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Development of Problem-Based Integrated Student Worksheets (LKPD) in Thermochemistry Class XI High School

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ABSTRACT

This study aims to develop a Problem-Based Learning (PBL) student worksheet (LKPD) integrated with scientific literacy on the topic of thermochemistry for Grade XI senior high school students, and to evaluate its feasibility and student responses. The research employed a Research and Development (R&D) method using the 4D development model (Define, Design, Develop, Disseminate), limited to the development stage. The development process began with needs analysis, material and layout design, product development, and expert validation. The instruments used included a BSNP-based feasibility assessment sheet and a student response questionnaire. Validation results from three lecturers and two chemistry teachers indicated that the developed LKPD is valid and highly feasible, with an average feasibility score of 3.62. Meanwhile, product testing conducted on Grade XI MIPA students showed very positive responses with an average score of 3.65. These findings indicate that the PBL-based LKPD integrated with scientific literacy is effective in improving students' understanding of thermochemistry concepts, motivating them, and enhancing critical thinking skills and scientific literacy in chemistry learning. This LKPD also has the potential to serve as an innovative teaching material aligned with the Merdeka Curriculum.

Keywords: LKPD; problem-based learning; scientific literacy; thermochemistry; teaching material development

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INTRODUCTION

Education is one of the most important factors in determining the quality of human resources and the progress of a nation. The educational process is able to give birth to creative and innovative ideas in the dynamics of the development of the times. Curriculum development is one of the instruments to improve the quality of education. The curriculum is the "spirit" of education that must be evaluated innovatively, dynamically, and periodically in accordance with the development of the times and science and technology, the competencies needed by the community and graduate users. (Azwardinsyah et al., 2023; Rohmat Hidayat & Alifah, 2022) (April, 2020; Ilias et al., 2023) (Nurdin & Marzuki Marzuki, 2023)

The Ministry of Education, Culture, Research, and Technology (Kemendikburistek) issued a policy in the development of the Independent Curriculum which is given to educational units as an additional option in order to restore learning during 2022-2024 and improve the quality of Curriculum education. According to the independent curriculum focuses on student competencies in each phase, students can learn more in-depth, meaningful, and fun material. The main characteristics of this curriculum that

support learning recovery are (1) Project-based learning for the development of soft skills and character according to the Pancasila student profile (2) Focus on essential materials so that there is enough time for in-depth learning for basic competencies such as literacy and numeracy. (Bahri, 2018; Ledia & Bustam, 2023; Rosadi et al., 2023) Ministry of Education and Culture (2020) (Hartoyo & Rahmadayanti, 2022; Rahmadayanti & Hartoyo, 2022)

The education sector is striving to develop 21st century life skills, especially in the field of science and technology. Along with the advancement of science and technology in developed countries, efforts have been made in the world of education to ensure that every student has science literacy skills. The need for science literacy for students has prompted developed countries to prioritize the development of science literacy early in the educational curriculum. This confirms how essential science literacy skills are for students. The importance of science literacy for students lies in their ability to understand environmental, technological, economic, health, and social aspects in the modern era. Science literacy in Indonesia is still at a low level, as can be seen from the achievements of students in the field of science literacy in the Program for International Student Assessment (PISA). It is important to build science literacy in the current generation, not with the aim of making them researchers, but rather on developing knowledge and skills in science and technology so that they are able to make smart choices and have a positive impact on their lives now and in the future. (Situmorang, 2016) (Pratiwi, 2021) (Tandjungbulu et al., 2023) (Cynthia & Sihotang, 2023)

Education in the field of Natural Sciences (IPA) or science has a very important role in shaping and developing students to have the ability to think critically, logically, creatively, innovatively, and competitively at the global level. Therefore, understanding and mastering science literacy becomes fundamental for every learner, as it not only prepares them for personal success, but also contributes to the development of society and the advancement of science as a whole. Science learning itself is an integration of biology, physics and chemistry. (Indrawati & Wardono, 2019)

Chemistry is one of the branches of basic science in the field of science that focuses on understanding matter in terms of structure, its properties, changes that occur, and the changes in energy that accompany the change process. In the chemistry curriculum at the high school level, the content of the material tends to be conceptual and theoretical, focusing on the explanation of scientific concepts of chemistry, rather than the application of chemistry in daily life. This causes students to rarely get enough understanding of the benefits of chemistry in the context of daily life. Chemistry in the scope of high school education is often only considered as a provision to meet the academic requirements and prepare students to continue their education to the college level. However, there are chemical materials that are considered difficult and abstract by some students, one of which is thermochemistry. Thermochemistry material deals with the energy involved in chemical reactions, which is often difficult for students to imagine concretely. (HERIANIS, 2019) (Hanifah et al., 2023)

