Vol 15 (2), 2026, 10- 25 DOI: 10.23960/jppkv2.1522
Jurnal Pendidikan dan Pembelajaran Kimia
e-ISSN: 2714-9595| p-**ISSN 2302-1772**
http://jurnal.fkip.unila.ac.id/index.php/JPK/index

Development of Acid Base e-Worksheet Based on Problem Based Learning Integrated with Batak Toba Ethnoscience to Improve Students' Scientific Literacy Skills

Citra Kudadiri*, Moondra Zubir

Departement Chemistry Education, Faculty of Mathematics and Natural Sciences,
Universitas Negeri Medan,
Jl. Willem Iskandar Pasar V Medan Estate, Percut Sei Tuan, Deli Serdang, North Sumatra.

*Correspondinge-mail: citrakudadiri@gmail.com, moondra@unimed.ac.id

Received: June 3rd, 2026 Accepted: July 22nd, 2026 Online Published: August 11th, 2026

Abstract: Development of Acid Base e-Worksheet Based on Problem Based Learning Integrated with Batak Toba Ethnoscience to Improve Students' Scientific Literacy Skills. This study aims to analyze the feasibility of an e-worksheet based on *Problem Based Learning* (PBL) integrated with Batak Toba ethnoscience in improving students' scientific literacy skills on acid–base material, its effectiveness in enhancing students' scientific literacy skills, and students' responses toward the use of the developed e-worksheet. The research method employed was *Research and Development* (R&D) using the ADDIE model, which consists of the stages of *analysis, design, development, implementation,* and *evaluation*. The research subjects were 34 students of class XI-C at SMAN 17 Medan. The research instruments included validation sheets, scientific literacy tests, and student response questionnaires. The test instrument was examined in terms of validity, reliability, difficulty level, discrimination index, and distractor effectiveness. The results showed that the developed e-worksheet was declared feasible for use with a validation percentage of 89.23%, which falls into the very feasible category. The practicality of the e-worksheet was indicated by students' responses, obtaining a percentage of 82.19% in the very good category. The effectiveness of the e-worksheet was demonstrated by the increase in students' average scores from 54.11 in the *pretest* to 83.33 in the *posttest*, an *N-Gain* value of 0.6394 in the moderate category, and the result of the *One Sample t-Test*, which showed that the value of t_{count} was 10.77, greater than the value of t_{table} of 1.697. These findings indicate that the PBL based e-worksheet integrated with Batak Toba ethnoscience was able to improve students' scientific literacy skills on acid base material.

Keywords: acid base, Batak Toba ethnoscience, e worksheet, *Problem Based Learning*, scientific literacy.

Abstrak: Pengembangan e-LKPD Asam Basa Berbasis Problem Based Learning Terintegrasi Etnosains Batak Toba untuk Meningkatkan Kemampuan Literasi Sains Siswa. Penelitian ini bertujuan untuk menganalisis kelayakan e-LKPD berbasis *Problem Based Learning* (PBL) terintegrasi etnosains Batak Toba dalam meningkatkan kemampuan literasi sains siswa pada materi asam basa, efektivitasnya terhadap peningkatan kemampuan literasi sains siswa, serta respon siswa terhadap penggunaan e-LKPD tersebut. Metode penelitian yang digunakan adalah *Research and Development* (R&D) dengan model ADDIE yang meliputi tahap *analysis, design, development, implementation,* dan *evaluation*. Subjek penelitian terdiri atas 34 siswa kelas XI-C SMAN 17 Medan. Instrumen penelitian meliputi lembar validasi, tes literasi sains, dan angket respon siswa. Instrumen tes diuji validitas, reliabilitas, tingkat kesukaran, daya pembeda, dan

efektivitas pengecoh (*distractor*). Hasil penelitian menunjukkan bahwa e-LKPD yang dikembangkan dinyatakan layak digunakan dengan persentase validasi sebesar 89,23% yang termasuk dalam kriteria sangat layak. Kepraktisan e-LKPD ditinjau dari hasil respon siswa yang memperoleh persentase sebesar 82,19% dengan kategori sangat baik. Keefektifan e-LKPD ditunjukkan melalui peningkatan nilai rata-rata siswa dari 54,11 pada *pretest* menjadi 83,33 pada *posttest*, nilai *N-Gain* sebesar 0,6394 dalam kategori sedang, serta hasil uji *One Sample t-Test* yang menunjukkan nilai t_{hitung} sebesar 10,77 lebih besar dari t_{tabel} sebesar 1,697. Hasil tersebut menunjukkan bahwa e-LKPD berbasis PBL terintegrasi etnosains Batak Toba mampu meningkatkan kemampuan literasi sains siswa pada materi asam basa.

Kata kunci: asam basa, e-LKPD, etnosains Batak Toba, literasi sains, *Problem Based Learning*.

▪ INTRODUCTION

In the modern era, the world of education bears a significant responsibility to equip the younger generation with the skills necessary to face dynamic global changes. Students are now required not only to master theoretical material but also to possess a willingness for lifelong learning, innovation, and proficiency in utilizing technology as a vital life skill. One of the primary competencies that must be developed in today's education system is scientific literacy. Scientific literacy is not merely the ability to read or write scientific terms; rather, it is how students can think critically in analyzing information, posing scientific questions, and explaining various phenomena based on scientific concepts supported by empirical evidence (Mutiah et al., 2024). With sound scientific literacy, students are expected to make logical decisions based on scientific facts in their daily lives (Odah & Yuniarti, 2023).

