Development of Problem-solving e-Worksheet to Improve Problem-solving Skills in Reaction Rate Materials

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Abstract: Development of Problem-solving e-Worksheet to Improve Problem-solving Skills in Reaction Rate Materials. This study aims to know e-worksheet feasibility for improving students' problem-solving skills in rate reaction materials. The reaction rate is also considered an abstract subject that requires a high ability to understand, memorize, calculate, analyze, and actively practice. Understanding phenomena associated with chemical concepts requires a special skill, it is a problem-solving skill. One way to train students' skills is to conduct appropriate learning and suitable media. This study uses Research and Development (R&D) with limited testing phases, ADDIE method, and descriptive-analytical models. Problem-solving e-worksheets are feasible based on validity, practicality, and effectiveness aspect. Validity reviewed by content and construct. The result validity is 4, which means it is very valid. Practicality reviewed by student responses which show 90–95% positive response results, so e-worksheets are considered in very practice category. Effectiveness is reviewed from gain results from understanding problem is 0,77; devising a plan 0,73; carrying out the plan 0,71; and looking back 0,46.

Keywords: e-Worksheet, Problem-solving, Rate of reaction.

Abstrak: Pengembangan E-LKPD Pemecahan Masalah untuk Meningkatkan Keterampilan pemecahan Masalah pada Materi Laju Reaksi. Tujuan penelitian ini untuk mengetahui kelayakan e-LKPD dalam meningkatkan kemampuan pemecahan masalah peserta didik pada materi laju reaksi. Laju reaksi adalah materi kimia yang dianggap abstrak karena membutuhkan kemampuan memahami, menghafal, menghitung, menganalisis, dan aktif berlatih pada tingkat tinggi. Memahami fenomena dan dihubungkan dengan konsep kimia memerlukan keterampilan khusus, keterampilan tersebut adalah keterampilan pemecahan masalah. Peserta didik perlu dilatihkan keterampilan pemecahan masalah melalui pembelajaran yang aktif dan menyenangkan, yaitu menggunakan e-LKPD. Penelitian ini disusun berdasarkan penelitian research & development (R&D) model ADDIE dengan menggunakan analisis deskriptif berdasarkan modus dan paired sample t-test. E-LKPD pemecahan masalah dinyatakan layak berdasarkan validitas, kepraktisan, dan keefektifan. Validitas ditinjau berdasarkan kriteria isi dan konstruk. Hasil validitas adalah modus 4, artinya e-LKPD pemecahan masalah berada pada kategori sangat valid. Kepraktisan ditinjau dari respon peserta didik yang menunjukkan hasil pada 90-95% respon positif, sehingga e-LKPD dinyatakan sangat praktis. Keefektifan ditinjau hasil gain peningkatan keterampilan menunjukkan 0,77 pada komponen pemahaman masalah, 0,73 pada komponen perencanaan, 0,71 pada komponen penyelesaian masalah, dan 0,46 pada komponen pemeriksaan kembali

Kata kunci: e-LKPD, Pemecahan Masalah, Laju Reaksi.

- **INTRODUCTION**

The 21st-century learning paradigm demands an active skills to acquire information from various sources, problems formulation, critical thought, and participate in solving any problems (Wijaya et al., 2016). The importance of problem-solving abillities inserted into education to promote students' habits for determining decisions correctly, systematically, logically, and considering from various points of view (Supiyati, Hidayati, Rosidi, Yuniasti, & Wulandari, 2019). Problem-solving skills is one competencies that students must possess (Hidayatullah, Azizah, & Suyono, 2020). This is because new experiences may be encourage in students through problem-solving skills by finding solutions and processes (Lismayani & Mahanal, 2017). Implementing problem-solving experts has diverse opinions used as reference approach. Polya (1973) identifies four problem-solving approaches; it is understanding the problem, planning the solution, carrying out the plan, and looking back.

