Vol 12 (3), 2023, 01-13 DOI: 10.23960/jppk.v12.i3.2023.01
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 Problem Solving Based E-LKPD on Acid and Base Materials to Train Students' Critical Thinking

Octavia Dwi Fadliilah [1], Harun Nasrudin [2]*

Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri SurabayaJl. Ketintang, Ketintang, Kec, Gayungan, Kota Surabaya, Jawa Timur 60231, Indonesia.

*Correspondinge-mail: harunnasrudin@unesa.ac.id

Received: August 14th, 2023 Accepted: September 2nd, 2023 Online Published: December 26th, 2023

Abstract: Development of Problem Solving Based E-LKPD on Acid and Base Materials to Train Students' Critical Thinking Skills. This study aims to determine the feasibility of developing e-LKPD in terms of validity, practicality, and effectiveness. The model used is the *4*D development model by Thiagarajan, Semmel, and Semmel with restrictions only on the third stage, namely (1) *Define* Stage, (2) *Design* Stage, (3) *Development Stage*, (4) *Disseminate* Stage.*The* research was conducted at SMAN Jogoroto Jombang with the research subject of class XI students who had insufficient critical thinking skills. The data analysis technique used is to determine the mode of validation results, calculate the percentage of student response questionnaire sheets, calculate the percentage of student activity observation sheets, and through the calculation of *N-gain* scores. The results of this study indicate that 1) content validity gets a mode number 5 with a very good category, 2) the average learner response questionnaire is 95% practical category, 3) relevant activity of students is 93.32% and 96.65% practical category, 4) *N-gain* score which is classified as a high category. Based on the results of the study, it can be concluded that the developed e-LKPD is feasible to use because it meets the criteria of validity, practicality, and effectiveness.

Keywords: Electronic Learner Worksheet, *Problem Solving*, Critical Thinking Skills, Acids and Bases.

Abstrak: Pengembangan E-LKPD Berbasis Problem Solving pada Materi Asam dan Basa untuk Melatih Keterampilan Berpikir Kritis Peserta Didik. *Penelitian ini bertujuan untuk mengetahui kelayakan pengembangan e-LKPD yang ditinjau dari validitas, kepraktisan, dan keefektifan. Model yang digunakan adalah model pengembangan 4D oleh Thiagarajan, Semmel, dan Semmel dengan pembatasan hanya pada tahap ketiga yaitu (1) Tahap Pendefinisan (Define), (2) Tahap Perancangan (Design), (3) Tahap Pengembangan (Development), (4) Tahap Penyebaran (Disseminate). Penelitian dilakukan di SMAN Jogoroto Jombang dengan subjek penelitian peserta didik kelas XI yang memiliki keterampilan berpikir kritis kurang. Teknik analisis data yang digunakan adalah menentukan modus dari hasil validasi, menghitung persentase lembar angket respon peserta didik, menghitung persentase lembar observasi aktivitas peserta didik, dan melalui perhitungan skor N-gain. Hasil dari penelitian ini menunjukkan bahwa 1) validitas isi mendapatkan modus angka 5 dengan kategori sangat baik, 2) rata-rata angket respon peserta didik sebesar 95% kategori praktis, 3) aktivitas relevan peserta didik sebesar 93,32% dan 96,65% kategori praktis, 4) skor N-gain yang tergolong kategori tinggi. Berdasarkan hasil penelitian dapat disimpulkan bahwa, e-LKPD yang dikembangkan layak digunakan karena memenuhi kriteria kevalidan, kepraktisan, dan keefektifan.*

Kata kunci: *Lembar Kerja Peserta Didik Elektronik, Problem Solving, Keterampilan Berpikir Kritis, Asam dan Basa*.

▪ INTRODUCTION

21st century learning is a learner-focused learning process. Learners are expected to have many skills that are mastered in various ways. The skills that must be mastered by learners in the 21st century include, critical thinking skills (Critikal thinking), creative (Creative), collaboration (Collaboration) and communication (Communication) this is known as 4C. These skills will be applied in the education process (Zubaidah, 2019).

