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THE DEVELOPMENT OF STUDENT WORKSHEETS TO IMPROVE HIGHER ORDER THINKING SKILLS ON THERMOCHEMICAL TOPIC

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ABSTRACT

This study aims to determine the design of Student Worksheets (LKPD) with a Problem-Based Learning (PBL) model that can improve higher-order thinking skills on thermochemical topics for class XI IPA SMAS Kartika I-2 Medan, to find out that the LKPD with PBL on a thermochemical topic that has been prepared has met the achievement of learning objectives and eligibility criteria according to BSNP standards and to find out the responses of teachers and students regarding the LKPD with PBL that has been prepared. This development is carried out using the R&D method with the 4D development model (Define, Design, Develop, Disseminate). The instrument used was a non-test instrument in the form of a modified BSNP questionnaire and with students' and teachers' response questionnaires to the developed LKPD. The results showed that the LKPD compiled had met the eligibility criteria according to the BSNP standards which were validated by material validators and media validators who were UNIMED chemistry lecturers by obtaining an average percentage score from material validators is 80.78% with the criteria "feasible" and the average percentage from media validators is 94.81% with "feasible" criteria. Meanwhile, based on the results of the teacher's response to the designed LKPD, the results obtained an average percentage is 94.17% with the "feasible" criteria and an average percentage of student responses is 86.56% with the "feasible" criteria. So, the student worksheets with problem-based learning models to improve higher-order thinking skills are feasible to use in the learning process, especially on thermochemical topics.

Keywords: *Development, student worksheets, higher-order thinking skills, thermochemical topic, problem-based learning.*

1. INTRODUCTION

The development of science and technology along with the turn of the 21st century has encouraged the education system to focus on producing creative, innovative, and forward-thinking generations of people (Syamsuar & Reflianto, 2019). 21st Century learning should equip students with four competencies (4C), namely critical thinking, communication, collaboration, and creativity which are expected to be able to equip students to face life (Utami & Aznam, 2020).

Higher Order Thinking Skills (HOTS) is an educational reform initiated in the early 2000s to prepare students for the Industrial Revolution 4.0. In this day and age, the average person should have a 21st-century mindset. HOTS is based on a learning theory developed in 1956 by American educational psychologist Benjamin S. Bloom. The thinking process dimension in Bloom's Taxonomy consists of the ability to: know, understand, apply, analyze, evaluate, and create. HOTS questions measure the ability to analyze, evaluate, and create (Fanani, 2018).

Research conducted by Pratiwi (2021) at MAN 2 Model Medan, found that students' abilities were not the same and they were not used to working on HOTS questions at C4-C6 levels. From the results of the implementation test, it was found that students' higher-order thinking skills in thermochemical material were below average, with a logit value of -2.25 to -0.01 or less than 0. From the results of student responses to the HOTS instrument developed, it was found that 78.90% of students could not answer questions on the HOTS instrument.

Educational media are all means or forms of non-personal communication that can be used as a container for lesson information to be conveyed to students and can attract interest and attention so that the goals of learning can be achieved properly (Hosnan, 2014). According to Wena (2009), using learning media has many benefits, including turning abstract and complex ideas into real, simple, structured, and clear ones.

Student Worksheets (LKPD) are one of the learning media that can be done effectively (Prastowo, 2015). The function of the LKPD is for students to know more about the material being taught, because several components have been created in the LKPD which aim to provide motivation or interest in the form of problems related to daily activities. Based on these problems, it is very important to use LKPD so that students can implement knowledge and skills in everyday life. Chemistry is often seen as a difficult subject that students don't even want to study. Many students still have difficulty understanding chemistry concepts (Chandrasegaran et al, 2007). One of the chemical concepts that is difficult for students to understand is the concept of thermochemistry.

Based on the results of interviews with teacher and 2 students at SMAS Kartika I-2 Medan, teacher still use old model. Teacher has not used learning models and learning media such as LKPD. Thus, students feel they don't understand and remember the subject matter that has been taught, especially on thermochemistry material.

Facing these conditions, it is necessary to make the learning process improve higher-order thinking skills in chemistry learning. One way is to use learning media based on higher-order thinking skills (HOTS) and problem-based learning (Problem-Based Learning). Problem-based learning (PBL) is a learning method that helps

students find problems through real-life activities, and gather information from their initiative to make decisions in solving problems.