At SMAN 1 Puri Mojokerto, pre-research data was collected. 80% of students have applied problem-solving learning, but the outcomes were not even better. Only 33% of student has ability to understand the problem, 36% can do problem planning, 41% from them can carrying out the plan, and 40% able to do looking back component. The data might be higher allowing for a less optimal use problem-solving skills abillities. According to student questionnaires, 55% of chemistry learning in classroom is done by explaining, which is teacher-centered. Students may do practicum sometimes, practicum has recently been carried out due to limited materials and school building renovation. The students also don't use much media, only some conventional ones like prinbooks or print-worksheets.

Research conducted by Hidayatullah et al. (2020) in one of the secondary schools regarding problem-solving skills did not have a better result. Some factors are caused by student necessity to precision in working on problems, rarely working on problems oriented to problem-solving skills, and lack to understanding reaction rate topics (Yuriev, Naidu, Schembri, & Short, 2017). Student's problem-solving skills are predicated to increase if they can construct or develop their knowledge through a deep understanding. The learning process must involve students actively participating, rather than simply reciving knowledge from their teacher. One of the learning strategies that might increase student problem-solving skills is the problem-based learning model (PBL), according to Jayadiningrat & Ati's research on 2018. PBL syntax often divided into of five phases: (1) Orienting students to an issue, (2) Arraging students to do a research, (3) Aiding student investigations individually or groups, (4) Presenting results, (5) Analyzing and evaluating problem-solving process (Arend, 2012). It is also crucial to evaluate the abillity for innovative strategic plans. The selection of an appropriate learning process will make it simpler for students to gain their knowledge and skills that can be used in accordance with the learning process, especially for chemical problem-solving skills.

The reaction rate is one of chemistry sub-materials that close to dailylife. Preventing wet food from rotting is one of reaction rate applications in life. However with teacher-centered learning, students need to be made aware that the usage of rate reaction idea in any certain issue. Concentration, temperature, surface area, and catalysts are parameters that impact rate reaction (Werwa et al., 2005). The factor that affects the reaction rate is less planned with the active role of students in it. As a result, learning media is needed to support active and fun learning.

Student Worksheets electronic (e-worksheet) are one type of media that may be used to support student activity and make enjoyable learning (R. Anggraeni & Yonata, 2020). E-worksheet can be provided in a web form that, not only contains material and

images but also contains audio and video. It makes e-worksheet looks more attractive. To develop an e-worksheet that the display can contains audio, video, power point, or other site, It can used to design an e-worksheet with a web called Liveworksheet (Triana et al., 2021). Munawaroh (2021) explains that using worksheet media provides benefits such as improving classroom learning, student motivation, effectiveness, or adjusting to the level of student development. E-worksheet with the use of technology becomes more efficient because students are used to facing the world of digitalization (Firtsanianta et al., 2022).

Rhaska and Mawardi (2020) explained in their study that an e-worksheet might educate students to solve problems independently. Teacher needs to choose a wise model, approach, method, or develop various learning media that may help students to understand in learning process. One of which is using liveworksheets (Nurmasita c 2023). The form of questions that can be made with the liveworksheets application is very varied such as multiple choice, short answer, choose right or wrong, and match (Prabowo, 2021). E-worksheets allow students to learn independently. According to Sholehah (2021), liveworksheets contain audio-visual learning material content and allow students to access e-worksheet anywhere, whether on a desktop, laptop, or mobile phone connected to the internet (Firtsanianta & Khofifah, 2022). E-worksheets that use liveworksheets can also increase students' interest in learning because it have been arranged excitingly and creatively, different from worksheets in general (Suastra et al., 2022).

Based on the data and literature reviewed, researcher is interested in developing problem-solving electronic student worksheets to improve problem-solving skills on reaction rate material using liveworksheets web.

▪ **METHOD**

This study was carried out using the R&D model and ADDIE method. The ADDIE model is one of learning system design models that shows and systematic basic steps of learning system (Pribadi, 2009). ADDIE divided into five stages: analysis, design, development, implementation, and evaluation stages. This study is restricted only to development phase.

Research Subject
The subject of this study is 20 students on XI Science 8 SMAN 1 Puri Mojokerto.

