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FEASIBILITY OF PRACTICUM-BASED E-SAS LIVEWORKSHEET TO IMPROVE CRITICAL THINKING SKILLS

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Abstract

This study aims to develop a laboratory-based E-SAS liveworksheet that is suitable for use as teaching material to train critical thinking skills in reaction rate material based on three aspects, namely validity, practicality, and effectiveness. This study uses an R&D research type with a 4D model limited to the develop stage. A limited trial was conducted in the 11th grade at a private high school in Surabaya with 30 students. The results showed that the content validity and construct validity of the practical-based E-SAS liveworksheet for training critical thinking skills in reaction rate material met the validity criteria, as indicated by a content criterion mode of 5 in the very good category and a construct of 4 in the good category. The practicality of the E-SAS liveworksheet based on practical work to train critical thinking skills in reaction rate material was declared practical based on the results of the average student response questionnaire of 97% and supported by the results of student activity observations with a mode of 5 in the very good category. The E-SAS liveworksheet based on practical work to train critical thinking skills in reaction rate material was declared effective based on the results of the paired sample t-test with a p-value of 0.000, p-value <0.05, which means that there was a significant difference between the pretest and posttest of students' critical thinking abilities.
Keywords: E-SAS, critical thinking skills, practical work, feasibility

INTRODUCTION

Improvements in the quality of learning in Indonesia are still being pursued in order to improve the quality of education, one of which is through curriculum reform, where the learning model that was originally teacher-centered has changed to student-centered, namely the independent curriculum. The independent curriculum can be applied to every subject, including chemistry [1].

Reaction rate is a chemistry learning material found in learning outcomes phase F. The learning outcomes of reaction rate material are to observe, investigate, and explain everyday phenomena according to scientific principles in explaining reaction rates in everyday life. To achieve this, the reaction rate material needs to be combined with an experiment or practicum to prove a concept [2]. This is because understanding the concept of reaction rate cannot only be obtained through theory, but must be proven through experiments or practicums so that students can observe changes in substance concentration over time and determine the reaction rate constant directly [3].

Practicum-based learning is a learning activity carried out in a laboratory, where students conduct experiments or practical activities to understand scientific concepts directly. Practicum activities can improve students' critical thinking skills, which is a form of skill development in the cognitive domain [4]. In addition, learning through the integration of practical work is effective in improving students' critical thinking skills because it requires scientific analysis and problem solving [5]. Through experimental activities, students can investigate, analyze, conclude, and evaluate to gain understanding and build their thinking skills [6]. The skill being trained is critical thinking.

Critical thinking skills are the ability of students to analyze arguments, apply reasoning in drawing conclusions, evaluate or assess, and make

decisions or solve problems that should be empowered through learning at school [7]. There are six critical thinking skills, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation [8]. However, this study only focuses on four indicators of critical thinking skills that play an important role in supporting the practicum-based learning process, namely interpretation, analysis, inference, and explanation.

These four indicators are very important in helping students understand concepts scientifically and logically. However, in reality, the critical thinking skills of high school students are still relatively low, as evidenced by the results of preliminary research conducted at a public and private high school in Surabaya. Based on the results of the preliminary research through critical thinking skills tests conducted at the private high school on 30 grade XI students, it was found that the interpretation indicator had a percentage of 41.25% (very low category), analysis 33.33% (very low category), inference 30.00% (very low category), and explanation at 27.50% (very low category). Based on these results, it can be concluded that students' critical thinking skills are still relatively very low and need to be improved through learning that supports the development of these abilities. To help students understand the concepts and think critically about reaction rate material, teachers need to be creative in selecting and developing appropriate learning media.