Thermochemistry is one of the materials included in the study of chemistry that

studies the changes in heat and heat that accompany a chemical and physical reaction or process. To learn this material, students are required to understand concepts, principles and theories. Learning thermochemistry has concrete benefits for life. In thermochemistry material, students learn about the energy released or absorbed during a chemical reaction, the units of energy used, and the changes in energy in a reaction. The goal of learning thermochemistry is for students to understand thermochemical equations and have the ability to calculate the heat of the reaction that occurs. A deep understanding of thermochemical materials and other chemical concepts is important to help students overcome difficulties in the learning process. With a good understanding, students will be better able to relate abstract concepts in chemistry to the real world and recognize their application in everyday life. (Yulianti et al., 2018) (Chityadewi, 2019)

Problem Based Learning (PBL) is a learning model that uses real-world problems as a context for students to learn about problem-solving skills, as well as to acquire essential knowledge and concepts from the subject matter, in addition to this problem based learning model is also considered as one of the learning models that can support the achievement of competencies that must be possessed in the 21st century. The application of the PBL learning model in the teaching and learning process is able to motivate students in the problem-solving process. In this learning, the teacher plays the role of facilitator and supports the learning of the side. So that students are skilled in learning problems and proposing solutions to problems by utilizing the knowledge they have. In the research conducted by stating that problem-based learning teaching materials are considered to be able to improve student learning outcomes, this is obtained from the results of the n-gain test or the percentage increase in student learning outcomes that use PBL-based teaching materials reaches 63% or the medium category and also gets a positive response from students. In addition, his research stated that the use of the problem based learning (PBL) model has been proven to be influential in developing students' creative thinking skills in science learning. The effectiveness of the problem-based learning model is very suitable to be applied in science-based learning. This is seen from the results of the calculation of effect size (ES) of 0.68 with high criteria. So it is concluded that the problem-based learning model has a positive effect on students' 21st century skills in science learning. also argues that the learning model that is assessed can improve science literacy skills, namely the problem based learning (PBL) model. This is concluded from the results of the study using the PBL model with a score of 0.56 with the medium category. Therefore, the PBL model is considered to be able to improve science literacy skills because there are several processes that can support the achievement of science literacy ability indicators. (Asri & Ratnaya, 2024) (Hotimah, 2020) Purba et al. (2022) Suryaningsih & Koeswanti (2021) Giriyanti, P; Pramadi, A; Listayawati (2019)

In Law Number 12 of 2012 Chapter I Article 1, it is stated that education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential so that students are expected to be more active than teachers who act as facilitators. Teachers as facilitators must be able to choose the

right teaching materials for students to use. Teaching materials that are considered appropriate in minimizing the role of teachers and can be adjusted to the competencies to be achieved are the Student Worksheets. In addition, from the initial observation that had been carried out at SMAN 1 Bangun Purba, it was found that the teaching materials used by chemistry teachers at the research school were only package books provided by the school. In teaching and learning activities, teachers assign students to study and work on questions from package books instead of from students' worksheets. The Student Activity Sheet (LKPD) is a form of learning guide used in learning that functions as a student learning guide to make it easier for students and teachers to carry out teaching and learning activities. The use of LKPD in learning can provide a full opportunity for students to express their abilities and skills in developing their thinking process through searching, guessing, and even reasoning. (Fatmawati et al., 2017; Wati et al., 2018)

The development of LKPD is intended to help and facilitate teaching and learning activities so that effective interaction will be formed between students, so as to increase student activities in improving learning achievement. LKPD is considered one of the learning media that encourages student learning activities. The LKPD serves as a comprehensive instructional guide to enhance cognitive development and facilitate holistic learning through the use of experiments and demonstrations. This statement is supported by research that states that LKPD based on Problem Based Learning can improve cognitive abilities through learning outcomes with an n-gain of 0.59 including the medium category and can increase interpersonal intelligence in discussion and practicum activities with a percentage of 84.93% including good criteria. In addition, in the study, it was found that students' problem-solving skills also increased judging from the results of the pretest by 57% and posttest by 96%, so it was concluded that this problem-based learning-based LKPD is effective in improving students' problem-solving skills. (Sylvia et al., 2019) Hidayah et al. (2020)

The purpose of this study is to determine the feasibility of LKPD based on Integrated Science Literacy Problems in Thermochemistry material and to find out the response given by grade XI students to the LKPD. The benefits of this research are expected to contribute both theoretically and practically. Theoretically, the output of this research is expected to be a foundation and reference for development research, especially the development of LKPD Integrated Problems Based on Science Literacy on thermochemical materials. Practically, the benefits of this research include for students, where the results of the development of LKPD can facilitate students in the learning process which can help increase students' knowledge, reading interest, and achievement in chemistry learning. For teachers, the results of the development of LKPD can be used as an independent learning resource for students and are expected to be an alternative for teachers in improving the quality of learning outcomes. For schools, the results of the development of this LKPD can be used as LKPD innovations that create active, creative, and innovative learning. Finally, for future researchers, the results of the development of this LKPD are expected to be a reference in developing relevant LKPDs.

METHOD

This research was carried out at SMA Negeri 1 Bangun Purba which is located on Jalan Perintis Kemerdekaan, Kec.Bangun Purba, Bangun Purba Village, Deli Serdang Regency. The research time was carried out in the odd semester of the 2023/2024 school year.

