

DEVELOPMENT OF STUDENT WORKSHEETS TO IMPROVE HIGHER ORDER THINKING SKILLS ON ACID-BASE SUBJECT

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ABSTRACT

This study aims to determine the feasibility and response of teachers and students to student worksheets to increase student HOTS using the PBL model. This study uses the R&D (Research and Development) research method, using the 4D model (Define, Design, Develop, Disseminate). Data collection techniques using a questionnaire in the form of a questionnaire. The assessment instruments used were material and media feasibility assessment sheets, teacher response questionnaires, student response questionnaires, and data analysis using a Likert scale. The feasibility of the Student Worksheet (LKPD) was assessed by 4 experts, namely two subject experts and two media experts. The feasibility of the subject obtained an average of 87.35% with the criteria of "Very Eligible" and the eligibility of the media obtained an average of 95.85% with the criteria of "Very Eligible". Furthermore, the results of teacher responses to Student Worksheets (LKPD) obtained an average of 95% with the criteria "Very Eligible" and student response results obtained an average of 91.78% with the criteria "Very Good". According to the results of the Student Worksheet (LKPD) research to improve higher-level thinking skills in acid-base material, it is stated that it is feasible to be tested in acid-base learning.

Keywords: *4D, Problem-Based Learning (PBL), Student Worksheet*

1. INTRODUCTION

Chemistry is a science that plays an important role in people's lives because humans cannot be separated from chemicals every day. Chemistry is often found in classes that teach Natural Sciences (IPA) subjects, which focus on material related to the matter, such as composition, structure, properties, transformation, dynamics, and energy of matter. There are three characteristics of chemistry that stand out, namely the balance between attitudes and behavior, skills and understanding, according to Permendikbud No. 65 of 2013 concerning process standards for primary and secondary education, the essence of the 2013 curriculum (Ainun & Rasmawan, 2021).

Chemistry learning is expected not only to provide students with as much knowledge as possible but to be able to be scientific, stimulate thinking, be creative, and be responsible for students' daily events that are relevant to chemistry lessons (Ainun & Rasmawan, 2021). One of the chemistries that must be studied is acids and bases. According to Utami et al. (2021), acids and bases are important subjects for students to learn because they are the basis for studying other chemical materials such as acid-base titrations, buffer solutions, salt hydrolysis, solubility, and solubility products.

Law No. 20 of 2003 clause 3 which discusses the National Education System states that the role of National Education for the

community is to increase capabilities and behavior as a respectable nation to realize the ideals of educating the nation's life, therefore education held in this country its role is very important in the context of producing Indonesian people who are skilled and have strong character (Hidayah et al. 2020). Education is a process in order to influence students so that they can adapt as best as possible to the environment and thus will cause changes in themselves that enable them to function strongly in social life (Wahyuni et al., 2021). However, the implementation of the goals and functions of education has not been fully realized because the formation of national identity is reduced due to education in Indonesia which has not played an optimal role.

Education is currently directed at developing abilities that refer to 21st-century skills. According to Ariyana et al. (2018) in Purwasi & Fitriyana (2020) 21st-century skills use the term known as 4Cs (critical thinking, communication, collaboration, and creativity), four skills that have been identified as very important and necessary skills for 21st-century education. Where are the four this section is part of higher-order thinking skills (HOTS). HOTS are abilities that must be present in students (Dinni, 2018).

HOTS is the ability of students to solve a problem where there are no steps to solve the problem that have been taught, which requires an explanation of these steps and has many solutions that will occur (Wahyuni et al., 2021). HOTS is a term that covers a variety of thinking skills, including critical thinking skills, logical, reflective, metacognitive, creative, non-routine, non-algorithmic problem-solving, analysis, evaluation, creating, involving concept formation, critical thinking, creativity/brainstorming, problem solving, mental representation, use of rules, reasoning, and logical thinking, and/or requires thinking to a higher level than simply restating facts (Sumaryanta, 2018; Alkarima et al., 2022).

Higher-order thinking ability is a thinking process that does not just memorize and convey information that is known to students, but is the ability to connect, manipulate, and transform existing knowledge and experience to think critically and creatively in making decisions and solving problems in new and different situations and cannot be separated from everyday life (Wahid & Karimah, 2018). Improving high-level thinking skills in students certainly requires variations in the learning process, one of which is using learning media.

