MANAZHIM
Jurnal Manajemen dan Ilmu Pendidikan

p-ISSN : 2656-5374
e-ISSN : 2656-0216

Terindeks : SINTA 4, DOAJ, Dimensions, Scilit, Lens Crossref, Garuda, Google, etc.

https://doi.org/10.36088/manazhim.v6i2.5262

# DEVELOPMENT E-WORKSHEET OF REACTION RATE BASED ON RADEC LEARNING MODEL WITH THE HELP OF LIVEWORKSHEET

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**Abstract**

The goal of this study is to develop reaction rate E-Worksheet based on RADEC learning model with the help of liveworskheet and analyze the quality of E-Worksheet developed. This Research and Development (R&D) study was developed utilizing the 4D development model, which includes the stages of Define, Design, Develop, and Disseminate.. The research was limited to the develop stage, namely validity test and practicality test. The instruments used were validity and practicality questionnaires. The validation process involved three lecturers from the UNP Chemistry Department and two chemistry teachers from Senior High School Negeri 1 Batang Kapas. The practicality test was conducted by two chemistry teachers and twenty-eight eleventh-grade students (Phase F) from the same school during the January to June 2024 semester. The validity test results were analyzed using Aiken's V, while the results of the practicality test with a percentage of the achievement score. From the results of the research analysis, the Aiken's V value was 0.87 with a valid category. The results of the practicality test from teachers and students respectively obtained a percentage value of 88% and 93%. The research findings indicate that the reaction rate E-Worksheet based on the RADEC learning model with the help of liveworksheet for Phase F of Senior High School is valid and practical, so it can be continued to the next research for effectiveness testing.

**Keywords**: E- Worksheet; Reaction Rate; Liveworksheet; Learning Model; RADEC

## INTRODUCTION

One of the learning outcomes of Phase F of Senior High School requires students to understand the theory of collisions between material particles as the basis for the concept of reaction rate. The curriculum demands state the reaction rate as essential material that students need to learn in Phase F of Senior High School. The reaction rate is a chemical concepts that students find challenging to grasp, because the content is abstract which makes it difficult for students to learn and can cause concept errors (Jusniar *et al.*, 2020). This is in line with the results of teacher interviews and analysis of students' needs related to the reaction rate including one of the chemical materials that are difficult for students to understand. The results of the percentage of the difficulty of the reaction rate by students were obtained around 47.1%. In addition, the limited learning facilities used are also one of the causes of the difficulty of students understanding reaction rate material (Sodanango *et.al.*, 2021). For this reason, efforts are needed that teachers can make in overcoming these problems.

One of the efforts that teachers can make to overcome students' learning difficulties is to increase students' involvement in the learning process. For this reason, the application of learning models is a solution that can be done. RADEC learning model can be an innovation that can be applied. This RADEC learning model aims to it is an alternative to improve the quality of the learning process and outcomes (Sopandi, 2017). Some previous studies related to the application of the RADEC learning model in chemistry learning include research with the results that the application of the RADEC learning model can effectively improve students' concept understanding of reaction rate and colloid material (Rara & Waworuntu, 2023; Ritonga *et al.*, 2021). In line with the analysis of students' needs, the application of the RADEC learning model can make it easier for students to participate in classroom learning by understanding the material first, besides that the discussion learning method used is also in accordance with the group learning method that students like. The data results from the analysis of the needs of each learner were obtained respectively around 92.9% and 64.7%. In addition to the application of learning models, the use of technology in learning can also increase students' involvement in learning.

Based on previous research, the use of mobile learning technology in English language learning can improve learner engagement and learning outcomes (Yu *et al.*, 2022). The use of mobile technology such as smartphone can engage learners in accessing

materials, and learners can interact with content material being studied. This is not in line with the results of teacher interviews related to the implementation of learning in schools that have not optimally utilized technology in learning. Meanwhile, around 97.6% of learners already havea personal smartphone and 62.4% have used it for learning. This can be a solution in increasing students' involvement in learning, namely through the use of smartphones. Several studies on reaction rates also state that teaching materials using technology can provide different experiences that can have an effect on increasing students' motivation and learning outcomes (Afrianis & Bunda, 2020;Haryanti & Fatisa, 2021;Putri *et.al.*, 2022;Merentek *et.al.*, 2022;Antris & Andromeda, 2023).

