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Student Worksheet Development to Practice Critical Thinking Skill Using Blended Learning on Reaction Rate

Intan Novitasari[a], Bertha Yonata[a,*]

[a]Department of Chemistry Education, Universitas Negeri Surabaya

*Corresponding author: berthayonata@unesa.ac.id

ABSTRACT: This research aims to determine the feasibility of student worksheets to practice critical thinking skills using blended learning on reaction rate matter. This research is using Research & Development (R&D) design with the subjects are 2nd-grade students. The instrument used which as the student worksheet, pretest-posttest sheet, student activity observation, and student responses questionnaire. The validity of the student worksheets on the concentration factor, surface area, temperature, and catalyst obtained the percentage respectively 89.37%, 87.55%, 87.67%, and 87.53%. Student activities, obtaining a percentage of 90% and observation of student responses by 91%. The effectiveness of the students' worksheets in terms of the N-gain score of the pretest and posttest with an average of 0.65 in the medium category is very effective to practice critical thinking skill. So the student worksheet using guided inquiry learning model and blended learning strategy in reaction rate matter to practice critical thinking skill is feasible to use in High School.

Keywords: student worksheet, critical thinking skill, blended learning, the reaction rate

INTRODUCTION

Chemistry is one of the branches of natural science to study a matter of substance through chemical reactions [1] . Chemistry is a process for scientific work but chemistry as a product for a fact, concept, principle, theory, and law. Chemistry learning must pay attention to the characteristics of chemistry as a process and product. As learning in the 21st century, education work in line with time changes which is conventional towards modern education. The 21st-century paradigm emphasizes the ability of students to think critically, be able to develop knowledge of the real world, master information technology, communicate, and collaboration. To fulfill the abilities that must be achieved before facing the 21st century, students need to be trained to have critical thinking skills using appropriate learning methods.

Most learning in schools still uses the lecture method. One of the disadvantages of face-to-face learning only doesn't have much time to learning. When teachers are the only learning method, students' critical thinking skills become less honed because students are not accustomed to thinking outside the context conveyed by the teachers and become passive in choosing additional learning sources outside of the learning resources provided by the teachers [2]. With the current technological advances, it can be used as an innovative learning methodusing the blended learning strategy. Conventional education can blend with modern education with a blended learning strategy. Blended learning means a combination of face-to-face learning system with e-learning that can be used by everyone, everywhere, and anytime [3]. Technological advances are supported by this learning strategy. Blended learning design and implementation on offline and online learning. The online learning gives the material learning to the student and the face to face class to make sure the understood of a student.

Students can search for more information on the website, discussion, and open the study to another relevant sources. Handbooks only contain subject matter but are not specially prepared to practice students' critical thinking skills. So it is necessary that students need special sheets to practice them so that students can master every aspect of critical thinking skills like student worksheet. The development of student worksheets needs a learning system. The curriculum of 2013 prioritizes the use of a scientific approach.The Curriculum currently used in Indonesian education is 2013 curriculum model, emphasizes on active student learning (student center) [4]. Learning with the concept of the student center, students given the freedom to build own understanding and the teacher acts as facilitator in learning activities [5].

Learning also becomes constrained because the teacher is the only source of learning for students. The information they get is only limited to what is conveyed by the teacher. Students also tend to learn only by listening to and memorizing what the teacher says so they tend to quickly forget material, especially material that is abstract in nature [6].

The factors affecting low learning outcomes on skills such as learning models [7]. The learning model is a study design that the teacher will carry out in the classroom. Use the wrong one learning models in the learning process can lead to saturation, understanding concepts, and monotonous so that students are less motivated to learn [8]. Learning models that suitable can use in this research is inquiry models. The inquiry learning model is learning that requires students to solve problems through investigation activities that increase skills and knowledge independently [9].

In the inquiry models student practice to critical thinking skill. Critical thinking is a students' skill in interpretation, analysis, evaluation, inference, explanation, and self-regulated [10]. It means students' critical thinking skills are still low. Critical thinking is a form of thinking that seeks to understans problems in depth, has an open mind to the decision and opinions of others, tries to properly understand and evalate information received before making decisions be able to connect causes and effects solution to problems [11]. Both of them in the activity of the learning process and in the enviroment of everyday life. Critical thinking can practice by themselves using the student worksheet.

