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DEVELOPMENT OF STUDENT WORKSHEETS BASED ON SCIENCE PROCESS SKILLS AND AIR POLLUTION THEMES TO GROW CRITICAL THINKING ABILITY IN JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

Development of Student Worksheets Based on Science Process Skills with The theme of Air Pollution to Develop Critical Thinking Skills for Junior High School Students aims to present the results of the development and describe the feasibility level of the LKPD that has been made. The research method used is Research and Development (R&D) and the 4-D model created by Thiagarajan et al., (1974) in which there are four phases of research and development, but in this case, it only concentrates on 3 stages. , especially the definition stage (Define), the planning stage (Design), and the development stage (Develop). The expert validation questionnaire instrument sheet is used to test the feasibility of a product and is evaluated by two expert lecturers and two science educators. Information is dissected descriptively, qualitatively, and quantitatively. The results of the development of Student Worksheets Based on Science Process Skills with the Theme of Air Pollution to Develop Critical Thinking Skills for Junior High School Students, which were viewed from the expert's assessment, scored 80.25% and were included in the appropriate category. Thus, the student worksheet based on science process skills developed is suitable for use at the junior high school level.

Keywords: Student Worksheet, Science Process Skills, Air Pollution, Critical Thinking Ability, and Junior High School.

Introduction

The science learning process emphasizes the logical interactions that students have on the grounds that science as a whole is considered a science whose improvement is through perception, problem definition, theoretical details, testing speculation through tests, making conclusions, and finding ideas and hypotheses. The dominance of science through hypothetical learning is not fully determined by the capacity and creativity of students to master the interaction of a science process (Prasetyo, 2011). Science as a cycle is the most widely known method to obtain data obtained through the scientific method. The science learning process must be guided so that students need to show something, not just get something.

Science learning underscores the direct insight of engagement through the utilization and improvement of Science Process Skills (KPS). Science as a cycle usually cannot be separated from science process skills or condensed as a science process. The process of science is a peculiarity of different capacities to focus on different regular peculiarities taking into account the particular purpose of obtaining data and developing further information. Science learning can offer opportunities to work together in utilizing KPS that can be used to deal with problems that exist in the surrounding environment (Kemendikbud, 2014).

KPS is the action of students through logical tests that empower the security of logical information and legitimate abilities. The emphasis in showing KPS is that it allows students to illustrate items and events, explain some pressing issues, collect clarifications, measure logical explanations of information and convey thoughts to others (Opara, 2011). KPS can support the improvement of critical thinking skills by utilizing the scientific method activities contained in the KPS, for example, paying attention to the situation, raising problems, planning speculations, collecting information and then drawing conclusions with these aspects so as to able to grow students' critical thinking skills in order to solve a problem using KPS that have.

The ability to think critically is basically one of the capacities that must be possessed in the 21st century that must be possessed by everyone. These abilities can be mastered using education. Education is a basic choice to prepare future generations to be able to compete and compete in the 21st century. Critical thinking skills utilize fundamental thinking ways to analyze arguments and create thoughts on each significance and interpretation to foster cohesive and logical thinking designs (Gillespie, 2011). Critical thinking skills can be developed in science learning through problem-solving, investigation activities, asking and responding to questions, observing, recording results, and drawing conclusions. Critical thinking skills must be coordinated in various types of learning materials, one of which is science learning.

In learning, the thing that cannot be separated is the fulfillment of the need for teaching materials. The science that meets many different disciplines, then the learning system requires extensive and more complete teaching materials. Teaching materials are materials that are arranged methodically so that students can involve in their learning (Oni, 2013). According to BSNP, (2010) there are rules for teaching materials that show quality, namely containing ideas that are presented interactively and stimulate the course of critical thinking skills. One of the teaching materials used is the Student Worksheet (LKPD). LKPD itself is a printed material that shows a sheet of paper containing materials, outline diagrams, and directions for carrying out learning tasks that can be completed by students by fixing the essential abilities to be achieved (Prasetyo, 2011).

