



Development of E-LAPD with Problem Based Learning Oriented to Train Creative Thinking Skills on Reaction Rate Material

An Dhini Dwi Nur Agustine¹, Rusly Hidayah²

^{1,2}Universitas Negeri Surabaya, Indonesia

E-mail: andhini.20029@mhs.unesa.ac.id, ruslyhidayah@unesa.ac.id

Article Info	Abstract
Article History Received: 2024-07-22 Revised: 2024-08-19 Published: 2024-09-04 Keywords: <i>E-LAPD;</i> <i>Problem Based Learning;</i> <i>Creative Thinking Skills;</i> <i>Reaction Rate Material.</i>	The purpose of this research is to describe the advisability of the E-LAPD developed, including its validity, practicality, and effectiveness. The type of research used is research and development (R&D) with the 4-D model proposed by S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel (1974). The data collection method used was observation, questionnaire, and test. The results showed that validity has a mode worth 3 because it has the largest percentage in three criteria (content, construct, and graphics). Practicality received very practical criteria, with a percentage of 97% in the content aspect and 98% in the graphic aspect. Effectiveness received effective criteria, with the outcome of the N-gain score obtained indicating a value of 0.8. Nevertheless, the N-gain score for each creative thinking component shows originality 0.7, fluency 0.82, flexibility 0.86, and elaboration 0.8. This research's finding is that E-LAPD with problem-based learning oriented to train creative thinking skills on reaction rate material is feasible to develop as teaching material.
Artikel Info	Abstrak
Sejarah Artikel Diterima: 2024-07-22 Direvisi: 2024-08-19 Dipublikasi: 2024-09-04 Kata kunci: <i>E-LAPD;</i> <i>Problem Based Learning;</i> <i>Keterampilan Berpikir Kreatif;</i> <i>Materi Laju Reaksi.</i>	Penelitian ini bertujuan untuk mendeskripsikan kelayakan E-LAPD yang dikembangkan meliputi validitas, kepraktisan, dan keefektifan. Jenis penelitian yang digunakan adalah <i>Research and Development</i> (R&D) dengan model 4-D yang dicetuskan oleh S. Thiagarajan, Dorothy S. Semmel, dan Melvyn I. Semmel (1974). Metode pengumpulan data menggunakan metode observasi, angket, dan tes. Hasil penelitian menunjukkan bahwa validitas memiliki modus senilai 3 karena memiliki presentase terbesar dalam tiga kriteria (isi, konstruk, dan kegrafikaan). Kepraktisan mendapatkan kriteria sangat praktis dengan presentase 97% pada aspek isi dan 98% pada aspek kegrafikaan. Keefektifan mendapatkan kriteria efektif dengan hasil skor N-Gain yang didapat menunjukkan nilai 0,8. Sedangkan skor N-Gain tiap komponen berpikir kreatif menunjukkan <i>originality</i> 0,7, <i>fluency</i> 0,82, <i>flexibility</i> 0,86, dan <i>elaboration</i> 0,8. Kesimpulan dari penelitian ini adalah E-LAPD berorientasi <i>problem based learning</i> untuk melatih keterampilan berpikir kreatif pada materi laju reaksi layak untuk dikembangkan sebagai bahan ajar.

I. INTRODUCTION

Today we are at the beginning of the era of the creative industry revolution. It is characterized by increased connectivity and interaction, as well as the development of digital systems, virtual systems, and artificial intelligence. Without a doubt, information and communication technology affects many aspects of life, including education in Indonesia. Preparing new literacy data must help boost traditional literacy based on reading, writing, and arithmetic. Education that enables innovative, creative, and ambitious generations to confront the period of industrial transformation (Lase, 2019).

One of the most important components of human life is education. A superior and competitive human resource in an era of globalization is based on good education. It is essential for education to form high-quality,

professional, critical, creative, and innovative individuals. The Indonesian Minister of Education made a number of initiatives to raise the standard of education, including creating the most recent, independent curricula. Independent curriculums were formed on the basis of outcome of the Programme for International Student Assessment, which indicating that 70% of 15-year-olds did not have the minimum knowledge in basic mathematics or understood simple reading. This study shows that there are many differences in the quality of interregional and intergroup socio-economic learning. The Covid-19 pandemic makes things worse (Kemendikbudristek, 2022).