This type of research is research and development. Research and Development is a research method used to produce certain products and test the effectiveness of those products. To be able to produce certain products, research is used that is a needs analysis and tests the effectiveness of the product so that it can function in the wider community, research is needed to test the effectiveness of the product. This study uses a 4-D development model which is a model for the development of learning tools developed by *S.Thiagarajan, Dorothy S. Semmel, and Melvyn I.Semmel*. The 4-D development model consists of 4 main stages, namely: (1). *Definite*; (2). *Design*; (3). *Develop*; and (4). *Disseminate*.

Data in this study, data were obtained using the BSNP instrument to determine the feasibility of the developed Science Literacy Integrated Problem-Based LKPD and a questionnaire to determine students' responses to the developed Science Literacy Integrated Problem-Based LKPD. The BSNP instrument was given to lecturers as expert validators and chemistry teachers while the response questionnaire was given to students in grade XI MIPA SMAN 1 Bangun Purba who had been selected by *purposive sampling*.

The data in this study was obtained from the LKPD feasibility instrument based on the BSNP criteria and the questionnaire of students' responses to the LKPD developed. The data obtained from the questionnaire was then processed by means of descriptive statistics. Descriptive statistics are statistics that are used to analyze data by describing or describing the data that has been collected as it is without intending to make generalized conclusions or generalizations. (Scott, 2016)

The steps taken in processing the questionnaire data are to calculate the average score of each aspect assessed by calculating the number of answer scores of all assessors divided by the number of assessors. Then the average score of the assessment is changed to a qualitative value based on the validity criteria table. The assessment scale used in the modified National Education Standards Agency (BSNP) eligibility questionnaire is 1 to 4, where 1 is the lowest score and 4 is the highest score. The formula used to calculate the data from filling out the questionnaire is with the following average calculation:

$$\overline{X} = \frac{\Sigma X}{n}$$

Information:

$\overline{X}$ = average value

$\sum\chi$ = number of validator/test subject assessment answers

n = number of validators/test subjects

The validity criteria for the average analysis used can be seen in the following table

Table 1. Validity Criteria

Average	Validity criteria
3,26 – 4,00	Valid and not required to be revised (very feasible)
2,51 – 3,25	Valid enough and does not need to be revised (eligible)
1,76 – 2,50	Invalid and Some content needs to be revised (less feasible)
1,00 – 1,75	Invalid and in need of a complete revision (not feasible)

The student response instrument was used to determine student responses regarding LKPD based on integrated problems of science literacy in thermochemical materials. Each aspect of the student response questionnaire was analyzed to find out the average of each aspect. The assessment criteria for each aspect for students are listed in the following table, while the analysis formula for each aspect uses the formula:

$$\text{Average score} = \frac{\sum \textbf{\textit{skor x jumlah responden}}}{\textbf{\textit{skor maksimum}}}$$

The results of the calculation of the assessment score of the student response questionnaire can be converted into the form of student response assessment criteria that are adjusted to the average criteria of the student response questionnaire score.

RESULTS AND DISCUSSION

This research and development was carried out through several stages to obtain research results from the process of Development of Integrated Science Literacy Problem-Based Student Worksheets in thermochemistry materials, namely in the form of feasibility data according to the BSNP assessment instrument and student response data to the LKPD developed. This research was carried out through the 4D method *(Define, Design, Development, Disseminate)* and was limited to the *development* stage, namely product testing to find out the response of students. The following is a description of the results of research and development that have been carried out:

1. Definition

   At this stage, the researcher conducts a definition stage consisting of curriculum analysis, student characteristics analysis, concept analysis, formulating learning objectives and thermochemical LKPD analysis.

   a. Curriculum Analysis

      At this stage, an assessment of the current curriculum is carried out. The applicable curriculum is the independent curriculum. After conducting a curriculum analysis, an analysis of the flow of learning objectives (ATP) of the independent curriculum is carried out to determine the learning outcomes and learning objectives that apply in the independent curriculum. The results of the analysis of the flow of learning objectives can be seen in appendix 1.

   b. Analysis of Student Characteristics

      Furthermore, an analysis of the characteristics of the students was carried out through observation activities that had been carried out and it was found that

during the chemistry lessons, the students only used the learning package books provided by the school.

c. Concept Analysis

This stage is carried out by means of an interview to analyze the material that must be taught. Based on the results of interviews with teachers, information was obtained that the chemical materials that were considered difficult by students were reviewed from daily grades and teachers' observations during learning, especially for grade XI high school, some of which were thermochemistry, chemical equilibrium, salt hydrolysis and buffer solutions. Therefore, the researcher chose one of them, namely the thermochemical material in the LKPD that was developed. The next phase of the concept analysis carried out is to analyze the important parts and main parts that will be studied later, as well as to compile relevant and systematic sub-materials on the students' worksheets based on the learning outcomes obtained from the flow of learning objectives of the independent learning curriculum, namely:

Students are able to observe, investigate, and explain everyday phenomena according to the rules of scientific work in explaining the concept of chemical energy transformation in thermochemistry.

d. Formulating Learning Objectives

Furthermore, based on the learning outcomes above, the learning objectives that are the learning reference for each submaterial for LKPD are integrated science literacy problems in thermochemistry materials are as follows:

1) Students are able to identify the legal concept of energy conservation through case studies appropriately.
2) Educators are able to analyze and identify the interaction of systems and the environment correctly
3) Students are able to classify the differences between exothermal and endothermic reactions through simple experiments
4) Students are able to write down the thermochemical equations of several chemical reactions precisely and determine the type of entalpine changes correctly

e. Analysis of Student Worksheets

At this stage, the researcher conducted an analysis of three thermochemical LKPDs which aimed to be a reference for researchers in compiling worksheets for students based on integrated science literacy problems in thermochemistry materials in grade XI of high school. The analysis was carried out to study the advantages and disadvantages of an LKPD from its components. The results of the analysis of the three thermochemical LKPD can be seen in appendix 2

2. Design

The design of problem-based worksheets for students with integrated science literacy on thermochemical materials designed using the Canva application, can be explained in detail as follows:

a. Preparation of the LKPD framework
   1) Opening Sections

      This section consists of the front cover of the LKPD, the foreword, the table of contents, instructions for use, the syntax of problem-based learning, aspects of science literacy, the flow of learning objectives, and the concept map.
   2) The contents of the LKPD

      This section is filled with thermochemistry material based on the PBL syntax in collaboration with science literacy aspects. This LKPD contains thermochemical materials in which each sub-material is associated with daily life
   3) Closing

      This section consists of evaluation questions, bibliography, summary, glossary and answer key for evaluation questions.

Material Planning

LKPD material is arranged according to indicators by looking at learning outcomes that are in accordance with the flow of learning objectives. The material contained in this LKPD is thermochemical material. The material was quoted from the journal and chemistry book of grade XI high school which was adjusted to the package book distributed by the school. The teaching materials designed are problem-based thermochemistry LKPD integrated with science literacy because by using this model, students can find problems in daily life or more contextual, so that students can more easily understand the concept of thermochemistry.

1. Development

The development steps that have been carried out by the researcher at this stage are as follows:

a. Creation of LKPD

   The worksheet for students based on problems integrated with science literacy on thermochemistry materials is designed using the Canva application, with a paper size of 21 x 29.7 cm can be explained in detail as follows:
   1) *Cover* and foreword

      The cover display contains information in the form of titles, materials and classes designed using the Canva application, and the image is adjusted with thermochemical materials and solid color selection to make it more attractive. The foreword contains brief information about LKPD based on integrated science literacy on thermochemical materials and the author's gratitude to all parties who helped solve the developed LKPD.
   2) Table of contents and instructions for use

      The table of contents contains information in the form of a list of sections in the LKPD that are systematically compiled to make it easier for readers to find the page they want to study. The instructions for use contain information about the procedures for using the developed LKPD.

3) Syntax of problem-based learning and Science literacy aspects

   This section contains information that makes it easier for readers to know the meaning or definition of problem-based learning and science literacy in a nutshell.

4) Learning objectives flow and concept map

   The flow of learning objectives contains information in the form of learning outcomes and learning objectives in the problem-based LKPD integrated science literacy on thermochemical materials. The concept map contains information in the form of materials and sub-materials in thermochemistry.

5) The contents of the LKPD

   This section is the main part where students can solve the problems presented in the LKPD based on integrated science literacy problems on thermochemical materials that are arranged in a simple way and related to daily life. The LKPD developed consists of four sub-subjects, namely the law of energy conservation, systems and environment, exothermic and endothermic reactions as well as enthalpy and enthalpy changes. The following is the design of the content of the LKPD developed:

   a) Energy Conservation Law Section

      In this section, the sub-material of energy conservation law is studied through case study activities that require students to be more active in reading some literature in order to complete the assigned assignment.

   b) System and Environment Parts

      In this section, the submaterial of systems and environments is studied through system and environment interaction analysis activities by working on several questions that require students to find out in advance the meaning of systems and environments, as well as system differences based on the type of interaction.

   c) Exothermic and Endothermic Reaction Parts

      In this section, the submaterial of exothermic and endothermic reactions is studied through simple practicum activities to identify the differences between exothermic and endothermic reactions based on their temperature.

   d) Enthalpy Parts and Enthalpy Changes

      In this section, the sub-material of enthalpy and enthalpy changes is studied through the analysis of the types of enthalpy changes by working on several questions that require students to find out in advance the form of chemical reactions of each type of enthalpy change.