Learning media itself is any form of physical tool that can convey messages and stimulate students to learn [9]. Learning media can serve as a bridge between students and difficult-to-understand material, thereby accelerating understanding and increasing motivation to learn [10]. Learning media is considered to be one of the determining factors in the success of the learning process and can also play a role in improving students' critical thinking skills. Based on the results of a pre-research questionnaire and an interview with a chemistry teacher at a private high school in Surabaya, it was found that learning is still dominated by lectures and discussions without any variation in learning media. This condition causes students to tend to feel bored and less motivated in participating in learning, resulting in difficulties in understanding concepts and being less trained to think critically, especially on reaction rate material related to everyday life. Therefore, efforts are needed to maximize the use of learning media so that the learning process becomes more interesting and meaningful. One medium that can be utilized for this purpose is the Student Activity Sheets (SAS). As an important component in learning, the Student Activity Sheets (SAS) is designed to facilitate students in understanding concepts through direct activities [11]. However, with the development of technology in the world of education, the SAS has been developed into a digital form known as E-SAS.

E-SAS (Electronic Student Activity Sheets) is a digital student worksheet that can be accessed via laptop, PC, or mobile phone. Based on the results of a pre-research survey conducted at a private high school in Surabaya, it was found that 93.33% of students frequently use mobile phones/Android devices in learning activities, so the use of E-SAS is considered appropriate to support the learning process of students. E-SAS was developed based on reaction rate material because many students still have difficulty understanding the concept. This can be seen from the results of the pre-research questionnaire, which showed that 65% of students had difficulty with this topic. Reaction rates are abstract and require visualization and experimental activities to be more easily understood. Through interactive features and digital data presentation, E-SAS helps students explore the factors that influence reaction rates in a more concrete way. This material also supports practical-based learning and the development of critical thinking skills, making the use of E-SAS relevant and effective. E-SAS is an electronic learning medium that is systematically arranged to help students achieve the expected competencies [12]. The developed E-SAS utilizes the liveworksheets platform, a website that allows teachers to convert conventional worksheets into interactive worksheets with automatic correction and assessment. In addition, the use of liveworksheets in learning activities has been

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proven to support efficient digital learning, as it facilitates teacher in assessment and increases student engagement [13]. Compared to printed SAS, E-SAS is superior because it can contain video, sound, and image features that will help students visualize abstract material [14]. In the learning process, teachers can use E-SAS liveworksheets to encourage students to think critically in solving problems and to foster courage in expressing their opinions so that students do not become passive when participating in classroom learning. Therefore, this study aims to test the feasibility of E-SAS liveworksheets based on the aspects of validity, practicality, and effectiveness. The E-SAS Liveworksheet is based on practical work on reaction rate material and was developed to train students' critical thinking skills as a solution to the problems described above.

METHOD

This research is a development study or Research and Development (R&D). R&D is a research method used to produce a specific product and test its effectiveness [15]. Research and Development in education is carried out as a systematic process that includes needs analysis, product design, prototype development, validation testing, and revision before dissemination [16]. The development of this learning media uses the 4D development model by Thiagarajan (1947), which has four stages, namely define, design, develop, and disseminate [17]. The 4-D model (Define, Design, Develop, Disseminate) is an R&D framework that is often used to ensure that learning products are valid and practical for use in schools [18]. However, this study is limited to the define, design, and develop stages. The research design can be seen in Figure 1.

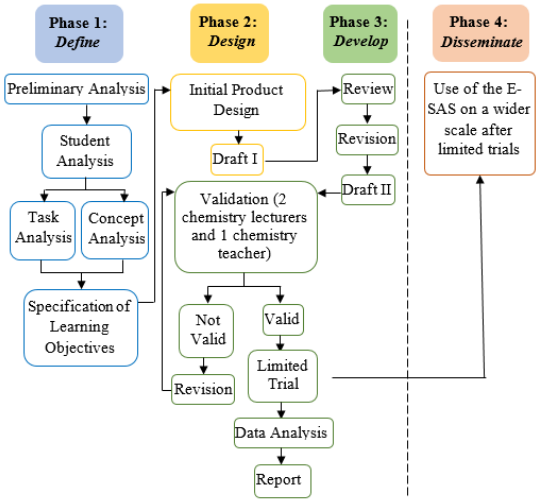

Figure 1. 4D Development Model Scheme

This study used a limited one-group pretest-posttest experimental design.

$$O_2 \quad X \quad O_1$$

[15]

Figure 2. One Group Pretest Posttest Design

Explanation:

O_1 : Pretest score (before treatment)

O_2 : Posttest score (after treatment)

X : Treatment using E-SAS liveworksheet learning media based on practical work.