Chemistry describes the matter, properties, structures, changes/reactions, and energies that arise from change. Each chemical sub-material has unique characteristics that teachers use to

determine the appropriate learning model and medium. It is intended to make learning easier for pupils (Hasanah & Agustini, 2023).

Pre-study results showed that chemistry was one of the most difficult subjects for students. 84% of students said they had difficulty with the subject because of the abundance of mathematics, formulas, and calculations, as well as because the matter was abstract and difficult to understand. In addition, 63% of students said they felt that chemistry lessons were difficult to understand. The majority of learners feel chemistry to be an enjoyable study since there are many attractive experiments, they recognize how it applies to daily life, and the teacher fulfills a short and straightforward explanation. Reaction-speed matter is one of the most common chemical materials and can be used in real life. Based on pre-research data carried out at Unesa Labschool 1 Surabaya High School, 89% of pupils stated difficulty in studying reaction-speed material due to many formulas and calculations.

Based on the access to independent phase F chemistry learning curriculum, one of the elements that students should understand is the concept of speed. The speed aspect has conceptual characteristics and process skills, such as observing, questioning, and predicting, planning and conducting research, processing, analysing and evaluating, as well as reflection. The independent curriculum is a new breakthrough made by the government to improve the profile of Pancasila students in the educational process. The independent curriculum encourages cross-disciplinary collaborative learning in observing, learning, and refining skills, as well as involving all learners in creative learning and thinking activities. The curriculum also encourages the active participation of students in learning activities (Kemendikbudristek, 2024).

Williams (1979) and Guilford (Munandar, 2017) stated that the ability to think in creativity consists of four aspects: fluency, flexibility, originality, and elaboration. According to outcomes of pre-research activities carried out at Unesa Labschool 1 Surabaya High School, the students obtained creative thinking skills of (1) Originality 42,1%, (2) Fluency 61,1%, (3) Flexibility 57%, and (4) Elaboration 32,8%. Based upon the data, the problem of low level of creative thinking of the students should be addressed immediately because creative thinking is one of the skills aimed at preparing the students in the face of real problems inside and outside of learning.

Model problem based learning using real-world problems as the main problems to be solved (Arends, 2008). Creative thinking skills should also be enhanced by applying a problem-based learning model. The reasoning for this is because students engage in a problem-solving process, a process driven by their own personal experience then their creative thinking develops. This sophisticated creative thinking skill allows students to control a variety of academic endeavours (Yildiz & GulerYildiz, 2021).

In the application of the learning model of course needed teaching materials, one of them is the LAPD "Lembar Aktivitas Peserta Didik". LAPD is an adaptation of the independent curriculum of the LKPD. However, the LAPD and the LKPD have the same purpose. The LAPD contains tasks that must be done by the pupils. With the advancement of technology in the world of education, LAPD can now be packaged in electronic form through electronic media that can be accessed through smartphones, computers, or laptops, which changed its name to E-LAPD. According to outcomes of pre-research at Unesa Labschool 1 Surabaya High School show that 57.9% of students support the development of electronic LAPD because it is practical as a teaching material.

Determined by the conclusion that of orientation towards the activity sheet that has been developed in the previous research as shown in the illustration above, it is necessary to develop an action sheet to train the creative thinking of the learners on the reaction speed material. Therefore, the title used in this study is "Development of E-LAPD with Problem Based Learning Oriented to Train Creative Thinking Skills on Reaction Rate Materials". The goal of this investigation is to describe the E-LAPD qualifications developed, covering the validity, practicality, and effectiveness of learning at the Unesa Labschool 1 Surabaya High School.

II. METHOD

Such kind of research is research and development. The procedure applied on the development of this teaching material uses the 4-D model which includes four research step, namely define, design, develop, and disseminate. This investigation is restricted by the develop step. This model was developed by S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel (1974). Instruments chosen include validation sheets, student response questionnaires and creative thinking skills test paper.

