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# Improving Science Process Skills And Collaboration On The Lesson On Reaction Rate Using Electronic Student Worksheet Assisted With Liveworksheets Website

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**ABSTRAK**

This study aimed to assess the feasibility of the usage of electronic student worksheets assisted with liveworksheets website to improve science process skills and collaboration on the lesson on reaction rate in terms of validity, practicality, and effectivity. The present study utilized the Analysis-Design-Development-Implementation-Evaluation (ADDIE) development model. Data collected were through interviews, questionnaires, observations, and tests. Data analysis methods used in this study comprised both qualitative and quantitative analysis techniques. Qualitative analysis techniques were carried out descriptively, while quantitative analysis techniques were performed by percentage analysis, normality test (one sample Shapiro-Wilk test), paired sample t-test, and n-gain analysis. The validity test showed an average percentage of 87% with very valid criteria. The practicality test included the results of student responses according to questionnaires and observations of student activities, and the results are an average percentage of 92% and 100%, respectively, which are categorized as very good. The effectivity test comprised the results of the pretest-posttest cognitive and science process skills. The results of the n-gains are 0,46 and 0,61, respectively, with moderate criteria, while the results of questionnaires and observation of collaboration skills are an average percentage of 94% and 83%, respectively, with very good criteria. Electronic student worksheets assisted with liveworksheets website to improve science process skills and collaboration is essential to be developed as an effort to train 21st-century skills.

Keywords: collaboration skills, electronic student worksheet, liveworksheets website, reaction rate, science process skills

**I N F O  A R T I K E L**

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## INTRODUCTION

Chemistry is a study of the composition, properties, and changes of a substance, as well as the energy that accompanies these changes (Anggraeni & Hidayah, 2019; Azizah et al., 2017). Chemistry consists of abstract topics as well as computational and theoretical concepts. These concepts can be proven through practical activities (Andromeda, Yerimadesi, & Iwefriani, 2017). One of the chapters of the chemistry lessons that require practical activities is the lesson on reaction rate. This is supported by a basic competence that should be mastered by class XI of senior high school, -i.e., "Design, conduct and conclude and present experimental results on factors that affect reaction rates and reaction orders" (Menteri Pendidikan dan Kebudayaan Republik Indonesia, 2018; Trimaryanto & Novita, 2019). Therefore, the lesson on reaction rate requires practical activities.

These days, practical activities in the learning process are more directed toward student-centered learning (Andromeda et al., 2017; Menteri Pendidikan dan Kebudayaan Republik Indonesia, 2018). This is indicated by the presence of more students who take an active role and can find concepts by themselves through scientific methods. Students who take an active role are shown by their active contribution, working productivity, flexibility, responsibility, and mutual respect (Nurjanah, Rudibyani, & Sofya, 2020; Rahmawati, Fadiawati, & Diawati, 2019). The five attitudes can be found as the components of collaboration skills. In addition, students should be able to find concepts by themselves through the scientific method. The scientific method includes activities of problem formulation, drafting a framework of thinking in submitting hypotheses, formulating hypotheses, testing hypotheses, and drawing conclusions (Mariana & Praginda, 2009). The five aforementioned activities have actually been included as the components of science process skills. Therefore, practical activities in the learning process should automatically train science process skills (Isnaini & Utami, 2020). Further, practical activities carried out in groups could also be used to improve students' collaboration skills.

Science process skills are a series that helps students to master scientific skills, which are very important in teaching and learning science to students, strengthening students' knowledge and understanding of theories and concepts, as well as developing and instilling scientific attitudes (Anggraeni & Hidayah, 2019). Meanwhile, collaboration skills are the ability to participate in every activity to build relationships with others, respect each other, and work together effectively to achieve the same goal (Le, Janssen, & Wubbels, 2018; Nurjanah et al., 2020; Rahmawati et al., 2019). Collaboration skills are necessary for the learning process to improve students' mastery of concepts so that they can obtain final quality results. In addition, collaboration skills can train students to work together in differences as a provision to face the era of globalization in the 21$^{st}$ century. There are four skills that must be possessed by all students in the 21$^{st}$ century, namely critical thinking and problem-solving skills, communication

skills, creativity and innovation, and collaboration skills (Nurjanah et al., 2020; Pratiwi, Juhanda, & Setiono, 2020). In the 21st century, science and technology are developing rapidly worldwide, causing stricter competition in the future life that all students must face. Therefore, it is critical to train students in science process skills and collaboration skills.

