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ARTICLE

Development of E-LKPD Based on Problem-Based Learning Oriented-Socioscientific Issues to Train Scientific Argumentation Skills in Redox Reaction

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Abstract

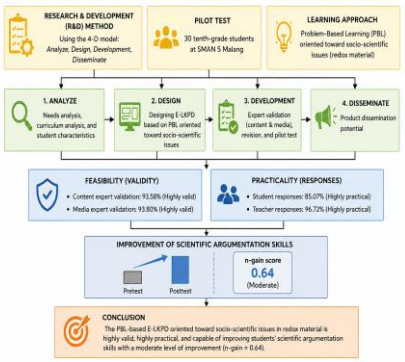
This study aims to describe the design, feasibility, and practicality of, as well as the improvement in, scientific argumentation skills through E-LKPD based on Problem-Based Learning oriented toward socio-scientific issues. The study employed the Research and Development (R&D) method using the 4-D model, which includes the analyze, design, development, and dissemination stages. In the Define stage, an analysis of students' needs, learning characteristics, and redox chemistry content was conducted. In the Design stage, the E-LKPD was designed by integrating PBL syntax, socio-scientific issues, and scientific argumentation activities. In the Develop stage, the E-LKPD was validated by content and media experts and tested for practicality at SMAN 5 Malang. The validation results indicated that the E-LKPD was highly valid, with content and media validation scores of 93.58% and 93.80%, respectively. Student and teacher responses yielded scores of 85.07% and 96.72%, respectively, indicating a very high level of practicality. Furthermore, a trial involving 30 tenth-grade students resulted in an N-gain score of 0.64, categorized as moderate, indicating an improvement in students' scientific argumentation skills. In the Disseminate stage, the developed E-LKPD was distributed to SMAN 5 Malang and other senior high schools in Malang City. The product was also made available through the TopWorksheets platform to broaden access to contextual digital learning materials. Overall, the developed E-LKPD demonstrated high validity and practicality and has the potential to train students' scientific argumentation skills in redox chemistry learning.

Keywords:

E-LKPD; Problem Based Learning; Socioscientific Issues; Redox Reactions; Argumentation Skills

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Graphical Abstract



Introduction

Science education is expected to develop students' ability to understand scientific concepts, evaluate evidence, and use scientific knowledge to address real-world problems. However, Indonesian students continue to face challenges in achieving these competencies. The Programme for International Student Assessment (PISA) 2022 reported a decline in Indonesia's science literacy score from 396 in 2018 to 384 in 2022 (OECD, 2023). One important competency within science literacy is scientific argumentation, which enables students to formulate claims, support their ideas with evidence, and justify conclusions through scientific reasoning (Hidayah et al., 2022). Therefore, chemistry learning needs to provide opportunities for students to engage actively in evidence-based discussions and construct scientific arguments rather than merely memorize concepts or follow calculation procedures.

These challenges are particularly relevant to redox reaction learning, which involves abstract concepts such as electron transfer, oxidation numbers, and the identification of oxidizing and reducing agents (Ngh et al., 2018). Based on the needs analysis conducted in this study, 80.2% of students experienced difficulties in learning redox reactions, particularly in determining oxidation numbers and balancing redox equations. Furthermore, 77.4% of students reported that they were not very active in expressing their opinions, while 72.7% were not accustomed to providing scientific justifications during learning activities. These findings indicate that students need learning experiences that facilitate conceptual understanding and provide structured opportunities to formulate, explain, and defend scientific arguments (Ban & Mahmud, 2023). Such opportunities are essential for connecting chemical concepts with evidence-based reasoning (Dewi et al., 2019; Wibawa et al., 2018).

The existing instructional materials also indicate a need for improvement. The student needs analysis revealed that 80% of students considered the worksheets currently used insufficient to support deep conceptual understanding. In addition, the teacher's need analysis indicated that the existing worksheets were not adequately contextualized and did not sufficiently connect chemical concepts with problems encountered in everyday life. The use of digital learning materials, particularly electronic student worksheets (E-LKPD), also remained limited. These conditions suggest a gap between students' learning needs and the instructional support currently available. Learning materials that primarily facilitate procedural problem-solving may not provide sufficient opportunities for students to investigate authentic problems, evaluate relevant evidence, and develop scientifically justified arguments (Johnson et al., 2020). Consequently, the development of an interactive and contextually relevant E-LKPD is needed to support a more active, meaningful, and argumentation-oriented chemistry learning process (Dawson & Carson, 2020; Rahayu et al., 2022).