Procedures
This study used ADDIE model, which is composed of analysis, design, development, implementation, and evaluation (Branch, 2016). This study was confiend to development stage. First, analysis stage is a fondation for all futurer ADDIE idea stages. Data on the initial analysis was obtained through conducting tests and questionnaires.

The design stage is done by making detailed product formulations, such as determining the subject matter, creating the concepts, compiling formats, and selecting supporting applications (Pribadi, 2009).
The development stage includes the learning media production stage and the learning media development stage based on suggestions from the expert team.

Research Instruments

Table 1 Research Instruments

No	Instrument	Purpose	Data Source	Time
1	Study Sheet	To provide input and suggestions on a product developed	Reviewers	Before e-worksheet applied
2	Validation Sheet	To determining e-worksheet validity	Material specialists, media specialists, and chemistry teachers	Before e-worksheet applied
3	Response Questionnaire	To know the practicality of media and find out students responses after learning.	Students	After e-worksheet applied
4	Problem Solving Skills Test Sheet	To know how far media effectiveness in increasing student problem-solving skills through pretest-posttest	Students	Before and after e-worksheet applied

Data Analysis Technique

Validity data analysis was analyzed based on validation tests result by material specialists, media specialists, and chemistry teachers. The expert validation test was carried out using an e-worksheet validation sheet instrument which contained assessment criteria following the Likert scale. It was arranged on a 0-4 rating scale on Table 2 below.

Table 2 Likert Scale

Score	Category
0	None
1	Unvalid
2	Less Valid
3	Valid
4	Very Valid

Data obtained on validation are ordinal data that cannot be performed by mathematical operations, so data is determined by mode (Lutfi, 2021). A product is valid if it has a minimum mode score on a scale 3. If aspects do not find the validity criteria, then revision is required and revalidation must be carried out until they match the specified valid criteria.

Data from student questionnaires were analyzed to determine e-worksheet practicality to improve problem-solving skills on reaction rate material. The response questionnaire analysis was carried out in a quantitative descriptive way by Guttman scale, according to Table 3.

Table 3 Guttman Scale Response Results

Statement	Positive Score	Negative Score
Yes	1	0
No	0	1

Every statement will be calculated based on a value category, then converted into a percentage:

$$\text{Percentage of practicality (\%)} = \frac{Number\ of\ scores\ obtained}{Maximum\ score} \ x \ 100\%$$

The percentages obtained are interpreted using interpretation criteria in Table 4 below.

Table 4 Response Interpretation

Percentage	Category
0%-20%	Unpractical
21%-40%	Less Practical
41%-60%	Practical Enough
61%-80%	Practical
81%-100%	Very Practical

Based on these categories, the interactive e-worksheet developed is considered to be practical if the percentage is more than 61% (Nuralifah & Hidayah, 2021).

E-worksheet effectiveness seen from the successful use of media to improved learning outcomes. It obtained if students get n-gain score at least 0.3. N-gain score will be calculated using the following formula:

$$\text{N-gain} = \frac{Posttest\ Scores - Pretest\ Scores}{Maximal\ Scores - Pretest\ Scores}$$

After that, it can be categorized with categories such as the following below.

Table 5 N-gain Score Assessment Criteria

N-gain Score	Criteria
$g \geq 0{,}7$	High
$0{,}3 \leq g < 0{,}7$	Medium
$g < 0{,}3$	Low

(Hake, 1999)

To examine the importance of students improvement in problem-solving skills, a t-test with paired sample was conducted as well these intructions:

a.   Normality Check

A normality check is a series of tests used to assess data distribution. A normal distribution occurs when symmetric distribution data with mode, mean, and median is centered. If the significance value is more than 0.05, the data are classified as normal distributed; otherwise, the data is not normally distributed.

b.   Hypothesis Test with Paired Sample t-Test

Once it has been proved that the acquired data is normally distributed, the analysis may go on to the paired sample t-test hypothesis testing using SPSS, its paired sample t-test. Paired sample t-test is one of test techniques used to determine a significant treatment. Even though using the same individual, researchers still obtained two kinds of sample data, namely data from pretest and posttest (Nuryadi et al., 2017).