Critical thinking is an organised and clear method of mental activity, namely problem solving, decision making, discovery of scientific operations, and analysis of assumptions (Kustianingsih & Muchlis, 2021). The indicators in critical thinking skills consist of six indicators which include: inferring, interpreting, analysing, evaluating, explaining,and self-regulation (Facione,2015).

Chemistry lessons are a means of learning and thinking exercises that are not just memorising concepts (Ihsan et al., 2019). One of them is chemistry learning which has a function and purpose to foster a critical attitude towards a statement so as not to believe quickly before observation. One of the main subjects studied at the high school education level is acid and base material. Learning Outcomes (CP) in phase F explaining acid and base material contains using the concepts of acids and bases in everyday life (Kemendikbudristek, 2022).

Based on the results of a pre-research questionnaire conducted on Tuesday 14 February 2023 with 25 student respondents, 60% considered that acid and base material was difficult, including 44% of students stated that acid and base material was more rote and 36% of students stated that acid and base material was a lot of calculations, so that the level of critical thinking skills was still obtained which was classified as a low category because almost all students did not complete the critical thinking skills question in the questionnaire given. For the acquisition of critical thinking skills results on the interpretation indicator of 40%, on the analysis indicator obtained by 60% and on the inference indicator obtained by 45%. The acquisition of these analysis results has been supported by previous research which states that the learning process can occur if the interaction between students involves cognitive and affective aspects (Hasibuan et al., 2019).

From the description above, it can be concluded that a problem solving learning model is needed. Problem solving is a learning model that is able to guide students in solving a problem in a structured manner through several cognitive stages such as reading, understanding the problem, developing a plan, carrying out the plan, getting answers, and confirming answers (Lee et al., 2020). In addition, teaching materials with new innovations are also needed that can be used to improve the success of the learning process. One of these teaching material innovations can be the development of LKPD. The function of LKPD is to assist students in deepening and increasing knowledge related to the material that has been given. This is because in LKPD there are components that have been formed with the aim of providing motivation in the form of problems related to daily activities (D.D. Lestari & Muchlis, 2021).

The LKPD product developed is an e-LKPD that uses liveworksheet media. Liveworksheet is an application that is freely available on search engines such as Google, Chrome, Browser, and Microsoft Edge (Fuada & Fajriati, 2021). These applications have

the advantage of being able to help save time and use paper for students because the liveworksheet application is interactive and motivating, researchers are interested in developing problem solving-based e-LKPD on acid and base materials to train students' critical thinking skills.

▪ METHOD

In this development research, the 4D development method (four-D method) was used as proposed by Thiagarajan, Semmel, and Semmel (1974). The target in this study is the development of problem solving-based e-LKPD on acid and base materials that aim to train students' critical thinking skills. The samples in this study were students of class XI MIPA 2 who had received acid and base materials with heterogeneous skill levels.

In this study, the sample used was class XI MIPA 2 SMAN Jogoroto Jombang in the academic year 2022/2023 which amounted to 25 students. The sample used students who lack critical thinking skills, it is determined from the pretest results that have been obtained. The percentage of the acquisition of critical thinking skills results in the interpretation indicator is 43%, the inference indicator is 44%, the analysis indicator is 27%, the explanation indicator is 54%, and the evaluation indicator is 57%. From the results obtained on each component of critical thinking skills can be categorised as quite effective and less effective.

Based on the percentage of the results obtained, it is continued with the e-LKPD trial that has been developed. The data collection technique in this study was carried out using the questionnaire method and the test method. The instruments used in this study were media validation sheets, student response questionnaires, student activity observations, and pretest and posttest sheets.

The data analysis technique used in this study is the validity data analysis which is reviewed from the results of the validation results data, on the practicality data analysis is reviewed from the results of the learner response questionnaire, learner activity observation, and on the effectiveness data analysis is reviewed from the critical thinking skills test (pretest and posstest).