Method

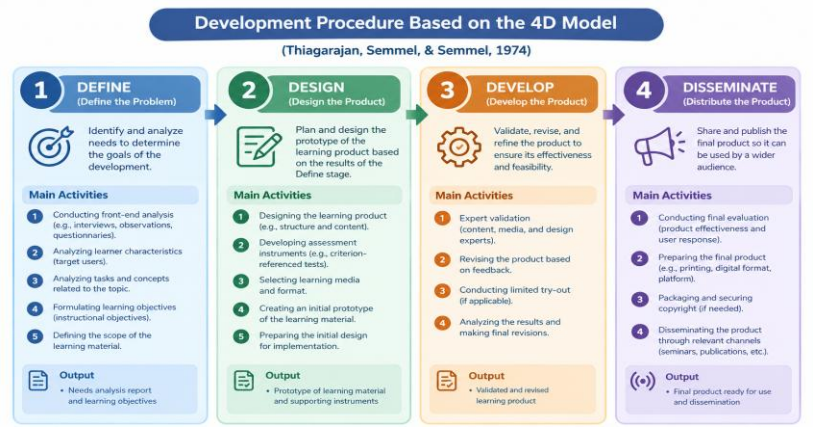


Figure 2. Development Procedure Based on the 4D Model (Thiagarajan et al., 1974)

This study employs a Research and Development (R&D) approach, adapting the 4D model. This development model consists of four stages: define, design, develop, and disseminate (Thiagarajan et al., 1974). The study focused on developing a problem-based learning (PBL)-based electronic student worksheet (E-LKPD) incorporating socio-scientific issues.

The research subjects consisted of two subject-matter and media experts, two chemistry teachers, and 20 students from SMAN 5 Malang. The research object was the PBL-based E-LKPD incorporating socio-scientific issues. Data sources included expert validation questionnaires and user-response questionnaires assessed using a Likert scale. Expert validation data were used to evaluate the validity of the developed E-LKPD, while user-response data were used to assess users' responses to the product. A limited trial involving 20 students was conducted at SMAN 5 Malang to examine the practicality of the E-LKPD, collect student responses, and assess potential improvements in scientific argumentation skills. The data from the validation questionnaires and response questionnaires obtained were calculated using the following formula:

$$\text{Percentage} = \frac{Skor\ obtained}{Maksimum\ score} \times 100\%$$

(Riduwan, 2007)

Once the validation percentage is obtained, the value is interpreted based on the E-LKPD validity criteria. The validity criteria are shown in Table 1.

Table 1. Validity Criteria

Percentage (%)	Criteria
81 - 100	Very Valid
61 - 80	Valid
41 – 60	Fairly Valid
21 - 40	Less Valid
0 - 21	Very Invalid

(Riduwan, 2015)

Next, the percentage of data obtained from the analysis of survey responses to the developed E-LKPD was interpreted based on its practicality, as shown in Table 2.

Table 2. User Response Criteria

Percentage	Criteria
81-100	Very Practical
61-80	Practical
41-60	Fairly Practical
21-40	Less Practical
0-20	Very Impractical

(Riduwan, 2015)

The pilot study also yielded data in the form of pretest and posttest scores. This data was analyzed using preliminary tests, including a normality test, a Wilcoxon test, and an N-gain score. The Wilcoxon test was conducted to determine whether the use of PBL-based E-LKPD had an effect on scientific argumentation skills. Meanwhile, the N-gain score test was used to determine the improvement in the use of PBL-based E-LKPD oriented toward socio-scientific issues. The N-gain score can be calculated using the formula:

$$g = \frac{Spost - Spre}{Sm\ ideal - Spre}$$

(Hake, 1998)

The calculated N-gain values are then interpreted based on the criteria levels in Table 3.

Table 3. N-gain Interpretation Criteria

Percentage	Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	Medium
g < 0,3	Low

(Hake, 1998)

Results & Discussion

This development study aimed to produce an E-LKPD in the form of a Top Worksheets website based on problem-based learning and focused on socio-scientific issues in redox reaction material. The E-LKPD was developed using the 4-D model. The results and discussion of each development stage are presented as follows.