The 2022 Programme for international Student Assessment (PISA) survey results indicate that the scientific literacy levels of students in Indonesia still require serious attention. With an average score of 383, Indonesia ranks 67th out of 81 participating countries (OECD, 2023, 2025). This low achievement suggests that most students still encounter obstacles in understanding and applying scientific principles to real world situations, often triggered by learning methods that emphasize conceptual rote learning and fail to connect lessons with the real life phenomena familiar to students (Limiansih et al., 2024; Nurhayati & Kurniawati, 2024; Ramdani et al., 2020; Sutrisna, 2021). This condition is also evident in the topic of acid base chemistry for Grade XI, which is perceived as abstract and involves complex mathematical calculations (Septiana et al., 2025; Azizah et al., 2021; Nofiarti, 2021). Observations at SMAN 17 Medan reveal a significant research gap, while students are surrounded by rich cultural practices, teaching materials remain limited to conventional textbooks and printed worksheets that do not fully incorporate problems relevant to their daily cultural context.

A relevant learning model to address this issue is Problem Based Learning (PBL), which is focuses on learning through real world problems so that students are motivated to construct their understanding independently (Dal et al., 2024). Efforts to create more meaningful learning can be achieved by integrating the PBL model with an ethnoscience approach, an approach that connects traditional knowledge in society with modern scientific concepts (Febriningtyas & Dwiningsih, 2024). Previous research has demonstrated that ethnoscience integration is generally effective in boosting learning motivation, strengthening conceptual mastery, and honing students' scientific literacy

skills (Hidayah et al., 2025). In this study, this approach is specially applied to Batak Toba culture, where chemical principles are reflected in traditional practices such as the processing of *Na Niura* and *Na Niarsi*k, as well as the consumption of *tuak*.

The novelty of this research lies in the specific reconstruction of these Batak Toba traditional practices into a digital platform. While advancement in digital technology allow for use for electronic based teaching materials, such as e-Worksheet (e-LKPD), to enhance literacy (Ika et al., 2025; Maharani & Suryani, 2025; Sahadah, 2024; Ramdani et al., 2020; Eviota & Liangco, 2020). The integration of Batak Toba ethnoscience within an HTML 5 base PBL framework remains unexplored. Therefore, the development of an Acid Base e-Worksheet Based on Problem Based Learning Integrated with Batak Toba Ethnoscience is essential. This innovation is designed to create a unique, contextual chemistry learning environment that strengthens students' recognition of their local identity while effectively improving their scientific literacy skills.

▪ METHOD

Research Design and Subjects

This study is a Research and Development (R&D) project aimed at producing an e- Worksheet product for acid base material. The development model employed is the ADDIE model, which is consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. The systematic procedure for this development is illustrated in Figure 1 below:

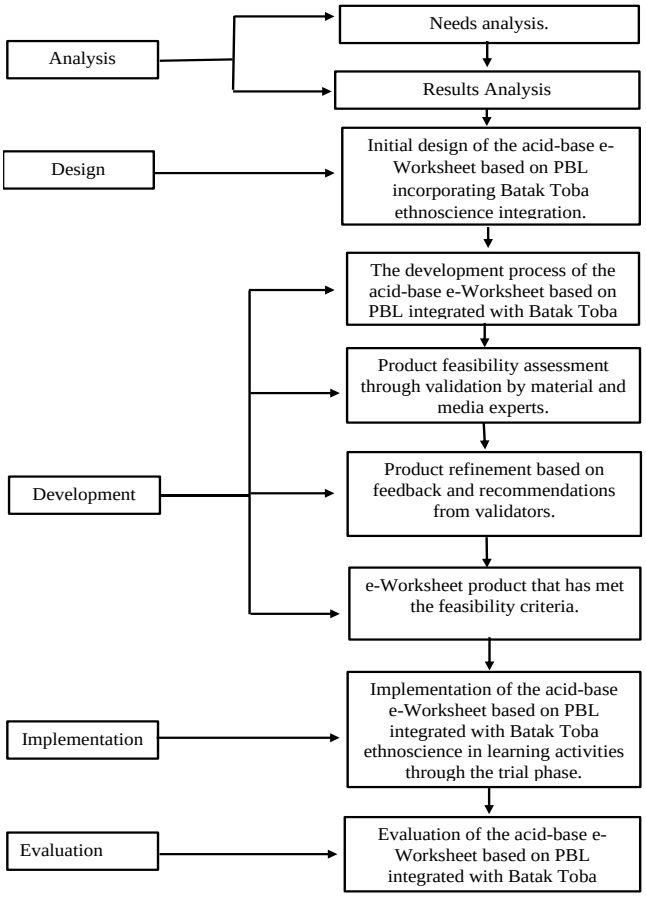


Figure 1. Procedure for Developing an e-Worksheet based on PBL integrated with

Batak Toba ethnoscience

The research was conducted at SMAN 17 Medan during the even semester of the 2025/2026 academic year. The subjects of this study included expert validators (chemistry lectures from Universitas Negeri Medan and chemistry teachers) and 34 students from class XI-C at SMAN 17 Medan as the product trial subjects.