Based on the results of interviews with one of the science teachers at SMPN 2 Serang City, SMPN 16 Serang City, and SMPN 23 Serang City, the educator said that the teaching materials used by teachers in schools were textbooks from the Ministry of Education and Culture with the 2013 curriculum. Need for improvement because the material contained is still shallow and has not applied critical thinking skills such as identifying problems. The limitations of teaching materials used in schools are one of the problems in learning activities, so other teaching materials are needed that can support the learning system. The LKPD used is still fixed on the LKPD listed in the package book as the only teaching material used, so there is no innovation or development of LKPD by educators. This makes it possible that the LKPD used is not in accordance with the needs of students.

Based on a literature study observing the LKPD used in several schools, the LKPD that has been used does not yet have the option to help in getting the concept because it only contains material and questions and only includes the cognitive of students to overcome it, while the LKPD should not only be in the form of sheets about only material but contains a list of problems, instructions for experimental steps that students must do efficiently to help get learning ideas through their activities and questions are used for student development. This result causes students to be less active during

learning activities, and the learning system looks monotonous.

LKPD, which is only in the form of questions also causes students' critical thinking skills to be less trained and developed so critical thinking skills are currently still low. The results of research by Saputra et al. (2016) show that the critical thinking ability of junior high school students is still relatively low, with a percentage of 28.6%. This is because students who meet each indicator of student ability are still low, so they need to be grown and trained through teaching materials that are able to stimulate students' critical thinking skills. There is a need for LKPD that can assist in preparing and growing critical thinking skills according to the needs of students. The importance of applying critical thinking skills in science learning is supported by the results of research by Bunt & Gouws (2020), which explains that critical thinking skills are a key ability that students should have in science learning because this ability provides opportunities for students to learn through discovery.

Based on Piaget's theory, ages 11-15 years at the junior high school level enter the stage of formal functional reasoning (formal operational thought). At this stage, students already have the option to think theoretically, and explain logically, have inductive-deductive thinking skills, and have the ability to make research results from accessible data (Widyati, 2014). Abstract thinking skills include the ability to express ideas, predict events that will occur, and interpret and develop hypotheses. At this stage, students are able to think efficiently to solve problems and have thoughts in making choices so that there are more diverse ways to solve problems. This is in accordance with learning that prioritizes students' critical thinking skills, such as conducting investigations on the information obtained, making decisions based on scientific data and evidence, and making conclusions from research data.

Giving direct experience to students can be a driving force for the development of student's abilities to understand nature deductively and experimentally. Science learning must be logical and introduce students to observing and experimenting with science objects to gain understanding. Additional growth opportunities show a reasonable component that will make the learning system more active. The conceptual linkage that is understood with the side of the study of science will form a cognitive mentality so that students get perfection in science (Hastuti, 2013).

Science learning is carried out in an integrated manner, so the KI and KD mapping is carried out, which can emphasize the learning experience of students. The integration model used is the integrated model. This integrated model combines several related basic competencies and learns the slices of material contained in basic basics so as to obtain a comprehensive and relevant agreement, and then the topic is raised related to environmental problems that students can encounter in real life (Fogarty, 1991). The theme chosen in this study is air pollution. Learning on the theme of air pollution in the 2013 Curriculum is in KD 3.8, analyzing the incidence of environmental pollution and its effect on the ecosystem. KD 3.3 describes mixtures, and single substances (components and mixtures), physical and synthetic properties, physical changes, and compounds in everyday life, and KD 3.7 analyzes the relationship between living things and their current state and population dynamics from these relationships.

Polusi udara merupakan salah satu konsep IPA yang sesuai dengan kemampuan berpikir kritis, karena materi yang abstrak tetapi konkret dalam kehidupan nyata. Dimana kemampuan berpikir kritis sangat dipengaruhi oleh faktor lingkungan dan tema ini merupakan tema yang dekat dengan lingkungan peserta didik dengan kondisi sekolah-sekolah peserta didik dekat dengan jalan raya dan kegiatan industri yang merupakan tempat-tempat penghasil zat polusi udara. Tema polusi udara akan memotivasi peserta didik untuk mempraktekan informasi yang diperoleh di kehidupan sehari-hari peserta didik sehingga memperoleh pengalaman langsung.