Learning media is one of the teaching aids for teachers to convey teaching material, increase student creativity and increase student attention in the learning process (Lutfer, 1993). One type of

learning media that can be used to increase student motivation in learning is Student Worksheets (LKPD). LKPD is used to assist teachers in training students' skills in finding concepts through work steps and problems provided and equipped with solutions. Students can be trained to be able to solve problems related to the subject matter. In addition, students also get practical study guides because the LKPD contains learning steps that must be carried out by students. Rosa et al. (2022) said that good LKPD device design is also very much needed in order to achieve a learning process that encourages students to play a more active role. LKPD is one of the teaching media that plays an important role in giving assignments that are relevant to the material being taught.

2. LITERATURE REVIEW

2.1 Learning Media

The word "media" comes from the Latin word "medium" which means "intermediary" or "introduction". Media is a tool to convey information or teaching material that the information provider wants to convey to the recipient of the information. Learning success can be achieved with the help of teaching media. In addition, teaching media are all things both physical and technical that are relevant to the learning process and can assist teachers in making teaching materials more effective for students so that it is easier to achieve the agreed learning objectives (Hz & Daulay, 2021).

Learning media has a role, among others, to be a tool to create better learning conditions, to be one of the elements that are related to other elements so that learning conditions are created as expected, to abstract the intangible so that it can suppress verbalism, stimulate students in learning increases, students' misunderstandings about the explanations given by the teacher decrease, students who have limitations can be overcome, students and their environment interact, generate harmony in supervision, and increase children's learning motivation (Widodo, 2018).

2.2 Student Worksheets

Student worksheets are student activities that are applied in the classroom to apply or implement subject matter that has been studied beforehand. It is very important to understand student work responsibilities in order to apply and understand the information just provided using the Learner Worksheets. (Widodo, 2017). Prastowo in Ainun & Rasmawan (2021) states that LKPD is a learning aid consisting of sheets of paper containing study materials, guidelines, and tips for carrying out learning tasks that must be carried out by capable students, both experts in theory and practice. In addition, LKPD uses certain directions to collect information, manufacture products, and other similar tasks (Ainun & Rasmawan, 2021).

2.3 Problem-Based Learning Models

Problem-based learning is a type of teaching that engages students in active, collaborative, student-centered learning while also maximizing their capacity for problem-solving as well as independent learning. Problem-based learning demonstrates student involvement in learning through authentic experiences which are reflected in the student-centered chemistry curriculum. Problem-based learning promotes higher-order questions and stimulates students' thinking, thereby playing an important role in preparing students for real-world challenges. PBL is an educational method by which students develop thinking and problem-solving

skills in addition to developing their understanding of key concepts through the analysis of real-world problems. One approach in which students experience and discover their own knowledge is called PBL. In PBL, small groups of 6 to 8 students are formed with a teacher. Authentic and complex problems are given to help students make connections between theory and its application in reality, as well as develop their skills to deal with the complexities of reality. This model is considered appropriate because generic skills will be formed if encouraged by learning situations that focus on students so that students have the right to express ideas that arise from their personal learning environment that encourage active participation of students in learning (Dibyantini et al., 2021).

2.4 Higher-Order Thinking Skills

Barrat (2014) in Panggabean et al. (2021) argued that Higher Order Thinking Skill (HOTS) is a type of critical, creative, analytical thinking that enables people to think critically and creatively about information and data to solve problems. Higher-order (critical) thinking skills are the skills of studying facts, constructing ideas, defending arguments, making comparisons, building conclusions, examining arguments, and solving problems (Wenno, 2008; Walid et al., 2019). Because critical thinking skills are required when solving problems or seeking educational solutions, critical thinking skills are often referred to as "critical skills". These skills include the ability to think critically and express oneself clearly (Walid et al., 2019).

3. METHODS

The type of research used is the development method or Research and Development. Research and development, commonly abbreviated as R&D, is a specific type of research to produce certain products and test their effectiveness in society (Sugiyono, 2010; Sakdiyah et al., 2020). The development model used is the 4D model (Define, Design, Develop, Disseminate). In general, there are 4 stages in this 4D model, namely definition, design, development, and dissemination. However, this research will only be carried out until the development stage due to the limitations of the researchers. The research and development design carried out in this study is presented in Figure 1.