Electronic learner worksheets (E-Worksheet) are a form of teaching material that is applied with technology. E-Worksheet as an innovative material needed in learning helps students understand and construct a material concept (Kosasih, 2021). Meanwhile, the use of E-Worksheet with the help of liveworksheet can be used to foster students' motivation in learning (Chandrawita, 2023) and facilitate students' understanding of learning materials (Kinanda *et.al.*, 2022). Learning motivation and understanding of concepts can have an effect on improving student learning outcomes (Sihombing *et.al.*, 2021).

This research is also according to interviews with chemistry teachers at State Senior High School Negeri 1 Batang Kapas and State Senior High School Negeri 2 Batang Kapas related to the lack of variety of instructional materials utilized in the learning process which also has not utilized technology. On the other hand, based on the analysis of students' needs including; about 95.3% of students stated that learning with the application of technology can make learning fun, for that about 78.8% of students are interested in learning using electronic-based learner worksheets, and about 82.4% of students stated that multidimensional learning can help them understand reaction rate material that is difficult to understand.

Based on the aforementioned points background, the objective of this study to develop E-Worksheet for reaction rate based on RADEC learning model with the help of liveworksheet for Phase F of Senior High School as a suitable teaching material expected by the needsof students.

## METHODS

This research represents a form of development or Research and Development (R&D). This development research applies the development model 4D (Define, Design, Develop, and Dessiminate) developed by Thiagarajan, (1974). The resulting product is an E-Worksheet based on the RADEC learning model on reaction rate material with the help of liveworksheet for Phase F of Senior High School. This research was conducted at Padang State University and Senior High School Negeri 1 Batang Kapas. The validity testing was conducted by a panel of experts, including three chemistry lecturers from the Faculty of Mathematics and Natural Sciences at Padang State University and two chemistry teachers from Senior High School Negeri 1 Batang Kapas. The development test, on the other hand, was carried out by practitioners, which included two chemistry teachers and 28 Phase F students from Senior High School Negeri 1 Batang Kapas. Research period Jan-Jun 2024.

In the define stage, preliminary research was conducted through four types of analyses: (1) problem analysis, which involved conducting literature reviews, interviewing three chemistry teachers from Senior High School Negeri 1 Batang Kapas and Senior High School Negeri 2 Batang Kapas, and analyzing the needs of Phase F Senior High School students.(2) Task analysis was obtained through analyzing the chemistry Learning Outcomes of Phase F of Senior High School to determine the Learning Outcomes for reaction rate and the derived Learning Objectives (TP). (3) Concept analysis is obtained through the identification of concepts contained in the reaction rate material. (4) Formulation of learning objectives is obtained through the formulation of the flow of learning objectives which will later obtain the material scope of the reaction rate. The preparation of the flow of learning objectives is obtained after outlining the Learning Objectives (TP) of the reaction rate Learning Outcomes.

During the design stage, the reaction rate E-Worksheet is created following the stages of the RADEC learning model proposed by Sopandi,( 2021). The learning stage consists of five stages, namely: (1) Read,(2) Answer, (3) Discuss, (4) Explain, and (5) Create (Sopandi, 2021). The format for preparing E-Worksheet is adjusted to the teaching material development guideaccording to (Kosasih, 2021), which consists of (1) E-Worksheet cover, (2) activity instructions, (3) activityobjectives, (4) material description, and (5) activity steps.

In the develop stage, the evaluation was conducted by experts, including three chemistry lecturers from FMIPA, Padang State University, and two chemistry teachers from Senior High School Negeri 1 Batang Kapas, for the validity test. Practitioners (users), consisting of two chemistry teachers and twenty-eight Phase F students from Senior High School Negeri 1 Batang Kapas, carried out the practicality test.The validity test data obtained was analyzed using Aiken's V. The E-Worksheet developed is categorized as valid when the Aiken's V value obtainedis $\geq 0.8$ and $\leq 0.8$ are categorized as invalid. The Aiken's V value used was obtained based on five choices and five validators (Aiken, 1985). The data obtained from the practicality test results were analyzed using the formula for the percentage of product practicality achievement scores. The practicality level of the E-Worksheet is classified into several categories: the very practical category, with a percentage value of 86% - 100%; the practical category, with 76% - 85%; the moderately practical category, with 55% - 59%; and the impractical category, with 0% - 54%.

## RESULTS

Research Results at the Define Stage

The results of the problem analysis obtained based on literature studies from previous research results that reaction rate material is one of the chemical materials that is difficult for students to understand due to its abstract material, but also due to the limited learning facilities used. For this reason, the application of the RADEC learning model and the use of E-Worksheet with the help ofliveworksheet can be a solution that is applied in learning.