Hypothesis testing is carried out after data is normally distributed, then the analysis can be continued to paired sample t- test using SPSS with the conditions:

Ho : Using an e-worksheet has no effect on increasing student problem-solving skills.

Ha : Using an e-worksheet has an effect on increasing student problem-solving skills.

Ha will be accepted if the significance value (2-tailes) is less than 0.05, whereas Ho is rejected. Ho is accepted and Ha rejected if the significance value (2-tailed) is greather than 0.05.

▪ **RESULT AND DISCUSSION**

First, analysis stage is a fondation for all futurer ADDIE idea stages.The results of analyzing are identify the problem and characteristics of students. It found that there is a problem where the learning process requires media to improve problem-solving skills in interactive students.

The design stage is done by create educational media that can encourage students to be more active. Therefore, this study aims was done to provide instructional materials for electronic problem-solving worksheet that would be used with liveworksheets web. The e-worksheet developed is based on a problem-solving by Polya approach on factors that affect the reaction rate. Phenomena on e-worksheet will related to reaction rate, so that students understand quickly and learning will be more meaningful.

The development stage includes the learning media production stage and the learning media development stage based on suggestions from the expert team. Here is the cover result.
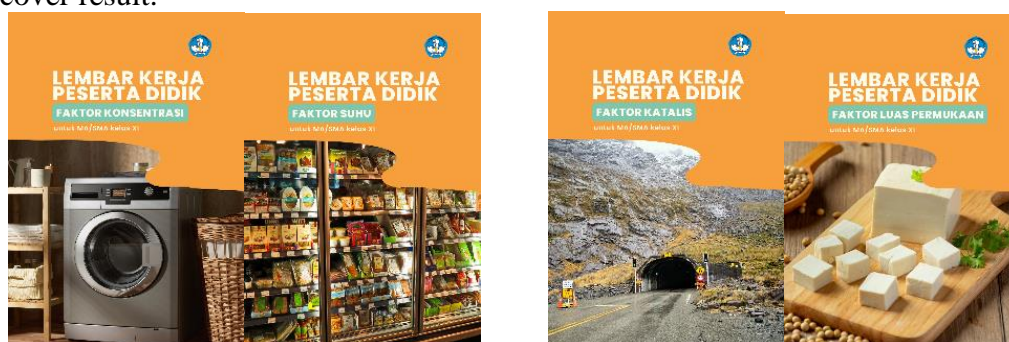
Figure 1 Cover e-worksheet

One group pretest-posttest design pre-experimental test was used to perform e-worksheet trials. Pretest was given before using e-worksheet, and posttest was provided after using the e-worksheets. With this treatment, we will collect data before and after using e-worksheet to see how far student problem-solving will be improved.

Eligibility is reviewed with media validity details based on validation results, the practicality of the media is reviewed in light of student feedback response, and media effectiveness is reviewed based on improving problem-solving skills. The following is a description of the three aspects of e-worksheet feasibility.

a) Validity

Before validating, the media was first conducted by a chemistry lecturer. The study data were analyzed through qualitative descriptions suggestions to improve e-worksheet quality. After going through the study stage, e-worksheet can be validated. Validation is a series of assessment activities with two chemistry lecturers and one chemistry teacher to evaluating media validity. Media validity is measured using validation sheet instruments reviewed from content and construct validity components (Plomp & Nieveen, 2010).

The data validity is determined using mode from three validators on a scale of 0-4. These scale are interpreted as none, unvalid, less valid, valid, and very valid. The validity of a learning device is valid if the learning device is confirmed in at least three modes by the validator. The validity aspect of a learning tool is arranged based on the consistency of the components of the learning tool with one another (Lase & Zai, 2022).