The practice of science process skills and collaboration skills can be supported by a so-called student worksheet (in the Indonesian language is often called "Lembar Kerja Peserta Didik"/LKPD). A student worksheet is a sheet containing assignments from teachers to students that are tailored to the basic competencies and particular learning objectives to be achieved (Wati & Suliyanah, 2018). Student worksheets can be designed and developed according to the learning situation and conditions that will be faced.

The Covid-19 pandemic condition does not allow direct face-to-face meetings in the learning process. Therefore, it is essential to combine electronic technology and internet-based technology to support online learning as part of distance learning. Based on this, an online-based student worksheet is needed. To create an online-based student worksheet, it is necessary to have a tool, namely liveworksheets. According to Andriyani, Hanafi, Safitri, & Hartini (2020), liveworksheets are a website provided free of charge by the Google search engine. This website allows teachers to convert conventional (printed) student worksheets into interactive online exercises called electronic student worksheets. Students can work on the electronic student worksheet online and send the answers to their teachers online.

Based on the interview result conducted with a chemistry teacher of class XI Science 6 at the Public Senior High School 1 Menganti, there is no use of electronic student worksheets yet that supports the implementation of the lesson on reaction rate during the Covid-19 pandemic. The result of a pre-research questionnaire given to 36 students also indicated that 83,8% of students have never used an electronic student worksheet.

Based on the aforementioned description, the development of an electronic student worksheet assisted with a liveworksheets website could be carried out to improve science process skills and collaboration on the lesson on reaction rate. The science process skills applied in the present research included observing, classifying, making hypotheses, identifying variables, analyzing data, and drawing conclusions. Meanwhile, the collaboration skills applied in this study included actively contributing, showing flexibility, showing an attitude of responsibility, and showing respect. This study aimed to assess the feasibility of the usage of electronic student worksheets assisted with liveworksheets website to improve science process skills and collaboration on the lesson on reaction rate in terms of validity, practicality, and effectivity.

## RESEARCH METHODS

The present research used the ADDIE development model adapted from Branch (2009), which comprises five stages, i.e., Analysis, Design, Development, Implementation, and

Evaluation. An analysis is the first step to finding out the needs, potentials, and problems at the Public Senior High School 1 Menganti. Design is the second stage carried out to design products in the form of electronic student worksheets assisted with liveworksheets website. Development is the third stage carried out to develop and validate the product. Implementation is the fourth stage carried out in the context of product testing, covering practicality and effectivity. Evaluation is the fifth or the last stage carried out to analyze the data that has been obtained.

The target of this research was the feasibility of electronic student worksheets assisted with liveworksheets website to improve science process skills and collaboration on the lesson on reaction rate in terms of validity, practicality, and effectivity (Nieveen, 1999). The data sources in the present study were three chemists, three observers, and 36 students of class XI Science 6 at the Public Senior High School 1 Menganti. The design applied when testing the product was a one-group pretest-posttest design.

The data collection methods used in this study were interviews, questionnaires, observation and tests. The interview method used a research instrument in the form of an interview guide. Meanwhile, the questionnaire method used research instruments in the form of pre-research questionnaire sheets, validation sheets, student response questionnaire sheets, and collaboration skills questionnaire sheets. The scoring guidelines on the validation sheet used a Likert scale adapted from Riduwan (2015) (Table 1).

**Table 1.** Scoring guidelines on validation sheet

| Score | Criteria |
|---|---|
| 1 | Very less |
| 2 | Less |
| 3 | Enough |
| 4 | Good |
| 5 | Very good |

In this study, the observation method used research instruments in the form of student activity observation sheets and collaboration skills observation sheets. Scoring guidelines on student response in questionnaire sheets, collaboration skills questionnaire sheets, student activity observation sheets, and collaboration skills observation sheets used the Guttman scale adapted from Riduwan (2015) (Table 2).

**Table 2.** Scoring guidelines on questionnaire sheets and observation sheets

| Answer | Score for positive statements | Score for negative statements |
|---|---|---|
| Yes | 1 | 0 |
| No | 0 | 1 |

The test method used research instruments in the form of cognitive pretest-posttest question sheets and science process skills pretest-posttest question sheets.