The validation step of the E-LAPD developed was conducted by two chemistry lecturers FMIPA Unesa and one chemistry teacher SMA Labschool Unesa 1 Surabaya. The data analysis process of the expert validation sheet uses a Likert scale. The assessment score used, namely:

Table 1. Likert Scale

Score	Statement
0	None
1	Invalid
2	Less Valid
3	Valid
4	Very Valid

Source: Riduwan, 2017

Based on Table 1, ordinal data were analyzed based on the mode. E-LAPD It's claimed to fulfill the standards of substance, apperance, and graphics if the mode of assessment obtained is at least 3. Analysis of students' response questionnaire uses a Guttman scale obtained from students' responses through positive and negative statements. The score criteria used, namely:

Table 2. Guttman Scale

Respon	Answer	Score
Negative	Yes	0
	No	1
Positive	Yes	1
	No	0

source: Riduwan, 2017

The data received was processed with a particular equation.

$$\% \text{ Respon peserta didik} = \frac{\sum \text{skor yang diperoleh}}{\sum \text{skor maksimal}} \times 100\% \quad (1)$$

The results of the analysis of learner response data used to determine the response of students to the E-LAPD developed are interpreted into the criteria in Table 3.

Table 3. Interpretation of Learner Response Score

Percentage (%)	Criteria
0 – 20	Very Unpractical
21 – 40	Less Practical
41 – 60	Practical Enough
61 – 80	Practical
81 – 100	Very Practical

source: Riduwan, 2017

Based on the results of students responses to the E-LAPD developed, It is defined to be practical to highly practical if a certain amount of practicality is obtained $\geq 61\%$.

Student test results evaluated by N-gain score. This evaluation aims to determine the effect of using E-LAPD developed on students creative thinking skills with pretest and posttest. The following is formula for calculating N-gain.

$$g = \frac{S_{posttest} - S_{pretest}}{S_{maks} - S_{pretest}} \quad (3)$$

Outcomes of the N-gain score The equations were explained by normalized gain. The interpretation of the N-gain assessment can be seen in Table 4 as follows.

Table 4. N-gain Score Criteria

Average of N-gain (g)	Criteria
$g > 0,7$	High
$0,7 > g > 0,3$	Medium
$g < 0,3$	Low

source: Hake, 1999

Based on the above criteria, E-LAPD was successfully trained if it obtained a minimum N-Gain value of $0.7 > g > 0.3$ due to the medium classification.

III. RESULTS AND DISCUSSION

A. Research results

The procedure applied on the development of this teaching material uses the 4-D model which includes four research step, namely define, design, develop, and disseminate. This investigation is restricted by the develop step. This model is adapted from Thiagarajan et al., (1974).

1. Define

The goal of this step is to identify and explain learning requirements. With the initial investigation completed, we can determine the objectives and difficulties with the present media or learning tools. The define stage is comprised of five steps. First, the beginning of the analysis seeks to explain the fundamental issues involved in the creation of learner activity sheets. Things to consider include the applicable curriculum, pertinent learning theories, and future demands. Second, learner analysis seeks to identify learners' characteristics, such as age, cognitive development, and past experiences with learning. Third, task analysis is a method for determining the organization of the content in the lesson unit. Task analysis involves outlining the subject's content. Fourth, concept analysis seeks to identify

the primary ideas that will be incorporated into the E-LAPD. Fifth, learning objective analysis is an activity that converts the objectives of task analysis and idea analysis into design recommendations for developing E-LAPD.

2. Design

The goal of this step is to create activity sheets with multiple supporting devices. The design step consists of three steps. We first choose test criteria to describe the effectiveness of the generated learning media in training creative thinking skills, based on pretest and posttest findings. Second, media selection is used to establish how the learning content is presented. The researcher's preferred media is liveworksheets. Third, consider the initial design of the developed E-LAPD. Experts should be consulted on the E-LAPD design's content, appearance, and graphics to ensure its suitability for use.



Figure 1. Cover E-LAPD



Figure 2. Content Snippet of E-LAPD

3. Develop

The goal of this step is to produce E-LAPD with problem based learning oriented that meets the eligibility criteria (valid, practical, and effective). In fulfilling the eligibility criteria, it is necessary to conduct validity tests and limited trials of the developed E-LAPD.

a) Product Validity

The validation stage aims to assess the E-LAPD developed regarding its validity. Validation of the product was conducted by three validators, which involved two Unesa chemistry education lecturers and one Labschool Unesa 1 Surabaya high school chemistry teacher. This validation has 3 aspects that must be assessed related to content, construct, and graphics. The results obtained are as follows.