Instruments and Data Collection

The instruments used for data collection included material and media validation sheets adapted from BSNP criteria, student response questionnaires, and scientific literacy tests in the form of pretest and posttest. Before being used for data collection, the test instruments underwent a trial phase of 30 items using Product Moment Pearson to determine item quality. An item is considered valid if $r_{count} > r_{table}$ (0.374 for N= 34 at α = 0,05). Based on the analysis, 15 items were declared valid and used for the final test. The reliability was determined using the Kuder-Richardson 20 (KR-20) formula, where the instrument is deemed reliable if the coefficient exceeds 0.60. Additionally, analyses of difficulty levels (index 0.31 – 0.71 for medium), discrimination power (index ≥ 0.30, and distractor effectiveness (minimum 5% selection) were performed to ensure instrument accuracy.

Data Analysis Techniques

Data were analyzed using descriptive qualitative and quantitative methods. Validation and student response data were processed based on a Likert scale, as presented in Table.1.

Table 1. Likert Scale for Feasibility Assessment and Responses

No	Answer Choices	Score
1	Very Good	5
2	Good	4
3	Fair	3
4	Poor	2
5	Very poor	1

(Sugiyono, 2013)

The percentage of the e-LKPD feasibility and students responses is calculated using the following formula:

$$Percentage = \frac{Observed\ Score}{Maximum\ Score} x\ 100\ \%$$

The results are classified based on the criteria in Table 2.

Table 2. Classification of Learning Media Assessment Criteria

Percentage	Feasibility Category	Response Category
80.1% - 100%	Very Feasible	Very Good
60.1% - 80%	Feasible	Good
40.1% - 60%	Quite Feasible	Fair
20.1% - 40%	Less Feasible	Poor
0.0% - 20%	Not Feasible	Very Poor

(Sugiyono, 2013)

To measure the effectiveness of the e-LKPD in improving scientific literacy, the Normalized Gain (N-gain) formula was used:

$$\text{N} - \text{Gain} = \frac{T_2 - T_1}{T_{max} - T_1} x\ 100\ \%$$

Note: T_1 (pretest), T_2 (posttest), T_{max} (maximum score) The calculation results are interpreted based on the classification in Table 3.

Table 3. Classification of N-Gain Values

N-Gain Value	Improvement Criteria
g ≥ 0.70	High
0.30 ≤ **g** < 0.70	Medium
g < 0.30	Low

(Meltzer, 2002)

Statistical Analysis

Hypothesis testing was conducted using a one-sample t-test with the following formula:

$$t_{count} = \frac{\bar{X} - \mu o}{\frac{S}{\sqrt{n}}}$$

Where:
t = test statistic
$\bar{X}$ = mean N-Gain score
μo = comparison value, namely the moderate N-Gain category of 0.3
S = standard deviation
n = sample size

The calculations were performed manually using Microsoft Excel 2010. This test was used to determine the effectiveness of e-LKPD based on Problem-Based Learning integrated with Batak Toba ethnoscience in improving students' scientific literacy skills. The decision-making criteria are as follows: if t count > t table, then H_0 is rejected and H_a is accepted; otherwise, if t count ≤ t table, then H_0 is accepted and H_a is rejected, at a significance level of α = 0.05.

▪ RESULT AND DISCUSSION

The product produced through this Research and Development (R&D) is an Acid Base e-Worksheets based on Problem Based Learning (PBL) integrated with Batak Toba ethnoscience. The main focus of this development is to create a media that is not only theoretically validated but also possesses real effectiveness in stimulating student's scientific literacy on acid base topics. This development model is based on the ADDIE model. The research process follows the stages in the ADDIE model, which include analysis, design, development, implementation, and evaluation.

Analysis Stage

The needs analysis was conducted as an initial step to map existing pedagogical challenges in the field. Based on interview data with three chemistry teachers and the needs assessment questionnaires distributed to 35 students, it was found that the predominant use of conventional textbooks worksheets has failed to facilitate student's scientific literacy skills optimally. Furthermore, the integration of local wisdom remains largely absent from the current chemistry curriculum in schools.

The urgency of developing this media is reinforced by data showing that 85.9% of students perceive acid base as difficult topic, while 97.2% of students express a need for digital learning innovations focused on scientific literacy. These findings confirm a critical demand for teaching materials capable of bridging abstract chemical theories with real world phenomena.

The rationale behind this approach is that inherent complexity of acid base concepts often leads to theoretical, the cognitive load is reduced as students encounter chemical principles through familiar socio-cultural phenomena, transforming learning into a contextual and meaningful process.

Design Stage

In the design stage, the e-Worksheet was structured by integrating Batak Toba ethnoscience into the PBL syntax as its main core framework. This process began with a comprehensive literature study to align acid base concepts with relevant cultural practices. The material was systematically organized into contextual problem discourses, such as the chemical processes in *Na Niura* preparation, the role of turmeric as a natural indicator in *Na Niarsik*, and pH dynamics during *tuak* fermentation. The rationale for selecting these specific cultural elements is to provide a concrete representation of abstract chemical principles, thereby facilitating deeper cognitive engagement and preventing conceptual fragmentation.

The e-Worksheet follows the formal PBL stages: problem orientation, student organization, investigation, results presentation, and evaluation. This structural alignment aims to transform students from passive recipients into active investigators by utilizing cultural phenomena as the catalyst for scientific inquiry. For technical development, Microsoft Word was utilized for content drafting, Canva Premium for visual aesthetics, and the Heyzine Flipbook platform to produce an accessible HTML 5 format. Simultaneously, a scientific literacy assessment consisting for 30 multiple choice questions was developed. The prioritization of alignment between e-LKPD activities and the best instrument was essential to ensure the construct validity and precision of the measurement. Before implementation, the quality of the material and media was rigorously evaluated by an expert lecturer from Universitas Negeri Medan and two experienced chemistry teachers from SMAN 17 Medan.