Student worksheet that are circulating in schools today are still general in nature and mostly contain only material summaries. The material presented is usually instantaneous without a detailed explanation and there are no instructions for using student worksheet for teachers and students. It will cause students to be less interested in existing student worksheet and less sharpening their critical thinking skills [12]. So it is necessary to update the student worksheet with content that can guide students to think critically and the design of student worksheet that does not seem monotonous. Student worksheet using the syntax in the inquiry learning model, namely presenting phenomena, formulating problems, making hypotheses, collecting data, analyzing experimental data, and concluding what has been learned.

Reaction rate material is one of the chemistry matter in senior high school. Some factors influence the reaction rate by the concentration, temperature, surface area, and catalyst. Factors that affected the reaction rate relate to the collision theory. Every factor that is affected by reaction has some different explanations for each other so the student should understand one by one. One of the problems of student difficulty that the material reaction rate is abstract, as said by Kirik and Yezdan that reaction rate is one concept chemistry which is abstract [13].. The student worksheet will help them to understand the reaction matter from doing the simple experiment. The experiment use the tools and material in daily life like a efforvecent tablet, ballon, and water. The purpose of this research was to determine the appropriateness of the student worksheets using the blended learning strategy and guided inquiry learning models in terms of validity, practicality, and effectiveness.
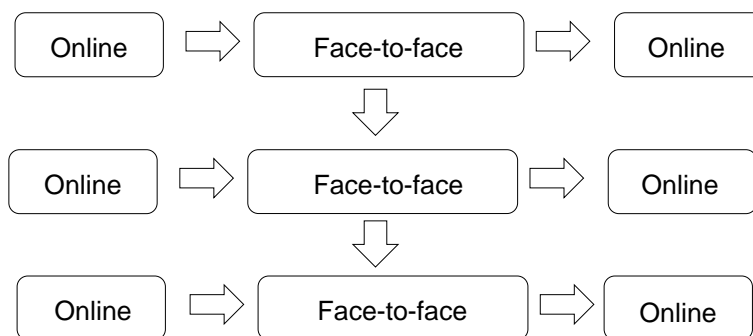
METHODS

Place, Time, and Subject Study

Research was conducted on student eleventh-grade Mathematics and Natural Science even the semester 2020-2021.

Study Instrument

Feasibility of student worksheet needs instrument which as student worksheet, pretest-posttest critical thinking skills sheet, and student activity observation.

Data Analysis

The design of blended learning is like **FIGURE 1**.

FIGURE 1. Design of Blended Learning [5]

The method of this research using descriptive analysis by Research and Development (R&D). Research and Development is one process or steps to develop a new product or complete a previous product. The method of R&D is like **FIGURE 2**.

FIGURE 2. The Method of Research and Development [4]

This research only develops until the sixth method is product trial. The result of student worksheet validity, practicality, and effectivity analyzed by quantitative descriptive, is the assessment from number and change to percentage. Percentage score of validation result obtained by the assessment criteria score using a Likert scale as a **TABLE 1.**

TABLE 1. Criteria Score The Likert Scale [5]

Scale Score	Criteria
5	Very good
4	Good
3	Normal
2	Bad
1	Very bad

Validation percentage obtained by the formula :

$$\text{Percentage (\%)} = \frac{the\ number\ of\ score\ obtained}{criteria\ score} \text{ x } 100\%$$

Then the percentages of validation interpretation as TABLE 2.

TABLE 2. Validation Interpretation [5]

Percentage (%)	Category
0-20	Not valid
21-40	Less valid
41-60	Quite valid
61-80	Valid
81-100	Very valid

As the criteria in TABLE 2, student worksheet developed can reach the validity criteria if get the percentage score of ≥ 61% and declared valid then can be tested on a limited basis in learning.The practical of student worksheet known by the result of student activity and student responses questionnaire during learning process. The student activity observation and student responses questionnaire were analyzed using descriptive analyzes by Guttman Scale as like TABLE 3.