Based on the description above, the researcher is interested in conducting research with the title "The Development of Student Worksheets to Improve Higher Order Thinking Skills in Thermochemical Topic". The LKPD that will be developed is expected to be able to help students to have 4C skills, and understand the material well

2. LITERATURE REVIEW

2.1 Learning Media

Media is a tool or facility that functions as a communicator or channel of information from the sender to the recipient. In the context of education, the media is often described as a teaching aid. This theory explains that all types of devices, both electronic and non-electronic, that can convey educational information are called media (Asyhar, 2012).

Based on the various definitions, educational media can be understood as anything that can channel information from all sources in a structured and efficient manner, to create an environment that provides opportunities where recipients can carry out educational programs effectively and efficiently (Susanto & Akmal, 2019). Based on the type of learning process is divided into three types. The first is the audio system, which is a system that only relies on sound power, such as a tape recorder. Second, visual media, namely media that only rely on visual perception. Then, audiovisual media, namely media that includes sound elements and visual elements (Fitria, 2014).

2.2 Student Worksheets (LKPD)

LKPD is a collection of sheets containing material, activities to be carried out in the learning program, and steps to be carried out in learning. The assignments given in LKPD must be clear and relevant to the subject matter so that basic skills and learning objectives can be achieved effectively and as expected (Kurniawan, 2015).

LKPD has many functions. According to Prastiwo (2012), LKPD has 4 functions as follows: (1) As a learning tool that reduces teacher work, but makes students work a lot. (2) As a learning tool that facilitates understanding of the material provided. (3) As a concise learning media and there are lots of practice questions. (4) Facilitate the implementation of the learning process.

LKPD as teaching material has elements that include (1) titles, (2) subjects, (3) semesters, (4) places, (5) study instructions, (6) competencies that to be achieved, (7) indicators to be achieved by students, (8) supporting information, (9) tools and materials to complete assignments, (10) work steps, and (11) assessment.

Salirawati (2004) mentions three conditions for an LKPD to be considered feasible, namely didactic requirements, construction requirements, and technical requirements. The didactic requirements are related to the fulfilment of the principles of effective learning in an LKPD. Terms of construction related to language. Technical requirements related to writing based on predetermined rules.

2.3 Problem-Based Learning Model

According to Octavia (2020), a learning model is a conceptual framework that describes a process (organized) of organizing learning activities (experience) to achieve learning objectives (learning ability). In other words, the learning process is the organization of learning activities so that the implementation of learning can take place in a fair, interesting, easy-to-understand, and systematic manner.

Problem-based learning (PBL) is a teaching method characterized by using real-world problems as a context for students to learn critical thinking and problem-solving skills as well as to acquire knowledge (Duch, 1995).

According to Sofyan, et al (2017), there are five main steps in implementing problem-based learning. These steps can be described as follows.

Table 1. Steps of the Problem-Based Learning Model

Steps	Teacher Behaviour
Step 1. Orient students to the problem	• Explain learning objectives • Explain the logistics (materials) needed • Motivating students to be actively involved in solving selected problems
Step 2. Organizing students to learn	Help students define and organize learning tasks related to these problems
Step 3. Guiding individual and group investigations	Encourage students to collect appropriate information, carry out experiments to get explanations, and solve problems
Step 4. Develop and present the work	Assist students in planning and preparing appropriate works such as model reports and sharing assignments with friends
Step 5. Analyze and evaluate the problem-solving process	Evaluate the learning outcomes of the topic that has been studied/ask the group to present the results of the work

2.4 HOTS in 21st-century learning

Bloom's taxonomy revised by Anderson and Krathwohl, three aspects in the cognitive domain are part of higher-order thinking skills. The three aspects are the analysis aspect, evaluation aspect, and creating aspect. Three other aspects in the same realm, namely remembering aspects, understanding aspects, and application aspects (applying) are included in the lower-order thinking section (Suyono & Hariyanto, 2014).

Higher-order thinking skills are thinking activities that do not just memorize and convey information that is already known, but higher-order thinking skills are also the ability to construct, understand, and transform the knowledge and experience that one already has to be used in making decisions and solving a problem in a given situation. new and it can't be separated from everyday life.

3. METHODS

3.1 Research Design

This research is based on the Research & Development (R&D) method. This study focuses on design, opportunities, and teacher and student responses to the development of Student Worksheets (LKPD) that can encourage higher order thinking skills in thermochemical.