6) Closing Parts

   The closing part consists of evaluation questions, bibliography, summary and glossary. Evaluation questions consist of questions that are relevant to the submaterial contained in the LKPD that was developed. The

bibliography contains literature sources that are a reference for the author's reading in compiling the LKPD. The summary contains brief information about the main learning points of each subsubject. The glossary contains information related to the meaning of several terms studied in thermochemistry.

b. Product Validation

The next stage is product validation carried out by expert validators, namely three lecturers in the Department of Chemistry UNIMED and two teachers of chemistry subjects at SMAN 1 Bangun Purba, to provide assessments and suggestions on LKPD developed using BSNP analysis instruments so that the lack of LKPD is known. Notes and suggestions from validators are used to revise the product and test the feasibility of the developed LKPD. The results of validation by expert validators are as follows

Table 2. LKPD Validation Results Based on Validator Review

No.	Assessment Aspects	Average	Validation Criteria
1.	Content eligibility	3.59	Valid (Very decent)
2.	Presentation eligibility	3.58	Valid (Very decent)
3.	Graphic Qualification	3.61	Valid (Very decent)
4.	Language qualifications	3.7	Valid (Very decent)
	BSNP Eligibility average score	**3.62**	**Valid** (Very decent)

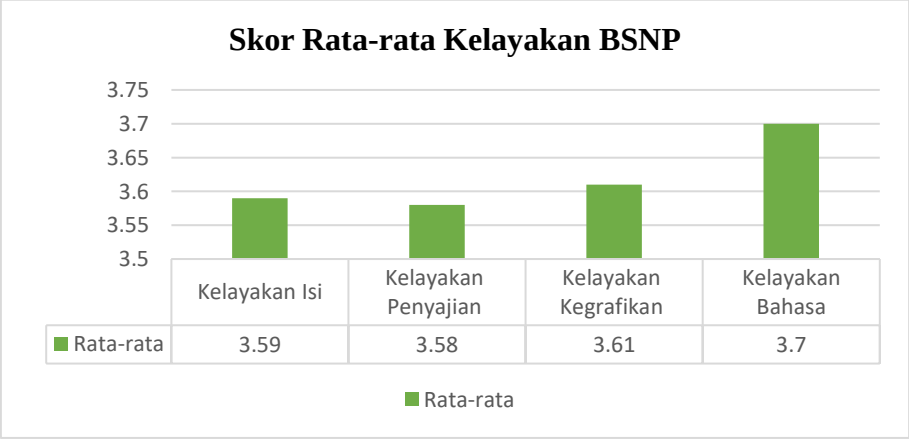


Figure 1. LKPD Feasibility Assessment Based on Validator Review

Based on the data above, it can be seen that the results of the validation of the LKPD based on integrated problems of science literacy in thermochemistry materials in accordance with the BSNP standard by expert validators have an average score of 3.62 which means that the LKPD is declared valid and very feasible to be used as one of the teaching materials that support chemistry learning, especially thermochemical materials.

c. Product Revision

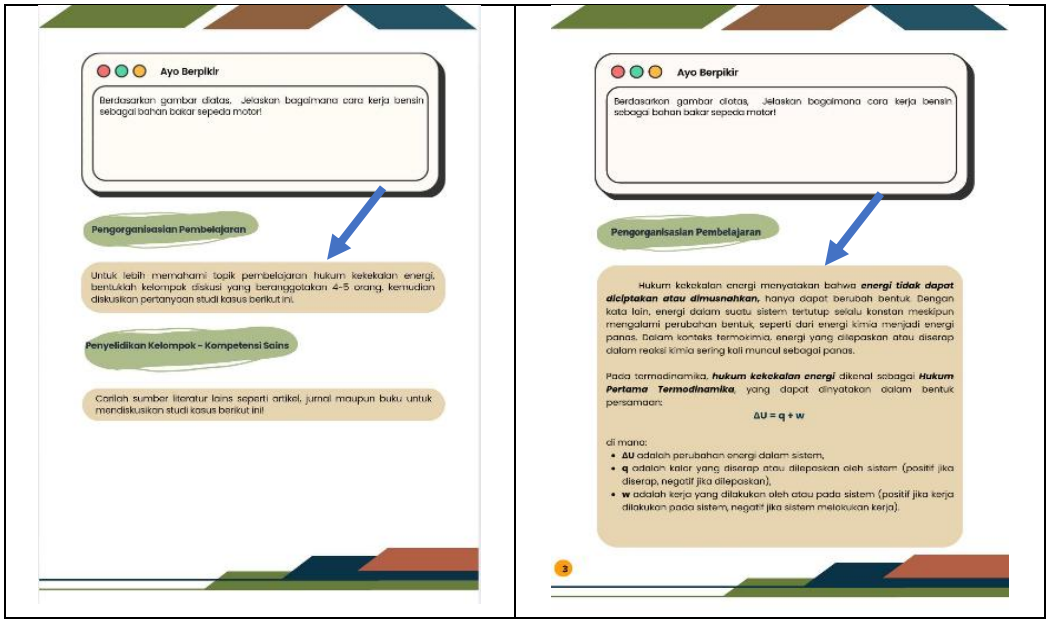
Table 3. Suggestions for Improvement From Validators

Validator	Suggestions for Improvement
Lecturer 1	a. Fix errors in typing chemical reactions
Lecturer 2	b. Add thermochemical material in each sub-chapter after the presentation of the problem c. Add a page to the LKPD d. Fix errors in narrative typing
Lecturer 3	a. Differentiate the font size between the topic and the subtopic and the content b. Add varied practice questions and encourage students to think critically according to learning objectives c. Fix the layout of the concept map
Teacher 1	a. Fix errors in typing chemical reactions b. Add practice questions
Teacher 2	a. Add some supporting literature sources from the internet

The following are some of the components of LKPD that must be improved based on suggestions from validators according to the table above

1) Adding thermochemical material to each sub-chapter

In the 'organizing learning' section, it is recommended to add thermochemical material to make it easier for readers to work on the practice questions made.