Define Stage

The define stage was conducted to analyze learning needs as the basis for developing the E-LKPD. Based on the analysis of the student needs-assessment questionnaire, 80.2% of students experienced difficulties in learning redox reactions, particularly in determining

oxidation numbers and balancing redox equations. These findings indicate that most students consider redox reactions to be a difficult topic. These difficulties are associated with the abstract nature of the material, including determining oxidation numbers, understanding electron transfer, and identifying oxidizing and reducing agents.

Furthermore, the questionnaire results showed that 63.2% of students were more interested in learning activities related to environmental and social issues. In addition, 70.7% of students stated that their understanding of the material improved when the learning process involved solving real-world problems, while 84% reported that group discussions helped improve their understanding. Therefore, learning materials that provide contextualized learning experiences, incorporate problem-solving activities, and are designed to develop students' argumentation skills are needed.

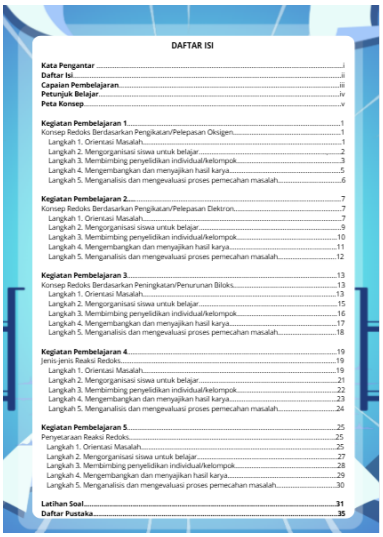
Based on the analysis of the student needs-assessment questionnaire regarding argumentation skills, 77.4% of students reported that they were not sufficiently active in expressing their opinions. Furthermore, 72.7% of students were not accustomed to providing scientific reasoning when expressing their opinions during the learning process. These findings indicate that students were not accustomed to constructing structured arguments supported by logical reasoning. Therefore, students' scientific argumentation skills need to be trained more systematically.

In addition, the learning materials currently in use had not fully supported optimal conceptual understanding. As many as 80% of students reported that the student worksheets currently used primarily helped them solve procedural problems. Based on the analysis of the teacher needs-assessment questionnaire, the existing student worksheets had not been designed contextually or connected chemical concepts with various real-world problems encountered in students' surroundings. Furthermore, the use of digital learning materials, particularly E-LKPD, remained limited, despite their potential to improve interactivity and flexibility throughout the learning process.

Design Stage

The design phase was conducted to develop a preliminary design for a PBL-based redox E-LKPD oriented toward socio-scientific issues to train students' scientific argumentation skills. This phase comprised four activities: developing a benchmark test, selecting instructional media, determining the format, and drafting the preliminary product design. The benchmark test was designed by aligning the questions with the scientific argumentation skill indicators and learning objectives formulated in the define stage, using an evaluative instrument consisting of argumentative essay questions on redox material presented via Google Forms. The choice of media was made with a focus on the need for interactive digital learning, leading to the selection of a web-based E-LKPD using Top Worksheets. This approach enables students to complete the E-LKPD directly and interactively.

Furthermore, the E-LKPD format was designed in accordance with the PBL stages and integrated socio-scientific issues related to redox material. The format included learning objectives, learning instructions, learning activities, and an assessment of scientific argumentation skills. This phase resulted in an E-LKPD prototype with a systematic structure and an engaging visual presentation, which served as the basis for the subsequent development phase.



DAFTAR ISI

Kata Pengantar i
Daftar Isi ii
Capaian Pembelajaran iii
Petunjuk Belajar iv
Peta Konsep v

Kegiatan Pembelajaran 1 1
Konsep Redoks Berdasarkan Pengikatan/Pelepasan Oksigen 1
Langkah 1. Orientasi Masalah 1
Langkah 2. Mengorganisasi siswa untuk belajar 2
Langkah 3. Membimbing penyelidikan individual/kelompok 3
Langkah 4. Mengembangkan dan menyajikan hasil karya 5
Langkah 5. Menganalisis dan mengevaluasi proses pemecahan masalah 6

