Development of High Order Thinking Skills Oriented Student Worksheets on Environmental Pollution Materials on Junior High School Students

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INFO ARTIKEL	ABSTRACT

The learning tool that will be developed is Student Worksheet oriented High Order Thinking (HOTS). Based on interviews with science subject teachers at research school used was student worksheet not HOTS-oriented, which was still Middle Order Thinking Skills level. This study aims (1) determine validity of student worksheets oriented HOTS on environmental pollution material, (2) describe practicality of student worksheets oriented HOTS on environmental pollution material, (3) describe effectiveness of student worksheets oriented HOTS on environmental pollution material developed. Research development with the Four-D development model developed by Thingarajan consists of 4 stages: define, design and develop. The results of the study were seen from percentage of each aspect obtained from 3 validators, namely validator I of 97%, validator II of 73% and validator III of 100% with very valid criteria. In addition, practicality of student worksheets oriented HOTS is seen from three stages, namely student activities (88.28%), learning implementation (100%), and student responses to student worksheets oriented HOTS (87%) with very good criteria. The effectiveness of student worksheets oriented HOTS states that the results of pretest and posttest carried out during learning show different results, namely the posttest is greater than pretest result using N-gain score % with value of 78 categorized as effective. Thus, student worksheets oriented HOTS is feasible and can be used in science learning about environmental pollution. Novelty this research is to produce student worksheets oriented HOTS on environmental pollution material. Benefits of research can foster creativity of students to think at higher levels independently.

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INTRODUCTION

Student Worksheets (LKPD) are teaching materials that have been packaged in such a way that they are used to carry out problem solving activities that can maximize understanding in accordance with achievement indicators and students are expected to be able to study the teaching materials independently. This is in accordance with the opinion of Prastowo (2015) that LKPD is one of the learning tools that can be used in the learning process. In addition, according to Firdaus & Wilujeng (2018), LKPD is a learning process activity sheet to find the concepts of science subjects, either through theory, demonstration, or investigation, accompanied by clear instructions and work procedures to practice thinking skills in completing tasks according to with the learning indicators to be achieved.

The application of the "2013 Revision 2016 Curriculum" emphasizes high-level thinking (HOTS) in learning, so that learning tools are needed, one of which is the student worksheet (LKPD) which is specifically prepared based on the characteristics of High Order Thinking Skills (HOTS). HOTS is a thinking process of students at a higher cognitive level developed from various cognitive concepts and methods and learning taxonomies. These HOTS include problem solving skills, creative thinking skills, critical thinking, argumentation skills, and decision-making abilities. According to Saraswati & Agustika (2020), training high-level thinking skills or HOTS is important to prepare the younger generation with the provision of critical, creative and skilled thinking skills in making decisions to solve problems. Meanwhile, Faridah (2019) also stated that adapting in the 21st century requires the ability to develop creativity and solve problems. Critical and creative thinking is needed in

solving problems, because the rapid development of knowledge and technology has resulted in more complex challenges and problems that will be faced by humans in the 21st century.

Previous research conducted by Noprinda & Soleh (2019) conducted a feasibility test on the development of HOTS-oriented LKPD on the static electricity material being developed. In addition, a limited trial was carried out related to the attractiveness of students to the developed LKPD. After that, the teacher's response test to the developed LKPD was carried out. What has not been done is to make HOTS-oriented worksheets on other science materials, such as environmental pollution materials and test the effectiveness of the products developed.

Based on interviews with science subject teachers at SMP Negeri 5 Gorontalo, teachers have used learning tools in learning including lesson plans, LKPD, evaluation tools and textbooks. However, the worksheets used are not HOTS-oriented but are still at the level of Middle Order Thinking Skills (MOTS), including learning activities with material that presents a lot of reading and is still teacher-centered. In addition, the learning tools used in learning activities still use LKPD which tends to test more aspects of understanding. This causes the high -level thinking process of students to be lacking. The learning tools used are still dominated by indicators of knowing, understanding and explaining. This makes students will have difficulty if given different questions and will not increase the cognitive knowledge of students.