This study was a combination of qualitative and quantitative analysis techniques. The qualitative elements in this study were obtained from interview guidelines and pre-research questionnaire sheets, which were subsequently analyzed descriptively. Quantitative elements were obtained from validation sheets, student response questionnaire sheets, student activity observation sheets, cognitive pretest-posttest question sheets, science process skills pretest-posttest question sheets, collaboration skills questionnaire sheets, and collaboration skills observation sheets. Data acquired from

validation results, questionnaires, and observations were then analyzed using percentage analysis with the following formula:

$$\text{Percentage} = \frac{\text{total score obtained}}{\text{maximum score}} \text{ x } 100\%$$

Subsequently, the results of the percentage analysis were interpreted based on the interpretation criteria adapted from Riduwan (2015) (Tables 3 and 4).

**Table 3.** Criteria for interpretation of validation results

| Percentage (%) | Criteria |
|---|---|
| 0 – 20 | Very invalid |
| 21 – 40 | Invalid |
| 41 – 60 | Sufficiently |
| 61 – 80 | Valid |
| 81 – 100 | Very valid |

From Table 3, the electronic student worksheet can be said to be valid if it reaches a minimum percentage of 61% with valid criteria.

**Table 4.** Criteria for interpretation of questionnaire results and observations

| Percentage (%) | Criteria |
|---|---|
| 0 – 20 | Very less |
| 21 – 40 | Less |
| 41 – 60 | Enough |
| 61 – 80 | Good |
| 81 – 100 | Very good |

Based on Table 4, an electronic student worksheet is said to be practical if the results of student response questionnaires, student activity observations, collaboration skills questionnaire results, and collaboration skills observation results reach a minimum percentage of 61% with good criteria.

Data obtained from the pretest and posttest results of cognitive and science process skills were analyzed using the normality test (one sample Shapiro-Wilk test), paired sample t-test, and n-gain analysis. The normality test was used to determine if the data was normal or not normally distributed, while the paired sample t-test was used to determine whether or not there was an average difference between the pretest-posttest results. Meanwhile, the n-gain analysis aimed to measure the improvement in cognitive abilities and science process skills of the students using the following formula:

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

Then, the results of the n-gain analysis were interpreted based on the interpretation criteria according to Hake (1999) (Table 5).

**Table 5.** N-gain interpretation criteria

| *N-gain* | Criteria |
|---|---|
| *N-gain* ≥ 0,7 | High |
| 0,3 ≤ *N-gain* < 0,7 | Moderate |
| *N-gain* < 0,3 | Low |

According to Table 5, the electronic student worksheet can be said to be effective if the n-gain value ≥0.3 is obtained with moderate criteria for the results of the pretest-posttest cognitive and science process skills.

## RESULTS AND DISCUSSION

This study used the ADDIE development model, which consists of five stages. The following describes the results from this research based on the development model.

### Analysis

Analysis is the first step to finding out the needs, potentials, and problems at the Public Senior High School 1 Menganti. The analysis carried out is related to the curriculum, core competencies, basic competencies,

materials, to the implementation of chemistry learning.

The curriculum used today by most schools in Indonesia is the 2013 curriculum. The curriculum analysis was performed in this study to identify basic competencies related to chemistry that require practical activities. The existence of practical activities in the implementation of chemistry learning is considered capable of making students more active and enhancing their understanding of the concepts (Andromeda et al., 2017). The results obtained from the curriculum analysis are basic competencies of 3.6, 3.7, and 4.7, which comprise the lesson on reaction rate.

Analysis of chemistry learning implementation, particularly the lesson on reaction rate, was carried out by interviewing the chemistry teacher of class XI Science 6 at the Public Senior High School 1 Menganti. From the results of the interview, it is known that the implementation of chemistry learning before the Covid-19 pandemic was supported by simple practical activities carried out in the classroom. However, since the Covid-19 pandemic, the implementation of chemistry learning has changed. Simple practical activities have been replaced by observing learning videos. This sudden change makes students feel it challenging to understand the lesson on reaction rate. Moreover, there is no electronic student worksheet yet that supports the implementation of the lesson on reaction rate. The teachers only take pictures of the practice questions in the package book, then send them to the students. Online learning in the students' respective home makes students feel that they can not collaborate with each other directly. Based on these problems, the teachers find it helpful if there is research that develops electronic student worksheets to improve science process skills and collaboration on the lesson on reaction rate. The teachers hope that such electronic student worksheets can improve the students' learning motivation.

The results of the interviews were in line with pre-research questionnaires given to 36 students of class XI Science 6 at the Public Senior High School 1 Menganti. Based on the pre-research questionnaire, it is known that 54,1% of the students had difficulty with the lesson of reaction rate. As many as 83,8% of the students stated that they have never used electronic student worksheets and 89,2% of the students have never collaborated directly. As many as 81,1% of the students feel interested if there is an electronic student worksheet to support the implementation of the lesson on reaction rate.

