



Development of Student Worksheet to Improve Higher-Order Thinking Skills on Reaction Rate Material

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Abstract: Development of Student Worksheet to Improve Higher-Order Thinking Skills on Reaction Rate Material. This study aims to develop and determine the feasibility of student worksheets to improve higher-order thinking skills on reaction material. This research method uses a development research procedure using a 4D model consisting of Define, Design, Development and Displacement stages. The instrument used in this study is a BSNP standard validation sheet that has been modified according to needs. Validation is carried out by material and media experts at Medan State University. The media developed was limited to students of grade XI Science 6 SMA. Based on the results of validation conducted by material expert 1, an average result of 89.76% was obtained and the results of media expert validators obtained an average result of 96.88, both results met the feasible criteria. The response of students in the limited trial obtained an average score of 89.1%. Therefore, as a whole, the Student Worksheets on the reaction rate material developed are suitable for use as learning media.

Keywords: Development, Student Worksheet, Higher Order Thinking, Reaction Rate.

Abstrak: Pengembangan Lembar Kerja Peserta Didik untuk Meningkatkan Keterampilan Berpikir Tingkat Tinggi pada Materi Laju Reaksi. Penelitian ini bertujuan untuk mengembangkan dan mengetahui kelayakan Lembar Kerja Peserta Didik Untuk Meningkatkan Keterampilan Berpikir Tingkat Tinggi Pada Materi Laju Reaksi. Metoda Dalam Penelitian ini menggunakan prosedur penelitian pengembangan menggunakan model 4D yang terdiri dari tahap Define, Design, Development dan Disseminate. Instrumen yang digunakan dalam penelitian ini adalah lembar validasi standar BSNP yang telah dimodif sesuai dengan kebutuhan. Validasi dilakukan oleh ahli materi dan media dosen di Universitas Negeri Medan. Media yang dikembangkan dilakukan penyebaran terbatas kepada siswa kelas XI IPA 6 SMA. Berdasarkan hasil validasi oleh ahli materi didapatkan hasil rata-rata 89,76% dan hasil dari validator ahli media didapatkan hasil rata-rata 96,88 yang kedua hasil memenuhi kriteria layak. Respon peserta didik pada uji coba terbatas diperoleh nilai rata-rata 89,1%. Maka dari itu secara keseluruhan Lembar Kerja Peserta Didik pada materi laju reaksi yang dikembangkan layak digunakan sebagai media pembelajaran..

Kata kunci: Pengembangan, Lembar Kerja Peserta Didik, Berpikir Tingkat Tinggi, Laju Reaksi.

▪ INTRODUCTION

Currently, rapid global development and change in various aspects of life are challenges that must be faced by the nation to prepare future generations. Therefore,

education is very important to create a generation that can keep up with the rapid development of science and technology. Education is a factor that determines the progress or decline of a nation's civilization (Rachmantika, 2019)

The results of the Program for International Student Assessment (PISA) Indonesia in 2018 for the category of Indonesian science ability have an average score of 396, ranked 71st out of 79 PISA participating countries. Indonesia is ranked below Thailand which is ranked 54th and Malaysia is ranked 49th, while Singapore is ranked 2nd. Indonesia's ranking is consistently ranked in the bottom 10 of all countries participating in the assessment. (OECD, 2019).

Chemistry is one of the basic sciences branches of science that specifically studies the existence of matter in terms of structure, properties, changes, and changes in energy that accompany these changes (Brady et al., 2012). Chemistry is a science in which it studies facts, theories, principles and laws, scientific findings and scientific work (Kurniasih et al, 2017).

Based on the results of an interview with one of the chemistry teachers at SMA Negeri 1 Stabat who said that on the topic of reaction rate only 55% of students graduated with a Minimum Passing Criterion of 80. The low percentage of graduation is caused by the learning activities of students obtaining more knowledge delivered by the teacher, making it difficult for some students to develop their abilities and making some students less understanding of the material delivered during the chemistry learning process which is an abstract concept. The chemistry teacher at the school also added that the learning process only uses textbooks and there is no supporting media in it.