In this study, data collection was conducted at a private high school in Surabaya through observation, questionnaires, and tests using research instruments, namely review sheets, validation sheets, student response questionnaires, student activity observation sheets, and pretest and posttest sheets for critical thinking skills. The following is a detailed explanation of the instruments used in this study.

1. Review Sheet

   The review questionnaire was used to obtain suggestions and comments regarding the developed media. The results of the review sheet were used as a reference to improve the media and research instruments before entering the validation stage.

2. Validation Sheet

   The validation sheet was used to determine the validity level of the developed media based on the assessment results from three validators, which included content validity and construct validity. The assessment

scores ed using a Likert scale as shown in Table 1.

Table 1. Likert Scale

Score	Category
5	Very Good
4	Good
3	Fair
2	Poor
1	Very Poor

[19]

The assessment results were analyzed for each indicator using the mode value, and the media was declared valid if it obtained a minimum score of 4 with good criteria.

3. Student response questionnaire

The student response questionnaire was given after a limited trial to determine student responses to the developed media. The questionnaire results were used as a reference to assess the practicality of the media. The questionnaire was analyzed using the Guttman scale with answer choices of "Yes" and "No" as presented in Table 2.

Table 2. Guttman Scale Scores

Answer	Statement Score	
	Positive	Negative
Yes	1	0
No	0	1

[19]

The students' response to the use of the developed media can be calculated using the following formula:

$$\% \text{ Response} = \frac{\text{Total score obtained}}{\text{Total maximum score}} \text{ x } 100\%$$

The analysis of the response questionnaire in this study was based on the acquisition of positive and negative responses. For positive statements, positive responses were obtained from the number of students who answered “Yes”, while for negative statements, positive responses were obtained from the number of students who answered “No.” The results obtained were then interpreted into the score interpretation criteria presented in Table 3.

Table 3. Interpretation of Student Response Questionnaire Scores

Percentage (%)	Criteria
0-20	Very Poor
21-40	Poor
41-60	Fair
61-80	Good
81-100	Very Good

[19]

Based on these criteria, student responses are considered positive if the percentage of scores obtained reaches ≥ 61% [19].

4. Student Activity Observation Sheet

The student activity observation sheet is used to obtain data on relevant student activities during the trial. This sheet is filled out by six observers. The results of the observation sheet are used to assess the practicality of the developed media. The measurement scale used is presented in Table 4 below.

Table 4. Likert Scale

Score	Category
5	Very Good
4	Good
3	Fair
2	Poor
1	Very Poor

[19]

The observation data were analyzed for each indicator using the mode value and were considered practical if they obtained a minimum score of 4 with good criteria.

5. Critical thinking skills pretest and posttest sheets

These critical thinking skills pretest and posttest sheets were designed to determine the improvement in students' critical thinking skills based on the use of the developed media. The tests were administered at the beginning (pretest) and end (posttest) of the learning process. An improvement in students' critical thinking skills was categorized as good if the students were able to answer the questions correctly and achieve the targets set in the study. Critical thinking skill scores were obtained from the pretest and posttest results using the following formula:

$$\% \text{ Critical thinking skills} = \frac{\text{Total score obtained}}{\text{Total maximum score}} \text{x } 100\%$$

The percentage value of critical thinking skills calculated is then categorized according to the criteria in Table 5.