**Design**

Design is the second stage which is a continuation of the analysis stage. The design stage aims to design products in the form of electronic student worksheets assisted with liveworksheets website and research instruments to collect data.

The design of the electronic student worksheet started with the preparation of indicators and learning objectives based on basic competencies, then adjusted to the science process skills used. The next step was to make the design and content of the electronic student worksheet using Microsoft Word and then save it in pdf format. The

resulting electronic student worksheet consisted of five parts, namely the reaction rate electronic student worksheet (concentration factor, surface area factor, temperature factor, catalyst factor, and reaction order and reaction rate constant). An electronic student worksheet in pdf format was uploaded on the website https://www.liveworksheets.com/. The presence of such an electronic student worksheet that allowed students to access and do the assignment directly online and then send the results to the teachers online as well via email. This electronic student worksheet can be accessed via mobile phone or computer. The appearance of available electronic student worksheets on the liveworksheets website is illustrated in Figure 1.

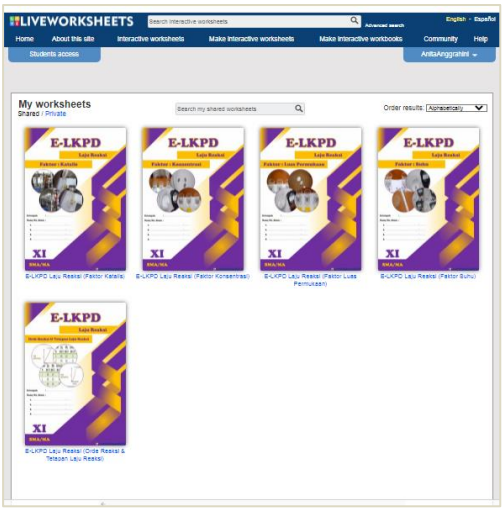


**Figure 1.** Electronic student worksheet about reaction rate available on liveworksheets website

The design of the research instruments needs to adjusted to the research objectives. In the case of this research, the adjustment is needed to determine the feasibility of an electronic student worksheet in terms of validity, practicality, and effectivity (Nieveen, 1999). The validity of using research instruments was tested in the form of validation sheets, while the practicality was examined by measuring student response using questionnaire sheets and student activity observation sheets. Meanwhile, the effectivity was tested by using research instruments in the form of pretest-posttest test sheets for cognitive and science process skills, collaboration skills questionnaire sheets, and collaboration skills observation sheets.

**Development**

Development is an advanced process from the design stage. In general, the objective of the development stage is to develop and validate the electronic student worksheet. Developing an electronic student worksheet aims to improve it according to the advice obtained from experts. One of the suggestions and improvements to the electronic student worksheets is shown in Figure 2.

**Figure 2.** Before repair (left) and after repair (right)

The electronic student worksheets were validated by three chemists. In this study, validation aimed to determine the quality of the developed electronic student worksheet until it is declared feasible to be tested at the subsequent stage. Validation was executed by providing an

assessment of the electronic student worksheet based on the scoring guidelines (Table 1) on the validation sheet. The validation sheet contained 25 indicators covering aspects of content (indicators 1-8), language (indicators 9-14), presentation (indicators 15-19), and graphic (indicators 20-25) (Badan Standar Nasional Pendidikan, 2006). The recapitulation of the validation results is depicted in Figure 3.

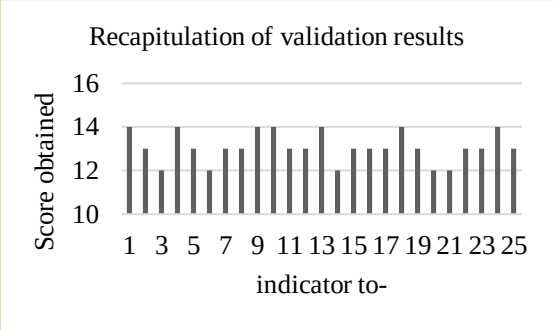


**Figure 3.** Recapitulation of validation results

**Implementation**

Implementation is the fourth stage carried out in the context of testing the electronic student worksheet. The trial was conducted on 36 students of class XI Science 6 at Public Senior High School 1 Menganti, covering practicality and effectivity.