The results of the research obtained are in line with the results of interviews with three teachers from Senior High School Negeri 1 Batang Kapas and Senior High School Negeri 2 Batang Kapas that reaction rate material is one of the materials that is difficult for students to understand, besides that there is a limited variety of teaching materials used in chemistry learning, teaching materials commonly used in learning in the form of books and the use of learning worksheet in printed form. While leraning worksheet that suits the needs of students does not yet exist.

Based on the analysis of students' needs: (1) reaction rate material is one of the topics that approximately 47.1% of students find difficult to understand, (2) about 82.4% of students stated that multidimensional learning can help understand reaction rate material

which is one of the subjects that is challenging for students to understand, (3) besides that about 95.3% of students agree that learning with the application of technology can make learning fun, (5) about 78.8% of students are interested in learning using electronic learner worksheets, and (6) about 64.7% of students like group learning methods. Therefore, this research was conducted to develop E-Worksheet of reaction rate based on RADEC learning model with the help of liveworksheet which is expected to help students find concepts, increase students' activeness in the learning process and enhance students' comprehension of the material being studied.

The results of the task analysis obtained in the form of Learning Outcomes of reaction rate material, namely "Understanding the theory of collisions between particles as the basis for the concept of reaction rate", with the Learning Objectives (TP) derived: (1) explain the concept of reaction rate, (2) determine the reaction rate equation, (3) explain the factors that affect the reaction on rate. Results The task analysis obtained is used to understand thelearning stages.

The results of the concept analysis obtained are: collision theory, reaction rate concept, reaction rate equation, reaction order, half-life, and factors affecting the reaction rate. The results of the concept analysis were obtained in the form of a concep map.

The outcomes of defining the Learning Objectives are in the form of a flow of Learning Objectives; (1) explaining the theory of collisions to the reactions that occur, (2) explaining the concept of reaction rates through a story/situation in the daily environment, (3) determine the reaction rate equation by calculating the reaction order price, (4) determine the half-life based on the reaction order, (5) explain the factors that affect the reaction rate and connectit with the collision theory.

Research Results at the Design Stage

The specification of the reaction rate E-Worksheet produced is that the E-Worksheet is designed based on the RADEC learning model syntax described in the research method section. E-Worksheet is crafted to align with the components of E-Worksheet including: (1) E-Worksheet cover, (2) activity instructions, (3) activity objectives, (4) material description, and (5) activity steps. In the activity instructions section, the E-Worksheet is equipped with instructions for the use of students and manual books that are used to assist students in using the RADEC learning model-based reaction rate E-Worksheet using liveworksheet. Instructions for the use of students include the

following. (1) During the Read stage, students are instructed to study independently at home using the E-Worksheet by accessing the link provided by the teacher in the class group. This stage guides students to understand learning materials through reading materials and learning videos that have been provided on E-Worksheet. (2) At the Answer stage, students are asked to understand the concept of material through questions that have been provided in the E-Worksheet. (3) During the Discuss stage, students engage in group discussions about the material concepts based on their independently completed questions. This process aims to deepen their understanding of the material through collaborative analysis of their previous answers. (4) At the Explain stage, students are required to be able to explain the concept of material through answers to questions that have been done and discussed. (5) At the Create stage, students are asked to generate ideas related to understanding the concepts that have been learned or students are asked to be able to implement the understanding obtained through creative ideas that will be carried out either in the form of investigative activities or research problem formulation or even product creation.

Research Results at the Develop Stage

From Table 1. it can be seen that all aspects assessed (content feasibility, language, presentation and graphics) have an average validity value of 0.87 or have a valid category with an Aiken'V value > 0.8. However, there are some parts of the E-Worksheet that need to be revised according to the validator's suggestions and comments. The revised E-Worksheet parts include (1) E-Worksheet writing, (2) adding learning objectives, (3) addition of questions on the E-Worksheet in the collision theory section, (4) improvement of the video used, (5) addition of reading material on the sub-concept of reaction rate, use of actual reactions, and (7) provision of activity limits. Furthermore, the practicality analysis, from Table 2, shows that all aspects assessed (usability, time efficiency, and advantages of use) have an average percentage of practicality by teachers and students of 88% and 93% respectively or have a very practical category with a percentage value of 86% - 100%.