This research was adapted into 3 stages, namely the define, design, and development stages. In developing LKPD, this stage consists of curriculum analysis, analysis of student characteristics, material analysis, and formulating learning objectives. In curriculum analysis, an assessment of the current curriculum is carried out. The curriculum that is still valid is the 2013 curriculum. After conducting curriculum analysis, an analysis of the 2013 curriculum chemistry syllabus is carried out to determine the core competencies and basic competencies applied to the 2013 curriculum. In developing LKPD, the characteristics of students need to be known in order to compile teaching materials according to their abilities. For example, if the education of students is still low, writing in LKPD uses language and words that are easy to understand. In this study, LKPD was developed for students of class XI IPA at SMA/equivalent level with the subject of acids and bases. In material analysis, the identification of the main material to be used in LKPD is carried out. The main material used is acids and bases with sub-materials a) acid-base concept, b) indicators, and c) degree of acidity. After conducting material analysis, the formulation of learning objectives is carried out for each sub-material.

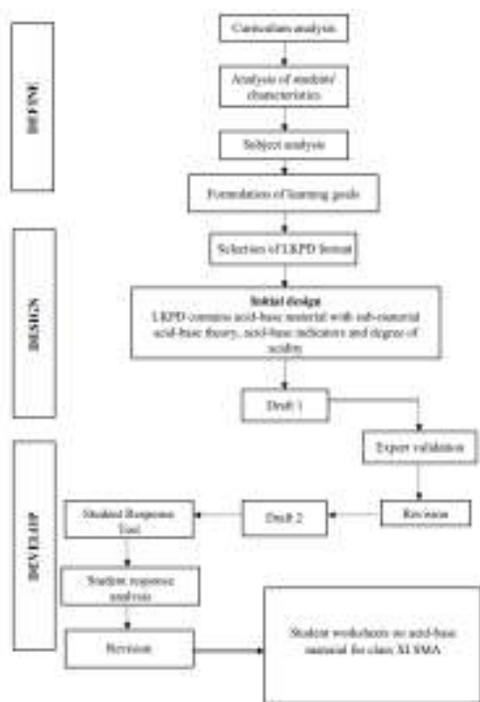


Figure 1. The 4D model scheme implemented in the study

In the design stage, the researcher makes a prototype or product design. In the development of teaching media, this stage is carried out to make Student Worksheets (LKPD) in accordance with the content framework of the results of curriculum and material analysis. Before the product design proceeds to the next stage, the product design needs to be validated. Product design validation is carried out by lecturers or teachers from the same field of study/expertise. Based on the validation results, there is a possibility that the product design still needs to be improved according to the validator's suggestions. After the product has been validated, the next step is to test the response to the teacher as a facilitator in learning activities.

In the development stage, evaluation is carried out by experts in their fields. The suggestions given are used to improve the materials and learning designs that have been prepared. Developmental testing is a product design trial activity on the actual target subject. During this trial, response data, reactions, or comments were sought from the target user of the model. The trial results are used to improve the product. After the product is repaired, it is then tested again until it obtains effective results. In this study, after the product has been designed, an analysis of students' responses to the LKPD product that has been developed will be carried out. Then from the results of the student responses, revisions were made so that the LKPD was suitable for use and dissemination.

The subjects in this study were acid-base materials. The object of this study is Student Worksheets (LKPD) based on higher-order thinking skills. The product in this study, namely LKPD, was validated for its eligibility by material expert validators, media expert validators, chemistry teachers, and students' responses to the developed LKPD were seen. In this case, the students who were the respondents were students of class XI IPA 2 at SMA Kartika 1-2 Medan.

The data generated from the results of this development is a type of quantitative data. The instrument used in this study was a validation sheet by a validator conducted by 4 expert lecturers and responses from 2 chemistry teachers. The validation sheet observed in the assessment is in the form of an LKPD validation sheet. The validator's assessment of the eligibility of the developed LKPD consists of 4 categories, namely unfeasible, less feasible, feasible, and very feasible. The next instrument is a student response questionnaire to find out student responses to high-level skill-based Student Worksheets on Acid-Base material. Questionnaires are used to obtain information related to students' opinions on student worksheets based on high-level skills that have been developed and validated by the Validator. This questionnaire will be filled out by students with a total of 10 students.