Table 5. Critical Thinking Skills Percentage Categories

Value Interval (%)	Category
$81{,}25 < X \leq 100$	Very High
$71{,}50 < X \leq 81{,}25$	High
$62{,}50 < X \leq 71{,}50$	Fair
$43{,}75 < X \leq 62{,}50$	Low
$0 < X \leq 43{,}75$	Very Low

[20]

The pretest and posttest results of students' critical thinking skills were also analyzed using a paired sample t-test. However, before the test was conducted, a normality test was first performed as a prerequisite to determine whether the data was normally distributed or not. The test was conducted using the SPSS (Statistical Product and Service Solution Ver. 27) program based on the following decision criteria:

H_0 : If the p-value is > 0.05, then the data is normally distributed

H_1 : If the p-value is < 0.05, the data is not normally distributed

If the data is normally distributed, the analysis is continued with a paired sample t-(Statistical Product and Service Solutions Ver. 27) program. This study used a significance level of 5% (0.05) with the following hypothesis:

H_0 : There is no increase in students' critical thinking skills after using the liveworksheet-based E-SAS for practical work on the subject of reaction rates.

H_1 : There is an increase in students' critical thinking skills after using the E-SAS liveworksheet based on practical work on the subject of reaction rates.

In the Paired Sample t-Test, the basis for decision making is based on the significance value (p-value). If the p-value is < 0.05, then $H_0$is rejected and $H_1$is accepted. However, if the p-value is > 0.05, then $H_0$is accepted and $H_1$is rejected.

RESULTS AND DISCUSSION

The Thiagarajan 4D development model used in this study consists of four stages, namely define, design, develop, and disseminate. However, this study only covers the development stage. The results and discussion are presented below.

Define Stage

The definition stage is the initial stage consisting of four main steps and is carried out during preliminary research at a high school in Surabaya. Student analysis serves to understand the characteristics, needs, and difficulties of students so that the learning products or strategies developed can be adapted to the actual conditions in the field. Curriculum analysis aims to ensure that learning development is in line with student needs, the material taught, and applicable educational objectives. Concept analysis is conducted to identify and examine important concepts contained in the reaction rate material so that they can be presented systematically and in accordance with the students' ability levels. Furthermore, task analysis is used to determine the types and forms of tasks given to students during the learning process, by adjusting them to the learning outcomes of phase F and the learning objectives of the reaction rate material.

Design Stage

The purpose of this stage is to design the E-SAS to be developed. In this stage, a liveworksheet-based E-SAS was designed. The design stage consisted of four steps, namely test preparation, media selection, format selection, and initial design [17]. This study produced four E-SAS based on factors that affect reaction rates, namely concentration, temperature, surface area, and catalysts.

Figure 2. Cover of E-SAS Based on Reaction Rate Factors

The developed E-SAS consists of ten components, namely the cover page, foreword, table of contents, instructions for use, concept map, introduction, summary of material, learning activities, glossary, and bibliography. Each component is systematically designed to support the achievement of learning objectives. In addition, this E-SAS contains questions compiled based on critical thinking skill indicators, which include interpretation, analysis, inference, and explanation. The E-SAS design that has been compiled at this design stage is then developed into a preliminary product that is ready to be validated by experts. The next stage, the development stage, focuses on the validation, revision, and limited testing processes to ensure that the E-SAS developed is suitable for use in learning and effective in training students' critical thinking skills.

Development stage

This stage is the third stage in the 4D development model, which focuses on the process of creating and refining learning materials in the form of E-SAS. This stage includes three main activities, namely: (1) review and revision by reviewers (chemistry lecturers to obtain input and suggestions for improvement), (2) validation by three validators to assess the feasibility of the developed E-SAS, and (3) limited trials involving students as users. In this study, the feasibility of E-SAS was assessed based on three main aspects, namely validity, practicality, and effectiveness.

Validity

The validity of the developed E-SAS was assessed based on two main criteria, namely content validity and construct validity. The validation process was carried out by three validators, namely lecturers and a chemistry teacher from SMA Labschool Unesa 1 Lidah Wetan. The E-SAS was declared valid if it obtained a mode score of ≥ 4 with valid or highly valid criteria. If the mode score of the E-SAS was below 4, revisions and re-validation were carried out until the required standard was achieved. The validity data results are presented in Table 6.