HOTS-oriented worksheets can be used as a supporting alternative to train students to get used to working on HOTS questions (Lufri, et al., 2020). Most of the science material can make students train HOTS, for example, environmental pollution material that has problems related to real life. Environmental

pollution material is deemed appropriate if it is supported by HOTS-oriented LKPD, because on environmental pollution material, basic competencies at the levels of analyzing (C4), evaluating (C5) and Creating (C6) will be achieved. Based on this, it is necessary to develop LKPD with a level of cognition that is in accordance with these basic competencies. In addition, the environment around students who live in riverside areas has been polluted.

Based on the various existing problems, one solution is in the learning process requires a HOTS-oriented LKPD form. If the HOTS LKPD is developed on environmental pollution material, students are expected to be able to improve their thinking skills and be motivated to connect the subject matter with everyday life, so that they are able to express their own opinions in solving a problem. Therefore, it is important to develop HOTS-oriented worksheets to train students in developing a higher-order thinking skill, so that they are able to solve a problem, and get used to solving problems that fall into the categories of analyzing, evaluating, and creating.

This study aims to determine the validity of the worksheets, describe the practicality of the worksheets and describe the effectiveness of the HOTS-oriented student worksheets on environmental pollution materials developed. The benefits of this research are to contribute thinking in the form of HOTS-oriented worksheets to educators, foster creativity in students to think at higher levels independently and train students to be able to find and combine their own knowledge and skills to create solutions to a problem.

METHOD
Place and time of research
This research was conducted at SMP Negeri 5 Gorontalo. The time of the research from January to February 2021/2022.

Research Target
The research target of the LKPD oriented High Order Thinking Skills was tested on class VII students. The number of students tested is 15 for small group trials.

Types of research
This type of research is development research with a Four-D development model, which consists of 4 stages: definition, design, development and dissemination (Thingarajan, 1974). can be described as follows.
1. **Define Stage**. According to Putri (2021) that this stage is to establish and define learning conditions. The define stage includes four main steps, namely front-end analysis, concept analysis, task analysis, and specifying instructional objectives.
2. **Stage of Design**. The design stage has 3 stages: the selection of learning tools, the selection of the format, and the initial design.
3. **Development Phase**. At this stage, LKPD validation is carried out to learning device experts, material experts and biology teachers. After that, revise the product and conduct product trials.
4. **Stage of Dissemination**. This learning tool is distributed by researchers only to teachers in junior high schools who will be the research sites and to several students as samples for product trials.

Data analysis technique
1. Expert Validation Analysis
The data obtained from the HOTS-oriented LKPD validation results in the form of qualitative descriptive data and quantitative data. Qualitative descriptive data comes from the suggestions and comments of the validator. Quantitative data comes from the assessment aspect using a check-list ($\sqrt{}$) with the assessment criteria in Table 1.

Table 1. Expert Validation Scoring Guidelines

Category	Score
Very good	5
Good	4
Good enough	3
Good not enough	2
Not good	1

(Sugiyono, 2017)

The average calculation of each aspect is carried out using the formula

$$\text{Validation value} = \frac{\text{Score obtained}}{\text{Highest score}} \times 100\%$$

(Sudjana, 2018)

The level of achievement of the HOTS-oriented LKPD validity category uses the classification with the provisions in Table 2.

Table 2. Criteria for Determining the Validity Level of LKPD

Range	Category
0-20	Very Invalid
21-40	Not Invalid
41-60	Invalid enough
61-80	Valid
81-100	Very Valid

(Riduwan, 2015)

2. Practical Analysis
Student Activity Analysis

The activities of students can be seen from the observations of the observer on the overall students according to the number of students that have been determined. The criteria for the percentage of student activities are presented in Table 3.

Table 3. Criteria for the Percentage of Student Activities

Percentage Range	Category
81%-100%	Very good
61%-80%	Good
41%-60%	Good Enough
21%-40%	Enough
0%-20%	Not good

(Arikunto, 2017)

Learning Implementation Analysis

This analysis is used to assess the implementation of learning by teachers in accordance with the criteria made. This observation uses the answer "YES" or "NO". This assessment guide refers to the Guttman scale in (Ayu & Kusumawati, 2018).