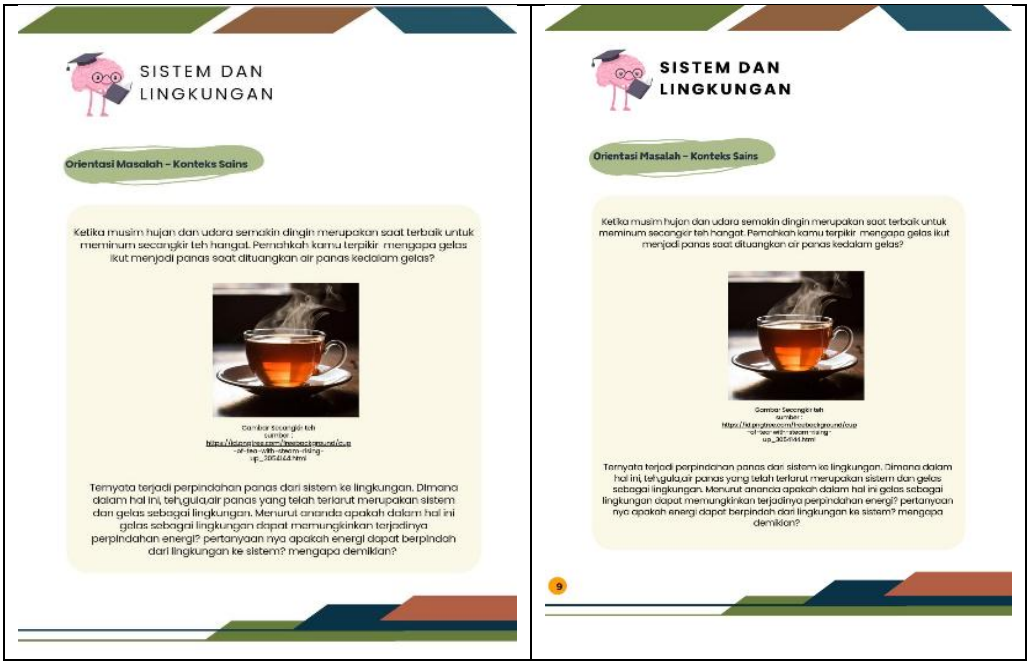


Before Revision **After Revision**

Figure 2. Addition of Thermochemical Material to Each Subchapter

2) Add a page to the LKPD

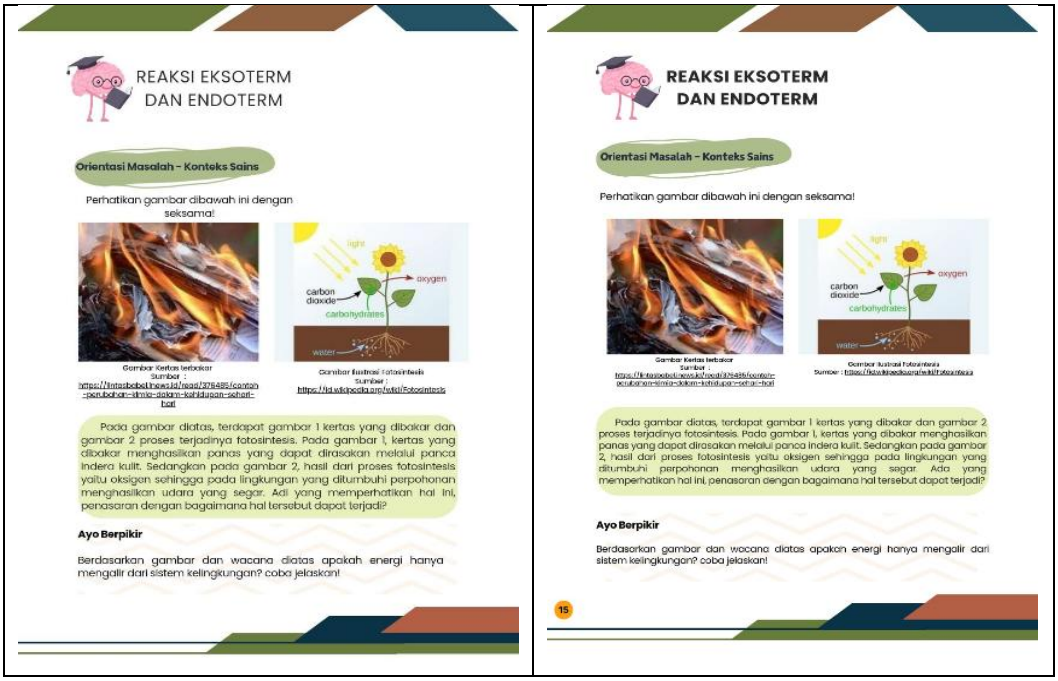
Adding a page number will make it easier for readers to browse and study the LKPD developed.