There are studies have been conducted regarding the development of LKPD. The study revealed that KPS-based worksheets were considered suitable for use in science learning. This statement is the same as the results of a study led by Sugianto (2013) regarding KPS-based LKPD on the theme of photosynthesis. Where the innovative work process begins, what is expected, diversity of information, LKPD plans, master approval process, including design specialists, language specialists, and materials specialists, limited scope introduction, and teacher and student reactions to LKPD. Data collection techniques are in the form of validation and tests, which show that the LKPD is valid and effective. Another study conducted by Prastyo (2019) regarding KPS-based LKPD on the theme of motion was developed with a 4D model which includes several stages, namely initial investigation, student investigation, curriculum investigation, concept investigation, structure preparation, initial design, expert validation, assessment revision, and last revision. Based on expert validation, it shows that the resulting LKPD is feasible and meets the valid criteria.

Based on the description above, research was carried out with the title "Development of Student Worksheets (LKPD) Based on Science Process Skills on Air Pollution Themes to Develop Critical Thinking Skills for SMP Students".

Research Methods

The research and development method used in this research is Research and Development (R&D). This method has the aim of knowing the level of feasibility and development to produce a product. The model used is the 4-D model created by Thiagarajan et al. (1974) with four steps in it which are abbreviated as 4-D. The research and development steps applied in this study only consisted of 3 steps based on the ability and needs of the researcher. The following are the stages of development carried out:

Defining Stage (Define)

Front-End Analysis

In this step, interviews were conducted with science educators in three schools in Serang City. Researchers obtained information from interviews that have been conducted, including schools that utilize the 2013 education program, have not implemented the theme of integration, and have focused on the application of the scientific method. The application of the scientific method by the practical method. Based on a literature study paying attention to the teaching materials used in several schools, the teaching materials that have been used so far do not have the option to find concepts, because they only contain material and questions and only include cognitive to solve them. The use of methods that highlight memorizing a concept without including the cycle of expertise in it so that students find it difficult to apply the material ideas that have been studied, especially on air pollution material. There is still no exercise that invites students to distinguish the problems that must be considered around the environment, and with the state of the teaching materials, the teacher agrees if there are teaching materials that are developed based on the needs and environment of students.

Learner Analysis

This step is used to identify the special abilities of the students themselves based on the junior high school level in terms of the development of knowledge, attitudes, and skills. Based on Piaget's theory, ages 11-15 years at the junior high school level enter the stage of formal operational thought. At this stage, students already have inductive-deductive thinking skills, are able to think efficiently to solve problems, and have thoughts in making choices so that there are more diverse ways of solving problems (Widyati, 2014). This is in accordance with learning that prioritizes students' critical thinking skills, such as conducting investigations on the information obtained, making decisions based on scientific data and evidence, and making conclusions.

So it is necessary to develop teaching materials based on the characteristics of students so as to allow students to explore their abilities at the junior high school level. Teaching materials are related to the ability to carry out scientific activities such as making decisions to giving conclusions about a problem. The existence of LKPD development that can foster critical thinking skills is in accordance with learning that can stimulate students' abilities.

Task Analysis

This step is carried out by marking the tasks of the teacher to the students. The task is seen in the LKPD, which only contains questions by memorizing concepts without applying them, so scientific method activities are needed. Ennis (2011) understands that the last three levels in Bloom's taxonomy, namely analyzing, assessing, and making, are included in critical thinking skills. This is one of the reasons for choosing the KD used. The results of the analysis are used as a kind of perspective in developing LKPD with the aim that they can achieve the basic competencies used. Given this, the task analysis in this study is a collection of procedures to determine the indicators contained in KI and KD that are associated with the material to be made through the LKPD.

Concept Analysis

This step is carried out based on the previously determined KI and KD. The concept used in the LKPD with the theme of air pollution is the concept of air pollution, substances, and their characteristics, as well as the interaction of living things with their environment. These concepts are then linked to the competencies that must be achieved. From the competencies determined, the researcher can determine the learning indicators.

Specifying Instructional Objectives

Determination of a learning goal is done after analysis of tasks and concepts. The results of the two analyzes, researchers can formulate learning objectives.

Stage of Design (Design)

Criterion-test construction

Measuring the achievement of predetermined learning objectives is the step at this stage by making an instrument. The instrument is adapted to KPS aspects. The preparation of instruments in the development of the KPS-based LKPD will be adjusted to the aspects of the KPS and the characteristics and abilities of students to measure the achievement of the learning objectives.