Table 4. Guttman Scale Criteria

Answer	Score
Yes	1
No	0

(Yazid, 2016)

The data obtained were analyzed using formula:

$$\text{Percentage} = \frac{\text{Number of "Yes" Answer Scores}}{\text{The number of aspects observed}} \times 100\%$$

Table 5. Criteria for Assessment of Learning Implementation

Percentage of Execution	Category
$P \geq 90\%$	Very good
$80\% \leq P < 90\%$	Good
$70\% \leq P < 80\%$	Enough good
$60\% \leq P < 70\%$	Not enough good
$P \leq 60\%$	Not good

(Yazid, 2016)

Analysis of Student Response Questionnaires

Response analysis was given during a small group trial to 15 students of class VII SMP Negeri 5 Gorontalo. To calculate the percentage of each student's response, the formula used is adapted from Yazid (2016) as follows:

$$K = \frac{F}{N \times I \times R} \times 100\%$$

Information:
K: The percentage of students' responses
F : Number of respondents' answers
N : Highest score in the questionnaire
I : Number of questions in the questionnaire
R : Number of respondents

The results of the calculation of the percentage of students' response questionnaires in small group trials are interpreted into criteria that can be seen in Table 6.

Table 6. Interpretation of Student Response Questionnaire Scores

Criteria	Percentage of Student Responses (%)
Very Worthy	86-100
Worthy	71-85
Decent enough	56-70
Not feasible	≤40

(Yazid, 2016)

3. Effectiveness Analysis

Calculation of student learning outcomes to see the ability of HOTS can be calculated using N-gain:

$$N - gain = \frac{Posttest\ score(\%) - Pretest\ score\ (\%)}{Ideal\ Score - Pretest\ score\ (\%)}$$

Table 7. Criteria for N-gain Score

Gain Score Results	Criteria
Gain > 0.7	High
0.7 >= gain >= 0.3	Currently
Gain < 0.3	Low

(Hake in Reynawati, 2018)

Table 8. Categories of Interpretation of N-gain.

Percentage (%)	Interpretation
≤40	Ineffective
40-55	Less effective
56-75	Effective enough
>76	Effective

(Hake in Setiawan & Aden, 2020)

RESULTS AND DISCUSSION

This development research was conducted using the 4-D (Four-D) development model developed by Thingarajan carried out in 4 stages, namely Define, Design, Develop and Desseminate. However, this research only reached the Develop stage, limited trials due to limited time, energy and adjusting to the current situation and conditions which are still in the Covid-19 pandemic.

Defining Stage

1. Front-End Analysis

Based on the results of interviews, the LKPD used during learning activities still uses LKPD which tends to test more aspects of understanding. This causes the higher-order thinking process to be less than optimal. The learning resources used are still dominated by indicators of knowing, understanding and explaining. This makes students will have difficulty if given different questions and will not increase the cognitive knowledge.

2. Concept Analysis

Based on the results of the interview, the concepts of each environmental pollution material in KD 3.8, analyze the occurrence of environmental pollution and its impact on the ecosystem associated with KD. 4.8. Writing about ideas for solving pollution problems in the environment based on observations.

3. Task Analysis

The results of the analysis obtained an overview of the tasks required in learning, after analyzing environmental pollution in the surrounding environment, students were able to solve the given contextual problems and make reports on the results of discussions on the LKPD that had been divided.

4. Analysis of Learning Objectives

In this analysis, researchers can determine indicators of learning achievement, learning objectives, and create a grid of questions to be given. The purpose of learning environmental pollution is that students can examine the definition of environmental pollution. Students can investigate the causes of water, air, and soil pollution. Students can analyze the impact of water, air, and soil pollution on ecosystems. Students can categorize ways to control water, air, and soil pollution. Students can make reports about solving pollution problems that occur in the surrounding environment.

Stage of Design

1. Selection of Learning Devices

The selection of learning tools or LKPD is carried out to identify learning tools that are relevant to the characteristics of the material. Learning tools are chosen to adapt to concept analysis and task analysis, as well as user characteristics, this is useful for assisting students in achieving basic competencies and optimizing the use of tools in the LKPD development process in learning.

2. Format Selection

The results of the selection of this format determined that the learning tools used were adjusted to the material in the LKPD, namely environmental pollution and science textbooks for class VII. The developed LKPD format contains elements of the title, indicators, basic competencies, steps/activities of students to be achieved and assessment.