**Table 1.** Validity Test Results of Reaction Rate E-Worksheet Based on RADEC Learning Model withLiveworksheet Assistance

| No | Aspects assessed | Value V | Description |
|---|---|---|---|
| 1 | Content eligibility | 0,87 | Valid |
| 2 | Linguistics | 0,85 | Valid |
| 3 | Presentation | 0,87 | Valid |
| 4 | Graphics | 0,90 | Valid |
| | Validity | 0,87 | Valid |

**Table 2:** Practicality Test Results of Reaction Rate E-Worksheet Based on RADEC Learning Model withLiveworksheet Assistance

| No | Aspects assessed | Teacher | Learners | Description |
|---|---|---|---|---|
| 1 | Ease of Use | 88% | 93% | Very Practical |
| 2 | Time Efficiency | 85% | 92,5% | Very Practical |
| 3 | Usage Benefits | 90% | 93,7% | Very Practical |
| | Practicality | 88% | 93% | Very Practical |

In addition, the E-Worksheet practicality analysis can also be seen from the results of the material provided in Figure 1 which helps students to understand abstract material related to the discovery of the reaction rate concept.

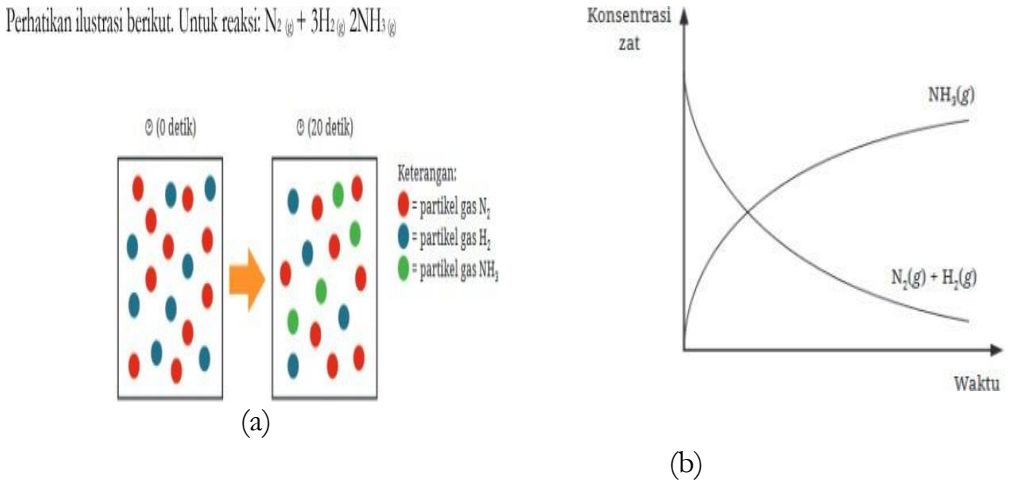


**Figure 1. Illustration of the discovery of the concept of reaction rate through changes in substance concentration**

Source: Chemistry book for Senior High School / MA class XI (Kemendikbudristek)

In addition, the practicality analysis of E-Worksheet can also be seen in Figure 2 which relates to the concept of catalyst as one of the factors that influence the reaction rate.

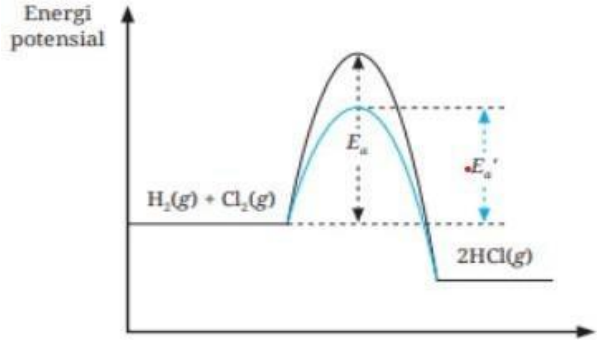


**Figure 2. Activation Energy Graph without Catalyst (Black Curve) and with Catalyst (BlueCurve)**

Source: Chemistry book for Senior High School / MA class XI (Kemendikbudristek)

The use of the RADEC learning model can help students in understanding the reaction rate material, the following seen in Figure 3 contains questions related to the reaction rate material that will lead students to understand the material in the Answer stage. In addition, the use of live worksheets with question features provided can create interactive learning.