In 21st century learning, students are required to be more active, not only active in communicating but also able to collaborate, creative, innovative and able to evaluate and teachers only become facilitators (Simatupang, 2019). In studying chemistry, students are expected to have the ability to think at a higher level or known as HOTS (High Order Thinking Skills). (Srikadarwati, 2013). These abilities are critical thinking, creative and innovative, communication skills, collaboration, and confidence (Ariyana, 2018). Aizikovitsh and Cheng (2015) stated that critical thinking skills are important and must be possessed by individuals who are often faced with decision making that requires reasoning, understanding, analysis and evaluation of the information received, so that critical thinking allows someone to take valid decisions. (As'ari, 2016).

But in reality the critical thinking ability of students is still low. This low critical thinking ability shows that the status of students has not been fully trained in solving problems (Prasetyowati & Suyatno, 2016). Critical thinking skills in chemistry lessons can be trained and improved with the use of student worksheets (LKPD) (hidayati et al, 2022).

With the use of LKPD, students are able to provide their ideas and opinions in criticizing the phenomena given in LKPD (astuti et al, 2017). LKPD is packaged in such a way that students can learn the material independently, so that students become more active to solve existing problems through group discussion activities, practicum, and activities to answer problems related to everyday life. This makes students more challenged in the process of learning activities that are only one-way (Astuti, Danial, & Anwar, 2018). The use of student worksheets in problem-based chemistry learning is effective in improving students' critical thinking and problem solving skills. (Dibyantini & Azaria, 2020)

Based on the information above, researchers are interested in conducting a study on the development of worksheets of learners to improve higher-order thinking skills on

reaction rate material. The objectives of this study are: 1) Knowing the validity of products in the form of Problem Based Learning based student worksheets on the Reaction Rate material to improve students' critical thinking skills; 2) Knowing the response of students to Problem Based Learning-based student worksheets on the Reaction Rate material developed in improving critical thinking skills

▪ **METHOD**

The type of research used in this study is Research and Development (R&D). Research and development method or Research and Development is a research method used to produce certain products, and test the effectiveness of these products (Sugiyono, 2011). The development model in this study refers to the 4D (four-D) research and development model. The 4D research and development model consists of 4 main stages, namely define, design, develop, and disseminate (Thiagarajan, et al., 1974).

This research was carried out at the Department of Chemistry, Chemistry Education Study Program, State University of Medan and will be tested at SMA N 1 Stabat which will be held in November 2022 until it is completed. The subjects of this study are material expert validators and media expert validators by chemistry lecturers and chemistry teachers. The object in this study is the learning media of Problem Based Learning Student Worksheets on the subject of reaction rate.

The data collection techniques that the researchers used in this study were interviews and questionnaires where interviews were conducted to find out the initial data in the study and the information obtained was used as input to develop Student Worksheet media, interviews were conducted with chemistry teachers of SMA Negeri 1 Stabat. Questionnaires are used during evaluation and trial of Student Worksheets. Evaluation of Student Worksheets is carried out by material expert validators and media expert validators.

The research instrument used is a questionnaire or questionnaire in the form of a checklist sheet with Likert scale. The data analysis technique used in this study is a qualitative analysis technique. Qualitative data is obtained from validator input at the validation stage, namely input from media experts and material experts. The data obtained based on BSNP validation questionnaires and assessment sheet questionnaires by students were processed by means of descriptive statistics (Arikunto, 2006). The rating scale used in the BSNP eligibility questionnaire is 1 to 5, where 1 is the lowest score and 5 is the highest score.

▪ **RESULT AND DISCUSSION**

This research produces products in the form of Student Worksheets based on Problem Base Learning on the subject of reaction rate. Development of Student Worksheets in this study using a 4-D model. The 4-D research and development model consists of 4 main stages of define, design, develop, and disseminate. The following is an explanation of the results of media development for each stage.

1) Define Stage

At this stage, the manufacture of a product begins with analyzing the needs for the purposes of product development. The analysis carried out was by conducting interviews with teachers in the field of chemistry studies at SMA Negeri 1 Stabat to find out the media used by teachers in the chemistry learning process, especially in reaction rate

materials. The following are the results of interviews with teachers in the field of chemistry:

- a) Students have not been fully trained in solving problems.
- b) Students do not understand the material delivered during the chemistry learning process which is an abstract concept.
- c) The media used by teachers in the learning process is only textbooks and there is no supporting media.