A practicality test was executed by assessing the electronic student worksheet based on the scoring guidelines (Table 2) on the student response questionnaire sheet. The student response questionnaire sheet contained 17 questions covering aspects of content (indicators 1-5), language (indicators 6-8), presentation (indicators 9-11), and graphics (indicators 12-17). The recapitulation of the student response based on questionnaire results is shown in Figure 4.

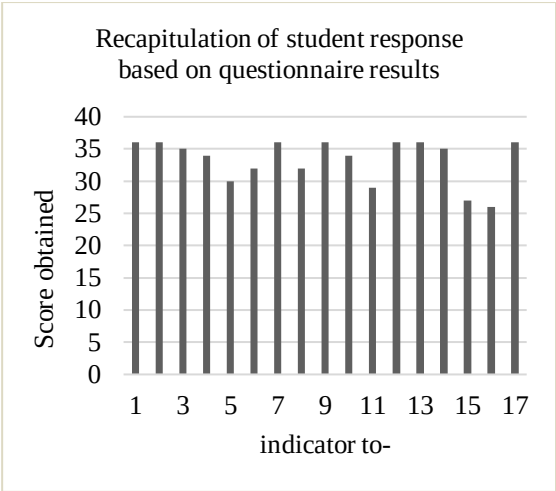


**Figure 4.** Recapitulation of student response based on questionnaire results

In addition, practicality is also supported by the results of observations of student activities. Observation of student activities was carried out by three observers. The results of observations are written on the student activity observation sheet with scoring guidelines according to Table 2. The student activity observation sheet contained 13 statements covering all activities or activities contained in the electronic student worksheet. The recapitulation of the observation results of student activities is shown in Figure 5.

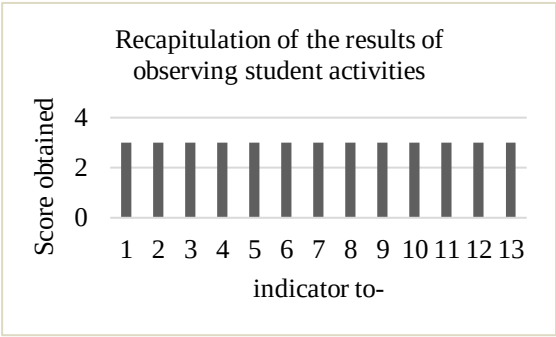


**Figure 5.** Recapitulation of the results of observing student activities

The effectivity test was carried out with a one-group pretest-posttest research design. In the first step, students were given pretest questions to determine their

cognitive abilities and science process skills before using the electronic student worksheet. In the second step, each student was given an electronic student worksheet to improve cognitive abilities and science process skills. In the third step, students were given posttest questions to investigate their improvement in cognitive abilities and science process skills after using the electronic student worksheet. Each cognitive pretest and posttest question sheet contained ten multiple-choice questions. Meanwhile, each science process skills pretest and posttest question sheet contained 27 questions in the form of descriptions which included observing skills, classifying, making hypotheses, identifying variables, analyzing data, and drawing conclusions. The recapitulations of the results of the pretest-posttest cognitive and science process skills are depicted in Figures 6 and 7