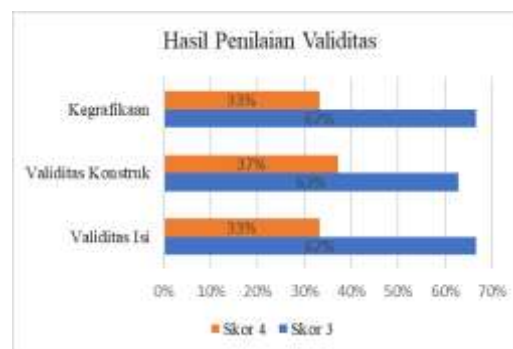


Figure 3. Validity Assessment Results

b) Limited Test

The limited test was held at Labschool Unesa 1 Surabaya Senior High School, with a total of 36 students getting reaction rate materials. The restricted test was designed to evaluate the practicality as well as effectiveness of the newly created E-LAPD. The practicality test involved giving students a response questionnaire that included questions about the feasibility of the content and graphics. The practicality test yielded the following results:

Table 5. Results of the Learner Response Questionnaire

Aspect	Percentage	Description
Contents	97%	Very Practical
Graphics	98%	Very Practical

Additionally, the effectiveness test was conducted with pretest and posttest questions to improve creative thinking skills. The goal of this test is to measure students' initial ability before and after the implementation of the E-LAPD. The findings of the pretest and posttest were evaluated using the N-gain. The findings of the pretest and posttest are reported in Figure 4.

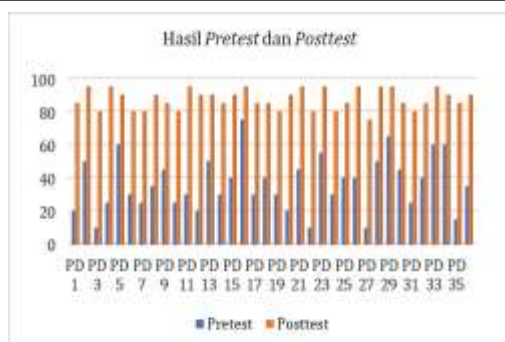


Figure 4. Pretest and Posttest Results of Creative Thinking Skills

The outcomes of the N-gain test are shown in Table 6.

Tabel 6. Hasil N-Gain Score

Average	Pretest	Post-test	N-Gain	Description
	36,5	87,5	0,8	High

The outcomes of the N-Gain test on each creative thinking component are shown in Table 7 below.

Tabel 7. N-Gain Results for Each Creative Thinking Component

Components of Creative Thinking	Pretest	Posttest	N-Gain
Originality	30,56	79,44	0,70
Fluency	35	88,33	0,82
Flexibility	26,67	90	0,86
Elaboration	53,89	91,11	0,80

B. Discussion

1. Validity of E-LAPD with Problem Based Learning Oriented to Train Creative Thinking Skills on Reaction Rate Material

E-LAPD with problem based learning oriented is a teaching material created by researchers to improve students' creative thinking skills with reaction rate content. The development of E-LAPD occurred in three steps: define, design, and development. Define consists of five phases. First, front-end analysis of this data is performed using observation activities at Labschool Unesa 1 Surabaya High School. Things to consider include the applicable curriculum, relevant learning theories, and future demands. The most recent curriculum, known as the independent curriculum, is used in high school. Second, examine students based on their age and cognitive development. According to observations, the average age of students is 16–17 years old. This age falls within the formal phase of cognitive development, which Piaget

defines as a period when children can understand abstract concepts and solve problems. Third, task analysis involves outlining the subject's content. The learning outcomes for Phase F of the independent curriculum outline that students must be able to comprehend and explain the rate aspect of daily life. As a result, the E-LAPD produced includes a subchapter on elements that influence reaction rate because its qualities are applicable in everyday life. Fourth, concept analysis generates a concept map for reaction rate material. Fifth, the analysis of learning objectives yields learning objectives that impact the design of E-LAPD.

Design is divided into three phases. First, the test criteria selection is utilized to characterize how well the created learning materials educate creative thinking abilities based on pretest and posttest outcomes. Essay-based questions are part of the written exam format that is utilized. The second is the choice of media to decide how the educational content is presented. A few of the materials used to create this E-LAPD include pictures and movies that have links to related content. Microsoft Word was utilized for the media's original design, and Canva was used to enhance its aesthetic appeal. The initial design yielded an initial PDF draft. Following that, the first draft was posted to the Liveworksheets website in order to be transformed into an electronic learner activity sheet. Third, in order to ensure that E-LAPD is appropriate for use, the supervisor must be contacted during the original design process with regards to content, presentation, and graphics.