Media Selection

In choosing learning media based on KI, KD, learning objectives, and critical thinking skills. Characteristics of media that can develop critical thinking skills, namely media, can be a means for students to decipher information obtained through practical activities that come from various sources. All of this data is collected as a unit and is related to the development of learning so that students can frame questions, analyze and conclude and convey thoughts convincingly through oral and written. The selection of media such as videos, pictures, and graphics used by researchers in the LKPD is used to develop critical thinking skills and make it easier for students to carry out activities in the LKPD.

Format selection

In this step, the researchers chose features that matched the LKPD, designed the LKPD to be more attractive, and made LKPD components that were adapted to the KPS aspect.

The initial design of learning devices (initial design)

Figure 1. LKPD components developed by the LKPD cover section and supporting information

The storyboard is a design for making LKPD. LKPD cover designs and layouts were created using the Canva application. The KPS-based LKPD uses KPS aspects in it, which are then integrated with indicators of critical thinking skills. After the LKPD is completed, it is then converted into pdf format for printing.

The pictures above are some of the components of the KPS-based LKPD after being designed by researchers, namely the LKPD cover component, supporting information, hypotheses, and LKPD identity.

Development Stage (Develop)

In obtaining a product feasibility assessment, the LKPD validation process is carried out, which is assessed by a team of experts. This research applies descriptive qualitative and quantitative analysis. Qualitative descriptions were obtained from various suggestions, comments, and responses from experts in the form of a questionnaire with a Likert scale. The determination of the score on the Likert scale is described in table 1.

Table 1. Scoring Rules

Rating Category	Score
Very Good (SB)	4
Good (B)	3
Enough (C)	2
Less (K)	1

(Arikunto, 2013)

The data obtained from the questionnaire was then processed using the equation, namely (Sugiyono, 2016):

$$\text{Nilai} = \frac{skor\ yang\ diperoleh}{nilai\ maksimum} \text{ x } 100\%$$

The expert test results obtained in percentages are carried out in qualitative form according to the rules described in Table 2.

Table 2. LKPD eligibility assessment category

Interval score	Category
81% - 100%	Very Worthy
61% - 80%	Worthy
41% - 60%	Enough Worthy
21% – 40%	Less Worthy

(Source : Modifikasi Riduwan, 2013)

Result and Discussion

This study aims to develop LKPD based on KPS with the theme of air pollution to foster the critical thinking skills of junior high school students.

The making of LKPD is carried out in accordance with the components of the LKPD which contains aspects of KPS with the integration of indicators of critical thinking ability. The LKPD that has been developed is then validated on the product developed by a team of experts to obtain product feasibility, which is then carried out at the product revision stage based on the recommendations and opinions of the expert team. The assessment was carried out by a team of experts, namely UNTIRTA Science Education Lecturers, Science Teachers at SMPN 2 Serang City, and Science Teachers at SMPN 23 Serang City, who filled out expert validation questionnaires. Aspects assessed by the expert team according to BSNP, (2014) are the appropriateness of the content, presentation of LKPD, graphics, and language.

Results of the Feasibility of LKPD Based on the KPS Theme of Air Pollution to Develop Critical Thinking Skills for Junior High School Students

The assessment of the LKPD based on the KPS theme of air pollution to foster critical thinking skills based on the assessment of the expert team obtained the results of the LKPD feasibility assessment. The results of the feasibility assessment of the developed LKPD as a whole got a score of 80.25% with appropriate criteria. The following are the results of the LKPD feasibility analysis contained in Figure 2.

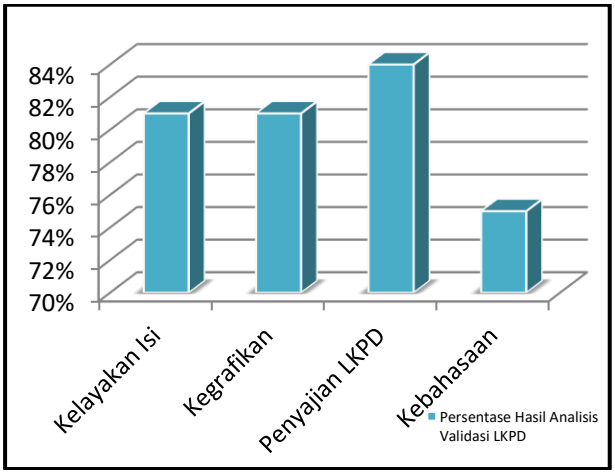

Figure 2. Diagram of LKPD Feasibility Analysis Results

The explanation of each aspect of the LKPD validation assessment is as follows:

Content Feasibility Aspect

The results of the assessment of the feasibility aspect of the content got a score of 81%, and this number was included in the very feasible criteria. Aspects of the feasibility of the content, there are six indicators in it, namely the curriculum, depth of material, aspects of KPS, indicators of critical thinking skills, student's abilities, and the accuracy of the use of terms according to the scientific field. These indicators are then assessed by experts to obtain the results shown in Figure 3.