The product feasibility assessment sheet and student response questionnaire consist of several statements in the assessment aspect; each aspect has a maximum score of 5 and a minimum of 1 and the teacher's response has a maximum score of 4 and a minimum of 1. Data on the results of the LKPD eligibility validation sheet are calculated using percentage descriptive analysis. The percentage calculation uses the formula: $P = f/N \times 100\%$.

Based on these calculations, to determine the feasibility of the LKPD that has been designed and developed, percentage analysis by category is used as a reference for assessing the data generated from the validator. As for the percentage scale, that is:

Table 1. Product eligibility criteria

No.	Percentage Range (%)	Criteria
1.	81.25% - 100%	Very Worth it
2.	62.50% - 81.24%	Worthy
3.	43.75% - 62.49%	Decent Enough
4.	25% - 43.74%	Not feasible

To obtain data on the results of student responses to the developed LKPD, a questionnaire was used which was circulated to students. The purpose of the questionnaire is to find out student responses to use LKPD in the learning process. After the data is analyzed, then the data is presented in the form of a percentage (%) in the questionnaire assessment percentage table with the following categories:

Table 2. Percentage and Criteria for Student Response Sheets

No	Appraisal Percentage (%)	Criteria
1.	80-100	Very well
2.	66-75	Good
3.	50-65	Enough

4.	36-49	Not enough
5.	0-35	Failed

4. RESULTS & DISCUSSION

4.1 Results

Student Worksheets (LKPD) which were developed using the Problem-Based Learning model to improve higher-order thinking skills or High Order Thinking Skills (HOTS) in acid and base material were validated by material expert lecturers and media experts based on the eligibility instrument according to BSNP and responded to by the teacher chemistry. Validation is carried out by providing material and media expert questionnaires using a Likert scale ranging from 1 to 5. To obtain the percentage results of the eligibility of the BSNP, it is calculated by the total score of the answers divided by the maximum expected score and multiplied by 100%, then obtained the percentage analysis criteria that the LKPD is feasibly used.

Material expert validation instruments were given to 2 expert validators in their fields, namely lecturers majoring in chemistry at Medan State University. The percentage of results from the validation assessment of LKPD developed according to the BSNP standards can be seen below.

Table 3. Subject Expert Validator Percentage Assessment Results

No	Assesment Aspect	Appraisal Percentage (%)		Average (%)
		Lecturer 1	Lecturer 2	
1	Content Eligibility Aspects	85	93.33	89.17
2	Presentation Feasibility Aspects	82	86	84.00
3	Aspects of Language Feasibility	82.22	95.56	88.89
Overall Average (%)				87.35
Results Criteria				Very Worth It

Based on the assessment percentage table 3, the percentage results from the 3 aspects of the assessment obtained an average of 87.35% with very worth-it results from the criteria. The average percentage was obtained based on the assessment of the chemistry department lecturer at Medan State University until it was found that the LKPD was very suitable for use according to the BSNP.

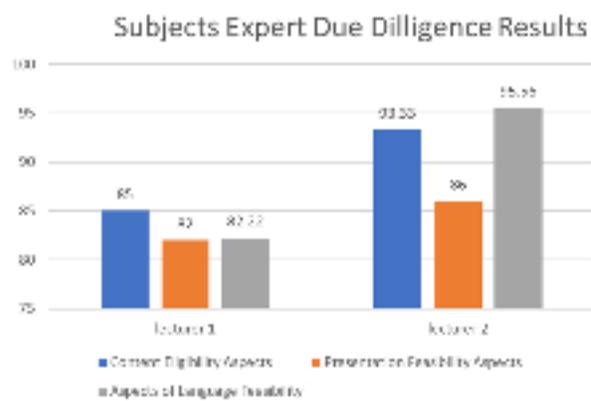


Figure 2. LKPD Assessment Diagram by the Material Expert Validator

In the Figure 2, the material expert's assessment consists of several aspects, namely content feasibility aspects, presentation feasibility aspects, and language feasibility aspects. In terms of content feasibility, the average of the two validators obtained 89.17%, in the aspect of the appropriateness of presentation, the average of the two validators obtained 84.00%, and in the aspect of language feasibility, the average of the two validators obtained 88.89%.