Table 6 Validation Results Data

No	Criterion	Assessment Mode	Category
1	Content	4	Very Valid
2	Construct	4	Very Valid

Based on Table 6, the e-worksheet problem-solving developed has a score mode of 4 which can be interpreted that the media category being very valid and can be used in learning. Aspects of the content criteria include conformity to the curriculum, problem-solving learning methods (PBL), and problem-solving skills. Validity in the content criteria includes four aspects:1) Compatibility with learning outcomes (CP), 2) Suitability to learning objectives (TP), 3) Conformity of matter to reaction rate concept, 4) Suitability of the phenomenon to the material. While validity based on construct criteria includes aspects of language, graphics, and presentation.

b)   Practically

Results of student response questionnaires are used to evaluated the media's practical reasons (Sugiyono, 2013). The response was made up of questions related to students' opinions after using e-worksheet to practice their problem-solving skills. The results of student response analysis on 90–95% positive response, so e-worksheets are considered in very practice category.

Table 7 Response Questionnaire Results

No	Aspects	Percentage of Positive Responses	Category
1	Problem-Solving Skill	92,5%	Very Practical
2	Language and layout	90%	Very Practical
3	Phenomena	95%	Very Practical

c)   Effectiveness

The effectiveness of e-worksheet may be shown in media used to improving problem-solving skills. This assessment is based on test instruments conducted before being tested, e-worksheet or pretest, and tests conducted after being tested e-worksheet or posttest. A test is an instrument used to measure students' problem-solving skills and knowledge so that it can be assessed and evaluated. The problem-solving skills test consists of eight breakdown questions with two problem-solving component questions each, i.e., problem understanding, planning, plan execution, and re-examination. Pretests and posttest are performed to obtain the initial and final score of problem-solving skills that students have before and after using the e-worksheet (Anggraeni & Aini, 2022). The results of difference student pretests and posttest shown in Figure 2 below.
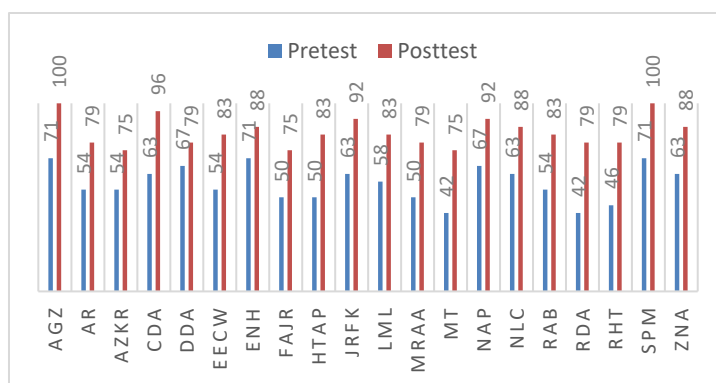
Figure 2 Pretest-Postest Result

Improvement of problem-solving skills can be reviewed from the results of tests conducted before (pretest) and after (posttest) problem-solving e-worksheet media applied. Here are the results of pretest, posttest, and skill improvement of students.

Table 8 Pretest-Postest Results of Problem Solving Skills

No	Skill	*Pretest*	*Postest*	*N-gain score*	**Information**
1	Understanding problem	61	91	0,77	High
2	Devising a plan	69	92	0,73	High
3	Carrying out the plan	57	88	0,71	High
4	Looking back	43	69	0,46	Medium

The following is an explanation of each skills.
1. Understanding the problem
Understanding the problem is one of problem-solving skills to understand the information in phenomena. Students will determine an information needed to solve any problem on next steps. Understanding problems indicators is, students are able to identify problems based on information on the phenomenon wholly and appropriately.

2. Devising a plan
The problem planning intended in this discussion is the ability of students to determine to problem-solve based on phenomena. Problem-solving planning depends on how students analyze a problem. If incorrectly, then the problem-solving planning will also experience errors (Hidayatullah et al., 2020). Indicators of problem planning problems are presented as the phenomenon of reaction rate, students are able to plan problem-solving based on the phenomenon appropriately.

3. Carrying out the plan
The implementation of the plan intended in this discussion is the ability of students to describe the solution to the problems they propose based on the concepts of reaction rate knowledge and collision theory they have learned. The implementation of problem-solving can be done well if supported by sufficient knowledge of students (Hadi, 2019). If students can understand and identify problems well, then they will be able to relate various information obtained as well (Hidayatullah et al., 2020). Indicators of planning problems have presented the phenomenon of reaction rate. By accurately describing problem-solving activities on phenomena, response into rate reaction, and collision theory, students are able to carry out problem-solving.