TABLE 3. The Guttman Scale [14]

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

The data of student acivity observationa and student responses questionnaire collected data that has been calculated into percentages using a formula :

$$\text{Percentage (\%)} = \frac{\text{the number of score obtained}}{\text{criteria score}} \times 100\%$$

As the criteria in TABLE 3, student worksheet developed can reach the practicality criteria if get the percentage score of ≥ 61% and declared practical then can be tested on a limited basis in learning.

TABLE 4. Validation Interpretation [5]

Percentage (%)	Category
0-20	Not practical
21-40	Less practical
41-60	Quite practical
61-80	Practical
81-100	Very practical

On the step trial test of the product, the design used in this research is One Group Pretest-Posttest Test. Pretest test on the beginning class before act the student worksheet, and Posttest after the class finished. The accuracy of the result is high because the opposite is before and after. The Design of One Group Pretest and Posttest Design is like **FIGURE 3.**

$$O_1 \; X \; O_2$$
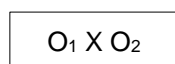
FIGURE 3. Design of Research One Group Pretest and Posttest [4]

Explanation :

O_1: Score pretest of critical thinking skill before learning
X: Test of the student worksheet
O_2: Score posttest of critical thinking skill after learning

Pretest and Posttest scores use to know the result of the practice critical thinking skill of the student. Practice can be known before and after test with the difference between the average pretest and posttest score using N-gain score with the formula below :

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

The N-gain score will be interpreted according to the following **TABLE 5** :

TABLE 5. N-Gain Score Category

| N-Gain Score (<g>)	Category
≥ 0,7	High
0,3 ≤ g ≤ 0,7	Middle
0,0 < g < 0,3	Low

RESULT AND DISCUSSION

The benefit of this research is that student worksheets can be used as an alternative in learning chemistry reaction rate material, these student worksheets can make it easier for students to understand the reaction rate material, as a medium for practicing students' critical thinking skills, and used as a learning media for rate material reactions in High School students. The appropriateness of the student worksheets for this reaction rate material as a learning medium can be viewed from its validity, practicality, and effectiveness.

In its implementation, the blended learning strategy is carried out in 3 stages, namely online pre-face to face, face to face, and online post face to face [15]. Online pre-face to face to observe videos related to phenomena, formulate problems, formulate hypotheses and design experiments. At face-to-face use the google meet platform to conduct experiments according to what has been previously designed. Each group representative presented the research data obtained and discussed them. Online post-face-to-face analysis of research data, conclude, and implement in everyday life.

Validity

The validity of the student worksheet and research instruments were validated by two chemistry lecturers and one chemistry teacher. Validation by providing a score in accordance with the results of the development of the student worksheet and the research instruments to be used. The validity of the student worksheet was assessed based on the validity of the content and criteria. Content validity is seen from its relevance to learning objectives [16].

Data validation results on content criteria consist of 4 aspects, namely the first aspect shows the purpose and accuracy of the material. The second aspect is suitability with the blended learning strategy, the third aspect is compatibility with the guided inquiry learning model which consists of 6 stages, and the fourth aspect is suitability with critical thinking skills. The aspects reviewed for critical thinking skills are in the form of interpretation, inference, analysis, and explanation. The score each aspect on content validiy can be shown **FIGURE 4.**
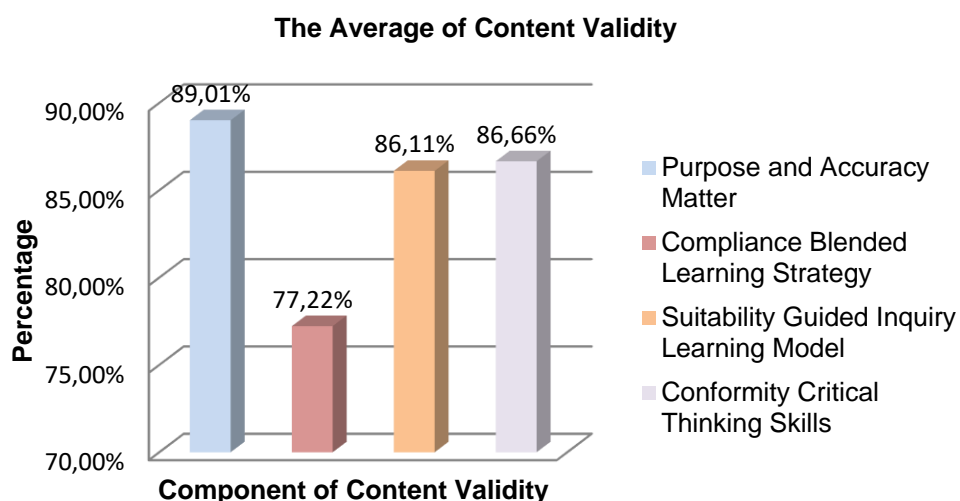
FIGURE 4. The Validity Content