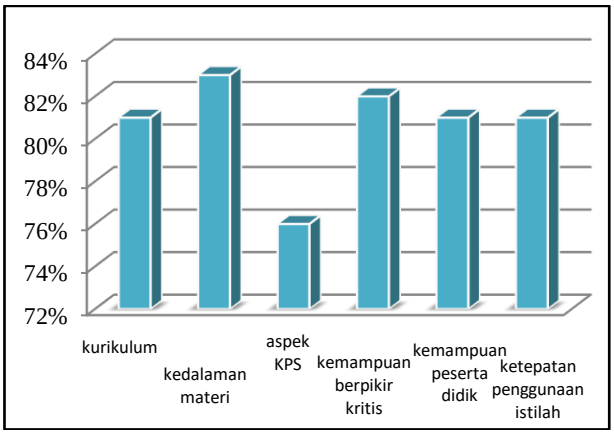

Figure 3. Content Feasibility Aspect Assessment Diagram

Figure 3 shows the results of the assessment of each indicator from the aspect of content feasibility. Curriculum indicators get an assessment of 81% which fall into the very feasible category. This shows that the experts consider that the scope and indicators of learning in the LKPD are relevant to the KI and KD used in the 2013 education program. Changes were made by placing the grade level in each KD used as well as 2013 revised 2017 curriculum in LKPD.

The material depth indicator gets a score of 83%, which is included in the very feasible category. Presentation of material that does not only focus on the achievement of a predetermined KD but also discusses the relationship between KD and the concepts used. Where the LKPD material is very contextual to the daily experiences of students, this indicator also gets advice from experts, namely the absence of writing on grade levels from KD and what curriculum is used in LKPD. Changes were made by placing the grade level in each KD used as well as 2013 revised 2017 curriculum in LKPD.

The KPS aspect indicator scored 76% in the decent category. This shows that the KPS-based LKPD learning activities have implemented steps of the scientific method or investigation activities from observing activities and applying concepts to making conclusions. In accordance with the opinion of BSNP, (2014), which states that learning that applies KPS can get direct experience to students.

In the aspect of observing (observation) carried out by collecting and using relevant facts using many senses, namely at the stimulation stage through video observations and descriptions of conditions around the environment so that it can identify whether the surrounding air is polluted or not by observing changes that occur in the air. This is in accordance with the statement of Trianto (2012), which reports that observation is a skill where students carry out observations using sensory devices such as sight, hearing, taste, touch, and smell. In the aspect of using the tools and materials contained in the data collection stage, it is done by using experimental tools and materials and applying them according to the work steps on the LKPD. This is in accordance with Zulfiani's (2009) statement that the skill of using tools and materials aims to find out how to use and the reasons for using these tools and materials.

In the communication aspect, it is obtained from the activity of recording observational data. For this activity, students are asked to write down observational data in the observation table that has been provided in the LKPD. In the aspect of classifying (classification), it is tried by comparing, looking for differences and similarities regarding the concepts of air pollution obtained from the analysis process of the problem whose answers are obtained based on the observations that have been tried by students. Experts consider that the problem of analyzing data is still lacking in finding differences and similarities regarding the concepts of air pollution which is a description of the classification aspect. This is in line with Dimyati and Mudijono (2013) that classification is a skill that includes activities, namely looking for differences and similarities, comparing activities, and finding the basis of classification. Then a revision was made by changing the wording in the question to emphasize the difference from the concept of air pollution. In the aspect of applying the concept, it is done by reflecting on the knowledge gained as the implementation of the concept through various questions; let's discuss. The aspect of interpreting (interpretation) is done by connecting the results of observations to find a conclusion from the experiment through activities where students draw conclusions.

