

# Development Of Inquiry Student Worksheet To Train High Order Thinking Skill (HOTS) In Reaction Rate

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**1  
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**Abstract: Development Of Inquiry Student Worksheet To Train High Order Thinking Skill (HOTS) in Reaction Rate.** This study aims to describe the feasibility of Students' Worksheet using inquiry-based to train High Order Thinking Skill (HOTS) on the Reaction Rate Material. The research method used is the 4-D model (Define, Design, Develop, Disseminate), but in this study it only reaches the stage Develop. Furthermore, a limited trial was carried out on 12 students of class XI at SMAN 1 Krian. The research instrument consisted of a review sheet, a validation sheet, a response questionnaire, a test sheet for learning outcomes in the domain of knowledge and a HOTS pretest-posttest question sheet. The feasibility of Students' Worksheet is reviewed based on 3 criteria, as the validity of the validation results by the validator, the practicality of the students' responses and the effectiveness of the learning outcomes test in the realm of knowledge and the HOTS pretest-posttest results. Data analysis using quantitative descriptive method. The results obtained showed the percentage of Students' Worksheet validity for content, language, practicality and effectiveness criteria of 86.2%, 87.8%, 88.4% and 91.3% with very valid categories. The developed Students' Worksheet received a very positive response with a percentage of 92.2% and was stated to be very effective. The results of the increase in HOTS of students are described by the acquisition of an n-gain score of 0.71 in the high category. Each HOTS component includes analyzing (C4) of 82.5%, evaluating (C5) of 81% and creating (C6) of 91.3% in the high category and declared effective.

**Keywords:** Student Worksheet, High Order Thinking Skill, Inquiry, Reaction Rate

**7**  
**Abstrak: Pengembangan LKPD Berbasis Inquiry Untuk Melatihkan High Order Thinking Skill (HOTS) Pada Materi Laju Reaksi.** Penelitian ini memiliki tujuan untuk mendeskripsikan kelayakan LKPD berbasis inquiry untuk melatihkan High Order Thinking Skill (HOTS) pada Materi Laju Reaksi. Pada penelitian ini digunakan metode penelitian model 4-D (Define, Design, Develop, Dissiminate). Namun pada penelitian ini hanya dilakukan sampai tahap Develop. Selanjutnya dilakukan uji coba terbatas pada 12 peserta didik kelas XI di SMAN 1 Krian. Instrumen penelitian menggunakan lembar telaah, lembar validasi, lembar angket respon, lembar tes hasil belajar ranah pengetahuan dan lembar soal pretets-posttest HOTS. Kelayakan LKPD ditinjau berdasarkan 3 kriteria yakni validitas dari hasil validasi oleh validator, kepraktisan dari respon peserta didik dan keefektifan dari tes hasil belajar ranah pengetahuan dan hasil pretest-posttest HOTS. Analisis data menggunakan metode deskriptif kuantitatif. Hasil yang diperoleh menunjukkan persentase validitas LKPD untuk kriteria isi, kebahasaan, kepraktisan dan keefektifan sebesar 86,2%, 87,8%, 88,4% dan 91,3% dengan kategori sangat valid. LKPD yang dikembangkan mendapatkan respon yang sangat positif dengan mendapat persentase sebesar 92,2% dan dinyatakan sangat praktif. Hasil peningkatan HOTS peserta didik digambarkan dengan perolehan score n-gain sebesar 0,71 dengan kategori tinggi. Pada setiap komponen HOTS meliputi menganalisis (C4) sebesar 82,5%, mengevaluasi (C5) sebesar 81% dan mencipta (C6) sebesar 91,3% dengan kategori tinggi dan dinyatakan efektif.

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**Kata kunci:** LKPD, High Order Thinking Skill, Inquiry, Laju Reaksi.

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▪ **INTRODUCTION**

Education is an effective way to achieve the goals of the Indonesian Nation as stated in the preamble to the 1945 Constitution<sup>9</sup> "the intellectual life of the nation". Establishing a dignified character and civilization to educate the nation's life and develop abilities is the goal of education (Depdiknas, 2006). Based on data from PISA results in 2018, it is known that Indonesia is ranked 72 out of 37 countries on the average score of science and mathematics (OECD, 2019). This data shows that the human resources of education in Indonesia are still under the average. In line with the statements of (Salahuddin & dan Hermawan, 2018) who state that the quality of Indonesian human resources in the education sector is still low, causing a decline in the competitiveness of the Indonesian nation