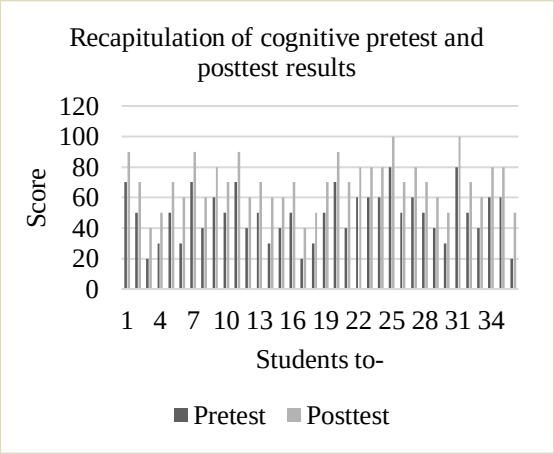


**Figure 6.** Recapitulation of cognitive pretest and posttest results

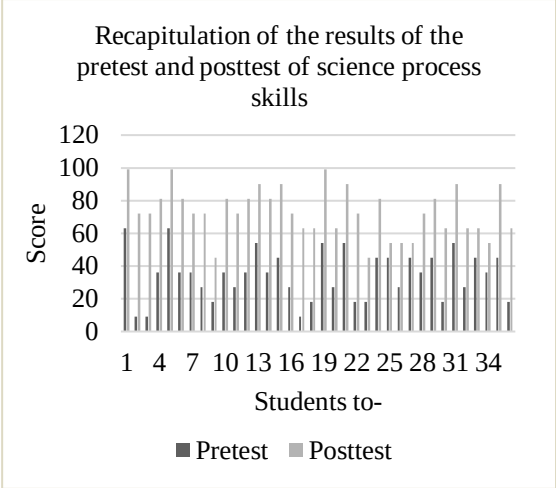


**Figure 7.** Recapitulation of the results of the pretest and posttest of science process skills

Further, in this study, effectivity was also assessed by filling out the collaboration skills questionnaire and collaboration skills observation sheets. The collaboration skills questionnaire sheet was filled out by the students, while the collaboration skills observation sheet was filled out by the three observers using scoring guidelines according to Table 2. Each collaboration skills questionnaire sheet and the collaboration skills observation sheet contained 12 statements, including actively contributing (indicators 1-2), showing flexibility (indicators 3-7), showing an attitude of responsibility (indicators 8-9), and showing respect (10-12). The recapitulation of the result of both the questionnaire and the observation of collaboration skills is portrayed in Figure 8.

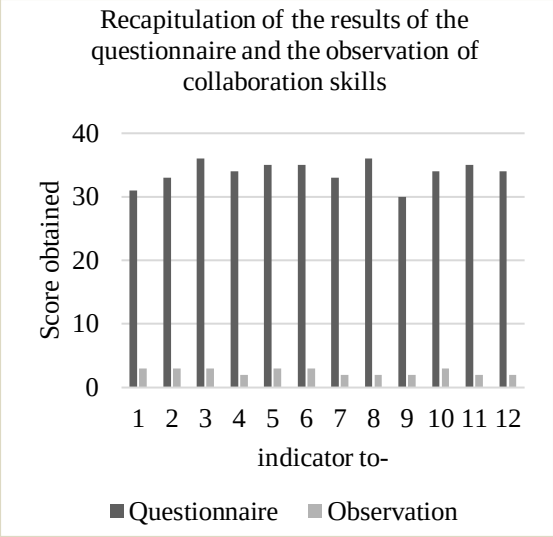


**Figure 8.** Recapitulation of the results of the questionnaire and the observation of collaboration skills

## Evaluation

Evaluation is the fifth stage carried out to analyze the data that has been obtained. Analyzing the data aims to measure the feasibility of the electronic student worksheet in terms of validity, practicality, and effectivity (Nieveen, 1999).

The validity was reviewed from the recapitulation of the validation results, which were analyzed using percentage analysis, then averaged. According to Nieveen (1999), a product as a result of development can be said to be valid if the components of a lesson are based on the latest knowledge (content validity), and all components must be related to each other consistently (construct validation). Based on the results of data analysis, the overall average percentage was 87%, with very valid criteria, and the average percentage for each aspect can be seen in Table 6.

**Table 6.** Results of validation of data analysis

| Rated aspect | Average percentage | Criteria |
|---|---|---|
| Content | 87% | Very valid |
| Language | 89% | Very valid |
| Presentation | 88% | Very valid |
| Graphic | 86% | Very valid |

From Table 6, it can be inferred that the average percentage of the four rated aspects of the validity of the electronic student worksheets is more than 81%, with very valid criteria. Content aspect includes the suitability of the title with the material; conformity with science process skills; suitability of collaboration skills; conformity of the material with core competencies and basic competencies; conformity with learning objectives; and the accuracy of the facts, the truth of the concept, the suitability of the theory in the presentation of the material. This is in alignment with preceding research conducted by Siagian & Yasthophi (2021), which stated that learning media must meet basic competencies and learning objectives to be achieved by students so that learning becomes meaningful. Language or linguistic facet includes the easiness of the language to understand; accuracy of sentence structure; the standardization of the terms used; conformity of grammar and spelling with the Indonesian language rules; and consistency in writing scientific names or foreign languages. In line with this, Yastini, Nurdian, & Wikanengsih (2018) stated that standard language has three characteristics, namely having dynamic stability (in the form of fixed rules and regulations); scholarly; and uniformity of rules. The presentation aspect comprises the suitability of the presentation of the material with the learning approach; convolution of