Development Stage

The development stage is the phase where the product is realized based on the previously prepared design. In this stage, the initial prototype of the acid base e-Worksheet based on PBL integrated with Batak Toba ethnoscience was produced, consisting of 12 main components: cover, preface, table of contents, usage instructions,

navigation buttons, learning outcomes, concept maps, learning activity units according to PBL syntax, ethnoscience review, scientific literacy evaluation instruments, bibliography, and author profile. All these components are systematically arranged to create s structured and meaningful learning experience for students.

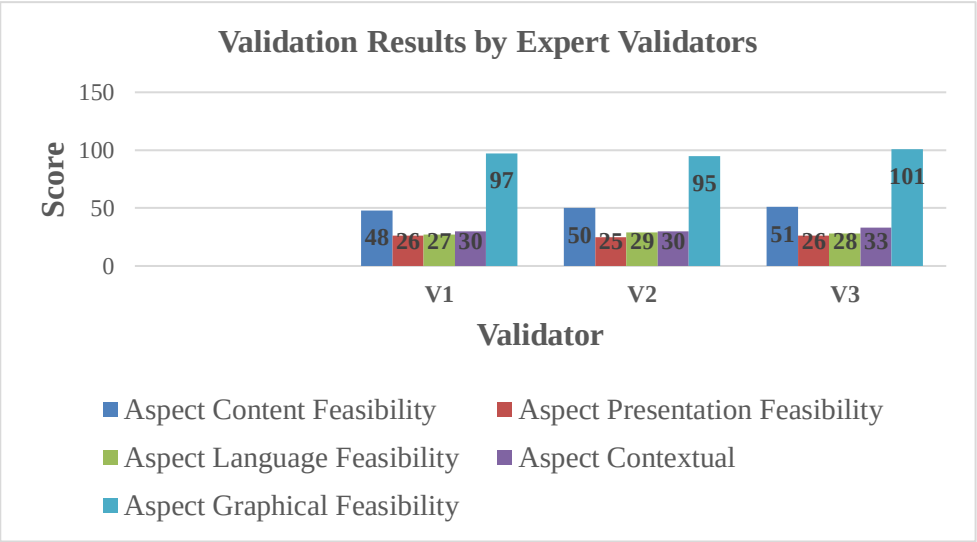
Expert Validation Results (Material and Media)

The feasibility of the e-Worksheet prototype was evaluated by three validators (one chemistry lecturer from Universitas Negeri Medan and two chemistry teachers from SMAN 17 Medan) using a modified BSNP instruments. The assessment covered aspects of content feasibility (CF), presentation (P), language (L), contextuality (C), and graphics (G). The validation results for the acid base e-Worksheet based on Problem Based Learning integrated with Batak Toba ethnoscience are presented in Table 5.

Table 4. e-Worksheet Validation Results Based on BSNP Instruments

No	Validator	Aspect (Scores)					Feasibility Percentage (%)	Criteria
		CF	P	L	C	G		
1	V1	48	26	27	30	97	87.69	Very Feasible
2	V2	50	25	29	30	95	88.08	Very Feasible
3	V3	51	26	28	33	101	91.92	Very Feasible
Average Feasibility Percentage (%)							89.23	Very Feasible

An average feasibility of 89.23 places the e-Worksheet in the "very feasible" category. This outcome demonstrates that the e-Worksheet has met the high quality standards for teaching materials as established by BSNP. The successful integration of Batak Toba ethnoscience has been functionally transformed into the content and contextual components without compromising visual aesthetics or linguistic clarity. Furthermore, the consistency across expert scores 87.69%, 88.08%, and 91.92% confirms that the developed product possesses high validity for classroom implementation. The comparative assessment from each validator is explicitly represented in Graph 1:



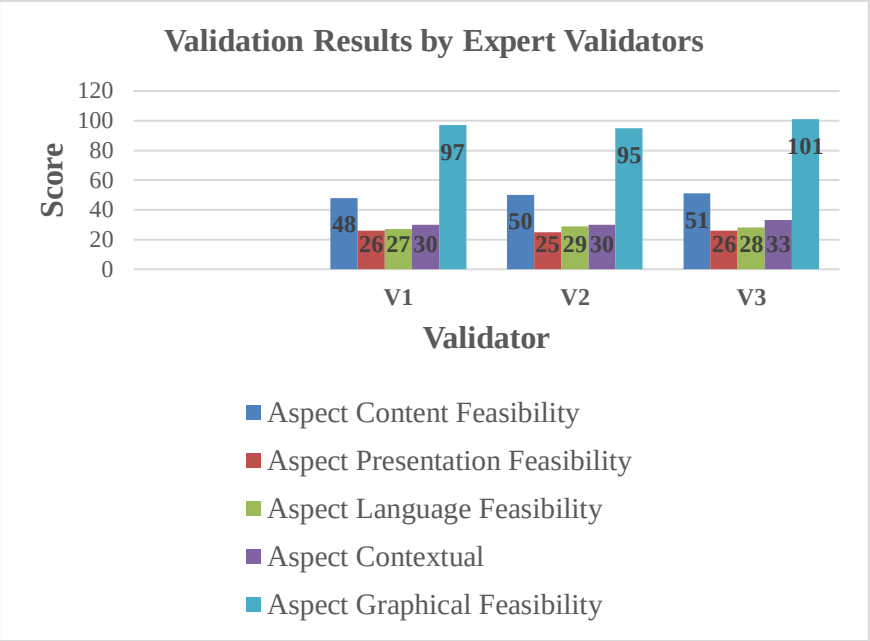
Graph 1. Validation Results by Expert Validators