From that table, the range of score of content validiy is ≥ 61% so the student worsheet can be declared

valid. The validity of the criteria consists of presentation criteria, language criteria, and graphic criteria. In the presentation criteria, there are components of the suitability of the video with the material, current references to literacy, and completeness of presentation such as a table of contents and instructions for using student worksheets. The language criteria consist of the accuracy of grammar and spelling. While the graphic criteria consist of the suitability of the layout, model, design, visibility of the text size and the appearance of the students worksheets. The validity for the criteria can be presented in the **FIGURE 5.**

The Average of Criteria Validity
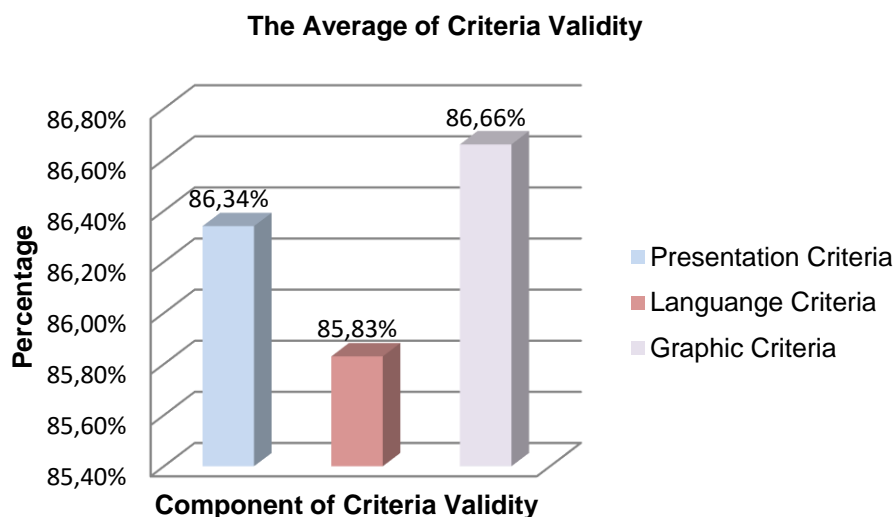
FIGURE 5. The Validity Criteria

The **FIGURE 5**. shown that the criteria validity the percentage of presentation criteria is 86.34%, the languange criteria is 85.83%, and the graphic criteria is 86.66%. The range of score of content validiy is $\geq 61\%$ so the student worsheet can be declared valid. The total percentage of student worskheet different between worksheet 1, worksheet 2, worksheet 3, and worksheet 4. The total validity result of student worksheet can be shown in **TABLE 6.**

TABLE 6. Validity Result of Student Worksheet

Validity Criteria	Worksheet 1	Worksheet 2	Worksheet 3	Worksheet 4
Score Average	89.37 %	87.55 %	87.67 %	87.53 %
Category	Very Valid	Very Valid	Very Valid	Very Valid

The worksheet used in the student is valid with the score average for worksheet 1 (concentration factor) is 89.37 %, worksheet 2 (surface area factor) is 87.55%, worksheet 3 (temperature factor) is 87.67%, and worksheet 4 (catalyst factor) is 87.53%. So the student worksheet in the category of valid to used. Thus the student worksheet uses the blended learning strategy and the guided inquiry learning model can be used to support the learning process and simple experiment. In line with the research conducted previously, stated that the results of the development of student worksheet which are prepared by applying a guided inquiry-based learning approach can require students to learn more on their own and develop activeness in problem solving [17]. The instrumen researches are the posttest-pretest sheet, student observation sheet, and student response questionnaire. The validity of each sheet shown in **TABLE 7.**

TABLE 7. The Validity of Instrumen Researches

Instrumen Research	Average Score	Category
Pretest and Posttest Sheet	91.79 %	Very Valid
Student Activity Observation Sheet	89.52 %	Very Valid
Student Response Questionnaire	88.33 %	Very Valid

Practicality

Practicality aims to determine that student worksheet can actually be used in learning with guided inquiry stages. The practicality of this experiment known by the result of student observation and student response observation.