Before Revision After Revision

Figure 3. Adding Page Numbers to LKPD

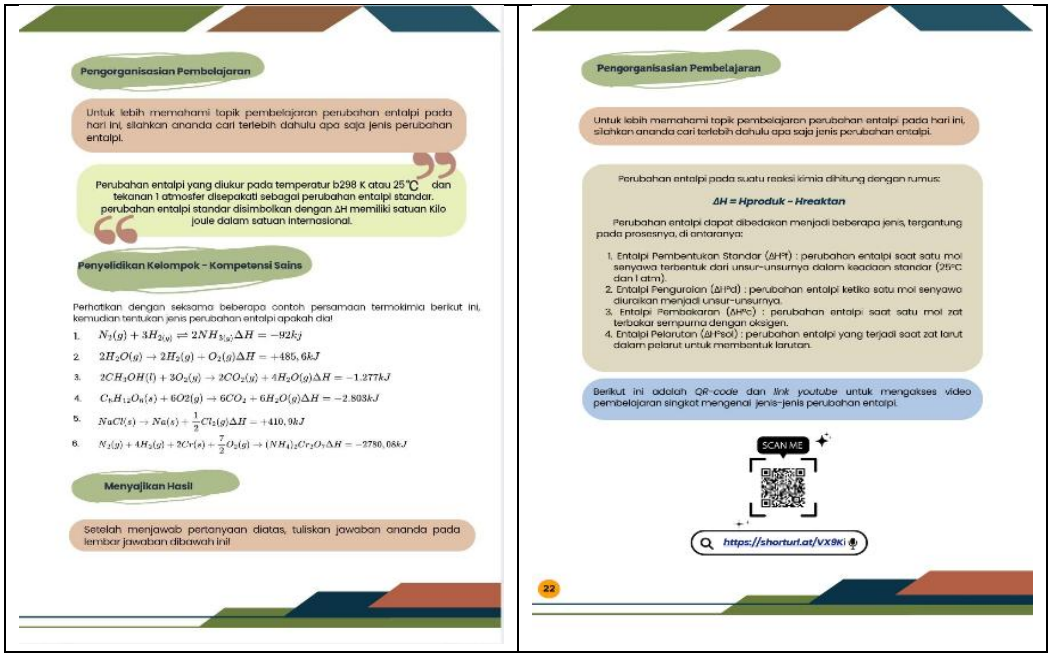
3) Differentiate font styles between topics and sub-topics



Before Revision **After Revision**

Figure 4. Distinguishing Topic Font Styles from Sub topics

4) Adding supporting literature sources from the internet



Before Revision **After Revision**

Figure 5. Addition of Supporting Literature from Youtube

d. Product Trials

The product trial stage in this study was carried out by testing the results of the product in the form of LKPD based on science literacy integrated problems on thermochemical materials to the research subjects, namely students of grade XII Science 1 SMAN 1 Bangun Purba which amounted to 35 students. The study on LKPD used a student response questionnaire to determine the quality of LKPD which was assessed as material aspects, display aspects and benefit aspects. The data from the student response questionnaire is presented in the following table:

Table 4. Assessment of Student Response to the LKPD developed

No.	Assessment Indicators	Student Response
1.	Material Aspects	3,70
2.	Aspect of Display	3,66
3.	Benefits Aspects	3,60
	Average	**3,65**

Based on the data from the questionnaire results of the student response to the LKPD based on the integrated problem of science literacy in the thermochemical material developed, an average score of 3.65 was obtained. So it can be concluded that students give a positive assessment with very good criteria for the LKPD that was developed and as expected, through this LKPD students can more easily understand the concept of thermochemistry.

This development research was carried out to develop a problem-based Student Worksheet integrated with science literacy on thermochemical materials that is simple, structured and associated with daily life so that students can more easily understand the concept of thermochemistry and pay more attention to the surrounding environment. The purpose of this study is so that the researcher can see how the students' responses and the feasibility of LKPD are developed through student response questionnaires and BSNP assessment instruments. LKPD is made based on learning outcomes and the flow of learning objectives in accordance with the independent learning curriculum. The images in the LKPD are presented in accordance with the thermochemical material so as to minimize misconceptions and make it easier for students to understand the context discussed. In addition, LKPD is developed on a problem-based basis so that students can relate personal knowledge (experience) and daily activities to learning and science literacy so that students in their lives have the ability to understand science, communicate science both verbally and in writing and have sensitivity to their environment. The research method used is Research and Development with a 4-D development model from Thiagarajan. The stages of the 4D model consist of 4 stages, namely: (1) Define; (2) Design; (3) Develop; (4) Disseminate.