After conducting a needs analysis in the form of interviews, then a competency analysis was carried out to determine the core competencies and basic competencies related to the reaction rate material by referring to the 2013 curriculum syllabus. After knowing the basic competencies used, an analysis is then carried out to find out the learning objectives achieved.

2) Design Stage

After the analysis, the next step is the design stage. At this stage, the preparation of product design is carried out including adjusting basic competencies and core competencies as well as the syllabus based on the 2013 curriculum. Student worksheets made using the canva application are in accordance with the syntax of the problem based learning method, namely orientation to problems, organizing students in learning, conducting investigations, presenting results and analyzing and evaluating the problem-solving process.

3) Develop Stage

The activities carried out at this stage are the student worksheet media starting to be made based on the design at the design stage after completion then the student worksheet is validated by experts.

a) Writing Draft Student Worksheets

Making student worksheets begins with writing a draft student worksheets where the outline of student worksheets content is developed into a learning medium. The draft is adjusted to the problem-based learning model developed. Initial design by creating a cover page. This student worksheet cover is the frontmost section that displays the title of a student worksheet. Furthermore, by making curriculum content standards used in problem based learning based student worksheets is the 2013 curriculum. The content standards in this module describe the basic competencies, indicators and learning objectives of each reaction rate subject. Another component is the instructions for using student worksheets which contain an overview of how students learn student worksheets as a whole. Furthermore, the preparation of the concept map aims to provide an outline or general overview of the student worksheet material studied so that the material can be presented in order.

Furthermore, making the contents of the problem based learning student worksheet, the material presented in the problem based learning student worksheet is arranged based on four subject matter in the subject matter of reaction rate, namely the concept of reaction rate, collision theory, reaction order and reaction rate equation and factors that affect reaction rate. The content of the material begins with a problem orientation that contains phenomena and natural wealth accompanied by questions that provide curiosity to answer these questions and train students to explore the problem more deeply. The display of the

contents of the student worksheet is adjusted by adding illustrations to some questions and backgrounds that do not interfere with writing the material on the student worksheet. The final draft is a bibliography.

b) Student Worksheet Validation

Problem based learning based student worksheet media that has been developed on reaction rate material according to the 2013 curriculum and syllabus is then validated the feasibility of the material and media using bsnp questionnaires given to expert validators.

Validation of student worksheets by material experts. Expert assessment of material on problem-based learning based student worksheet media is based on three feasibility aspects, namely the feasibility of content, presentation, and language. Based on the results of expert validator research, the material contained in the learning media, the worksheets of students developed can be seen in the following table.

Table 1. Material Validation Results

No	Assessment Aspect	Average Percentage (%)		Average (%)
		Lecturer 1	Lecturer 2	
1	Content Eligibility Aspect	95	93.33	94.17
2	Feasibility Aspects of Presentation	86	82	84.00
3	Language Eligibility Aspects	91.11	91.11	91.11
Average (%)				89.76
Result Criteria				Proper