Validation analysis

Validation was carried out by 2 lecturers and 1 chemistry teacher on the e-LKPD developed using a Likert scale. According to Riduwan (2015), to get accurate, efficient, and communicative results, the variable values measured by certain instruments are expressed in numerical form.

Table 1. Likert Scale

Scale Value	Category
5	Very good
4	Good
3	Medium
2	Bad
1	Very bad

(Riduwan, 2015)

The data obtained in validation in the form of ordinal data which has the nature that mathematical operations cannot be performed (plus, minus, multiply, and divide), so the determination is made using the mode seen from the highest number of scores (Lutfi, 2021). E-LKPD is declared valid if the minimum criterion obtained is 3 or the sufficient category.

Analysis of Learner Response Questionnaire

Learner response questionnaire data is carried out using a Guttman scale which aims to obtain clear and consistent answers (Riduwan, 2015). The results of the assessment of the learner response questionnaire were analysed using the practicality percentage formula as below.

$$(\mathrm{P})\% = \frac{\sum \mathrm{Y}}{\sum \mathrm{MY}} \text{ x } 100\%$$

With information, (P) is the percentage (%) of students' responses, (∑Y) is the number of "Yes" answers from students, and (∑MY) is the maximum number of "Yes" answers from students. The percentage of the results of the learner response questionnaire can be interpreted according to the practicality criteria according to the Guttman scale. The following is the Guttman scale table used.

Tabel 2. Guttman Scale

Answer	Value/Score
Yes	1
No	0

(Riduwan, 2015)

Tabel 3. Guttman Scale Criteria

Percentage %	Criteria
0,001-20,99	Not Very Practical
21,00-40,99	Not Practical
41,00-60,99	Less Practical
61,00-80,99	Practical
81,00-100,00	Very Practical

(Riduwan, 2015)

E-LKPD is declared practical if the percentage obtained is ≥ 61%.

Learner Activity Observation Analysis

Observation of learner activities aims to determine the results of observations of learner activities carried out by an observer and will obtain the dominant activity. Learner activities can be declared well implemented if the percentage of relevant learner activities is greater than irrelevant learner activities. The percentage of learner activity can be calculated using the following formula:

$$(\mathrm{P})\% = \frac{\sum \mathrm{Y}}{\sum \mathrm{MY}} \text{ x } 100\%$$

The results of the acquisition of the percentage of observation of students' activities can be interpreted using the Guttman scale criteria.

Tabel 4. Guttman Scale Criteria

Percentage %	Criteria
0,001-20,99	Not Very Practical
21,00-40,99	Not Practical
41,00-60,99	Less Practical
61,00-80,99	Practical
81,00-100,00	Very Practical

(Riduwan, 2015)

E-LKPD is declared practical if the percentage obtained is ≥ 61%.

Analysis of Critical Thinking Skills Test (Pretest and Posttest)

In the analysis of effectiveness data, the data used are the results of the pretest and posttest. The pretest and posttest questions were developed in accordance with the problem solving learning model with critical thinking skills indicators. Data analysis of the critical thinking skills component was calculated using the following formula:

$$\text{Critical thinking skills (\%)} = \frac{\text{score obtained}}{\text{total score}} \text{ x } 100\%$$

The percentage analysis of each component of critical thinking skills is interpreted as shown in the table below.

Table 5. Critical Thinking Skills Category Criteria

Percentage (%)	Category
0-20	Very less effective
21-40	Less effective
41-60	Effective enough
61-80	Effective
81-100	Very very

(Riduwan, 2018)

Each component of critical thinking skills can be said to be successfully trained if a percentage of ≥ 61% is obtained with an effective or very effective category.