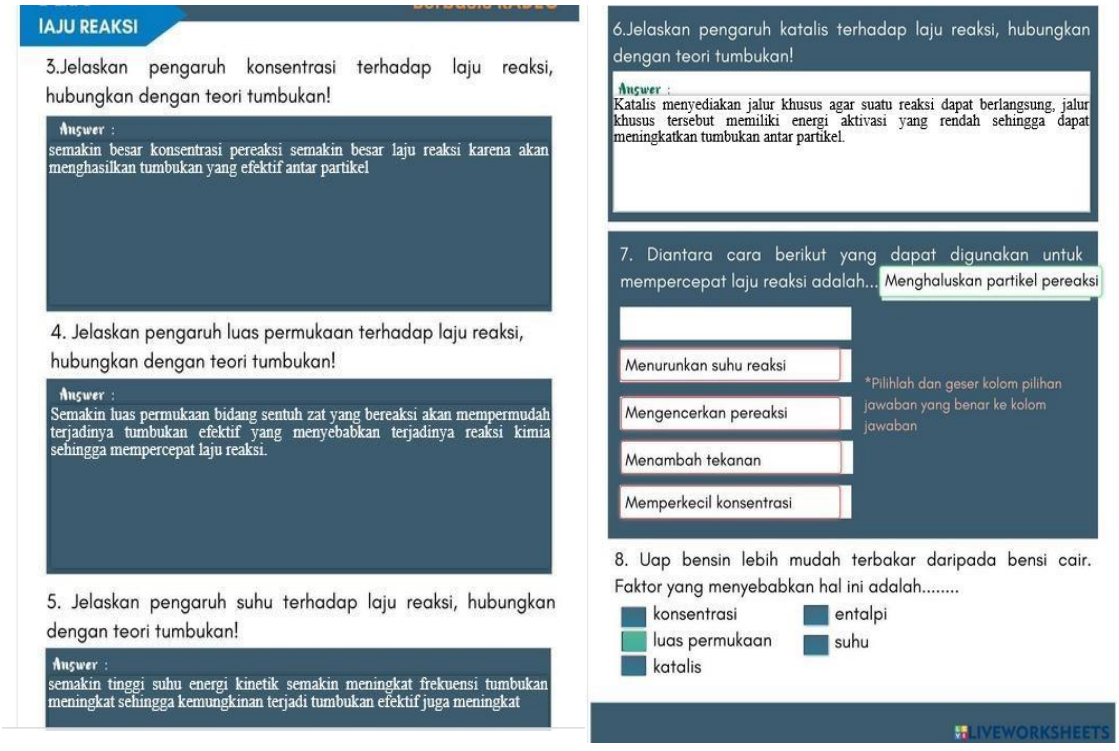


**Figure 3: Reinforcement of understanding of reaction rate through answer syntax**

## DISCUSSION

### Validity Analysis of E-Worksheet

Based on Table 1, it can be seen that the E-Worksheet developed is valid with the Aiken's V value obtained of 0.87. From the content aspect this reaction rate E-Worksheet is valid. This data shows that the reaction rate E-Worksheet based on the RADEC learning model with the help of a liveworksheet is in accordance with the curriculum, and is able to train students' abilities through Content validation indicates that the E-Worksheet developed aligns with the curriculum, contains processes and skills that are trained, and prioritizes important activities (Kosasih, 2021).

The linguistic aspect of the developed E-Worksheet is valid. This data shows that the E-Worksheet developed has used simple sentences and straightforward for students to grasp and the E-Worksheet has introduced the meaning of new terms that students do not know. The linguistic validation shows that the E-Worksheet made has introduced the meaning of new terms and the sentences used are simple so that they are easy to understand (Kosasih, 2021).

From the presentation aspect, the E-Worksheet developed is valid. This data shows that the entire E-Worksheet has been prepared based on the components of an E-Worksheet and also consistent with the syntax of the RADEC learning model (Sopandi, 2021). Validation of E-Worksheet presentation must be able to show the sequence of activities logically and systematically, and show the parts that have been followed from beginning to end (Kosasih, 2021).

From the aspect of graphics, the developed E-Worksheet is valid. The data shows that the E-Worksheet has been designed with an attractive design and added illustrations and a layout that is not boring. Graphic validation shows that E-Worksheet displays attractive designs and illustrations and layouts that are not boring (Kosasih, 2021).

### Practicality Analysis of E-Worksheet

Based on Table 2, the results of the E-Worksheet practicality evaluation by teachers obtained a scoreof 88% and students with a score of 90% with avery practical category. The data shows that the E-Worksheet developed has been practical from allaspects of the assessment, namely usability, learning time efficiency, and advantages.