The development model used is the 4D model (Define, Design, Develop, Disseminate). However, this research will only be carried out until the development stage due to the limitations of the researcher.

3.2 Data Collection Technique

The data collection process is the most important step in research because the main purpose of research is to obtain data. Without knowledge of the data collection process, researchers will not obtain data in accordance with established data standards. In this study, data collection techniques were carried out as follows:

1. Literature Study

Literature analysis was carried out through an analysis of thermochemical material which included KI, KD, concept analysis, and syllabus as well as theoretical analysis of worksheets that had been developed previously. The results of the study will become a reference in the development of PBL-based worksheets to improve higher-order thinking skills in the thermochemical topic.

2. Questionnaire

A questionnaire is a data collection process that is carried out by providing a series of questions or written statements to respondents to answer. In this study, the questionnaire used was a closed question using a Likert scale, and responded by giving suggestions in the given column. Questionnaires are used during validation and in small tests of LKPD which can improve higher-order thinking skills in thermochemical material. LKPD validation that can improve higher-order thinking skills is carried out by material expert validators to determine the feasibility aspects of the content, presentation, and language of the LKPD being developed. Meanwhile, to find out the aspects of graphic feasibility, it will be validated by a media expert validator. In a limited trial, data collection was carried out by giving LKPD to teachers and students. Then ask the teacher to fill out a validation instrument to determine the feasibility of the content, presentation, language, and graphics, while students fill out a questionnaire or interest questionnaire, material, and language for the LKPD being developed.

3.3 Research Procedure

The research procedures using the 4-D model are:

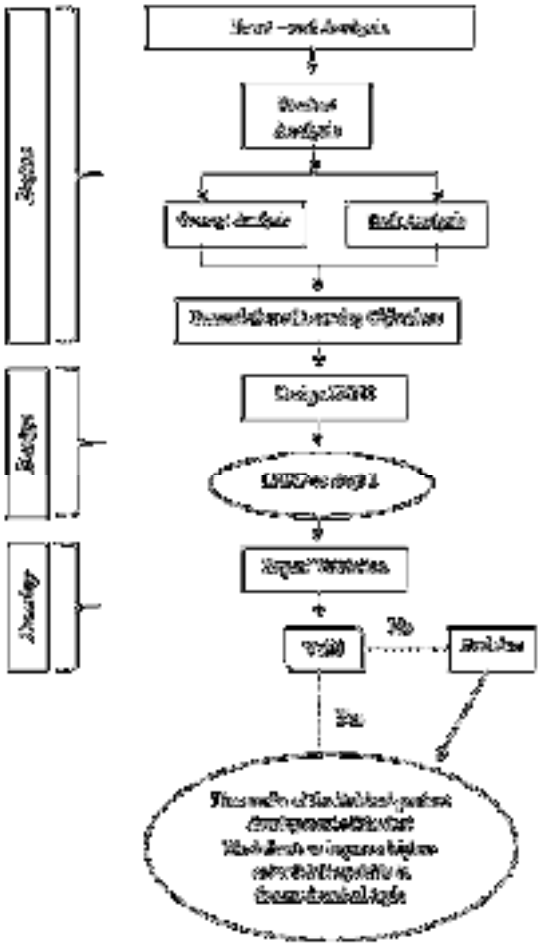


Figure 1. Research Procedure of Student Worksheets

This research was adapted into 3 stages, namely define, design, and development stages. On define stage, consist of front-end analysis, student analysis, concept analysis, task analysis, and then formulation of learning objectives. All the analysis used 2013 curriculum, interview a teacher and two students at SMAS Kartika I-2 Medan.

On design stage, consist of design student worksheets with thermochemical topic. Researcher use Microsoft Word to design the student worksheets. The design namely as draft 1.

Next to develop stage, draft 1 from student worksheets needs to be validated. It needs media validation and material validation from each 2 lecturers in Universitas Negeri Medan. Based on the validation results, there is a possibility that the product design still needs to be improved according to the validator's suggestions. After the product has been validated, and improved, the next step is to test the response to the two teachers and two students.