The pretest and posttest results of each individual were analyzed using N-gain to calculate the gain (improvement) using the following formula:

$$\text{N} - \text{gain} = \frac{\text{score posttest} - \text{score pretest}}{\text{score maximal} - \text{score pretest}}$$

Table 6. N-gain Score Criteria

N-gain score	Criteria
g<0,3	Low
0,3≤g<0,7	Medium
g≥0,7	High

(Riduwan, 2015)

E-LKPD is declared effective if the N-gain value on the measurement of the results of improving critical thinking skills reaches ≥ 0.7 with high criteria or ≥ 0.3 with moderate criteria.

▪ RESULT AND DISCUSSION

The following are the results of research and discussion using the Research and Development (R&D) method proposed by Thiagarajan, Semmel and Semmel which aims to describe the feasibility described based on the validity, practicality and effectiveness of e-LKPD based on acid and base problem solving to train students' critical thinking skills. The (R&D) method proposed by Thiagarajan, Semmel and Semmel consists of three stages as follows.

1. Define Stage

At this stage, it consists of 5 main stages, including:

a) Front End Analysis

A front-end analysis was conducted to adjust the circumstances and conditions of the research site used. This is related to the applicable curriculum.

Curriculum Analysis

Curriculum analysis is the initial stage in the preparation of LKPD. The school that will be used for research is SMAN Jogoroto Jombang which still uses the 2013 revised curriculum. Information related to this was obtained by researchers through interviews with the school directly, namely the vice principal in the field of curriculum (waka curriculum) and also the chemistry teacher. The LKPD development plan carried out by researchers using an independent curriculum based on the CP in phase F of class XI SMA explained that the concept of acids and bases as well as their strength and ionizing balance in solution, and analysing the trajectory of pH changes of several indicators extracted from natural materials through experiments (Kemendikbudristek, 2022). This is done so that the finished development results are expected to be used in a long enough period of time.

b) Learner Analysis

Learner analysis is the initial stage carried out by conducting observations at SMAN Jogoroto Jombang. This is supported by the results of interviews with chemistry teachers of class XI who have the authority to determine the value of students, which can be used as a research topic. This research topic was chosen in accordance with the agreement with the chemistry teacher of class XI MIPA 2.

Based on the results of observations made by researchers, it was found that students lacked critical thinking skills in acid and base materials, and found an unattractive learning model because during the learning process there were too many lectures, making students less active and critical in the learning process of acid and base materials.

According to Piaget's theory, learning will focus on the thinking process of students, emphasizing the importance of the role of students in their own initiative and active involvement in learning (Nurdyansyah & Fahyuni, 2016).

c) Task Analysis

Task analysis is carried out to identify the main tasks to be performed by learners and determine the content of the material to be achieved in the learning activities to be carried out. Task analysis consists of analysing CP and Learning Objectives (TP) related to the material to be developed. This stage is carried out to review the material being taught.

The tasks contained in the e-LKPD include identifying problems, setting hypotheses, making hypotheses, testing the truth of hypotheses, and drawing conclusions (Sudjana, 2011).

d) Concept Analysis

Concept analysis is carried out with the aim of knowing the understanding of students in learning acid and base chemistry material. Lack of concept understanding will make it difficult for students to later be able to work on the questions contained in the e-LKPD development carried out. According to David Ausubel's theory, the key to successful learning lies in the meaningfulness of the teaching materials received or learned by students. Concept analysis can also be seen based on the results of the pre-research questionnaire that has been conducted.

e) Formulation of Learning Objectives

The formulation of learning objectives is carried out so that the research carried

out is in accordance with the material contained in the basic competencies and indicators of critical thinking skills. The formulation of learning objectives includes: (a) Through literature review, students are able to determine substances that are acidic and basic and determine the approximate degree of acidity (pH) of substances that are acidic and basic in everyday life correctly, (b) Through the phenomena displayed, students are able to identify problems related to the nature of acidic and basic solutions and the degree of acidity (pH) of acids and bases correctly, (c) Through the displayed phenomenon, learners are able to find data to solve problems related to the nature of acidic and basic solutions and (pH) of acids and bases correctly, (d) Through the displayed phenomenon, learners are able to formulate hypotheses related to the nature of acidic and basic solutions and the degree of acidity (pH) of acids and bases correctly, (e) Through experimental procedures, students are able to carry out experiments related to the properties of acids and bases and the degree of acidity (pH) of acids and bases correctly, (f) Through the discussion process and experiments carried out, students are able to formulate problems related to the properties of acids and bases and (pH) of acids and bases correctly, (g) Through the discussion process and experiments that have been carried out, (g) Through the discussion process and experiments that have been carried out, students are able to write down the experimental data correctly, (h) Through the experimental data, students are able to analyze the experimental data correctly , (i) Through the experimental data and data analysis, students can make conclusions correctly, (j) Through the experimental data and data analysis, students can communicate the results of the experiment correctly.