3. Preliminary Design

The initial design at this stage is called draft I. This initial design aims so that the LKPD developed is in accordance with the steps and components contained in the learning design.

Development Stage

1. Validation

Analysis of the validity of the student worksheets that have been developed, first validated by 3 validators, namely material validators, LKPD validators and biology teacher validators.

LKPD Validity Results by Material Experts

Validation by the material validator aims to determine the validity of the LKPD product produced in terms of material. During the material validation stage, the LKPD product was revised 2 times. The results of the assessment from the validator obtained that the percentage of validation results regarding HOTS-oriented LKPD on environmental pollution materials is presented in Figure 1.
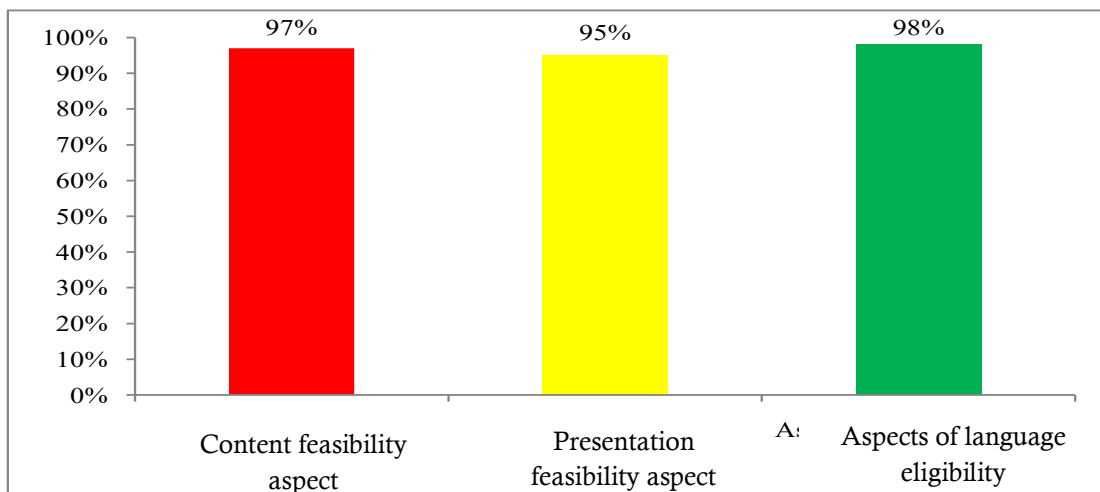
**Figure 1.** Diagram of Material Validation Results

Based on Figure 1. shows that the content feasibility aspect which has 63 assessment points gets a score of 97%. The presentation feasibility aspect which has 19 the material in the LKPD in order to support students in the learning process, help students understand the material, and train students so that their critical thinking can solve problems

assessment points gets a score of 95%. the aspect of language eligibility which has 44 assessment points gets a score of 98%. Then the percentage results obtained on three aspects of feasibility, namely 97% with the criteria "Very Valid". These criteria are obtained after conducting guidance by a material expert first. There are several suggestions from experts to change the context of the sentence to be more standard. Based on the validation data on the material expert validator instrument, the HOTS-oriented LKPD has been said to be valid and feasible to be tested without revision. According to Sulistyorini (2018), LKPD validation is carried out for the feasibility of that occur around them.