Kegiatan Pembelajaran 2 7
Konsep Redoks Berdasarkan Pengikatan/Pelepasan Elektron 7
Langkah 1. Orientasi Masalah 7
Langkah 2. Mengorganisasi siswa untuk belajar 9
Langkah 3. Membimbing penyelidikan individual/kelompok 10
Langkah 4. Mengembangkan dan menyajikan hasil karya 11
Langkah 5. Menganalisis dan mengevaluasi proses pemecahan masalah 12

Kegiatan Pembelajaran 3 13
Konsep Redoks Berdasarkan Peningkatan/Penurunan Biloks 13
Langkah 1. Orientasi Masalah 13
Langkah 2. Mengorganisasi siswa untuk belajar 15
Langkah 3. Membimbing penyelidikan individual/kelompok 16
Langkah 4. Mengembangkan dan menyajikan hasil karya 17
Langkah 5. Menganalisis dan mengevaluasi proses pemecahan masalah 18

Kegiatan Pembelajaran 4 19
Jenis-jenis Reaksi Redoks 19
Langkah 1. Orientasi Masalah 19
Langkah 2. Mengorganisasi siswa untuk belajar 21
Langkah 3. Membimbing penyelidikan individual/kelompok 22
Langkah 4. Mengembangkan dan menyajikan hasil karya 23
Langkah 5. Menganalisis dan mengevaluasi proses pemecahan masalah 24

Kegiatan Pembelajaran 5 25
Penyetaraan Reaksi Redoks 25
Langkah 1. Orientasi Masalah 25
Langkah 2. Mengorganisasi siswa untuk belajar 27
Langkah 3. Membimbing penyelidikan individual/kelompok 28
Langkah 4. Mengembangkan dan menyajikan hasil karya 29
Langkah 5. Menganalisis dan mengevaluasi proses pemecahan masalah 30

Latihan Soal 31
Daftar Pustaka 35

Figure 3. Format for Compilation

This study produced an E-LKPD in the form of a Top Worksheet website based on problem-based learning oriented toward socio-scientific issues in the subject of redox reactions. The E-LKPD presents learning activities in a systematic manner. The components of the E-LKPD consist of a cover page, a preface, a table of contents, an overview of learning outcomes and objectives, study guidelines, learning activities 1 through 5, practice questions, and a bibliography. At the beginning of each learning activity, the learning outcomes and sequence of learning objectives are presented, structured in accordance with curriculum guidelines. The following is the design of the resulting E-LKPD.



Figure 4. E-LKPD Title Page



Kata Pengantar

Assalamualaikum Wr. Wb.

Puji syukur alhamdulillah senantiasa penulis panjatkan kepada Allah SWT yang telah memberikan limpahan rahmat dan karunia-Nya sehingga penulis dapat menyelesaikan E-LKPD dengan judul "Pengembangan E-LKPD Redoks berbasis Problem Base learning berorientasi isi sosiosaintifik untuk melatih keterampilan argumentasi ilmiah". Sholawat serta salam semoga tetap tercurah kepada Nabi Muhammad SAW. yang telah membimbing umat islam ke jalan yang terang benderang.

E-LKPD Redoks berbasis Problem Base learning berorientasi isi sosiosaintifik ini berisi tentang petunjuk penggunaan E-LKPD, peta konsep, Pendahuluan, Kegiatan-kegiatan pembelajaran, Kegiatan Pembelajaran Problem Base learning pada materi Redoks dan penjelasan materi yang terintegrasi isu sosiosaintifik. Tujuan pembuatan E-LKPD untuk memudahkan peserta didik dalam mempelajari materi Redoks dengan model pembelajaran problem base learning berorientasi isi sosiosaintifik untuk melatih keterampilan argumentasi ilmiah.

Penulis menyampaikan terima kasih kepada Nur Candra Eka Setiawan, S.Si., S.Pd., M.Pd., Ph.D selaku pembimbing serta semua pihak yang telah membantu dalam pembuatan E-LKPD ini. Penulis menyadari sepenuhnya bahwa dalam penyusunan E-LKPD ini terdapat banyak kekurangan, karena penulis hanyalah manusia biasa yang jauh dari kata sempurna. Oleh karena itu, penulis menghorapkan kritik dan saran yang membangun guna perbaiki E-LKPD ini.

Akhir kata, semoga E-LKPD ini dapat bermanfaat bagi penulis khususnya dan bagi semua pihak pada umumnya.
Wassalamu'alaikum Wr.Wb.