2. Design Stage

At the design stage, this is done to make it easier to design the e-LKPD of acid and base chemistry material to be developed. There are four steps in this stage, including the following.

a. Developing the test.

The preparation of the test aims to connect the link between the defining stage (define) and the design stage (design). The test referred to in this stage is the initial stage test in the form of pretest questions and posttest questions. The preparation of the pretest aims to determine the effectiveness of the application of the problem solving learning model, while the preparation of the posttest is used to determine the success of the problem solving learning model using critical thinking skills.

b. Media selection.

Media selection is adjusted to the needs that will be used during the research. The media to be used in this research is e-LKPD developed using liveworksheet. The liveworksheet contains a predetermined acid and base chemistry material accompanied by critical thinking skills exercises with a problem solving learning model.

c. Selection of e-LKPD preparation format.

The choice of format in the preparation of e-LKPD aims to facilitate the delivery of material content for readers and users.

3. Development Stage.

The development stages are organized using steps including, verification, research validation, validation and testing. The purpose of the development stage is to produce a

product that is divided into several stages. These stages are:

a. Review.

The review is carried out to get suggestions or comments from chemistry lecturers that can be used as a basis for starting materials on the initial design if there are errors. The review was conducted by the thesis supervisor. The results are used as a reference to revise the e-LKPD developed so that the e-LKPD is made more interesting, the presented is to the used, the presented are adjusted to used and the selected

b. Revision.

At this stage, the results of the revision of the thesis by the thesis supervisor are based on the improvement suggestions that have been made.

c. Validation.

Validation was carried out to obtain an assessment of the content and construct validity of the e-LKPDs that were balanced in relation to the chemistry of acids and bases to train the critical thinking skills of students with probleim solving learning mode.

Validation of LKPD

a. Content Validity

The aspects assessed based on the content validity eligibility criteria include the suitability of the acid and base materials developed. Validation was carried out by three validators. The following is a table of the results of the content validation assessment.

Table 7. Results of Content Validation Assessment

Assessed Aspect	Mode/Category
The suitability of acid and base sub-materials with Learning Outcomes	5/Very good
The suitability of acid and base sub-materials with content	5/Very good
The suitability of acid and base sub-materials with Learning Objectives	5/Very good
Correctness of Phenomena with Material	5/Very good

Based on Table 5 above, the mode of assessment is 5 which is classified as very good according to (Riduwan, 2015).

b. Construct Validity

The aspects assessed based on the construct validity eligibility criteria include the suitability of the content with the problem solving learning model and critical thinking skills indicators. The following is a table of construct validation assessment results.

Table 8. Results of Construct Validation Assessment

Assessed Aspect	Mode/Criteria
Content criteria	5/ Very Good
Language criteria	5/Very good
Presentation criteria	5/Very good
Graphics criteria	5/ Very good

Based on Table 6 above, the mode of assessment is 5 which is classified as very good according to (Riduwan, 2015).

d. Product Trial.

Product trials were carried out after obtaining the results of the review and validation. The validation results obtained results with a very valid category (mode number 5), which can be concluded that the development product can proceed to the trial stage. The e-LKPD product trial was developed based on the results of the review, the results of the learner response questionnaire, the learner activity observation sheet, and the results of the pretest and posttest. The following are the results of the product trial.

a. Practicality

1) Result of the Learner Response Questionnaire

The results of the learner response questionnaire are used to determine the development of e-LKPD on practicality criteria. The learner response questionnaire is used to get responses or answers from students after learning by practicing critical thinking skills with a problem solving learning model. The following is a table of the results of the students' response questionnaire.