Student Activity Observation

Observation of student activities is used to find out which students carry out the stages according to the guided inquiry learning model. The concept found by students through the bath learning experience, makes students more enthusiastic and accustomed to using the learning model used. The teacher becomes easier in guiding learning with the inquiry stage, because students build their own knowledge. Activities carried out by students were assessed by two observers. Worksheet 1 and 2 were discussed at the first meeting and worksheet 3 and 4 at the second meeting. Data from the observation of student activity can be seen in the **FIGURE 6.**
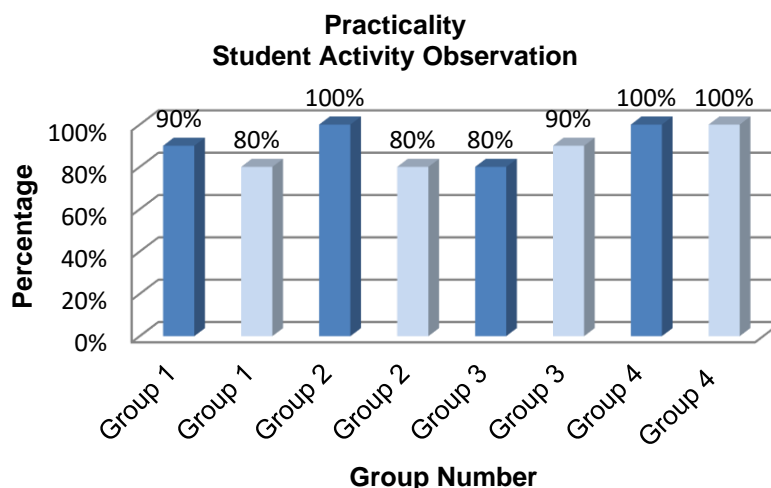

FIGURE 6. The Percentage of Observation Activies Student

Based on the graph 3, each student meeting has carried out according to the stages in the guided inquiry learning model. Student worksheets can be said to be practical if the student's activity ≥ 61% [14]. Based on the data it can be stated that the feasibility category student worksheet is practical.

Student Response Questionnaire

Observation of student responses contains ten questions related to student worksheets in practicing critical thinking skills. Observation is also used to determine the suitability of the guided inquiry learning model and the blended learning strategy in the reaction rate material.

Student Responses Questionnaire
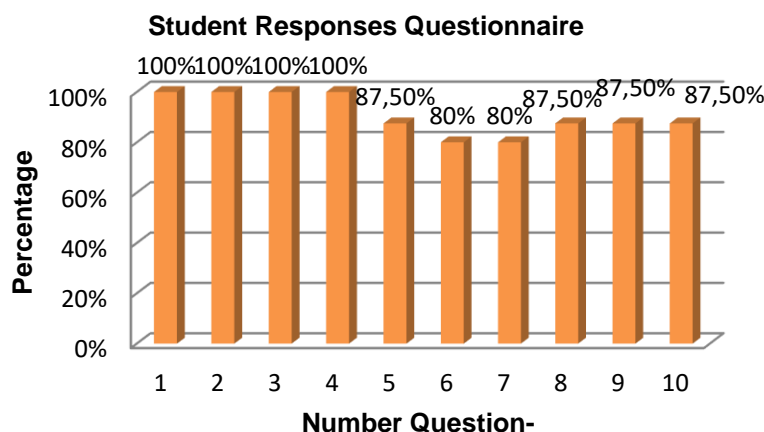
FIGURE 7. The Student Responses Questionnaire

Based on **FIGURE 7**, questionnaire of student responses has a percentage of ≥ 61% so it can be said that the students' worksheets developed are practical to be given to students.