Table 6. Results of Content and Construct Validity Assessment of the Developed E-SAS

Aspect	Mode	Category
Content Validity	5	Very Good
Construct Validity	4	Good

Content validity describes the extent to which the content presented in the E-SAS is in line with the competencies, indicators, and learning objectives to be achieved. A learning instrument is said to have content validity if the material presented is relevant to the curriculum, in line with the characteristics of the learners, and capable of measuring the targeted skills and competencies [21]. Based on Table 6, the content validity validation results obtained a mode of 5 with a category of very good and can be declared valid. These results indicate that the content of the E-SAS is in accordance with the Learning Outcomes (CP), Learning Objectives (TP), and Learning Objective Flow (ATP), thereby supporting the achievement of student competencies [22, 23]. The material is arranged sequentially and systematically following the curriculum structure to improve concept integration and make it easier for students to follow a learning flow that is consistent with the curriculum competency map [24], [25], and contains skills that are trained in an integrated manner to improve students' ability to understand and apply concepts [26]. In addition, E-SAS is considered effective in training critical thinking skills, including interpretation, inference, analysis, and explanation [8]. Through activities such as formulating problems, determining hypotheses,

analyzing experimental results, and explaining conclusions, students are trained to think logically and systematically. E-SAS also contains images and videos relevant to the topic of reaction rates, which help reinforce conceptual understanding through visual representation [27]. Overall, the validation results show that the material aspects of E-SAS are in the good to very good category and are declared valid for use in learning.

Meanwhile, construct validity refers to the degree of accuracy of an instrument in measuring the concepts that should be measured based on the underlying theory of s [15]. Construct validity in this study includes three indicators, namely presentation, language, and graphics. Based on Table 6, the validation results for construct validity obtained a mode of 4 with a good category and can be declared valid. In the presentation indicator, this shows that the images and videos in the E-SAS are clear and of good quality. This is in line with the opinion that multimedia elements such as images and videos can improve understanding and learning quality. In the linguistic indicator, the sentences used in the E-SAS are simple, easy to understand, and use appropriate and consistent terms [28], [29]. This is in line with the criteria for good SAS according to [30]. Meanwhile, in terms of graphic design, the E-SAS is considered to use fonts, color compositions, and layouts that are harmonious, as well as combining attractive text, images, and videos. This assessment is in line with the opinion that a harmonious visual display can clarify the function of the media and improve student understanding [31], [29].

Practicality

The practicality of SAS is determined through questionnaire results and observation of student activities. SAS is considered practical if the questionnaire response results show a percentage of ≥61%, and the student observation data obtains a minimum score of 4 with good

criteria. The student activity observation sheet was distributed to six observers during the learning process, and the questionnaire was given to students after using the developed E-SAS. The following data on the results of student activity observations are shown in Table 7.

Table 7. Results of Student Activity Observations

Observation Results	Mode	Category
Meeting 2	5	Very Good
Meeting 3	5	Very Good
Mode	5	Very Good

Based on observations of student activities, the E-SAS liveworksheet developed was deemed practical with an excellent rating, as indicated by a mode score of 5 in most aspects of the learning activities.

All stages of learning, from the introduction, core activities, to the conclusion, were carried out optimally. Students showed active participation in each practical-based learning syntax, such as observing, questioning, exploring, analyzing, communicating, and concluding. This high level of participation shows that E-SAS is able to facilitate student engagement, independence, and conceptual understanding, in line with the opinion that learning tools are considered practical if they are easy to use and support learning activities effectively [19]. These results also reinforce the findings of other studies that confirm that learning media with interactive and attractive displays can increase student motivation and learning outcomes [27].

In addition to observation sheets, this study also used student response questionnaires as a supporting instrument to assess the practicality of E-SAS. The student response questionnaire aimed to determine students' responses after using the developed E-SAS. This questionnaire was filled out by 30 students who had participated in learning using E-SAS. The results of the analysis of the student response questionnaire are presented in Table 8.

Table 8. Results of the Student Response Questionnaire

Number of Students	Practicality Percentage	Category
30	96,97%	Very Good

Based on Table 8, the practicality percentage of 96.97% indicates that the developed E-SAS is practical with a very good category. This indicates that the E-SAS liveworksheet based on practical

work is considered easy to use in learning, helps to understand the material on reaction rates, uses communicative language, and has an attractive appearance and questions that are in line with the critical thinking skills being trained. These results are in line with the opinion that a percentage above 80% indicates a very good level of practicality [19], as well as the opinion that the use of media with an attractive appearance and communicative language can improve student understanding [27].