3

As an education facilitator, the government has made various efforts to improve the quality of education, one of which is implementing the 2013 Curriculum or commonly called C13. The main point of C13 learning is that students are given the facility to find out for themselves the concepts to be taught by utilizing information and communication technology so that students are free to gain knowledge from anyone and anywhere (Abdullah <sup>11</sup> et al., 2018). In C13, the strengthening of the learning process is carried out by means of a scientific approach. The scientific approach is learning that encourages students to have the ability to observe, ask, try / collect data, associate / reason and communicate (Menteri Pendidikan dan Kebudayaan, 2019)

Chemistry study is not only learn about the concept of calculation but also proves the concept through experiment. Thermochemistry, reaction rates, chemical equilibrium, acid-base, electrolyte and non-electrolyte solutions as well as the colligative properties of solutions are chemical materials that require proof through experiments in accordance with Basic Competency (KD) 4 (Damaianti et al., 2019). In accordance<sup>6</sup> with C13 which has been adjusted to the conditions during the current pandemic, <sup>16</sup> that must be achieved by students in the material reaction rate <sup>6</sup> 3.4 Explaining the factors that affect the rate of reaction using collision theory and 4.5 Designing, conducting and concluding and presenting the experimental results of the factors affecting the reaction rate (Anggraeni & Yonata, 2020) Based on these facts, students must be trained in their High Order Thinking Skills to make it easier to understand the concepts to be studied.

High Order Thinking Skill (HOTS) is a thinking ability which includes logical, critical, <sup>4</sup>reflective, creative and metacognitive thinking (Irham et al., 2017). Based on the revised Bloom's Taxonomy, higher-order thinking skills are the most abstinent thinking skills in the cognitive domain, they are C4 (analysis), C5 (evaluating) and C6 (creating) levels (Nurkholik & B, 2020). The scientific approach (Scientific) needs to be improved by applying disclosure-based learning or research (discovery / inquiry) (Aulia, E & Ismono, 2015). The main character of the inquiry learning model is to emphasize the

activities of students in order to be able to find concepts that are learned independently by thinking critically and analytically (Verdina et al., 2018). HOTS is an important part of the inquiry process (Wright, J. and Burrows, 2004). HOTS of students can be improved by inquiry learning (Khaleel Younis, 2017).

The implementation of the learning model must be followed by appropriate teaching materials. One of the teaching materials that can be used in the learning process is Students' Worksheet. Students' Worksheet is sheets which contain instructions, assignments <sup>5</sup> and stages given to help students solve problems both in groups and individually. Based on research conducted by Aulia (2015), it is stated that inquiry-oriented Students' Worksheet can train students' HOTS on chemical bonding material with an n-gain score of 0.66 in the sufficient category. Thus, Students' Worksheet and as many as 79.6% of students felt that the use of Students' Worksheet could facilitate the learning process and understanding of the material. However, based on the results of interviews with chemistry teachers, it was found that in the learning process, the method used was still teacher-centered (Teacher Center), as lectures. This causes students to be less active in the learning process, the Students' Worksheet used only contains questions and material and has never used an inquiry-based Students' Worksheet or concept discovery. Students have also never been trained in HOTS.

Based on the background that has been described, it is necessary to develop Inquiry-based Students' Worksheet to Train High Order Thinking Skills (HOTS) in the Material of Reaction Rate. This development aims to describe the feasibility of the Students' Worksheet which includes validity, effectiveness and practicality.

## **1 ▪ METHOD**

The development research design used in the development of this Students' Worksheet is a 4-D development design which consists of 4 stages, as define, design, develop and disseminate which have been adapted to online learning during the pandemic. However, this study was only carried out until the develop stage and with the trial process limited to 12 students (Ibrahim & Wahyusukartiningsih, 2014). The developed Students' Worksheet is tested for its feasibility which includes validity, practicality and effectiveness (Nieveen, dkk , 2010).

Sources of research data used came from the results of the review, validation and data from the results of a limited trial conducted at SMA Negeri 1 Krian with 12 randomly selected students. The research instruments used in this study include review sheets, validation sheets, response questionnaires, knowledge test sheets and HOTS test sheets.

The data from the review by the supervisor in the form of suggestions and input were analyzed descriptively qualitatively and then used to improve the Students' Worksheet. Data validation results obtained from 2 Chemistry lecturers from Unesa and 1 of Chemistry teacher of SMAN 1 Krian were analyzed using quantitative descriptive methods through percentages. The percentage of validation results is obtained from the assessment result score, guided by the Likert scale contained in table 1.