The indicator of critical thinking ability gets a score of 82% which is included in the very feasible category. This indicator is well integrated because the material in the LKPD is adjusted to the ability of students, and the LKPD material contains words that indicate a foreign term and contains a scientific field, and in this LKPD the use of these words is considered appropriate by experts. The indicator of critical thinking ability is to provide a basic classification related to problems obtained from the problem statement stage (aspects of asking questions) obtained through information in the previous stage. Then, students formulate problems after reading the information. In indicators providing a basic classification of problems, the experts consider that the written instructions for identifying problems still need to be adjusted to their statements; therefore, revisions are needed.

The next indicator is to collect basic information obtained from the process of students using trusted sources in providing answers. The indicator provides opinions and initial conclusions containing activities to identify general things, express hypotheses, and make and determine the results of decisions based on background facts that are in accordance with what has been done contained in the verification phase (let's discuss) through answering questions in accordance with the concepts that have been developed understood. The indicators make further clarification, namely making further explanations of the practicum activities that have been carried out contained in the verification stage (data analysis) obtained through analyzing the data after conducting the experiment. The indicators for drawing conclusions are obtained based on information and experience from the practicum activities carried out so students make conclusions.

The indicator of the ability of students to get a score of 81% is included in the very feasible category because the material used is in accordance with the abilities of junior high school students. The last indicator in this aspect is the accuracy of the use of terms according to the scientific field, which gets a score of 81% in the very appropriate category because in the LKPD material, there are words that indicate a foreign term and contain a scientific field and in this LKPD the use of these words is assessed right by the experts.

Graphic Aspect

The results of the assessment on the graphic aspect got a score of 81%, and this number was included in the very feasible category. There are 2 indicators in the graphic aspect, namely the LKPD cover design and the LKPD display. These indicators are then assessed by experts to obtain the results shown in Figure 4.

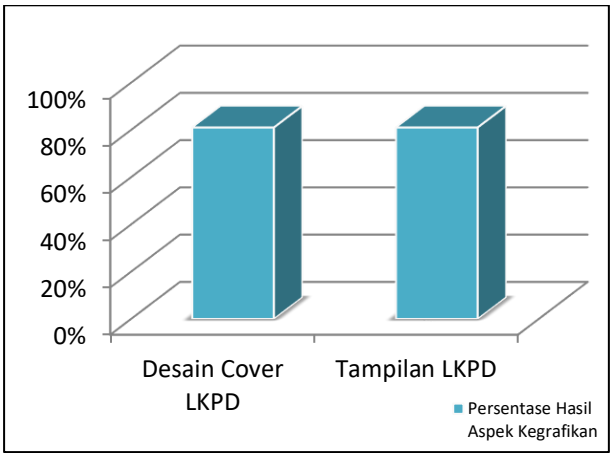

Figure 4. Graphical Aspect Assessment Diagram

Figure 4 shows the results of the assessment of each indicator from the graphic aspect. The LKPD cover design indicator gets a score of 81%, and this value is included in the very feasible category. This happens because the cover design used in the LKPD has described the content or material in the LKPD, namely air pollution. The LKPD display indicator gets a score of 81%, where the value is included in the proper category. This shows that the experts considered the appearance of the LKPD to be good. The assessment received advice from the experts, namely that the display of the LKPD still had a lot of empty space, and the size of the images, page numbers, and letters used still needed improvement. Improvements to the graphic aspect of the KPS-based LKPD are needed to improve the LKPD. This is in accordance with the results of the statement from Effiong & Igiri (2015) that students are very enthusiastic about participating in a lesson because they are interested in the appearance of teaching material.

Aspects of LKPD Presentation

The results of the assessment on the presentation aspect of the LKPD got a score of 84%, and the results were included in the very feasible category. The presentation aspect has two indicators in it, namely the presentation of the material and the steps of the development model. These indicators are then assessed by experts to obtain the results shown in Figure 5.