4. Looking back

Looking back is student capacity to articulate some solution to the issue they suggest based on the concept of reaction rate knowledge and collision theory that they have learned. Skills test at the looking back stage are in the medium category, with n-gain is 0,46. Many students are still unabled to make conclusions based on examination outcomes. Rahmawaty's (2020) research was explained that students tend to rely on or still expect guidance from teachers in terms of making conclusions, so students' ability to conclude is not well-trained. Indicators of planning problems is students are able to draw a conclusions from outcoms of solving issues based on rate reaction factor and collision theory. One of student improvement problem-solving answer are shown below.

Figure 3 SPM's answer to problem number 4 posttest component on temperature factor e-worksheet

Figure 4 SPM's answer to problem number 4 posttest component on temperature factor e-worksheet

Figure 5 SPM's answer to problem number 8 pretest component on catalyst factor e-worksheet

Figure 6 SPM's answer to problem number 8 posttest component on catalyst factor e-worksheet

Before e-worksheet implementation, SPM was unable to write a conclusion. SPM tends to rewrite the problem-solving answers in phenomena without explaining why those answer were chosen. The conclusions are not properly and systematically arranged.

According to pretest-posttest analysis, using e-worksheet to practice problem-solving skills on reaction rate material improved. Those skills has 75% of students in the medium category, 25% in the high category, and 0% in the low category,

additionally pertinent research was done by Devanti (2020). It stated that using e-worksheet can train students' active, creative and productive thinking skills, so that the learning carried out is more meaningful. This statement is agreed under research conducted by Suhardiman et al. (2022) where e-worksheet based on problem-solving can train students to think logically, systematically, creatively, and independently according to the stage of solving the given problem.

The formulated hypothesis needs to be tested statistically using a two-paired t-test to determine significant differences in problem-solving skills before and after e-worksheet trials. Parametric statistical tests require data to be normally distributed (Sugiyono, 2013). It is necessary to conduct a hypothesis test and normality test in order to obtain data distribution conditions. Data is declared normal when focusing on the average and median values so that the distribution pattern is symmetric. The following are the results of the normality test on the pretest and posttest values of the results of problem-solving skills.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pre	.165	20	.154	.934	20	.181
post	.190	20	.057	.909	20	.061

a. Lilliefors Significance Correction

Figure 7. Data Normality Test Pretest-Posttest Problem-Solving Skills

Because the sample was more than 30, the normality test was done by IBM Statictics SPSS 20 on Shapiro-Wilk test. The results of the distribution of normality test pretest data are 0.181 and the posttest is 0.061, indicating that the distribution of pretest and posttest data is normal. The result of Sig. <0.05 suggest that Ho is rejected and Ha is approved (Lutfi, 2021). The mean and median values are primary focus on data as reault. The paired sample t-test can be used to determine whether there is a difference between average scores on pretest an postest students problem-solving skills. Once data have been confirmed to be normal, hypotheis test can be performed as follows.

Paired Samples Test

		Paired Differences							
				Std. Error	95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	pre - post	-27.150	5.860	1.310	-29.893	-24.407	-20.718	19	.000

Figure 8. Paired sample t-test

It may be inferred from Table 10's result of Sig. (2-tailed) less 0.05, so it can be concluded that Ho will rejected and Ha is accepted (Lutfi, 2021). It means, there's any signifficant difference before and after using e-worksheet to improve student problem-solving skills.

The results of statistical tests and increased student gain show that problem-solving skills and student learning outcomes after using e-worksheet problem-solving media can be confirmed as effective in training students' problem-solving skills on reaction rate material.

▪ **CONCLUSION**

Based on the results of research up to data analysis and discussion, it is possible to conclude that using e-worksheet problem-solving can improve problem-solving skills

on reaction rate material. It is feasible to use with very valid details in terms of content and construct validity, 92% practicality, and effectiveness improving problem solving skills with skill improvement gain score showing 0.77 in understanding problem, 0.73 in devising a plan, 0.71 on carrying out the plan, and 0.46 on looking back.

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