Table 9. Results of the Learner Response Questionnaire

No.	Assessed Aspect	Percentage (%)	Criteria
1.	Do the images presented in the e-LKPD help you to understand the phenomenon?	100	Very Practical
2.	Is the question related to the phenomenon easy to understand?	80	Very Practical
3.	Are you trained to identify problems related to the issue at hand?	100	Very Practical
4.	Are you trained to look for data to solve the problem?	100	Very Practical
5.	Were you trained to come up with a hypothetical answer to the problem?	100	Very Practical
6.	Are you trained to test the hypothesis that has been set regarding the problem?	100	Very Practical
7.	Are you trained to conduct experiments according to the experimental procedure?	100	Very Practical
8.	Were you trained to formulate problems related to the experiment?	100	Very Practical
9.	Were you trained to hypothesize about the experiment?	100	Very Practical
10.	Are you trained to be able to write down the experimental data in the experimental data table related to the experiment conducted?	100	Very Practical
11.	Are you trained to be able to analyze the data according to the data table of the related experiment?	100	Very Practical
12.	Are you trained to be able to make conclusions	100	Very Practical

No.	Assessed Aspect	Percentage (%)	Criteria
	from the data table of the results of the experiments that have been carried out?		
13.	Can this e-LKPD increase your learning motivation?	92	Very Practical
14.	Can this e-LKPD realize your curiosity?	96	Very Practical
15.	Is the language used in writing e-LKPD short and clear?	80	Very Practical
16.	Is the cover used in the e-LKPD in accordance with the contents of the e-LKPD?	92	Very Practical
17.	Is the font type, and font size used in the e-LKPD appropriate?	100	Very Practical
18.	Is the layout of text and images in the e-LKPD appropriate?	88	Very Practical
19.	Do you think the color combination used in the e-LKPD is contrasting and harmonious?	88	Very Practical
20.	Is the presentation of this e-LKPD interesting?	92	Very Practical
Average		95%	

Based on the table above, the results of the students' response questionnaire obtained the percentage of students' answers on average 95% with very practical criteria.

2) Results of Observation of Student Activity

The results of the observation of students' activities are used to determine the development of e-LKPD on practicality criteria. Learner observations are used for learner activities to obtain the results of observations of learner activities during learning by practicing critical thinking skills with a problem solving learning model. The following is a table of student activity observation results.

Table 10. Observation Results of Learner Activities

Learner Activity	Average Learner Activity (%)	
	Pert 1	**Pert 2**
Relevant Activity (%)	93,32	96,65
Irrelevant Activity (%)	6,67	3,33

Based on the table above, it is obtained that each observed aspect obtained a percentage of ≥ 61% by using the e-LKPD developed in learning activities. At meetings 1 and 2, the percentage of relevant activities of students was 93.32% and 96.65% with both criteria being very practical. These results are supported by previous research which states that students' critical thinking skills can successfully increase if relevant activities get a higher percentage than irrelevant activities (Firdausichuuriyah & Nasrudin, 2017).

b. Effectiveness

1) Pretest and Posttest Results of Students

The results of the Learner Pretest and Posttest are used to determine the feasibility of balancing e-LKPD on the effectiveness criteria. Giving students' pretests and posttests aims to determine the effect of giving what is used to train critical thinking skills with the problem solving learning model. The following is a table of the effectiveness of giving pretests.

Table 11. Pretest Effectiveness Results on the Learning Process

KBK	Percentage (%)	Category
Interpretation	43	Effective enough
Inference	44	Effective enough
Analysis	27	Less effective
Explanation	54	Effective enough
Evaluation	57	Effective enough

Each component of critical thinking skills can be said to be successfully trained if a percentage of ≥ 61% is obtained with an effective or very effective category.