**Table 1. Likert scale**

Score	Criteria
5	Very suitable
4	Suitable
3	Quite suitable
2	Less suitable
1	Not suitable

(Riduwan, 2017)

1

Furthermore, the percentage score that has been obtained is calculated using the formula (Suyono, 2015):

$$\% \text{ Percentage} = \frac{\Sigma \text{ score obtained}}{\Sigma \text{ score criteria}} \times 100\%$$

1 The score criteria in the formula above are obtained from the multiplication of the highest score, the number of aspects and the number of respondents. Furthermore, the percentage of validation results is interpreted using the criteria in Table 2.

**Table 2. Interpretation Criteria**

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

(Riduwan, 2017)

Based on the criteria listed in Table 2, Students' Worksheet is said to meet the validity criteria if it gets a percentage score of  $\geq 61\%$  in the valid category so that it can be used as teaching material in the learning process. 1

The response questionnaire sheet was filled in by 12 students of class XI at SMAN 1 Krian who had used Students' Worksheet in the learning process. The response questionnaire contains questions that can find out what students think about the Students' Worksheet being developed including the criteria for content, language, practicality and effectiveness. The response questionnaire was analyzed based on the scores obtained from positive and negative questions whose measurements were guided by the Guttman scale according to Table 3.

**Table 3. Guttman scale**

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

(Riduwan, 2017)

The score obtained from the calculation is in accordance with the Guttman scale then the percentage is calculated using the formula:

$$\% \text{ Percentage} = \frac{\Sigma \text{ score obtained}}{\Sigma \text{ score criteria}} \times 100\%$$

1

The results of calculations using the Guttman scale that have been calculated for the percentage are then interpreted in Table 4.

**Table 4. Interpretation of Response Scores**

Percentage (%)	Criteria
0 – 20	Not responsive
21 – 40	Less responsive
41 – 60	Quite responsive
61 – 80	Responsive
81 – 100	Very responsive

(Riduwan, 2017)

Based on Table 4, Students' Worksheet can be declared practical if student responses reach a percentage of  $\geq 61\%$ .

The test scores for the learning outcomes obtained by students are calculated using the formula:

$$\text{Knowledge test} = \frac{\sum \text{obtained}}{\sum \text{Maximum}} \times 100$$

Students are considered to have mastered knowledge if the value of the learning outcomes obtained is equal to or more than the Minimum Study Completion (KKM), which is  $\geq 75$ . 5

The HOTS assessment results were **processed in a descriptive quantitative manner** to **the aspects of thinking in the realm of C4 (analyzing) C5 (evaluating) and C6 (creating)**. Each of these aspects is calculated using the formula:

$$(\%) \text{ percentage} = \frac{\sum \text{obtained}}{\sum \text{Maximum}} \times 100 \%$$

The percentages obtained 1 are then interpreted in Table 5.

**Table. 5 Score Interpretation Criteria**

Percentage (%)	Criteria
0 – 30	Very high
31 – 54	High
55 – 74	Normal
89 – 75	Low
90 – 100	Very low

(Ridwan, 2017)

The HOTS test analysis results obtained by each individual were analyzed by calculating the n-gain-score  $\langle g \rangle$ . Here is the formula for calculating the n-gain-score  $\langle g \rangle$ :

$$N - \text{gain score} = \frac{\text{score posttest} - \text{score pretest}}{\text{score maximum} - \text{score pretest}} \times 100 \%$$

The n-gain-score obtained by students is then interpreted in Table 6.

**Table 6. Criteria for n-gain score**

N-Gain	Category
$\geq 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$0,0 \leq g < 0,3$	Low

(Hake, 1991)

Students are said to be trained in HOTS if the n-gain score is  $\geq 0.7$  and gets a learning result value  $\geq 75$  in accordance with the minimum completeness criteria or KKM at the school.

## ▪ RESULT AND DISCUSSION

The research entitled "Development of Inquiry-based Student Worksheet to train High Order Thinking Skill (HOTS) on Reaction Rate Material" aims to develop proper Students' Worksheet. The eligibility criteria for the Student Worksheet are based on the **validity, practicality and effectiveness of the Student Worksheet** (Llewellyn, 2005). The Students' Worksheet that has 1 been developed will then be tested on 12 class XI students to obtain student HOTS data and student responses to the developed Student Worksheet. The following is a description of the results of each stage of development:

**Define Stage (Defining)**

The definition stage aims to analyze and define the criteria in the preparation of Students' Worksheet. At the defining stage, the activities of needs analysis, competency analysis, student analysis, task analysis concept analysis, and indicator specification are carried out (Nieveen, dkk, 2010). The results obtained at this stage are the main purpose of learning. The main purpose of learning to be achieved is that students can identify problems in phenomena, evaluate and design experiments, manage experimental data and apply the concepts obtained to phenomena in everyday life scientifically.