LKPD Validity Results by Learning Device Experts

Validation by the LKPD validator aims to test the validity of the LKPD product in terms of the activities used in the LKPD. The LKPD product was revised 2 times based on criticism and suggestions for improvement from the LKPD validator. The results of the assessment from the validator obtained the percentage value of validation regarding LKPD oriented to High Order Thinking Skills presented in Figure 2.
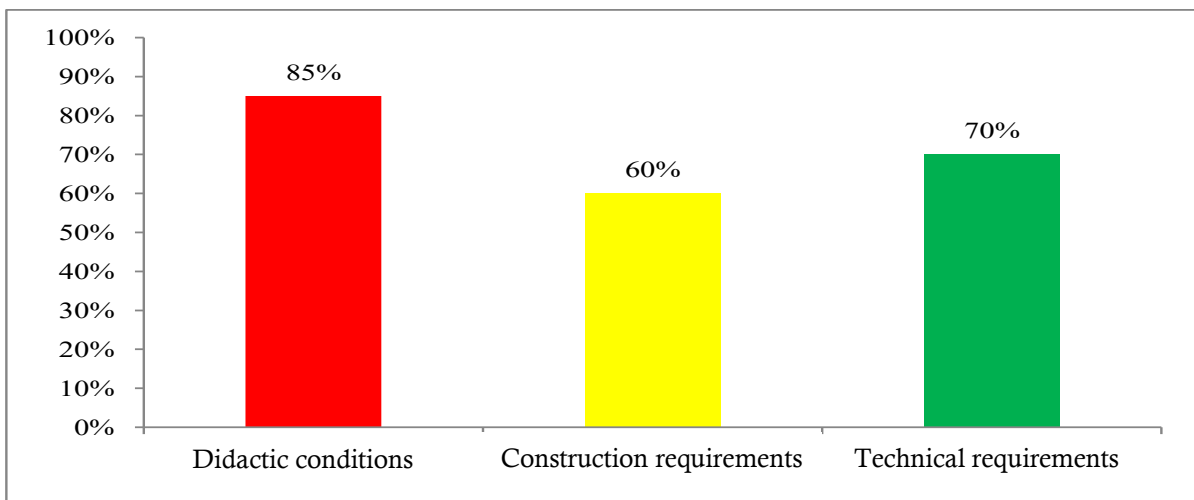
Figure 2. LKPD Validation Diagram

Based on Figure 2, the didactic requirement which has 17 assessment points gets a score of 85%. Construction requirements that have 9 points of assessment get a score of 60%. The technical requirements that have 7 assessment points get a score of 70% so that the percentage results on the three conditions are 73% with the "Valid" criteria. The results of the validation with the criteria were obtained from the valodator's

of obtaining the minimum criteria is in the valid category.

LKPD Validity Results by Biology Teachers

Validation by the LKPD validator by the biology teacher aims to test the validity of the LKPD product in terms of the materials and activities used in the LKPD. The LKPD product was revised 1 time based on criticism and suggestions for

suggestions so that there was a slight improvement for the perfection of the LKPD. In line with Aida (2017) suggests that the learning device developed is said to be valid if the minimum score for all aspects

improvement from the LKPD validator. The following in Figure 3 presents the results of the percentage of LKPD validators by biology teachers.
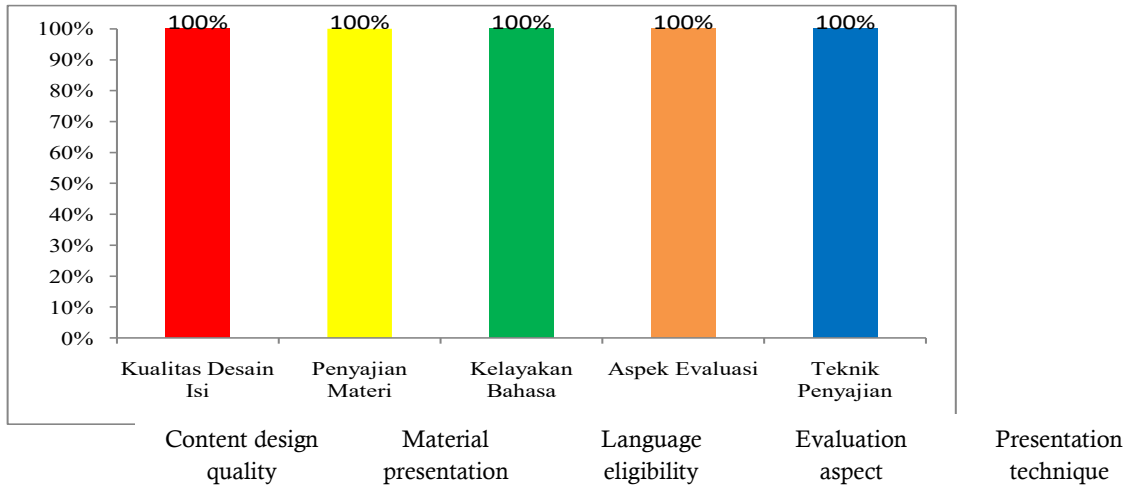
Figure 3. Validation Diagram by Biology Teacher