Giving posttest questions to students. The is a table of the effectiveness of giving posttests.

Table 12. Results of Posttest Effectiveness in the Learning Process

KBK	Percentage (%)	Category
Interpretation	86	Very effective
Inference	86	Very effective
Analysis	84	Very effective
Explanation	83	Very effective
Evaluation	88	Very effective

Based on the table above, the posttest results were declared very effective where the percentage of each component was obtained ≥ 61%.

The results of each individual's pretest and posttest were analyzed with N- gain to calculate the gain (improvement) of critical thinking skills after the use of e-LKPD. The following are the results of the analysis with pretest and posttest using N-gain (0.7).

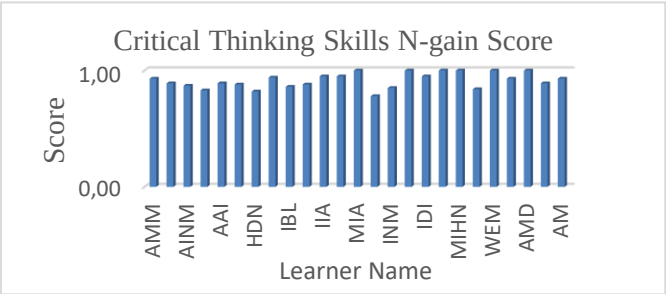

Figure 1. Critical Thinking Skills N-gain Score

Based on the results of pretest and posstest analysis using N-gain obtained 0.91 or 91% with a very effective category, so it can be concluded that the use of e-LKPD effectively improves critical thinking skills using the problem solving learning model in students of class XI MIPA 2 at SMAN Jogoroto Jombang.

▪ CONCLUSION

Based on the results of the study, it is concluded that the e-LKPD developed is declared feasible in terms of the acquisition of the results of content and construct validity which get a mode of assessment score 5 which is included in the very good category.

E-LKPD is declared practical based on the results of the students' response questionnaire with an average percentage of 95% and the results of observations of students' activities in two meetings obtained an average percentage of 93.32% and 96.65%, both of which are included in the very practical category.

E-LKPD is declared effective based on the results of the N-gain score on pretest and posttest analysis of 0.91 or 91% which is included in the very effective criteria category.

▪ REFERENCES

Agnia, D. N. (2019). Analysis of Students' Critical Thinking Skills in Biology Learning. Florea, 6(1), 45-43.

Anjarwati, B.C. and Nasrudin, H. (2022). Implementation of Guided Inquiry Based on Contextual Approach to Improve Students Critical Thinking Skills on Reaction Rate Material. Journal of Science Education Research, 6(1), pp.1-14.

Azizah, U., & Nasrudin, H. (2022). Problem Solving Thinking Skills: Effectiveness of Problem-Solving Model in Teaching Chemistry College Students. Journal of Science Education Research, 8(3), 1462-1469.

Dahar, R. Wilis. (2011). Theories of Learning and Learning. Jakarta: Erlangga.

Daryanto, S. (2017). 21st Century Learning. Gava Media.

Denisa, L. & Hakim, L. (2021). Development of Class XI Sharia Banking Accounting Contextual E-Modules Based on Flip Pdf Professional. JPAK: Journal of Accounting Education, 9 (1): 79-87.

Ministry of Education. (2008). Teaching Material Development Guide. Jakarta: Directorate of Senior High School Development, Directorate General of Primary and Secondary Education Management, Ministry of National Education.

Dewi, R., & Azizah, U. (2019). Development of Problem Solving Oriented Learner Worksheets (LKPD) to Train Critical Thinking Skills of Grade XI Learners on Chemical Equilibrium Material. Unesa Journal of Chemical Education, 8(3), 332-339.