Media expert validation instruments were given to 2 expert validators in their fields, namely lecturers majoring in chemistry at Medan State University. The percentage of results from the validation assessment of LKPD developed according to the BSNP standards can be seen below.

Table 4. Media Expert Validator Percentage Rating Results

No	Assesment Aspects	Average Percentage (%)		Average (%)
		Lecturer 1	Lecturer 2	
1	LKPD Size	100	100	100
2	LKPD Cover Design	94.29	88.57	91.43
3	LKPD Content Design	97.78	94.44	96.11
Overall Average (%)				95.85
Results Criteria				Very Worth It

Based on the assessment percentage table 4, the percentage results from the 3 aspects of the assessment obtained an average of 95.85% with very decent results criteria. The average percentage was obtained based on the assessment of the chemistry department lecturer at Medan State University until it was found that the LKPD was very suitable for use according to the BSNP.

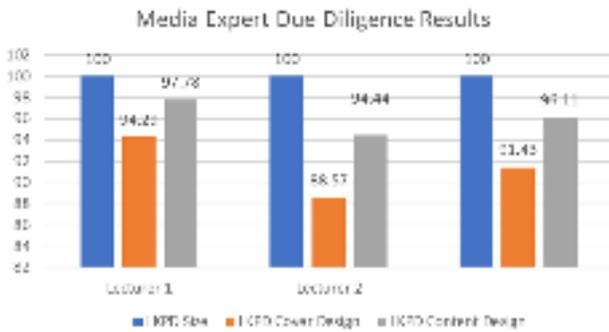


Figure 3. LKPD Assessment Diagram by Media Expert Validator

In the figure 3, the media expert's assessment consists of graphical aspects, namely the size of the LKPD, the design of the LKPD cover, and the design of the LKPD content. In the aspect of LKPD size, the average percentage of the two validators obtained 100%, in the aspect of LKPD cover design the average percentage of the two validators obtained 91.43%, and in the design aspect of the content of LKPD, the average percentage of the two validators obtained 96.11%.

Teacher response questionnaires were given to 2 high school chemistry teachers from SMA Negeri 1 Stabat and SMA Swasta Kartika I-2 Medan. The questionnaire contains 15 teacher response statements and suggestions for LKPD which have been developed according to the Problem-Based Learning model to improve students' higher-order thinking skills. This teacher response questionnaire uses a Likert scale with a scale of 1 to 4. Following are the results of the percentage of teacher response assessments on the developed LKPD:

Table 5. Results Percentage of Teacher Response Assessment

No	Evaluator	Average Percentage (%)
1	Teacher 1	91.67
2	Teacher 2	98.33
Total Average Percentage (%)		95.00
Results Criteria		Very Worth It

Based on the teacher response assessment percentage table 5, the percentage results from 2 teachers obtained an average of 95% with very decent results criteria. The average percentage was obtained based on the assessment of teachers in the field of chemistry studies so it was found that the LKPD was very suitable for use in learning.

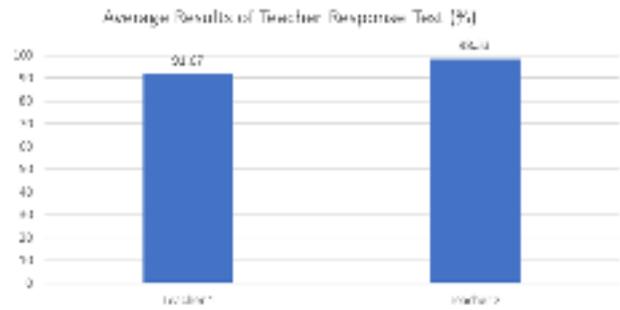


Figure 4. Teacher Response Assessment Chart

In the Figure 4, teacher 1's assessment of the chemistry LKPD that has been developed is found to have an average percentage value of 91.67%. In teacher assessment 2, it was found that the average percentage value was 98.33%.

A limited trial to find out student responses to LKPD was carried out using a questionnaire given to 10 students of class XI IPA 2 SMA Kartika I-2 Medan. In the questionnaire given there were 15 questions which were divided into 3 aspects, namely aspects of interest, material aspects, and language aspects. This student response questionnaire uses the Likert scale method with a rating range of 1 to 5. Following are the results of the percentage of student response assessments on the Student Worksheets (LKPD) that have been developed.