Product Revision

Following the experts' recommendations, the researcher implemented several strategic refinements to the e-Worksheet to ensure its quality and feasibility before classroom implementation. In the content dimension, chemical reaction equations were meticulously corrected to comply with standard chemical rules, a vital step in minimizing the potential for scientific misconceptions among students. The systematic presentation was further enhanced by integrating formative practice questions and answer keys at the end of each activity to reinforce material mastery and self-evaluation. Additionally, improvements in the graphical aspect involved rearranging the layout and image proportions of the cover design to create a more professional and aesthetically engaging visual appeal. These integrated revisions collectively ensure that the e-Worksheet serves as both a technically accurate and visually compelling medium for learning.

Figure 2. e-Worksheet Cover

An average feasibility of 89.235 places the e-Worksheet in the "very feasible" category. This outcome demonstrates that the e-Worksheet has met the high quality standards for teaching materials as established by BSNP. The successful integration of Batak Toba ethnoscience has been functionally transformed into the content and contextual components without compromising visual aesthetics or linguistic clarity. Furthermore, the consistency across expert scores 87.69%, 88.08%, and 91.92% confirms that the developed product possesses high validity for classroom implementation. The comparative assessment from each validator is explicitly represented in Graph 2:



Graph 2. Validation Results by Expert Validators

The Instruments Analysis

Prior to implementation, the scientific literacy test instrument, comprising 30 multiple choice items, underwent a trial with 28 students from class XII-B at SMAN 17 Medan. The analysis revealed that 15 items were declared valid, exhibiting a validity index $r_{count} > r_{table}$ (0,374). These 15 valid items were subsequently positioned as the test instruments for both the pretest and posttest stages, as they accurately represented the scientific literacy indicators. Conversely, 15 items that did not meet the validity requirements were eliminated from research instrument. This was due to the r_{count} values being lower than r_{table}, rendering those items incapable of accurately measuring student's scientific literacy.

The reliability test using the KR-20 formula yielded a reliability coefficient of $r_{11} = 0{,}910$. Referring to the established criteria, which falls into the "very high" qualification this, it can concluded that this scientific literacy test instrument possesses an excellent level of consistency, making it feasible for use in research and data collection. Based on the difficulty level, the distributions of the items consisted of easy (37%), medium (33%), and difficult (30%) categories. The discrimination power analysis also classified the test items within the range of "fair" to "excellent". Although the majority of the distractors functioned effectively, the researcher still revised several answer options that had a distractor efficiency below 5%. Ultimately, the 15 selected items were declared to meet scientific quality standards for use as pretest and posttest instruments in the research data collection.

Implementation Stage

The implementation stage involved a product trial with 34 students from class XI-C at SMAN 17 Medan across six face-to-face meeting. The instructional sequence commenced with a pretest to map the students' initial competencies, followed by core activities based on the PBL framework integrated with Batak Toba ethnoscience. In these

sessions, acid base theory was systematically linked to the traditional preparation of *Na Niura*, while natural indicators were explored through the *Na Niarsik* cooking process, and pH concepts were analyzed within the context of *tuak* fermentation. This integration served as a contextual bridge, allowing students to observe chemical principles within familiar cultural phenomena. The implementation concluded with a posttest and the administration of student response questionnaires to evaluate the effectiveness and overall acceptance of the developed e-Worksheet.

Pretest and Posttest Result Analysis

Based on data processing using IBM SPSS version 30, there was a significant improvement in the scientific literacy skills of the 34 students in class XI-C at SMAN 17 Medan. The mean score increased substantially from 54.12 to 83.33 in the posttest (Table 5). The decrease in standard deviation from 10,98 to 8.72 indicates that the distributed significantly to sharpening students' abilities became more uniform following the treatment. This proves that the integration of local cultural contexts into the e-Worksheet contributed significantly to sharpening students 's scientific understanding of acid base topics. The distribution of statistical data from the pretest to the posttest is presented in Table 5.

Table 5. Descriptive Statistics of Pretest and Posttest

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	34	33.33	73.33	54.1174	10.98078
Posttest	34	66.67	100.00	83.3332	8.72317
Valid N (listwise)	34				

The shift in these descriptive parameters indicates that the PBL-based e-Worksheet integrated with Batak Toba ethnoscience contributed to the increase in student scores. The rise in the minimum and maximum values suggests that the intervention helped students reach the required competency levels. Additionally, the decrease in the standard deviation reflects that student scores became more uniform, indicating a more even distribution of understanding across the class. This consistency shows that the contextual approach provided a clearer framework for students to understand acid-base chemistry.