Malang, 18 November 2025

Penulis

Figure 5. E-LKPD Introduction



Capain Pembelajaran

Peserta didik mampu mengamati, menyelidiki dan menjelaskan fenomena sesuai kaidah kerja ilmiah dalam menjelaskan konsep kimia dalam kehidupan sehari hari; menerapkan konsep kimia dalam pengelolaan lingkungan termasuk menjelaskan fenomena pemanasan global; menuliskan reaksi kimia dan menerapkan hukum-hukum dasar kimia; memahami struktur atom dan aplikasinya dalam nanoteknologi.

Alur Tujuan Pembelajaran

- Menjelaskan konsep reaksi reduksi oksidasi.
- Menjelaskan reaksi reduksi oksidasi berdasarkan pengikatan dan pelepasan oksigen, penangkapan dan pelepasan elektron dan perubahan biloks.
- Menentukan oksidator dan reduktor dari persamaan reaksi reduksi oksidasi
- Menjelaskan konsep autoredoks
- Menentukan bilangan oksidasi (biloks)
- Menyetarakan persamaan reaksi reduksi oksidasi menggunkana metode setengan reaksi dan perubahan biloks

Figure 6. Learning Outcomes and Learning Objective Sequence



Petunjuk Belajar

1. Bacalah dan pahami petunjuk belajar ini terlebih dahulu agar dapat menggunakan E-LKPD secara optimal.
2. Gunakan fitur zoom atau scroll pada perangkat apabila tulisan, gambar, atau video kurang terlihat jelas.
3. Perhatikan dengan cermat isu sosiosaintifik dan fenomena yang disajikan pada setiap kegiatan pembelajaran.
4. Identifikasilah permasalahan yang muncul dari isu tersebut dan pahami kaitannya dengan konsep reaksi redoks.
5. Lakukan kegiatan penyelidikan dan diskusi dengan rasa ingin tahu, jujur, teliti, tekun, dan bertanggung jawab.
6. Kumpulkan serta analisis data atau informasi yang diperoleh untuk menjawab pertanyaan yang disajikan.
7. Susun jawaban dalam bentuk argumentasi ilmiah yang memuat klaim, data/bukti, dan alasan ilmiah yang logis.
8. Diskusikan hasil pekerjaan bersama kelompok dan hargai perbedaan pendapat yang muncul.
9. Buatlah kesimpulan berdasarkan hasil penyelidikan,dan argumentasi yang telah disusun.
10. Kerjakan seluruh aktivitas dalam E-LKPD ini dengan sungguh-sungguh agar Anda dapat memahami materi Reaksi Reduksi Oksidasi secara komprehensif.

Figure 7. Study Guide



Figure 8. Redox Reaction Concept Map

Step 1. Problem Orientation

This step presents readings on socio-scientific issues in our surrounding environment that are related to the topic of redox reactions. This step serves to establish connections between chemical concepts and social reality, thereby making learning more meaningful, activating students' prior knowledge, and fostering curiosity about the material. The teacher guides students in identifying the core of the problem and helps them formulate the problem statement. This guidance ensures that the resulting problem statement is more structured, clear, and aligned with the learning objectives.



Figure 9. Step 1. Problem Orientation

Step 2. Organizing Students for Learning

In this step, students are guided to work together in small groups of 4–5 members at a time to determine the steps for solving a problem presented by answering the questions provided in the E-LKPD.

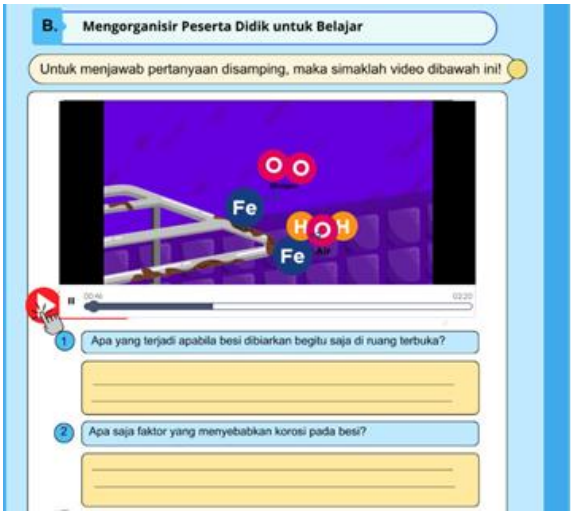


Figure 10. Step 2. Organizing Students

Step 3. Guiding Group/Individual Research

In this step, students analyze and compile various data and information to answer the research question by developing the components of scientific argumentation facilitated within the E-LKPD, including claims, data, warrants, backing, rebuttals, and qualifiers. This step plays a crucial role in training students to logically, systematically, and structurally connect evidence with scientific concepts.