3.4 Data Analysis

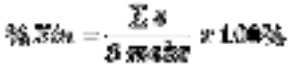
1. Data Analysis Techniques of Expert Validation

No	Answer Choices	Score
1	Very Agree	5
2	Agree	4
3	Less Agree	3
4	Disagree	2
5	Very Disagree	1

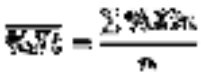
The results of expert validation data are analyzed by coding and classifying data, aims to group answers based on validation instrument questions. Perform data tabulation based on the classification made, aiming to provide an overview of the frequency and trend of answers to each question item on the validation instrument. Giving a score to the respondent's answer. The scoring of respondents' answers in the questionnaire was carried out based on the Likert scale in Table 2.

Table 2. The scoring in the questionnaire is based on a Likert scale

Next, calculating the percentage of answers to the questionnaire for each statement using the calculation formula in Sudjana (2005), is as follows:



Calculating the average percentage of answers for each questionnaire to determine the suitability of the content, construction, readability, and attractiveness of worksheets that can improve higher-order thinking skills as follows:



Then, interpret the percentage of the questionnaire using Arikunto's interpretation (2008) based on Table 3.

Table 3. Interpretation of Percentage Questionnaire

Percentage	Criteria
80.1% - 100%	Very good
60.1% - 80%	Good
40.1% - 60%	Enough
20.1% - 40%	Less
0.0% - 20%	Very Less

Interpret the validation criteria for the analysis of the percentage of products resulting from expert validation using the interpretation of Arikunto (2008) based on Table 4.

Table 4. Percentage Analysis Criteria

Percentage(%)	Validation Level	Information
100 – 76	Valid	Feasible / no revision needed
75 – 51	Pretty valid	Feasible enough / partial revision
60 – 26	Less valid	Less feasible / partial revision
<26	Invalid	Not feasible / all revision

2. Data Analysis Techniques of Teacher's Response

The results of the teacher's response data are analyzed by coding and classifying data, aims to group answers based on validation instrument questions. Perform data tabulation based on the classification made, aiming to provide an overview of the frequency and trend of answers to each question item on the validation instrument. Giving a score to the respondent's answer. The scoring of respondents' answers in the questionnaire was carried out based on the Likert scale in Table 5.

Table 5. The scoring in the questionnaire is based on a Likert scale

No	Answer Choices	Score
1	Very Agree	4
2	Agree	3
3	Less Agree	2
5	Disagree	1

Calculating the percentage of answers to the questionnaire for each statement using the calculation formula. Then, calculating the average percentage of answers for each questionnaire to determine the suitability of the content, construction, readability, and attractiveness of worksheets that can improve higher-order thinking skills. After that, interpret the percentage of the questionnaire using Arikunto's interpretation (2008) based on Table 4.

For data analysis techniques of student's response, it same like as data analysis techniques of expert validation.

4. RESULTS & DISCUSSION

4.1 Results

In this research, many steps must be taken to obtain research results from the process of developing student worksheets to improve high-level thinking skills in thermochemical material, namely by validating materials and media based on the BSNP feasibility instrument, as well as responses from teachers and students for the LKPD that has been produced. The results of research that has been done by researchers will be explained as follows.

4.1.1 Eligibility according to BSNP

Student Worksheets (LKPD) based on Problem-Based Learning (PBL) to improve higher-order thinking skills in thermochemical material are carried out by providing material and media validation instrument sheets to each of the 2 chemistry lecturers who act as material and media validators. In the material and media instruments, a Likert scale is used in the range of 1 – 5. To get results from eligibility according to the BSNP, the total score of the answers can be used to obtain the average of each aspect. In this

media and material feasibility test, the score of the answers from 2 lecturers in each aspect was averaged, then the average of the three aspects was added up and divided by the number of aspects so that the criteria for the results of the media and material were obtained. Below is the validation result of a PBL-based worksheet to improve higher-order thinking on the thermochemical topic.

A. Material Validators

Material validation instruments were given to material validators consisting of 2 UNIMED chemistry lecturers. Below are the results of the percentage assessment of material validation by the BSNP standards obtained from 2 material expert validators.

Table 6. Material Expert Percentage Results

No	Evaluator	Average Percentage (%)
1	Teacher 1	91.67
2	Teacher 2	96.67
Percentage (%) Overall		94.17
Results Criteria		Feasible

Based on the table of results of the percentage of material expert validators from making student worksheets on thermochemical material, the overall average (%) is 80.78%. The average value was obtained based on the assessment of 2 UNIMED chemistry lecturers so that it was stated that the PBL-based LKPD was feasible to use.