From the aspect of ease of use, the practicality of E-Worksheet obtained an assessment with a very practical category. This data shows that the E-Worksheet by teachers and students is easy to use and understand in the learning process, the use of the RADEC learning model used makes it easy to explain and understand the material, the instructions provided on the E-Worksheet are easy to understand and make it easier to guide and easy for students to use in learning. In accordance with the results of previous research that practicality is easy to use because it is easy to learn, can be controlled, and can be understood (Sadraini & Hamdi, 2021).

In terms of time efficiency, the practicality of E-Worksheet is obtained in the highly practical category. This indicates that the E-Worksheet developed has practicality in accordance with the lesson hours and the time needed to understand the material is not too long by teachers and students, and the costs required are relatively cheap and can be used for self-study. Consistent with the findings of previous research that efficient (cost effective) can produce interactive teaching materials so that the time needed in learning is moreeffective and efficient (Sadraini & Hamdi, 2021).

Based on the benefit aspect, the practicality of the E-Worksheet obtained an assessment within the highly practical category. This proves that the E-Worksheet developed is very useful by teachers in achieving learning objectives, accelerating the learning process, guiding learning activities and can be a source of additional teaching materials for teachers and students, so its practicality is very good. Inaddition, for students, the practicality of E-Worksheet can help in understanding the concept of material. This aligns with the research findings that E-Worksheet can be used to accelerate learning, improve learning, and increase effectiveness in learning (Sadraini & Hamdi, 2021).

In addition to the results of the E-Worksheet practicality test analysis obtained, the use of E-Worksheet based on the RADEC learning model with the help of liveworksheet can also facilitate students' understanding of the reaction rate material.This is illustrated in Figure 1, including Figure 1(a). At the 0th second, there were ten nitrogen molecules. By the 20th second, eight of these molecules had been separated. For hydrogen gas molecules, there were eight molecules at the 20th second. As time progressed to the 20th second, the number of remaining hydrogen molecules decreased to four. Meanwhile, ammonia molecules at the 0th second do not exist, as time increases at the 20th second ammonia molecules are formed with four molecules. From this description, nitrogen and hydrogen

molecules are reacting molecules or called reactants that experience a reduction in the number of molecules per unit of time, while ammonia molecules are molecules formed from the reaction or called products. Based on Figure 1 (b), it can be seen that the reaction graph that occurs in nitrogen and hydrogen molecules has a decrease in the concentration of substances as time increases and the reaction graph that occurs in ammonia molecules ($NH_3$ ) has an increase in concentration as time increases. From this description, the graph of the decrease and increase in the concentration of reactants and products as a unit of time can be summarized as follows helps students describe the abstract concept of reaction rate so that students can find the concept of the reaction rate, both the reaction on the reactants and the reaction on the product.

In Figure 2, we can see the activation energy graph for the reaction of hydrogen ($H_2$ ) and clorine ($Cl_2$ ) to form hydrogen chloride (HCl) with a catalyst and without a catalyst. From the figure, it can be seen that the reaction of hydrogen chloride formation without a catalyst is seen in the curve that forms a black curved line, with the potential energy obtained greater than the potential energy formed from the reaction of hydrogen chloride with a blue curved line that shows the formation reaction with the help of a catalyst. This shows that theactivation energy generated in the formation of hydrogen chloride without a catalyst is greater than using a catalyst. So that the hydrogen chloride formation reaction with a catalyst is faster than without a catalyst. This is because low activation energy can cause more molecules to experience effective collisions so that the reaction rate increases.

Figure 3 includes questions about the factors influencing reaction rates and their connection to collision theory. The questions provided at the Answer stage assist in guiding students to grasp the concept of these factors and their relationship to collision theory. In addition, the question features on the liveworksheet used can make students interactive in working on questions, where students can directly provide answers on the E-Worksheet sheet. In Figure 3 (a), it can be seen that the question feature used is in the form of a short form where students can type the answer directly on the E-Worksheet. In Figure 3 (b),we can see the answer feature used in the form of drag and drog and checkboxes

## CONCLUSION

Based on the objectives, discussion and research results, the reaction rate E-Worksheet based onthe RADEC learning model with the help of liveworksheet for Phase F of Senior High School that has been developed with the 4D model is valid and practical. In order for this E-Worksheet to be used in actual learning, it is recommended to continuethe research to the effectiveness test stage

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