Figure 11. Step 3. Guiding the Investigation

Step 4. Developing and Presenting the Final Product

This step focuses on students' activities in processing and presenting the results of their investigations in the form of an infographic or scientific poster. This step is designed to help students communicate ideas scientifically and present arguments in a coherent and

structured manner. The results show that students are able to fully integrate the components of scientific argumentation into a communicative poster.



Figure 12. Step 4. Developing and Presenting the Final Product

Step 5. Analyzing and Evaluating the Problem-Solving Process

In this step, students are guided to present the scientific arguments they have developed, after which other groups provide responses, suggestions, and feedback on the arguments presented. This step aims to evaluate the accuracy of the data, the validity of the reasoning, and the strength of the conclusions in the scientific arguments. In this activity, the teacher acts as a facilitator in guiding the discussion and reinforcing concepts. Through this process, students can improve the quality of their scientific arguments and develop the ability to reflect on each step of the problem-solving process.



Figure 13. Step 5. Analyzing and Evaluating the Problem-Solving Process

Development Stage

The development stage involved evaluating the product through a validation process conducted by subject matter experts and media experts. The validation results showed that the E-LKPD developed was rated as “highly valid.” This indicates that the E-LKPD is suitable for use in instruction. The product was then revised by incorporating suggestions from both

validators before being subjected to a limited trial with students to determine its level of practicality of using the E-LKPD.

E-LKPD Validation Results

The validation of the problem-based learning-based E-LKPD on redox reactions, which is oriented toward socio-scientific issues, was conducted through an assessment by one chemistry lecturer from Malang State University and one chemistry teacher at SMAN 5 Malang. The validity of the E-LKPD was determined through validation by subject matter experts and media experts. The results of the E-LKPD validation are presented in Tables 4 and Table 5 below.

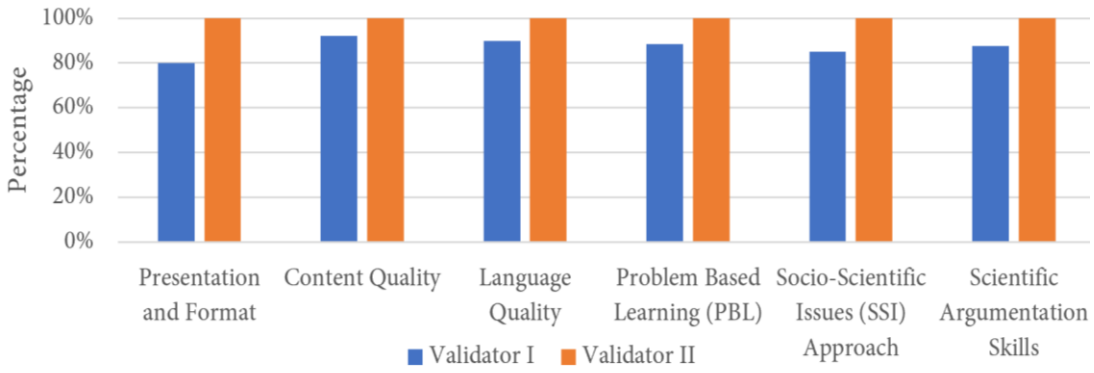


Figure 11. Comparison Chart of Validations I and II by Matter Expert Validators

Table 4. E-LKPD Validation Results by Subject Matter Experts

Assessment Criteria	Assessment Score (%)	Category
Presentation and Format	90%	High Valid
Content Quality	96%	High Valid
Language Quality	95%	High Valid
Problem Based Learning (PBL)	94,28%	High Valid
Socio-Scientific Issues (SSI) Approach	92,5%	High Valid
Scientific Argumentation Skills	93,75%	High Valid
Average (%) and Total Criteria	**93,58%**	**High Valid**