#### Design Stage (Design)

The design stage aims to compile an initial design (Nieveen, dkk, 2010). At this stage, material preparation activities are carried out, choosing the format for drafting Students' Worksheet and designing Students' Worksheet. The results of this stage are 4 Students' Worksheet, each of which contains one factor that affects the reaction rate. The stages in Students' Worksheet follow the inquiry stage according to Arrend (2012).



**Figure 1.** Example of Student Worksheet Cover

**Figure 2.** An example of the inquiry stage at Students' Worksheet

Figures 1 and 2 are snippets of the initial draft produced at the planning stage in accordance with the results of the analysis carried out in the previous stage. Figure 2 is an example of the inquiry stage accompanied by HOTS cognitive domains such as identifying problems in phenomena included in the cognitive evaluating domain (C5).

#### Develop Stage (Development)

The development stage aims to produce Students' Worksheet that has gone through the improvement stage based on suggestions from reviewers and validators. The process carried out at this stage is a review and validation of the tools followed by revisions then a limited trial is carried out using the revised Students' Worksheet. The review process was carried out by 1 of Chemistry lecturer from Unesa. Meanwhile, the validation was carried out by 3 validators including 2 Chemistry lecturers of Unesa and 1 Chemistry teacher at SMAN 1 Krian. The revised Students' Worksheet was then tried out limited to 12 class XI students at SMA Negeri 1 Krian on October 30, 2020.

#### Review

The first step in the development stage is the review of the tools carried out by the supervisor. The result of the review is that the Students' Worksheet that has been compiled has met all the assessment criteria but there are suggestions for improvement, as the sentence structure used must be in accordance with the SPOK pattern.

The use of sentences that are in accordance <sup>4</sup> with the SPOK needs to be paid attention, because with good and correct sentences can make it easier for students to understand the content of the developed Students' Worksheet, and make it easier to understand the concepts presented. In line with Diani's <sup>4</sup> research (Diani et al., 2019) which state that effective sentences in Students' Worksheet can make it easier for students to understand the material

#### **Validity Of Student Worksheet**

The validation was carried out by 2 Unesa Chemistry lecturers and 1 Chemistry teacher at SMA Negeri 1 Krian. The validity <sup>1</sup> of the developed Students' Worksheet was reviewed from the content validity and construct validity. The criteria for construct validity include language, presentation and graphics. Validation activities are needed to improve Students' Worksheet developed based on suggestions given <sup>1</sup> by experts, then used for limited trials (Nieveen, dkk, 2010) The developed Students' Worksheet is said to be valid if the percentage results obtained for each criterion are  $\geq 61\%$  (Riduwan, 2017). The following is the validation result data obtained:

**Table 7. Validation Results**

Criteria	Percentage	Category
Content	86,2 %	Very valid
Language	87,8 %	Very valid
Presentation	88,4 %	Very valid
Graphics	91,3 %	Very valid

<sup>3</sup> Based on Table 7 above, it can be seen that the value of the Students' Worksheet validation results developed on the content criteria  $\geq 61\%$ , as 86.2%. This shows that the developed Students' Worksheet has met the content eligibility criteria according to BSNP, as the compatibility of the material with Competency Standards, Basic Competencies and learning objectives (Badan Standar Nasional Pendidikan, 2016).

The content in the Students' Worksheet must be adjusted to the material, content and development <sup>4</sup> of students so that with the Students' Worksheet that is developed students can achieve the learning objectives and basic competencies set out in the 2013 Curriculum (Widodo, 2017)

The results of validation on the construct criteria generally get a very valid category. The linguistic criteria get a percentage  $\geq 61\%$ , as 87.8% with a very valid category. So it can be said that the developed Students' Worksheet has met the criteria, as using language that is short, communicative and easy to understand. According to Singh (2017) students with an age range of 16-18 years are at the formal <sup>1</sup> operational stage, so the teaching materials used must be arranged in terms that are easy to understand. So that students more easily understand the information or material obtained by students through discovery <sup>13</sup> (Mayasari & B, 2019).

Based on Table 7, it can be concluded that the presentation criteria get a percentage of 88.4% with a very valid category, which indicates that the presentation in Students' Worksheet has met the minimum standard  $\geq 61\%$  (Riduwan, 2017). So it can be said that

the material presented is coherent, paragraphs arranged regularly and the images used are appropriate and there are references. This is in accordance with the statement that the presentation of the material, the regularity of paragraphs, and the concordance of concepts in Students' Worksheet must be presented systematically, clearly and consistently (Irham et al., 2017).