concepts; inclusion of references or sources of reference, completeness of identity, and accuracy of numbering in the presentation of texts, tables, and pictures and attachments. Meanwhile, the graphical aspect includes the type and size of letters that make it easier to understand, read and attract; compatibility of appearance design; illustrations that can clarify and facilitate understanding; ease of opening links and operating electronic student worksheets. This is in accordance with the opinion of Mumpuni & Nurbaeti (2019); Syahrul (2019) that the use of the appropriate typeface is essential to minimize misunderstandings, and the combination of background colors is designed in such a way as to be comfortable and easy to read and produce an attractive appearance that affects students' reading interest. In addition, there are videos and supporting images in the electronic student worksheet that can support students' understanding of the lesson (Kamila, Fadiawati, & Tania, 2018). The four facets of the validity test of the electronic student worksheet were also used by Enistoneisya, Lukman, & Mulyanti (2019), who obtained very valid criteria with an overall average percentage of 81,79%.

A practicality test was indicated from the recapitulation of the results of student response questionnaires and the results of observing student activities. The recapitulation was analyzed using percentage analysis, then averaged. According to Nieveen (1999), a product developed can be said to be practical if the user considers the product to be easy to use and is made according to the designed learning plan. The student response from the questionnaire and data analysis showed an overall average percentage of 92% with very good criteria. The average percentage for each aspect can be seen in Table 7.

**Table 7.** Results of student response from the questionnaire and data analysis

| Rated aspect | Average percentage | Criteria |
|---|---|---|
| Content | 95% | Very good |
| Language | 93% | Very good |
| Presentation | 92% | Very good |
| Graphic | 91% | Very good |

From Table 7, it is known that the average percentage obtained for the four practical aspects of electronic student worksheets is more than 81%, with very good criteria. Aspects of content, language, presentation, and graphics on the student response questionnaire sheets were compared with those on the validation sheet. The results from both sheets are almost the same, and they are presented with positive and negative statements. This use of four aspects was performed to ensure that students read and filled out the questionnaire seriously. The four practical aspects of the electronic student worksheet were also previously used by Rahmawati & Yonata (2019), which received a positive response, indicated by the percentage result for each aspect of more than 61%. In addition, the results of the observation data analysis of student activities obtained an average percentage of 100% with very good criteria. Observation of student activities comprises all activities or activities contained in the electronic student worksheet, i.e., observing, asking, collecting data, associating, and concluding. The five activities are scientific approaches that include scientific process skills and collaboration.

The effectivity is seen from the recapitulation of the results of the pretest-

posttest cognitive and science process skills, the results of the collaboration skills questionnaire, and the results of the observation of collaboration skills. The results of the pretest-posttest cognitive and science process skills were analyzed using the normality test (one sample Shapiro-Wilk test), paired sample t-test, and n-gain analysis. According to Nieveen (1999), a product as a result of development is said to be effective if it can describe the experiences and learning outcomes of students. The results of the pretest-posttest normality test of cognitive and science process skills are shown in Tables 8 and 9.

**Table 8.** Cognitive pretest and posttest normality test results

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Pretest | .138 | 36 | .080 | .954 | 36 | .142 |
| Posttest | .139 | 36 | .077 | .958 | 36 | .188 |

a. Lilliefors Significance Correction

**Table 9.** Normality test results of pretest and posttest of science process skills

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Pretest | .123 | 36 | .184 | .952 | 36 | .120 |
| Posttest | .117 | 36 | .200* | .955 | 36 | .149 |

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

From Tables 8 and 9, it is known that the value of sig. for the cognitive pretest and posttest were 0,142 and 0,188. While the value of sig. for the pretest and posttest science process skills are 0,120 and 0,149. The four values of sig. are more than 0,05 so it can be stated that the data is normally distributed and can be continued with the paired sample t-test. This is in accordance with the decision-making criteria adapted from Arikunto (2002), which stated that if the value of sig. >0,05 then $H_0$ (normally distributed data) is accepted and $H_1$ (non-normally distributed data) is rejected. The results of the paired sample t-test pretest-posttest of cognitive and science process skills can be seen in Tables 10 and 11

**Table 10.** The results of the paired sample t-test pretest and posttest cognitive

| | | | Pair 1 |
|---|---|---|---|
| | | | Pretest – posttest |
| Paired differences | Mean | | -21.11111 |
| | Std. deviation | | 3.18728 |
| | Std. error mean | | .53121 |
| | 95% Confidence interval of the difference | Lower | -22.18953 |
| | | Upper | -20.03269 |
| t | | | -39.741 |
| df | | | 35 |
| Sig. (2-tailed) | | | .000 |