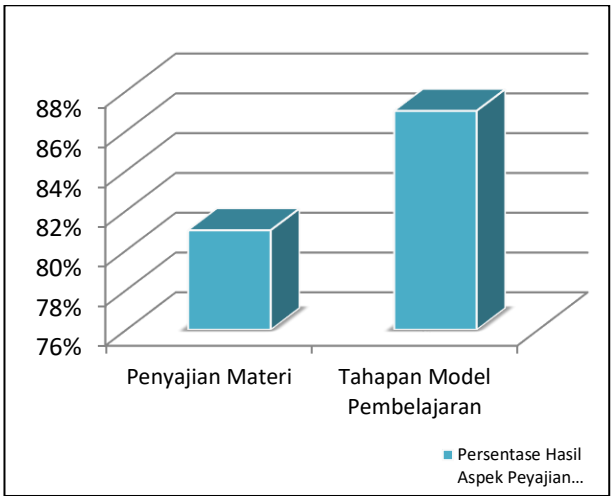

Figure 5. Assessment Diagram of LKPD Presentation Aspects

Figure 5 shows the results of the assessment of each indicator from the aspect of LKPD Presentation. In the indicator of material presentation, the score is 81%. This value is included in the appropriate category, meaning that the material is presented coherently and systematically from the introduction in the form of LKPD cover, LKPD contents to the bibliography. This is in accordance with the statement according to the Ministry of National Education (2008) a good teaching material must at least include instructions for use, competencies to be achieved, learning materials, and practice questions. The indicator for the stages of the learning model where the learning model used is discovery learning gets a score of 87%, which is included in the feasible category. This shows that the steps of the learning model used are already contained in the LKPD and are appropriate in their placement.

Aspek Kebahasaan

The results of the assessment on the linguistic aspect got a score of 75%, and this value was included in the decent category. The linguistic aspect has two indicators in it, namely the PUEBI spelling and the LKPD language. These indicators are then assessed by experts to obtain the results shown in Figure 6.

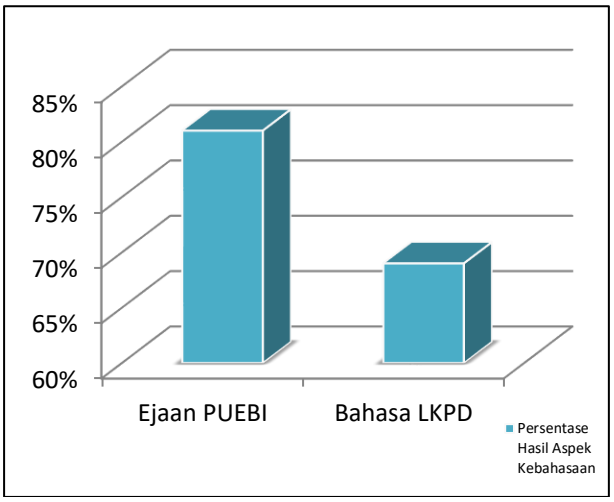

Figure 6. Diagram of the Assessment of Linguistic Aspects

Figure 6 shows the results of the assessment of each indicator from the linguistic aspect. The PUEBI spelling indicator gets a score of 81% this value is included in the very decent category. This shows that overall the use of PUEBI spelling in LKPD is good. It's just that there is still a language that is not in accordance with the ability of students to understand it. In this indicator, experts assess that the language used in LKPD is still not in accordance with the level of understanding of students with the use of words that are difficult for students to understand, such as the words "analyze" and "hypothesis."

The LKPD language indicator received an assessment of 69%, which was included in the appropriate category. Experts consider that the language used in LKPD is still not in accordance with the ability of students to understand it, so experts suggest using easy-to-understand language that is in accordance with students' abilities and common language. Prastowo (2015) revealed that good teaching material must pay attention to the correct use of Indonesian language rules and adjust to the level of understanding of students. Therefore the use of language in LKPD must be adjusted to the ability of the object or target of the LKPD. This is in accordance with the statement of Daryanto, (2013) that one form of good language is that every instruction and information exposure is friendly to the target, including simplicity in reacting and obtaining it as desired.

Conclusion

The development of LKPD based on the KPS theme of air pollution to foster critical thinking skills of junior high school students is carried out based on the stages in research and development according to Thiagarajan et al. (1974) This research consists of 3 stages, namely the definition stage (Define), the design stage (Design). And the development stage (Develop). Assessing the level of feasibility of the product developed is carried out by a team of experts. Suggestions and input from a team of experts are used as material to revise the product. The feasibility level of the KPS-based LKPD based on the results of expert validation obtained a percentage value of 80.25%, which is included in the feasible criteria.

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