N-Gain Effectiveness and Achievement of Literacy Indicators

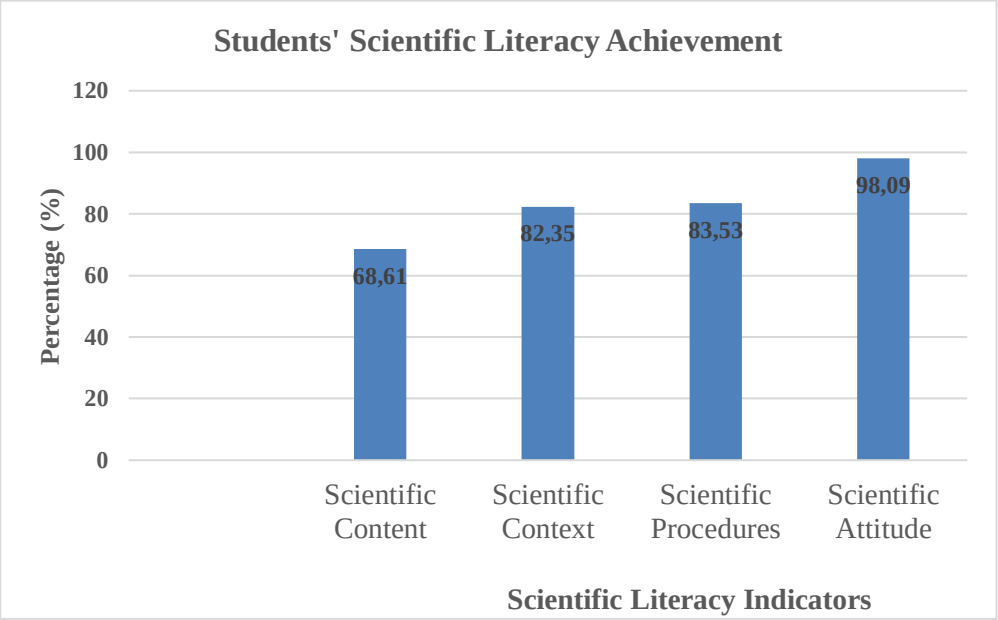
The effectiveness of the developed e-Worksheet was quantified through an N-gain analysis, which measures the normalized improvement between pretest and posttest scores. Data processing revealed an average N-gain score of 0.64, equivalent to 63.94%. The detailed statistical distribution of these results is presented in Table 6.

Table 6. N-Gain Effectiveness Results

Descriptive Statistics					
	N	Minimun	Maximum	Mean	Std.Deviation
N-Gain Score	34	.33	1.00	.6394	.18382
N-Gain Percent	34	33.32	100.00	63.9375	18.38217
Valid N (listwise)	34				

In accordance with Hake's criteria, an N-gain score of 0.6394 categorizes the improvement in students' scientific literacy within the "Medium" range. Furthermore, based on effectiveness interpretation parameters, the implementation of the PBL-based e-Worksheet integrated with Batak Toba ethnoscience is classified as "Quite Effective". A granular assessment across the four dimensions of scientific literacy revealed varied levels of mastery. The scientific attitude indicator achieved the highest percentage at 98.09%, followed by scientific procedures (83.53%) and scientific context (82.35%). These results indicate that the integration of the PBL model with local cultural contexts effectively stimulated student curiosity and facilitated the connection between theoretical chemical concepts and real-world phenomena.

Conversely, the scientific content indicator recorded the lowest achievement at 68.61%. This suggests a persistent cognitive challenge in describing complex scientific principles in depth, which aligns with the findings of Dal et al (2025) regarding the inherent complexity of acid-base material. Despite this specific challenge, the e-Worksheet demonstrated its capacity to enhance students' overall scientific literacy across all measured dimensions, as visualized in Graph 3.



Graph 3. Students' Scientific Literacy Achievement

Normality Test

The initial step before conducting further statistical analysis was to ensure whether the pretest and posttest data followed a normal distribution. This computation was performed digitally using IBM SPSS version 30.0.2.0 for Windows. The significance value (Sig.) was used as the primary parameter, where data is considered to satisfy the

normality requirement if the probability exceeds 0.05. Conversely, if the Sig. value is below this threshold, the distribution is considered non-normal. The summary of these test results is presented in Table 8 below.

Table 7. Normality Test Results

Test of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.118	34	.200*	.995	34	.178
Posttest	.149	34	.054	.994	34	.082
a. Lilliefors Significance Correction						
***. This is a lower bound of the true significance**						

Reviewing the results in Table 7, two approaches are available: the Kolmogorov-Smirnov and Shapiro-Wilk methods. Since the sample size in this study consists of 34 respondents (N < 50), the interpretation is focused on the Shapiro-Wilk results to ensure higher accuracy. Based on the output, it is observed that the significance value for the pretest score reached 0.178, while the posttest score stood at 0.082. As both results are consistently greater than the 0.05 standard, it can be concluded that all scientific literacy data in this study are normally distributed. Consequently, the data analysis proceeded using parametric statistics, specifically the One-Sample T-Test.

One-Sample T-Test

Hypothesis testing was conducted to determine whether the mean N-Gain score of students' scientific literacy skills was higher than the moderate N-Gain criterion value of 0.3. A One-Sample t-Test was employed as the data met the assumptions of normality. The decision rule stated that H_0 is rejected and H_a is accepted if $t_{count} > t_{table}$. The summary of the hypothesis testing results is presented in Table 8 as follows.

Table 8. One-Sample T-Test

	t_{count}	t_{table}	**Description**
$\bar{x}$ = 0.6394 S = 0,184 μo = 0,3 n = 34	10.77	1,697	H_0 is rejected and Ha is accepted

Based on the data in table 8, the results show that the mean N-Gain score was 0.6394 with a standard deviation of 0.184 and a sample size of 34 students. The t-test result indicated that t_{count} (10.77) was higher than t_{table} (1.697) at a significance level of 0.05 with degrees of freedom (df) = 33. Since $t_{count} > t_{table}$, H_0 is rejected and Ha is accepted. Therefore, the students' mean N-Gain score of scientific literacy skills is higher than the moderate criterion value of 0.3, indicating that the developed e-LKPD is effective in improving students' scientific literacy skills.