Develop aims to produce E-LAPD with problem based learning oriented that meets the eligibility criteria (valid, practical, and effective). Based on the validity results that have been listed in Figure 3, researchers can interpret it as follows. Based on Figure 3 above, the outcomes of content validity assessment obtained a score of 3 by 67% and a score of 4 by 33% from three validators, while the construct validity received a score of 3 by 63% and a score of 4 by 33% and on the criteria for graphics received a score of 3 by 67% and a score of 4 by 33%. According to assessment results, It might be viewed

the mode obtained is 3 because it has the largest percentage in three criteria (content, construct, and graphics). It can be stated that the E-LAPD problem based learning oriented developed has met the valid criteria to be applied as teaching materials that train creative thinking skills on reaction rate material in accordance with the provisions of data analysis proposed by Lutfi (2021).

2. Practicality of E-LAPD with Problem Based Learning Oriented to Train Creative Thinking Skills on Reaction Rate Material

Practicality is one element of the released media's feasibility. This usefulness is assessed based on students' responses after receiving treatment with the created E-LAPD. According to table 5, the findings of the students' response questionnaire to the produced E-LAPD obtained a percentage of 97% in content aspect and 98% in the graphical aspect. These results can be stated that the E-LAPD developed is very practical because it is in the range of 81-100% according to the provisions of data analysis proposed by Riduwan (2015).

3. Effectiveness of E-LAPD with Problem Based Learning Oriented to Train Creative Thinking Skills on Reaction Rate Material

Effectiveness is part of feasibility assessment of a media or teaching material development. The effectiveness of the developed E-LAPD It's evaluated using the outcomes of a pretest and posttest of students' creative thinking abilities. The pretest and posttest findings revealed a considerable increase in the score. This indicates an increase after the treatment with the developed E-LAPD. Additionally, the N-gain score calculated shows a value of 0.8, indicating $g > 0.7$ in a high category Hake (1999). Based on calculation of N-gain improvement in creative thinking, the students were placed in the highest category. This is shown on each component obtained N- gain score originality 0.7, fluency 0.82, flexibility 0.86, and elaboration 0.8. On the originality aspect, the student is able to give a new idea in dealing with the problem in each of the factors that influence the speed of reaction. On the fluency aspect the student can give more than one answer in the questions given. It is in line with the characteristics of

the flexibility aspect where the student is required to see the problem from different perspectives. On the elaboration aspect the student can answer and explain in detail by associating the problem with the theory of speed of reaction. From these results it can be stated that E-LAPD with problem based learning oriented is effectively applied to improve creative thinking skills on reaction rate material.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

According to outcomes of research and discussion in the development of E-LAPD with problem based learning oriented to train creative thinking skills on reaction rate material, it's able to say:

1. The E-LAPD teaching materials produced are considered valid by analyst validity results. Following the validity phase, outcomes of content validity were attained a score of 3 by 67% and a score of 4 by 33% from three validators, while the construct validity obtained a score of 3 by 63% and a score of 4 by 63% and on the criteria for graphics obtained a score of 3 by 67% and a score of 4 by 33%.
2. The E-LAPD teaching materials developed were declared practical Regarding the results of a student's response questionnaire. According to the questionnaire answers, the percentage results were 97% for content and 98% for graphics. These results can be stated that the E-LAPD developed is very practical because it is in the range of 81-100%.
3. The E-LAPD teaching materials produced were certified effective based on student pretest and posttest results. The pretest and posttest findings were analyzed using the N-gain Score method. The analysis yielded an N-gain score of 0.8, indicating that g is greater than 0.7, which places it in the high category. E-LAPD-oriented problem-based learning is beneficial for training creative thinking skills, as indicated by the improvement in pretest and posttest scores.

B. Suggestion

According to results of discussion, several things can be suggested, including:

1. The development of Problem Based Learning Oriented E-LAPD to Train Creative Thinking Skills on Reaction Rate

Material is just implemented until the develop step so it is hoped that the next research can be implemented to the disseminate step.

2. Future researches are expected to develop teaching materials like E-LAPD with problem based learning oriented on other chemistry materials to train creative thinking skills.

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