B. Media Validators

The media validation instrument given to the media validator consisted of 2 UNIMED chemistry lecturers. The results of the percentage assessment of media validation analysis in the form of Student Worksheets (LKPD) by 2 chemistry lecturers according to the BSNP standards can be seen below.

Table 7. Media Expert Validator Percentage Rating Results

No	Assessment Aspects	Average Percentage (%)		Average (%)
		Lecturer 1	Lecturer 2	
1	LKPD Size	100	100	100.00
2	LKPD Cover Design	94.29	85.71	90.00
3	LKPD Content Design	95.56	93.33	94.44
Average (%) Overall				94.81
Percentage Analysis Validation Result Criteria				Feasible

From the results of the assessment carried out by two media expert lecturers on the thermochemical topic LKPD based on the BSNP, the overall average value (%) was 94.81%. Thus, the PBL-based Student Worksheet (LKPD) to improve higher-order thinking skills in the thermochemical topics that has been developed is feasible for learning thermochemical topic.

4.1.2 Teacher's and Student's Response

Teacher response questionnaires were given to 1 chemistry teacher at SMAS Kartika I-2 Medan, and a chemistry teacher at SMAN 1 Stabat. In the teacher's response questionnaire, there are 15 statements using a Likert scale with a rating range of 1 – 4. From the table below it can be seen the results obtained from the teacher's responses.

Table 8. Results Percentage of Teacher Response Assessment

No	Assessment Aspects	Average Percentage (%)		Average (%)
		Teacher 1	Teacher 2	
1	Content Eligibility Aspects	93.33	70.00	81.67
2	Presentation Feasibility Aspects	80.00	68.00	74.00
3	Aspects of Language Feasibility	91.11	82.22	86.67
Average (%) Overall				80.78
Percentage Analysis Validation Result Criteria				Feasible

From the results of the teacher's response assessment conducted by two teachers, the overall average value (%) was 94.17%. Thus, the Student Worksheet (LKPD) that has been developed is feasible for learning thermochemical topics.

Questionnaire student responses were given to 10 students of class XI at SMAS Kartika I-2 Medan. In the student response questionnaire, there are several component aspects, namely aspects of attractiveness, material aspects, and language aspects using a Likert scale with a rating range of 1 - 5. From the table below it can be seen the results obtained from student responses.

Table 9. Results Percentage of Student Response Assessment

No.	Assessment Aspects	Appraisal Percentage
1	Interest Aspect	86.67
2	Material Aspect	83.67
3	Language Aspect	89.33
Average (%) Overall		86.56
Interpretation of Percentage Questionnaire		Feasible

From the results of the assessment of student responses conducted by 10 students to the thermochemical subject worksheets, the overall average value (%) was 86.56%, the results of this worksheet assessment were classified as very high. Thus, the

Student Worksheet (LKPD) that has been developed is feasible for learning thermochemical topics.

4.2 Discussion

This study aims to determine the feasibility of PBL-based Student Worksheets (LKPD) that have been developed by BSNP standards and also to determine teacher and student responses to Student Worksheets (LKPD) to improve higher-order thinking skills in the thermochemical topics.

LKPD validation was carried out by expert validators, namely 2 chemistry lecturers for media validators, 2 chemistry lecturers for material validators, responses from 2 chemistry teachers, and responses from 10 students. The LKPD assessment is carried out through each expert validator and the respondent is given a validation assessment questionnaire or response to the LKPD which will be filled in by giving a score using a Likert scale of 1 - 5 in each aspect, as well as criticism and/or suggestions for improving the finished LKPD (draft 1).

4.2.1. Material Validation

This study uses instruments according to the BSNP where in material validation there are 3 assessment aspects, namely (a) content feasibility aspects, (b) presentation feasibility aspects, and (c) language feasibility aspects. The following is detailing the material expert validator's assessment of the LKPD developed in each aspect. (a) For content feasibility aspects it can be seen that the results of the validation analysis by material experts, for lecturer 1 the score obtained was 56 out of a maximum score of 60 with a percentage of 93.33%. for lecturer 2 the score obtained is 42 out of a maximum score of 60 with a percentage of 70%. (b) on presentation feasibility aspects it can be seen that the results of the validation analysis by material experts, for lecturer 1 the score obtained was 40 out of a maximum score of 50 with a percentage of 80%. At lecturer 2 the score obtained was 34 out of a maximum score of 50 with a percentage of 68%. (c) on the aspect of language feasibility, it can be seen that the results of the validation analysis by material experts, for lecturer 1 the score obtained was 41 out of a maximum score of 45 with a percentage of 91.11%. At lecturer 2 the score obtained was 37 out of a maximum score of 45 with a percentage of 82.22%.