The graphic criteria in Students' Worksheet get the highest percentage at 91.3% with a very valid category that exceeds the minimum standard as 61% (Riduwan, 2017). The graphic criteria assessed include an attractive cover consisting of titles and subtitles, the use of fonts that make it easier for students, layout of text and images and the presence of illustrations and pictures. The percentage of 91.3% indicates that the developed Students' Worksheet has met the graphic criteria.

An attractive and complete cover (containing titles and subtitles), the use of fonts that make it easier for students, is expected to be able to inspire students' enthusiasm to study the Students' Worksheet that has been compiled. It is in line with (2019) which states that an attractive design and the use of clear fonts in the titles and subtitles will make students clearer in understanding the material being studied.

#### Practicality Of Student Worksheet

The Students' Worksheet developed was reviewed for practicality based on the response questionnaires that had been filled in by students. The response questionnaire contains a number of questions related to several criteria, as the criteria for content, language, presentation and graphics of the developed Students' Worksheet. The response questionnaire was filled in by 12 students who had tested the developed Students' Worksheet. The following is the response data from 12 students:

**Table 8. Student Response Questionnaire Results**

Criteria	Percentage	Category
Contente	94,4 %	Very practice
Language	91,6 %	Very practice
Presentation	83,3 %	Very practice
Graphis	91,6 %	Very practice

Based on the table above, it can be seen that each criterion in the developed Students' Worksheet gets a percentage of 83.3% - 94.4% in the very practical category. The percentage obtained shows that the developed Students' Worksheet meets the criteria of practicality. This is because each component in the response questionnaire has reached a percentage of  $\geq 61\%$  (Riduwan, 2017). Based on Table 8, it can also be seen that the presentation criteria received the lowest value, as 83.3%. This is because some students feel that the developed Students' Worksheet has a presentation that is less attractive and less motivating, so it is necessary to revise it. A good presentation is considered important in developing teaching materials, one of which is Students' Worksheet, where a good presentation can increase the motivation of students to be more interested in reading the teaching materials that have been developed (Andrean et al., 2019)

#### Effectiveness Of Student Worksheet

The effectiveness of the developed Students' Worksheet is seen from the extent to which students are able to understand the concepts given through the use of the developed

9 Students' Worksheet. This can be seen from the completeness of the cognitive learning outcomes test and the increase in HOTS of students.

The test of learning outcomes in the domain of knowledge is carried out after the learning using the developed Students' Worksheet takes place. This test is a written test with 10 multiple choice questions that include an understanding of the 4 factors that affect the reaction rate. Students are declared complete if the value obtained is  $\geq 75$  in accordance with the Minimum Score in the school. The results obtained were all students scored above 75 with an average of 85 and classical completeness of 100%. So it can be said that all students have completed the learning process.

The increasing of HOTS was measured using pretest and posttest. Pretest is done before learning and posttest is done after learning. The pretest 15 and posttest were in the form of a written test with 8 descriptive questions covering the cognitive domains of C4 (analyzing), C5 (evaluating), and C6 (creating) according to the HOTS indicator. Pretest aims to measure the initial abilities of students, while the posttest aims to measure the ability of students after learning using Students' Worksheet which was developed with the inquiry learning model. Students are said to be HOTS trained if the n-gain score obtained is  $\geq 0.7$  in the high category. 12

The result obtained was that the average n-gain score of the 12 students was  $\geq 0.7$ , as 0.71 in the high category. So it can be said that HOTS of trained students after learning using Students' Worksheet which was developed with the inquiry learning model. The average percentage obtained from each indicator was 82.5% for the cognitive realm of analyzing (C4), 81% for the cognitive evaluating domain (C5) and 91.3% for the cognitive realm of creating (C6). This shows that the developed Students' Worksheet is effective in increasing the HOTS of students. The results obtained are in line with research conducted Aulia (2015) which states that inquiry-oriented Students' Worksheet can train students' HOTS on chemical bonding material with an n-gain score of 0.66 in the sufficient category.

## ▪ CONCLUSION 4

The conclusion that can be written based on the description of the discussion of the research results above is that the Students' Worksheet developed is suitable for use in the learning process with details of the eligibility criteria as follows:

1. The results of the Students' Worksheet validation developed on the criteria for content, language, practicality and graphic were 86.2%, 87.8%, 88.4% and 91.3% with very valid categories.
2. The results of the questionnaire responses of students to the Students' Worksheet developed were an average of 92.2% with the very practical category.
3. The cognitive realm learning outcomes test got an average score of 85. The HOTS pretest posttest results of students got an n-gain score of 0.71 with the high category, each HOTS component includes analyzing (C4) of 82.5%, evaluating (C5) of 81% and creating (C6) of 91.3% in the high category.

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