Based on the percentage results in Figure 3, it shows that the quality of the content design which has 15 assessment points gets a percentage value of 100%. Presentation of material that has 25 assessment points gets a percentage value of 100%. Language eligibility that has 25 points of assessment gets a percentage value of 100%. The evaluation aspect that has 25 assessment points gets a percentage value of 100%. The presentation technique which has 15 points of assessment gets a percentage value of 100% so that the overall result of the percentage value in 5 aspects is 100% with the "Very Valid" criteria. In line with Krissandi's opinion (2018), that the assessment aspects are very supportive in the creation of a good product so that products that have been validated can be used for product trials. The results of teacher validation

with an average score of 100% with a very valid category can be used during learning. The very valid category was obtained because before being validated to the LKPD biology teacher it was validated by media experts and device experts. So there are few suggestions for improvement from the teacher.

2. Product Revision

After the LKPD is validated and assessed for validity by material experts, learning device experts and biology teachers, the next step is to revise or correct the LKPD as necessary according to the criticisms and suggestions of the validators. After the LKPD is repaired, the LKPD is feasible to be used and tested.

LKPD Validator by Material Expert

Table 9. Criticism/Suggestion of Material Expert Validator

Material Validator Criticism/Suggestion
All images use images of environmental pollution in Gorontalo and write down the source.
Use standard grammar.

Based on Table 9. The material validator looks at the developed LKPD and provides input in the form of criticism and suggestions that are used as guidelines for revising the developed LKPD.

LKPD Validator by Learning Device Expert

Table 10. Criticisms/Suggestions of LKPD Validators

LKPD Validator Criticism/Suggestion
Background design changed.
Indicators and learning objectives are adjusted to the basic competencies.
Write down the syntax of the learning model used.
The image is replaced with a more visible image of the cause of environmental pollution.

Based on Table 10. The LKPD validator sees the HOTS-oriented LKPD developed and provides input in the form of criticism and suggestions that are used as guidelines for revising the developed LKPD.

LKPD Validator by Biology Teacher

Table 11. Criticisms/Suggestions for Improvement by Biology Teachers

Criticism/Suggestion for Improvement
The use of LKPD in this material is very good and interesting, because it can increase students' interest in studying the material.
The time allocation in the LKPD is adjusted to the school hours.

(Primary data, 2022)

3. Product Trial

The LKPD that has been repaired based on criticism and suggestions from the validators is continued by conducting product trials. The trial will be conducted in small groups of 15 students. During small group trials, practicality tests and product effectiveness tests were conducted.

LKPD Practical Results

The practicality of HOTS-oriented LKPD is obtained through observation of student activities, implementation of learning and student responses which can be described as follows.

Student Activity Analysis

Student activities are given a checklist that is adjusted to the syntax in the lesson plans and get results according to the recapitulation of each in three meetings (Table 12).

Table 12. Percentage of Student Activity Results

Meeting	Percentage	Average
I	86.28%	
II	85.71%	88.28%
III	92.85%	

(Primary data, 2022)

Based on Table 12. The percentage of student activities at the first meeting, second meeting, and third meeting respectively were 86.28%, 85.71% and 92.85%. So that the average percentage result becomes 88.28% with very good criteria. This is in line with Basri, et al., (2020), that the results of the analysis of student activities for three meetings have an average percentage of 81% in the very good category. This is because the appearance of the LKPD is

made attractive, which is accompanied by pictures and contextual problems so that students are motivated to find out more about the material presented in the LKPD.

Learning Implementation

The implementation of learning is given a list of checklists that are adjusted to the syntax in the lesson plans and get results according to the recapitulation of each in three meetings (Table 13).

Table 13. Percentage of Learning Implementation Results

Meeting	Percentage	Average
I	100%	
II	100%	100%
III	100%	

(Sumber :Data Primer, 2022)

Based on Table 13. The percentage of implementation at meetings I, II & III has a percentage value of 100%, so that the average percentage result is 100% with very good criteria. This is in line with Hidayati, et al (2021) that the LKPD developed is said to meet the practicality value if the results of observing the implementation of learning using the LKPD at least get a good conclusion, which is ranging from a score of 70% SR < 90% based on the criteria for the percentage of observations on the implementation of the LKPD.