Student Response Questionnaire

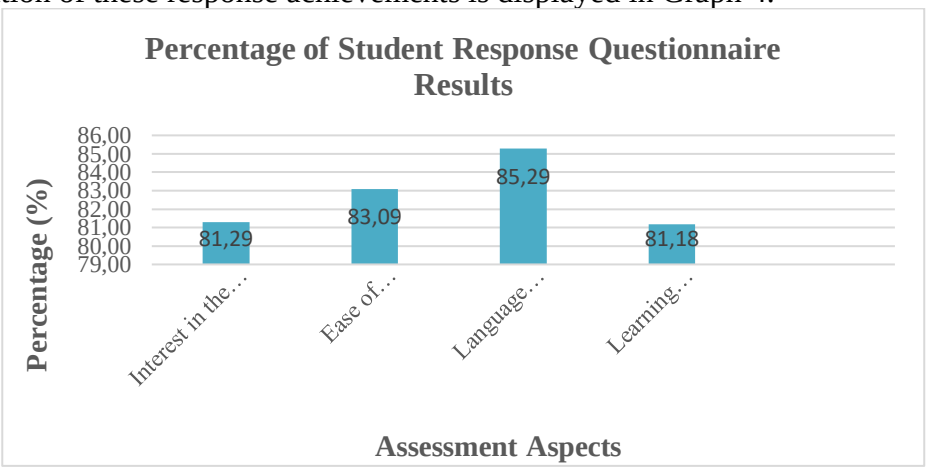
The student response questionnaire was implemented to map the level of student acceptance toward the e-Worksheet within learning activities. The assessment focused on several key parameters, including media attractiveness, practicality, visual and linguistic clarity, and the media's contribution to mastering acid-base concepts. These data serve as a critical indicator to measure the acceptability of the developed product. The detailed recapitulation of student response percentages is presented in Table 9.

Table 9. Percentage of Students Responses to the e-Worksheet

No	Assessment Aspect	Student Response Percentage (%)
1	Interest in the e-Worksheet	81.29
2	Ease of material presentation	83.53
3	Language and dimensions	85.29
4	Benefits of ethnoscience integrated PBL	81.18
	Average	82.19

Based on the data in table 9, an average student response of 82.19% was obtained, placing the e-Worksheet in the "Very Good" category. A dimensional analysis shows that the interest aspect recorded 81.29%, while the ease of understanding material presentation reached 83.53%. The language and visual quality dimension obtained the highest percentage at 85.29%, and the perceived benefits of the ethnoscience-integrated PBL model reached 81.18%.

These findings indicate that the developed e-Worksheet received significant positive appreciation from students. This high positive response is attributed to the systematic structure of the material and the use of communicative language that facilitates easier comprehension. Furthermore, the implementation of the PBL model proved effective in stimulating student engagement in analyzing chemical problems contextually. The integration of ethnoscience within the PBL framework encouraged direct student involvement in analyzing chemical phenomena within their own culture. The visualization of these response achievements is displayed in Graph 4.



Graph 4. Percentages of Student Response Questionnaire Results

Evaluation Stage

The feasibility and effectiveness of the developed e-Worksheet were assessed during the evaluation stage of this research. This process encompassed the analysis of expert validation results, classroom implementation observations, improvements in scientific literacy, and user responses toward the e-Worksheet. The developed e-Worksheet successfully met the "highly feasible" criteria, as evidenced by the validation results from material and media experts across content, presentation, linguistic, contextual, and graphical dimensions. Furthermore, the implementation of the e-Worksheet in the learning process successfully demonstrated an enhancement in students' scientific literacy skills. This achievement is substantiated by the significant difference between pretest and posttest scores, an N-gain achievement within the "medium" category, and hypothesis testing results confirming that students significantly exceeded the established Learning Objective Achievement Criteria (KKTP).

▪ CONCLUSION

Based on the research and development results, it can be concluded that the acid base e-Worksheet product based on Problem Based Learning integrated with Batak Toba ethnoscience has met the “very feasible” qualification, with an average expert validation score for material and media of 89.22%. Empirically, the implementation of this media is proven to have contributed significantly to improving students' scientific literacy, as shown by the substantial increase I the average score from 54.11 to 83.33.

The effectiveness of the product is further reinforced by an N-gain index of 0.6394 (medium category) and the t value (10.77) was higher than the t table value (1.697), which indicates that students significantly exceeded the established mastery standards. Furthermore, the use of this e-Worksheet received a highly positive response from students, with an average questionnaire score 82.19%. This confirms that the developed media is not only practical and visually appealing but also effective in helping students construct their understanding of chemistry contextually through local wisdom relevant to their lives.

▪ REFERENCES

Azizah, D. N., Irwandi, D., & Saridewi, N. (2021). Pengaruh Model Pembelajaran Problem Based Learning Berkonteks Socio Scientific Issues Terhadap Kemampuan Literasi Sains Siswa pada Materi Asam Basa. *Jurnal Riset Pendidikan Kimia*, *11*(1), 12–18.