4.2.2. Media Validation

This assessment uses an instrument according to the BSNP where in the media validation there are 3 aspects of the assessment, namely (a) LKPD size, (b) LKPD cover design, and (c) LKPD content design. Here are the details of the media expert validator's assessment of the developed LKPD. (a) In the aspect of LKPD size, it can be seen that the score obtained from lecturer 1 is 10 out of a maximum score of 10 with a percentage of 100%. At lecturer 2 the score obtained is 10 out of a maximum score of 10 with a percentage of 100%. Aspects of LKPD size consist of 2 contents, namely (1) suitability of LKPD size with ISO standards, and (2) suitability of size with LKPD content material. (b) On the design aspect of the LKPD cover it can be seen that the score obtained from lecturer 1 is 33 out of a maximum score of 35 with a percentage of 94.29%. At lecturer 2 the score obtained was 30 out of a maximum score of 35 with a percentage of 85.71%. (c) On LKPD content design it can be seen that the score obtained from lecturer 1 is 86 out of a maximum score of 90 with a percentage of 95.56%. At lecturer 2 the score obtained was 84 out of a maximum score of 90 with a percentage of 93.33%.

After the revision was carried out based on the material and media expert validators, then a limited trial was carried out on the developed LKPD. Trials are included in a series of evaluations under development. At this stage, it was tested on a limited group. This test was carried out on 2 high school chemistry teachers, and 10 students of class XII IPA.

The test to find out the teacher's responses was carried out on 2 high school chemistry teachers from SMAS Kartika I-2 Medan, and SMAN 1 Stabat. There are 15 statements in the questionnaire. The teacher is asked to give an assessment using a Likert scale with a range of 1 – 4. The score obtained from teacher 1 is 55 with a maximum score of 60. At score 2, a score of 58 is obtained with a maximum score of 60. Based on Table 3 it is known that the results of limited trials, the LKPD that has been developed reaches an average percentage of 94.17% with an interpretation of the percentage questionnaire is very high. This shows that student worksheets to improve higher-order thinking skills in thermochemical material can help streamline the chemistry learning process, especially in thermochemical topics.

The researcher also conducted a small group test with 10 senior high school students in class XI IPA. The researcher conducted a small group trial via a Google form containing 15 statements and students was asked to provide an assessment by filling out the questionnaire using a Likert scale with a value range of 1-5.

Based on Table 3 it is known that the results of the trial are limited, the LKPD that has been developed reaches an average percentage of 86.56% with the interpretation that the percentage of the questionnaire is very high. This shows that LKPD to improve higher-order thinking skills in thermochemical material helps students understand the thermochemical topic, and are interested in the design of the LKPD.

This is also consistent with research conducted by Hermawan (2009) in educational supervision teaching materials which states that validity is a measure that indicates the levels of validity or validity of an instrument. A valid instrument has high validity. Conversely, a less valid instrument means that it has low validity.

5. CONCLUSION

Based on the results of data analysis in this research, it can be concluded that the development of Student Worksheets based on Problem-Based Learning using the R&D research method and the 4D development model which is only until the development step. In this LKPD there are 7 activities with PBL syntax, video media that can be accessed through the links, pictures, and animations, and there are HOTS questions to improve students' higher-order thinking skills. Student Worksheets (LKPD) to improve higher-order thinking skills in thermochemical topics meet eligibility criteria according to BSNP standards. Based on the aspects of content feasibility, presentation feasibility, and language feasibility, an average percentage of 80.78% was achieved in the valid/feasible criteria, and based on the aspects of LKPD size, LKPD cover design, and LKPD content design, an average score of 94.81% was obtained with the criteria valid/feasible. Student responses to Student Worksheets (LKPD) to improve higher-order thinking skills in thermochemical topic got scored very high with an average of 86.56%, and teacher responses also scored very high on LKPD with an average of 94.17%.

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