Student Response

Student responses were carried out to get one of the practical results of the HOTS-oriented LKPD which was implemented at SMP Negeri 5 Gorontalo. The results of the student response questionnaire of SMP Negeri 5 Gorontalo obtained a total score of 784, when presented, it resulted in 87% of the 15 students who gave positive scores to the HOTS-oriented LKPD. Therefore, LKPD is oriented to get the "Very Eligible"

criteria to be used as teaching materials at SMP Negeri 5 Gorontalo. This is in line with the opinion of Telaumbanua & Waruwu (2022), revealing that field trials on students with 15 respondents obtained an average score of 66 with an average percentage of 88% in the very feasible category. The results of the assessment of the feasibility of the worksheet on the product trial show that the worksheets can be used in learning.

LKPD Effectiveness Results

The last trial stage, a learning device or LKPD is said to be well developed if it is tested for effectiveness. LKPD is said to be effective if students are successful in the learning process and there is consistency in the curriculum, student learning experiences and achievement of learning outcomes. Based on the objectives that refer to the effectiveness criteria, the work results of the LKPD and learning outcomes tests will be used to measure the effectiveness of the HOTS-oriented LKPD.

LKPD Work Assessment Results

Based on the assessment of work results when students work on the LKPD with groups that have been divided, the results of the group assessment are graphed in Figure 4.

Water pollution   Air pollution   Soil pollution
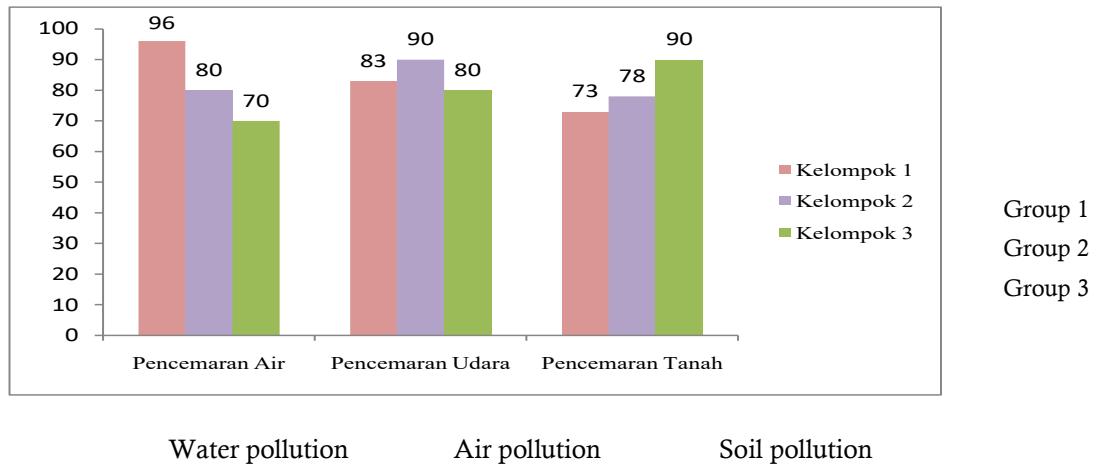
Figure 4. LKPD Work Result Assessment Diagram

Based on Figure 4. that the value of each group on environmental pollution material is declared complete with a value range of 70-96, as the maximum completeness standard value that has been set at SMP Negeri 5 Gorontalo in science subjects is 70. In line with Karsono's opinion (2017), that the learning tools or HOTS-oriented LKPD are effective in increasing the percentage of students' learning mastery so that higher-order thinking skills and student learning outcomes increase.