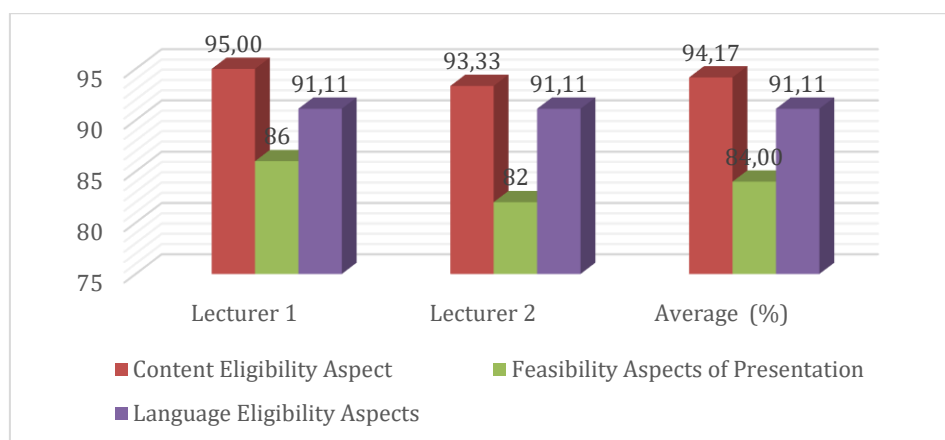


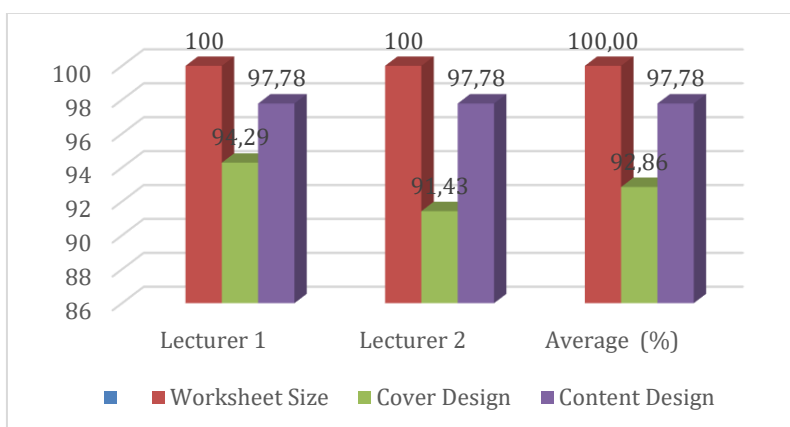
Figure 1. Results of Assessment of Material

From table 1. and figure 1. It can be seen that the results of the assessment conducted by two material expert lecturers on the Student Worksheet on the subject of reaction rate obtained an average score for the content feasibility aspect of 94.17%, the presentation feasibility aspect of 84% and the language feasibility aspect of 91.11% with an average of the three aspects of 89.76%. Based on the eligibility criteria, the results of the validation of this Student Worksheet material are classified as "feasible" as a medium that has been developed in learning reaction rate material.

Validation of student worksheets by media experts. The assessment of media experts is based on aspects of size, cover design and content design. Based on the results of expert validator research on the developed media can be seen in the following graph.

Table 2. Media Validation Results

No	Assessment Aspect	Average Percentage (%)		Average (%)
		Lecturer 1	Lecturer 2	
1	Student Worksheet Size	100	100	100.00
2	Student Worksheet Cover	94.29	91.43	92.86
	Design			
3	Student Worksheet Content	97.78	97.78	97.78
	Design			
Average (%)				96.88
Result Criteria				Proper

**Figure 2.** Results of Media Assessment

From table 2. and figure 2. It can be seen that the results of the assessment conducted by two media expert lecturers on the worksheets of students on the subject of reaction rate obtained average values for aspects of student worksheet size of 100%, aspects of student worksheet cover design of 92.86% and aspects of student worksheet content design of 97.78% with an average of three aspects of 96.88%. Based on the eligibility criteria, the results of the validation of student worksheet media are classified as "feasible" as media that have been developed in learning reaction rate material.

4) Dissemination Stage

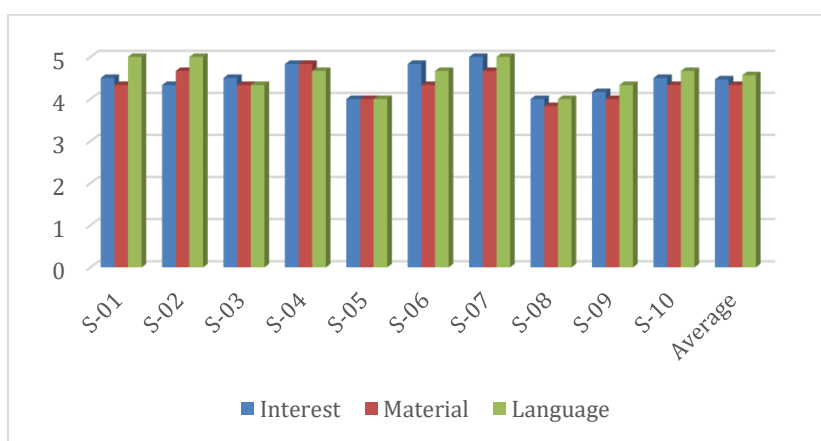
Media dissemination was carried out in class XI Science 6 SMA Negeri 1 Stabat. This stage is carried out to find out how students respond to student worksheet media that has been developed by giving questionnaires to students. The questionnaire provided consisted of 5 assessment scales, namely 5 (strongly agree), 4 (agree), 3 (disagree), 2 (disagree), and 1 (strongly disagree) and were assessed from aspects of interest, material and media language of problem-based learning worksheets on reaction rate material.