Effectivity

The effectiveness of student worksheet is the media worthness vriteria based on the predictability of learners. Test trials were carried out to test the feasibility of students 'worksheets in practicing students' critical thinking skills [18]. The step of trial use the student worksheet to know the effectivity. The effectivity of student worksheet known by the score each student of pretest and posttest.
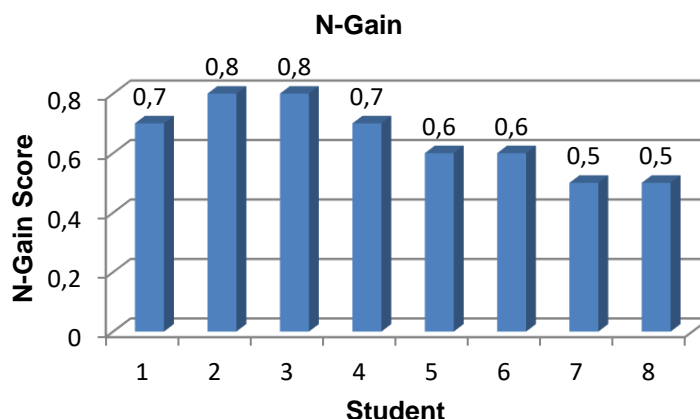
N-Gain

FIGURE 8. The N-gain Score

From the **FIGURE 8**, students can be trained to think critically using learners worksheets on reaction rate material. Based on the results of the pretest and posttest, it can be seen that students have increased from the pretest to postest scores. Normalization of the gain from the scores obtained by 4 students in high category and 4 student in intemediate category. Aspects of critical thinking skills that are trained to students are interference, inference, analysis, and explanation. Interpretation is a skill to understand and the importance of various kinds of procedures, or criteria [3]. In the interference aspect, students formulate a problem formulation, determine the experimental variables. Interpretation stage seen in the second stage of inquiry learning which presents the problem of inquiry or inconsistent events [19]. Inference is a skill for forming hypotheses and developing the consequences for the form of representation [3]. In the inference aspect, students formulate hypotheses, make observation tables. Inference stage seen in the third stage of inquiry learning, which is asking students to formulate a hypothesis to explain the problem [19]. Analysis is a skill to identify what is desired and actual inferential relationship between questions,

concepts, descriptions, or other forms representations to reveal reasons [3]. In the analysis aspect, students analyze the data from the observations and connect to the theory and in the aspect of analysis, students explain phenomena in everyday life related to theory. The analysis stage in the four stages of inquiry learning, namely encourage students to collect data and test hypotheses [19]. Explanation is the skill of expressing one's results Reasoning in conceptual, methodological, and contextual considerations [3]. Explanation aspects, student connect the experiment data result into theory and daily life. The stages of explanation are visible at the sixth stage of incubation learning that is flexibly reflected on troubled situations and thought processes used to investigate them [3]. Guided inquiry based student worksheet effectively makes students more careful in carrying out activities and providing experiences and lessons related to daily activities [20].

TABLE 8. The Percentage of Aspect Critical Thinking Skills

Aspect	Pretest	Posttest
Interference	78.13%	90.62%
Inference	53.13%	100%
Analysis	56.25%	81.25%
Explanation	84.38%	100%

Based on **TABLE 8,** there is an increase in every aspect of critical thinking skills, namely as much as 12.49% in the interference aspect, 46.87% in the inference aspect, 25% on the analysis aspect, and 15.62% on the explanation aspect. There are differences in the results before giving students worksheets and after giving students worksheets. Blended learning strategies can increase learning independence and students' critical thinking skills in the digital era [2]. Students' critical thinking abilities are differences between blended learning and direct or face-to-face learning, with blended learning higher than direct learning. Relevant researches previously, the results showed that there was a significant effect of blended learning on students' critical thinking skills in temperature and heat material [21]. Based on the validity, practicality, and effectivity so it can be stated that the student worksheet using blended learning and inquiry learning model can train students' thinking skills on the reaction rate material. This is in line with previous research shows that use learning tools using strategies blended learning has successfully improved critical thinking skills and learning outcomes students [22].

CONCLUSION

Based on the analysis and discussion, student worksheets can be declared feasible if they have validity, practicality results with a percentage of ≥ 61% and the effectiveness of pretest posttest score n-gain in category medium or high. So that the student worksheets using the blended learning strategy and the guided inquiry model are appropriate for use in high schools.

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