In the *Define stage* , the researcher made initial observations at SMAN 1 Bangun Purba by looking at several points such as the learning process during class, the media or teaching materials used, the material taught and so on. Data based on the results of interviews with chemistry teachers at SMAN 1 Bangun Purba obtained that the teaching materials used during learning were in the form of thermochemistry package books for SMA/MA Class XI Independent Learning Curriculum published by the Ministry of Education and Culture of the Republic of Indonesia and Chemistry Class XI High School books published by YRAMAWIDYA. This problem is one of the factors that students are less interested and lack understanding of the material taught, especially thermochemistry. It is hoped that LKPD can help increase material references from educators to students. In addition, LKPD helps students to understand thermochemical materials more easily because in LKPD they are presented pictures and problems that we usually find in daily life. These problems made the researcher have the idea of developing thermochemistry LKPD teaching materials based on integrated science literacy problems.

The next step is the Design stage, in this stage the researcher conducts activities to compile the initial part of the LKPD, then the presentation of materials and instruments is adjusted to the learning outcomes and flow of learning objectives. The instruments in this study are an assessment questionnaire for feasibility according to BSNP and a student response questionnaire. The result of its development is a thermochemical LKPD based on integrated science literacy problems.

Furthermore, the Development stage is the stage of making products that have been conceptualized at the design stage. It starts by putting together the LKPD framework which consists of the LKPD cover to the material (content) to the cover, using the Canva application. The opening part of the LKPD is an LKPD cover adjusted to the thermochemical material. The content of the LKPD consists of sub-material on the law

of energy conservation, systems and the environment, exothermic and endothermic reactions, enthalpy and enthalpy changes, explanations of the material accompanied by pictures, learning activities that are done in groups, so that students also learn how to work well in the group. Not only that, the steps in problem learning also emphasize the existence of modeling so that students are required to be able to actualize this knowledge into something useful for daily life. Once the LKPD is completed, it is continued to the validation stage and conduct an assessment of the feasibility and validity of the LKPD developed so that it can be applied to students. This assessment is carried out to get criticism and suggestions on the LKPD that is developed, because the suggestions from the validators are a reference in its improvement. This thermochemistry LKPD was validated by 5 experts consisting of three lecturers of the Department of Chemistry of UNIMED, and two chemistry teachers of SMAN 1 Bangun Purba. The results of the development of this LKPD include the following:

1. The results of the Expert Validator Assessment on the feasibility aspect of the content obtained an average score of 3.59. The average score of the assessment of the feasibility aspect of presentation was 3.58. The average score of the assessment of the feasibility aspect of graphics is 3.61. The average score of the assessment of language feasibility aspects was 3.7. With this, based on the validity criteria according to BSNP standards, it can be stated that the LKPD is integrated with integrated science literacy developed that is valid and very feasible to use.
2. The results of the Product Trial which was carried out to determine the students' response to the developed LKPD, obtained an average score of assessment in the material aspect of 3.7. The average score of the assessment on the display aspect was 3.66. The average score of the assessment on the display aspect was 3.6. With this, based on the criteria for assessing student responses, it can be stated that the students' assessment of the LKPD based on integrated science literacy problems developed is very good and receives a positive response from students. Zahroh & Yuliani (2021)

The final result of this study is that the problem-based thermochemistry LKPD integrated science literacy on thermochemistry materials is valid and very feasible for use in thermochemistry learning. This LKPD contains learning outcomes, learning objectives, concept maps, materials, practice questions, summaries, glossaries, bibliographies, answer keys and several additional components in the form of reading materials about chemist figures and chemical information relevant to thermochemistry. The presentation of this LKPD is made interesting and systematic and with color pictures that make learning not boring. In addition, the LKPD is equipped with problem-based learning steps so that the LKPD developed is more structured. The advantage of the LKPD developed is the novelty of presenting teaching materials in the form of LKPD based on problems integrated with science literacy on thermochemical materials, so as to attract students' interest in learning because the problems displayed in the LKPD are related to daily life problems. The LKPD also provides practice questions and student activities that can be used to solve problems so that the material takes longer to remember. The disadvantage of the LKPD developed is that the material presented is incomplete, namely the material

on the calculation of enthalpy values with the law of hess and the average bond energy is not developed in the Problem-Based Integrated Student Worksheet of science literacy on thermochemical materials.

CONCLUSION

Based on the results of the data analysis that has been carried out, it can be concluded that the Student Worksheet (LKPD) is problem-based that is integrated with science literacy in thermochemical materials that have been developed meets the eligibility criteria of content, presentation, graphics, and language based on BSNP standards. This is evidenced by the average validation of lecturers and teachers as validators of 3.62, which shows that the LKPD is valid and suitable for use in the learning process. In addition, the results of the questionnaire involving 35 student responses to the LKPD showed an average score of 3.65, which means that students responded positively and were interested in the LKPD that had been developed.

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