a) Student Response

Student responses to the media were obtained by involving 10 students of grade XI Science 6 SMA Negeri 1 Stabat. The class is chosen based on the advice of the teacher. The data collection process is carried out by providing learning media for problem-based learning worksheets on reaction rate material and assessment questionnaire links made through google form, which are then sent to students to be used and provide their respective assessments in accordance with the statements in the questionnaire. Based on the results of student responses to the developed media can be seen in the following table.

Table 3. The results of the assessment of student responses on the subject of reaction rate

No	Assessment Aspect	Average										Sum	Average Percentage (%)
		S-01	S-02	S-03	S-04	S-05	S-06	S-07	S-08	S-09	S-10		
1	Interest	4.5	4.3	4.5	4.8	4	4.8	5	4	4.2	4.5	44.7	89.3
2	Material	4.3	4.7	4.3	4.8	4	4.3	4.7	3.8	4	4.3	43.3	86.7
3	Language	5	5	4.3	4.7	4	4.7	5	4	4.3	4.7	45.7	91.3
Total												133.7	89.1
Result Criteria												Totally Agree	

**Figure 3.** Graph of assessment of student responses to reaction rate material

From the results of the assessment of student responses conducted by 10 students to the worksheets of students on the subject of reaction rate, the average percentage for aspects of interest was 89.3%, material aspects of 86.7% and language aspects of 91.3%, with an average overall percentage of 89.1% with the criteria of "strongly agree", so that overall the media of problem-based learning student worksheets on the reaction rate material did not need to be revised again.

b) Teacher's Response

The chemistry teacher's response was obtained by involving 2 chemistry teachers from SMA Negeri 1 Stabat. Based on the results of teacher responses to the developed media can be seen in the following table.

Table 5. The results of the assessment of teacher responses on the subject of reaction rate

No	Assessment	Average percentage
1	Teacher 1	88.3
2	Teacher 2	93.3
Average Total		90.8
Result Criteria		Proper

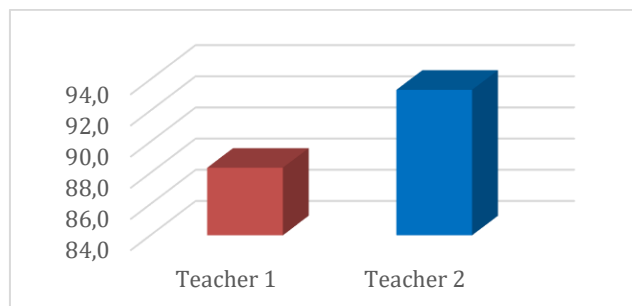


Figure 4. Graph of assessment of teacher response on reaction rate material

From the results of the assessment of teacher responses conducted by two teachers in the field of chemistry to the worksheets of students on the subject of reaction rate, the average percentage given by teacher 1 was 88.3% and the average percentage given by teacher 2 was 93.3% with a total average of 90.8% where the results of the assessment of student worksheets were classified as "feasible".

▪ CONCLUSION

Based on the results of the data analysis that has been carried out, the following conclusions can be drawn:

Student Worksheets (e-LKPD) based on Problem Base Learning to improve higher-order thinking skills on Reaction Rate material that has been prepared meet the eligibility criteria according to BSNP standards. The results of validation carried out by material expert lecturers obtained an average result of 89.76%. And the validation results carried out by media expert validators obtained an average result of 96.88%. The response of students to the Problem Based Learning based Student Worksheet on the reaction rate material developed was "strongly agree" with an average percentage of 89.1%.

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