Pretest and Posttest Results

Students before and after working on the HOTS Oriented LKPD, were tested for learning outcomes by giving pretest and posttest questions. The results of the calculation of pretest and posttest learning outcomes can be seen in Figure 5.
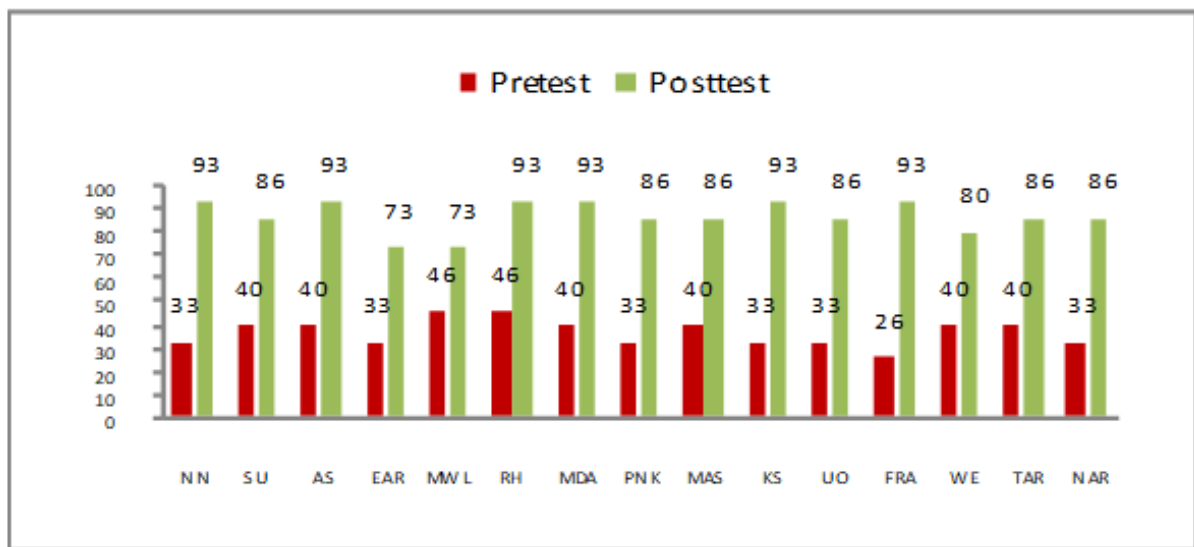
Figure 5. Diagram of Pretest and Posttest Results

Table 14. Calculation Results of N-gain

Respondent	Average		N-Gain Score	N-Gain Score %	Sig. (2-tailed)
	Pre-Test	Post-Test			
15	37.06	86.66	0.7	78	.000

(Sumber :Data Primer, 2022)

Based on Figure 5. and Table 14. that the pretest score is 100% incomplete, the lowest score is 25 and the highest is 40. While the posttest score is 100% complete, the lowest score is 73 and the highest is 93 with the KKM set at SMP Negeri 5 Gorontalo is 70. In line with the opinion, Lase & Lase (2020) that learning using an effective LKPD can improve student learning outcomes so that the majority of students are able to achieve complete learning. This can be proven by the high level of student learning completeness of 85%.

The average value of the pretest of students' learning outcomes before the learning was carried out was 37.06, then it increased on the posttest with an average of 86.66. Furthermore, the N-gain score of 0.7 is a high criterion, while the N-gain score % indicates the effectiveness of the HOTS-oriented LKPD product with a value of 78 in the effective category. In accordance with the opinion of Ramadhana & Hadi (2022), that the N-gain test is carried out to see the increase in student learning outcomes before (pretest) and after (posttest), from the calculation of the N-gain test, the N-gain value is 0.7, which refers to on the high criteria N-gain criteria. So it can be concluded from the acquisition of the N-gain value that there is an increase in learning outcomes by applying the HOTS-oriented LKPD in the high category.

CONCLUSION

Based on the results of research on the development of High Order Thinking Skills oriented LKPD on environmental pollution material (class VII students of SMP Negeri Gorontalo) that has been carried out by researchers, it can be concluded that a valid High Order Thinking Skills oriented LKPD has been developed, so that it can be used in learning. The practicality of LKPD oriented to High Order Thinking Skills is seen from three stages, namely student activities, implementation of learning and student responses to HOTS-oriented LKPD, classified in the very good criteria. The effectiveness of LKPD oriented High Order Thinking Skills is obtained from the work of LKPD in the complete category and the results of the N-gain analysis are included to the effective criteria.

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