Effectiveness

The effectiveness of the E-SAS was assessed based on the results of the students' critical thinking skills test, obtained through pretest and posttest scores in the form of an essay test. This test was given to 30 students in class XI Science 2 at a high school in Surabaya and consisted of 14 questions based on reaction rate material, specifically factors that affect reaction rates. The following table presents the percentage of achievement for each critical thinking skill indicator obtained through the students' pretest and posttest scores in Table 9.

Table 9. Percentage of Achievement of Each Critical Thinking Skill Indicator

No	Crtical Thinking Skills Indicators	Pretest	
		Percentage Achievement (%)	Category
1.	Interpretation	33,75	Very Low
2.	Analysis	24,17	Very Low
3.	Inference	31,25	Very Low
4.	Explanation	27,50	Very Low

No	Crtical Thinking Skills Indicators	Posttest	
		Percentage Achievement (%)	Category
1.	Interpretation	96,04	Very High
2.	Analysis	82,08	Very High
3.	Inference	82,92,	Very High
4.	Explanation	85,83	Very High

The indicators used in this study were interpretation, inference, analysis, and explanation. In the context of practical work, interpretation refers to the process of giving meaning to data or results obtained during an experiment. Inference is the activity of drawing conclusions based on available data or information. Analysis involves examining experimental data by breaking down information into smaller parts to identify relationships between variables. Meanwhile, explanation is an in-depth explanation of the observed phenomenon by linking the experimental results to relevant theories.

The results of the pretest and posttest of students' critical thinking skills were analyzed using a paired sample t-test to determine whether there was a significant difference between the scores before and after the treatment, thereby demonstrating the effectiveness of the developed E-SAS [15]. The paired sample t-test is included in parametric statistical analysis, so the data analyzed must be normally distributed. To ensure this, the Shapiro-Wilk normality test was conducted because the number of research samples was less than 50, namely 30 students. The results of the normality test are presented in Table 10.

Table 10. Normality Test Results

Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest Scores	.138	30	.153	.939	30	.085
Posttest Scores	.126	30	.200*	.934	30	.065

Based on the normality test results shown, the Sig. pretest value is 0.085 and the Sig. posttest value is 0.065. Both values are greater than 0.05, so H_0 is accepted and H_1 is rejected. Thus, the pretest and posttest data are normally distributed and meet the assumptions for a paired sample t-test. The results of the paired sample t-test are presented in Table 11.

Table 11. Paired Sample T-test

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	df	Sig. (2-tailed)
Pair 1	CTS Pretest Scores CTS Pretest Scores	-59.76167	7.96924	1.45498	-62.73743	-56.78590	-41.074	29	.000

Based on Table 11, it is known that the sig. value obtained is 0.000, so H_0 is rejected and H_1 is accepted. Based on this, it is shown that there is an increase in critical thinking skills in students after using the E-SAS liveworksheet developed in learning.

CONCLUSION

Based on the analysis and discussion of the research, the E-SAS liveworksheet based on practical work to train students' critical thinking on the subject of reaction rates is deemed suitable for use as a learning medium because it meets the aspects of validity, practicality, and effectiveness. Based on the content validity aspect, a mode of 5 was obtained with a category of very good and a construct that obtained a mode of 4 with a category of good. From the practicality aspect, the results of the student response questionnaire obtained an average percentage of 97% and was supported by the results of observations of student activities which obtained a mode score of 5 with a category of very good. Meanwhile, in terms of effectiveness, the paired sample t-test results obtained a sig. value of 0.000, which means that this E-SAS is effective in training students' critical thinking skills on reaction rate material. Thus, this study provides benefits as an alternative effective digital learning medium to improve the quality of the chemistry learning process, as well as a reference for educators in developing practicum-based learning tools in line with the demands of the 21st century.

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