criteria.

The following is Table 9 below regarding the results of the N-gain index analysis.

Table 9. N-Gain Index Analysis Results.

| ***N-gain* Index** | **Criteria** |
|---|---|
| 0.50 | Medium |

Based on the Table 9 above, the N-gain index obtained a value of 0.50 with medium criteria. This is characterized by an increase between the pretest and posttest scores. The posttest score becomes a reference if there is an improvement so that the E-LKPD developed is proven to be effective in learning (Novitasari et al., 2022).

The increase in N-gain was because the STEM-based E-LKPD in this research was also supported by the PBL model. The application of STEM-based LKPD with the PBL model has an influence on students' scientific literacy abilities. Students' scientific literacy abilities are in the good category after implementing STEM-based LKPD with the PBL model (Fatmawati & Shofiyah, 2022). In addition, this research applies discussion and experimental learning methods related to real-life problems. STEM-based learning can improve students' scientific literacy skills based on strategies implemented in activities. For example, discussing and investigating contextual problems that are then understood by students (Sabila et al., 2023).

This strategy has the same characteristics as the PBL model in that the model presents contextual problems as an initial step in learning so that it can stimulate students to solve these problems. The use of the PBL model can lead to a habit of using problems in learning so that it will be easier to improve students' scientific literacy skills. The application of the PBL model can increase scientific literacy because basically PBL is a constructivist-based learning model so that it helps students mature in concepts. (Imaningtyas et al., 2016). It can be seen from the research results which show that the average value of E-LKPD completion is above the minimum completion


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criteria and the n-gain results are in the medium criteria.

There are a number of factors that influence N-gain within the medium criteria. One of them is limited time in implementing learning (Nuzula & Sudibyo, 2022). To obtain an N-gain index that can reach a range of significant increases in high criteria, it must be given repeated treatment (R. M. M. Putri & Wasis, 2016). Therefore, further efforts are needed to obtain more optimal learning outcomes and increase scientific literacy skills.

## CONCLUSION

Based on the research, it can be concluded that a STEM-based E-LKPD product on environmental change material has been produced with an average assessment of 85.2% with very feasible criteria from the validity test. From the readability test, it received an average assessment of 86.2% with very feasible criteria. This research also has an average assessment of 81.25% with very feasible criteria from teacher responses and 82.25% with very feasible criteria from student responses. The implementation of STEM-based E-LKPD products in learning can improve students' scientific literacy skills based on a normalized gain test of 0.50 with moderate criteria. The final conclusion obtained is that E-LKPD is very feasible to use in the learning process.

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