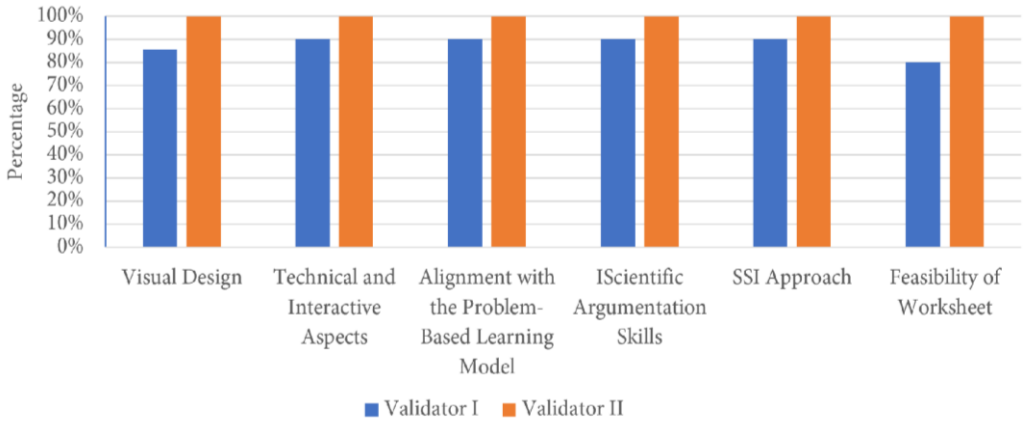


Figure 11. Comparison Chart of Validations I and II by Media Expert Validators

Table 5. Results of the E-LKPD Validation by Media Experts

Assessment Criteria	Assessment Score (%)	Category
Visual Design	92,85%	High Valid
Technical and Interactive Aspects	95%	High Valid
Alignment with the Problem-Based Learning Model	95%	High Valid
Integration of Socioscientific Issues (SSI)	95%	High Valid
Scientific Argumentation Skills	95%	High Valid
Feasibility of Worksheet	90%	High Valid
Average (%) and Total Criteria	**93,80%**	**High Valid**

The analysis results show that the validation score for the subject matter expert was 93.58% and for the media expert was 93.80%; therefore, it can be concluded that the problem-based learning-based redox E-LKPD, which is oriented toward socio-scientific issues to train scientific argumentation skills, is suitable for use. Furthermore, products that have been deemed suitable based on the validation results can proceed to the limited pilot testing phase. Feedback in the form of comments and suggestions from the validators was used as the basis for revising and refining the developed learning media to further optimize the product's quality.

Results of the Student and Teacher Response Survey on the E-LKPD

The E-LKPD response survey was conducted by distributing questionnaires to 30 10th-grade students at SMAN 5 Malang to determine their responses regarding the practicality of the developed worksheet. The results of the student and teacher response surveys regarding the worksheet are presented in Table 12 below.

Table 6. Results of the Student Response Survey Regarding the E-LKPD

Evaluation Criteria	Evaluation Score (%)	Category
Appeal (appearance/design)	86,66%	High Practical
Ease of use	86%	High Practical
Clarity of content/material and instructions	83,50%	High Practical
Usefulness	84,14%	High Practical
Average (%) and Total Score	**85,07%**	**High Practical**

Table 7. Results of the Teacher Survey on E-LKPD

Evaluation Aspect	Evaluation Results (%)	Category
Appeal (appearance/design)	96,66%	High Practical
Ease of use	96,66%	High Practical
Clarity of content/material and instructions	95%	High Practical
Usefulness	98,57%	High Practical
Average (%) and Total Criteria	**96,72%**	High Practical

Based on the results of the response questionnaire, the developed E-LKPD received an average score of 85.07% from students and 96.72% from teachers, which falls into the "practical" category. This indicates that the developed E-LKPD is highly practical for use in chemistry instruction.

Results of the Normality Test

A pilot study was conducted to determine the effectiveness of problem-based learning-based E-LKPDs focused on socio-scientific issues in developing scientific argumentation skills. The results of the normality test for the LKPDs are shown in the following Table 8

Table 8. Results of the Normality Test

Result Data	Shapiro-Wilk		
	Statistic	df	Sig
Pretest	.950	30	.170
Posttest	.811	30	.000

Based on the results of the normality test using the Shapiro-Wilk method chosen because the sample size was less than 50 (N = 30)—it was found that the pretest data on argumentation skills had a significance value of 0.170 ($p > 0.05$), indicating that the data are normally distributed. Meanwhile, the posttest data showed a significance value of 0.000 ($p < 0.05$), indicating that the data were not normally distributed. Thus, it can be concluded that the assumption of normality was not met overall. Therefore, the subsequent statistical analysis does not use a parametric test but instead uses a non-parametric test, namely the Wilcoxon Signed Rank Test, which is suitable for paired data with a non-normal distribution.