**Table 11.** Test results paired sample t-test pretest and posttest science process skills

| | | | Pair 1 |
|---|---|---|---|
| | | | Pretest – posttest |
| Paired differences | Mean | | -38.75000 |
| | Std. deviation | | 12.32506 |
| | Std. error mean | | 2.05418 |
| | 95% Confidence interval of the difference | Lower | -42.92020 |
| | | Upper | -34.57980 |
| t | | | -18.864 |
| df | | | 35 |
| Sig. (2-tailed) | | | .000 |

Based on Tables 10 and 11, the value of sig. (2-tailed) for pretest-posttest cognitive and science process skills are 0,000. The value of sig. (2-tailed) is less than 0,05, so it can be said that there is an average difference between the results of the pretest and posttest. This is in alignment with the decision-making criteria adapted from Arikunto (2002), which postulated that if the value of sig. <0,05, then $H_0$ (there is no difference in average between the results of the pretest and posttest) is rejected and $H_1$ (there is an average difference between the results

of the pretest and posttest) is accepted. Next, an n-gain analysis was carried out to find out how much the students' cognitive abilities and science process skills increased. The results of the n-gain pretest-posttest analysis of cognitive and science process skills can be seen in Table 12.

**Table 12.** The results of the n-gain pretest-posttest analysis of cognitive and science process skills

| | N-gain average | Criteria |
|---|---|---|
| Cognitive pretest and posttest | 0,46 | Moderate |
| Science process skills pretest and posttest | 0,61 | Moderate |

From Table 12, pretest-posttest cognitive and science process skills obtained an average n-gain of 0,46 and 0,61 with moderate criteria. This result is in line with the research of Fitriasari & Yuliani (2021); Nurjanah et al. (2020), who obtained n-gains of 0,70 (high) and 0,67 (medium) for the pretest-posttest of cognitive and science process skills.

The results of the questionnaire and observation of collaboration skills were analyzed using percentage analysis and then averaged. The results of questionnaire data analysis and observation of collaboration skills for each aspect are depicted in Tables 13 and 14.

**Table 13.** The results of data analysis of the collaboration skills questionnaire

| Rated aspect | Average percentage | Criteria |
|---|---|---|
| Actively contributing | 89% | Very good |
| Showing flexibility | 96% | Very good |
| Showing an attitude of responsibility | 92% | Very good |
| Showing respect | 95% | Very good |

**Table 14.** The results of data analysis of the observation of collaboration skills

| Rated aspect | Average percentage | Criteria |
|---|---|---|
| Actively contributing | 100% | Very good |
| Showing flexibility | 87% | Very good |
| Showing an attitude of responsibility | 67% | Good |
| Showing respect | 78% | Good |

Based on Tables 13 and 14, it can be seen that the four aspects of collaboration skills indicated an average percentage ranging from 67-100% with good to very good criteria. The aspect of active contribution includes the attitude of expressing ideas, suggestions, or solutions in discussions. The facet of showing flexibility includes an attitude of accepting joint decisions, criticism, and suggestions and always compromising with the team to solve problems. The aspect of displaying an attitude of responsibility includes the attitude of following orders that have become their duties and not depending on others. Meanwhile, the aspect of showing respect includes showing politeness and listening to and respecting friends' opinions. Nurjanah et al. (2020); Rahmawati et al. (2019) also used these four aspects in their research. The results of questionnaire data analysis and observation of collaboration skills obtained an overall average percentage of 94% and 83% with very good criteria.

The present study results are expected to be a source of inspiration for further research activities to improve science process skills and collaboration as 21st-century skills that must be mastered by every student.

## CONCLUSION

From this study, it can be concluded that electronic student worksheets assisted with liveworksheets website are feasible to use and can help improve science process skills and

collaboration on the lesson on reaction rate in terms of validity, practicality, and effectivity. The validity test showed an average percentage of 87% with very valid criteria. The practicality test includes the results of student response questionnaires and observations of student activities, with an average percentage of 92% and 100%, respectively, with very good criteria. The effectivity test includes the results of the pretest-posttest cognitive and science process skills, with n-gains of 0,46 and 0,61, respectively, with moderate criteria. Meanwhile, the results of questionnaires and observation of collaboration skills showed an average percentage of 94% and 83%, respectively, with very good criteria.

Overall, based on the research results, a suggestion we can provide is to develop electronic student worksheets assisted with liveworksheets website for chemistry lessons and other skills.

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