Dal, M., Lidi, M. ., & Priska, M. (2024). Pengembangan Lembar Kerja Peserta Didik Berbasis Etnosains Untuk Melatih Keterampilan Literasi Sains Peserta Didik SMP Mikhaela. *Pancasakti Science Education Journal*, *9*(April), 39–57. https://doi.org/10.24905/psej.v9i1.204

Eviota, J. S., & Liangco, M. M. (2020). Validasi: LKPD Terintegrasi Model Problem Based Learning untuk Melatih Keterampilan. *Jurnal Pendidikan*, *14*(September), 723–731.

Febriningtyas, S. A., & Dwiningsih, K. (2024). Validity of Problem Based Learning

Oriented E-LAPD to Improve Chemical Literacy Skills of High School Students Siti. *Jurnal Penelitian Dan Pengembangan Pendidikan*, *11*(4), 797–806.

Hidayah, N., Idrus, A. Al, & Purwoko, A. A. (2025). Validity of Ethnoscience-Integrated Problem Based Learning Student Worksheet to Train Science Literacy and Creative Thinking. *Jurnal Penelitian Pendidikan IPA*, *11*(8), 576–584. https://doi.org/10.29303/jppipa.v11i8.9904

Ika, R. P., Erna, M., & Hayati, S. (2025). Pengembangan E-LKPD Berbasis Model Problem Based Learning Terintegrasi Etnokimia pada Materi Asam Basa. *Chemistry Education Practice*, *8*(1), 241–251. https://doi.org/10.29303/cep.v8i1.9091

Limiansih, K., Sulistyani, N., & Melissa, M. . (2024). *Persepsi Guru SMP terhadap Literasi Sains dan Implikasinya pada Pembelajaran Sains di Sekolah*. *14*(September), 786–796.

Maharani, M., & Suryani, O. (2025). Efektivitas LKPD Berbasis PBL pada Materi Asam Basa Terhadap Hasil Belajar Peserta Didik Fase F SMA. *Afeksi: Jurnal Penelitian Dan Evaluasi Pendidikan*, *6*(3), 590–597. https://doi.org/10.59698/afeksi.v6i3.496

Mutiah, Andayani, Y., Siahaan, J., & Haris, M. (2024). Implementation of Integrated Problem-Based Learning Model With Ethno Cemistry Sasambo to Improve Chemistry Literation. *Jurnal Pijar MIPA*, *19*(3), 396–400. https://doi.org/https://doi.org/10.29303/jpm.v19i3.6537

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American Journal of Physics*, *70*(12), 1259–1268.

Nofiarti, T. (2021). Analisis Keterampilan Abad 21 Menggunakan Instrumen Tes Literasi Sains Pada Materi Asam Basa. *Bedelau: Journal of Education and Learning*, *2*(1), 8–12. https://doi.org/10.55748/bjel.v2i1.51

Nurhayati, N., & Kurniawati, D. (2024). Pengembangan LKPD Berbasis Problem Based Learning Berbantuan Aplikasi PhET Pada Materi Asam Basa Fase F. *Jurnal Pendidikan Tambusai*, *8*(1), 874–881. https://doi.org/10.31004/jptam.v8i1.12480

Odah, A., & Yuniarti, Y. (2023). Budaya Literasi Sekolah untuk Mengembangkan Keterampilan Abad 21. *Basic Edu*, *7*(6), 4193–4203. https://doi.org/10.31004/basicedu.v7i6.6730

OECD. (2023). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*, *PISA: Vol. I*. OECD Publishing. https://doi.org/https://doi.org/10.1787/53f23881-en

OECD. (2025). *PISA 2025 SCIENCE FRAMEWORK (DRAFT)*. 1–93. https://doi.org/https://pisa-framework.oecd.org/science-2025/

Ramdani, A., Jufri, A. W., Jufri, A. W., Jamaluddin, J., & Setiadi, D. (2020). Kemampuan Literasi Sains Peserta Didik SMPN di Kabupaten Lombok Tengah Kemampuan Literasi Sains Peserta Didik SMPN di Kabupaten Lombok Tengah. *PSEJ (Pancasakti Science Education Journal)*, *5*(2), 16–22. https://doi.org/10.24905/psej.v5i2.19

Sahadah, S. . (2024). *Pengembangan E-Lkpd Interaktif Perubahan Lingkungan Berbasis Problem Based Learning Untuk Melatih Keterampilan Berpikir Kritis Peserta Didik The Development Problem-Based Learning Based Environmental Change Interactive e-LKPD to Train Students ' Critical*. *13*(3), 582–593.

Sari, A. A., & Purwaningsih, D. (2019). *Pengembangan E-Lkpd Berbasis Problem Based*

Learning (Pbl) Dengan Liveworksheets Pada Materi Asam Basa Development Of Electronic Student Worksheet Based On Problem-Based Learning (PBL) On Acid Base Material. 13–26.

Septiana, I., Aisyah, R. S. S., & Fatmasari, N. (2025). Development of Teaching Modules Based on Problem Based Learning Integrated with Scientific Literacy on Acid Base Material. *Jambura Journal of Educational Chemistry*, *7*(2), 53–63.

Sugiyono. (2013). *Metode Penelitian Kualitatif dan Kuantitatif (R & D)*. Alfabeta Bandung.

Sutrisna, N. (2021). Analisis Kemampuan Literasi Sains Peserta Didik Sma Di Kota Sungai Penuh. *Jurnal Inovasi Penelitian*, *1*(12), 2683–2691.