Results of the Wilcoxon Test

Table 9. Results of the Wilcoxon Test

Comparison	rank category	N	Mean Rank	Sum of Ranks
Posttest on Argumentation Skills – Pretest on Argumentation Skills	Negative Ranks	0[a]	.00	.00
	Positive Ranks	30[b]	15.50	465.00
	Ties	0[c]		
	Total	30		

The results indicate that all students (N = 30) demonstrated improved scientific reasoning skills following the intervention. The absence of negative ranks suggests that there was no decline in learning outcomes, while the predominance of positive ranks (100%) indicates that the use of the instructional tool specifically, the Problem-Based Learning E-LKPD focused on socio-scientific issues had a consistent positive effect on enhancing students' abilities.

Table 10. Results of the Wilcoxon Signed-Rank Test

Test statistic	Posttest on Argumentation Skills – Pretest on Argumentation Skills
Z	-4.783[b]
Asymp.Sig.(2-tailed)	.000

The results of the analysis using the Wilcoxon Signed-Rank Test indicate that there is a significant difference between students' pretest and posttest scores on argumentation skills. This is indicated by a Z-value of -4.783 with a significance level (Asymp. Sig. 2-tailed) of 0.000, which is smaller than the significance level of 0.05. Thus, the null hypothesis (H_0), which states that there is no difference, is rejected, and the alternative hypothesis (H_1) is accepted. This indicates that the treatment or learning intervention provided has produced a significant change in students' argumentation skills.

N-gain Score Test Results

Table 11. N-gain Score Test Results

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Ngainscore	30	.05	.94	.6480	.29428
Ngainpercentage	30	5.27	93.88	64.8000	29.42755
Valid N (listwise)	30				

Note: An N-Gain Score analysis was conducted to measure the extent of improvement in students' scientific argumentation skills. Based on the calculation results, an average N-Gain score of 0.6480, or 64.80%, was obtained; this value falls within the moderate category ($0.3 \leq$ N-Gain < 0.7). This indicates that the improvement in students' argumentation skills is in the moderate category, meaning that the implemented instruction was sufficiently effective in enhancing students' scientific argumentation skills

Disseminate Stage

The dissemination stage was carried out by distributing the developed PBL-based E-LKPD, which integrates socio-scientific issues into redox reaction material, to SMAN 5 Malang and senior high schools in Malang City. In addition, the product was made available through the Top Worksheets platform to enable broader access by users. This dissemination is expected to expand the use of digital learning materials that integrate contextual problems with opportunities to practice scientific argumentation skills in chemistry learning. As an effort to protect the outcomes of the development process, the E-LKPD was also registered for intellectual property rights (IPR) protection. Thus, product dissemination encompasses both expanding access to digital learning materials and protecting innovations in chemistry education.

Conclusion

The development of Problem-Based Learning (PBL)-based E-LKPDs focused on socio-scientific issues using the 4D model yielded a very high level of validity, with a rating of 93.58% from subject matter experts and 93.80% from media experts, thereby deeming the developed product suitable for use. Furthermore, survey results indicate that the E-LKPD received positive feedback from students at 85.07% and from teachers at 96.72%, suggesting that the product is practical for implementation in chemistry instruction. The n-gain test

result of 64.80%, falling into the moderate category, indicates that the developed E-LKPD is sufficiently effective in enhancing students' scientific argumentation skills.

AI-assisted technology statement

In preparing this work, the author utilized ChatGPT as a tool to improve linguistic clarity, grammar, and academic writing style, particularly in the abstract, research methods, and discussion sections. All results generated by the tool were subsequently reviewed and edited by the author as needed, so that full responsibility for the content of this publication remains with the author.

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Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The funder had no role in the design of the study; the collection, analysis, or interpretation of data; the writing of the manuscript; or the decision to submit the manuscript for publication.

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