Diah Ayu Saraswati, Diva Novi Sandrian, Indah Nazulfah, Nurmanita Tanzil Abida, Nurul Azmina, Riza Indriyani, & Septionita Suryaningsih. (2022). Analysis of P5 Activities at SMA Negeri 4 Tangerang City as an Implementation of Differentiated Learning in the Merdeka Curriculum. Journal of Mipa Education, 12(2), 185-191. https://doi.org/10.37630/jpm.v12i2.578

Ennis, R. H. (2018). Critical thinking across the curriculum: A vision. Topoi, 37(1), 165-184.

Kustianingsih, S. E., and Muchlis. (2021). Development of Student Worksheets Oriented Learrning Cycle 7-E to Improve Students' Critical Thinking Skills in Chemical Equilibrium Materials. In Unesa Journal of Chemical Education (Vol. 10, Issue 2).

Facione, P. (2015). Critical Thinking: What It Is and Why It Counts. Insight Assessment. Measured Reasons LLC, Hermosa Beach, CA.

Fisher, A. (2014). Critical Thinking: An Introduction. Jakarta: Erlangga

Fitriyah, A., & Ramadani, S. D. (n.d.). The Effect of Project-Based-Learning on Creative Thinking and Critical Thinking Skills (Issue 1).

Hake, R. (1999). Interactive Engagement versus Traditional Methods: A Six Thousand Student Survey of Mechanics Test Data for Introductory Physics Courses. American Journal Physics, 64-74

Irawati, R., & Santaria, R. 2020. Perception of Students of SMAN 1 Palopo Towards the Implementation of Online Learning in Chemistry Subjects. Journal of Teacher and Learning Studies, 3(2), 265. https://doi.org/10.30605/jsgp.3.2.2020.286 264-270

Khoiriyah, A. J., & Husamah, H. (2018). Problem-based learning: Creative thinking skills, problem-solving skills, and learning outcome of seventh grade students. JPBI (Indonesian Journal of Biology Education), 4(2), 151-160. https://doi.org/10.22219/jpbi.v4i2.5804

Lestari, D. D., & Muchlis, M. (2021). Development of e-LKPD Oriented Contextual Teaching and Learning (CTL) to Train Students' Critical Thinking Skills on Thermochemical Material for Class XI SMA. Indonesian Journal of Chemical Education, 5(1), 25-33. https://doi.org/10.23887/jpk.v5i1. 30987

Nisa, F. A., & Nasrudin, H. (2022). Development of Student Worksheet with Guided Inquiry to Train High Order Thinking Skills on the Reaction Rate Materials. Prisma Sains: Journal of Assessment of Science and Learning in Mathematics and Science IKIP Mataram, 10(1), 69-83.

Pahlevi, I., Rudibyani, R. B., & Emmawaty Sofia, E. S. (2020). Application of problem solving model to improve students' communication skills and mastery of acid-base concepts. Journal of Chemical Education and Learning, 9(1), 1-14.

Permendikbud. 2016. Primary and Secondary Education Process Standards Law Number 22 of 2016. Jakarta: Minister of Education and Culture.

Rahayu, R., Iskandar, S., & Abidin, Y. (2022). 21st Century Learning Innovation and its Implementation in Indonesia. Basicedu Journal, 6(2), 2099-2104. https://doi.org/10.31004/basicedu.v6i2.2082

Rudibyani, R. B. (2020). Problem-Based Learning to Improve Chemical Literacy and Concept Mastery of FETT Students at Lampung University. Journal of Chemical Education and Learning, 9(1).

Sugiyono, (2010). Educational Research Methods (Quantitative Education, Qualitative Research, and R&D) Bandung: Alfabeta Publisher.

Syah, R. H. (2020). The Impact of Covid-19 on Education in Indonesia: Schools, Skills, and Learning Processes. Journal of Syar'I Social & Culture, 7 (5), 398-397.

Yuzan, I. F., & Jahro, I. S. (2022). Development of e-LKPD Based on Guided Inquiry on the Subject of Chemical Bonding to Measure Students' Critical Thinking Ability. Encyclopedia: Saburai Journal of Education and Learning Innovation, 2(01),