Table 6. Results Percentage of Student Response Assessment

No	Assessment Aspect	Average (%)
1	Interest	91.33
2	Subject matter	91.33
3	Language	92.67
Average Percentage Total (%)		91.78
Results Criteria		Very Well

Based on the table 6 on the percentage of the limited trial assessment with the student response test above, the percentage results of 10 students obtained an average of 91.78% with very good criteria. The average percentage is obtained based on an assessment of student responses to the LKPD that has been developed so that it is found that the LKPD is very suitable for use in learning and students' high-level skills are expected to increase when using this Student Worksheet (LKPD).

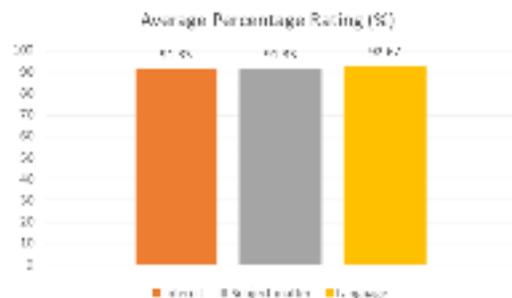


Figure 5. Student Response Assessment Diagram

In the Figure 5, the assessment of student responses consists of aspects of interest, material aspects, and language aspects. In the aspect of interest, the average percentage of student responses was

obtained 91.33%, in the material aspect the average percentage of student responses was obtained 91.33%, and in the language aspect, the average percentage of student responses was obtained 92.67% with the highest rating being in the Language.

4.2 Discussion

Student worksheets (LKPD) on acid-base materials are made using the Problem-Based Learning model in each of its activities. The PBL model itself is used to improve students' higher order-thinking skills. Zahid (in Inayati, 2020) states that PBL has the goal of increasing the ability to apply concepts to new or real problems, integrating the HOTS concept of desire in learning, self-direction, and skills. Therefore, the LKPD developed uses the PBL model so students are expected to be able to understand HOTS (High Order Thinking Skill) learning. The design of this LKPD was started by analyzing the chemistry syllabus according to the 2013 curriculum, understanding basic competencies and core competencies, developing learning objectives from core competencies, and determining acid-base materials to be used according to the 2013 curriculum.

1) Material eligibility

In the instrument used, namely the eligibility instrument according to the BSNP standard (National Education Standards Agency) there are 3 aspects in the material expert validation. The assessment aspects contained in the instrument are (a) content feasibility aspects and (b) presentation feasibility aspects and language feasibility aspects. Based on the assessment of the three aspects of the material experts above, the percentage of the assessment obtained from the three aspects, namely 89.17%, 84%, and 88.89% where the results category of the assessment of each aspect obtained results that were very feasible to use. The average percentage of the overall value of the three aspects is 87.35% with a very feasible category to use. This means that the developed LKPD is suitable for use and is in accordance with BSNP standards.

2) Media eligibility

In the instrument used, namely the eligibility instrument according to the BSNP standard (National Education Standards Agency) there is 1 aspect of media expert validation. The assessment aspect contained in the instrument is the graphical feasibility aspect. After obtaining the percentage value of each validator, then average it so that it gets an average percentage value of 95.85% and obtains a very feasible category to use. This shows that the LKPD that has been developed is in accordance with the existing indicators on the graphical feasibility aspect.

3) Teacher response

After the LKPD was validated by experts, a teacher response assessment test was carried out. The teacher's response to the PBL-based LKPD to improve students' higher-order thinking skills had a good response based on the percentage of ratings from the questionnaire distributed. The teacher's response assessment instrument is in the form of a statement questionnaire totaling 15 response statements regarding the LKPD that has been developed. The assessment of the teacher's response was carried out by 2 chemistry teachers who each came from different agencies, namely SMA Negeri 1 Stabat and SMA Swasta Kartika I-2 Medan. The percentage of assessment obtained from Teacher 1 was 91.67% and Teacher 2 was 98.33%. With an overall average percentage of 95%, this shows that the LKPD with the PBL model that has been developed is very suitable for use in the learning process.

4) Student response

After revisions were made based on the suggestions of subject expert validators, media experts, and chemistry study teachers, a limited trial was carried out or a test of student responses to the LKPD that had been developed. This trial was conducted on 10 students of XI IPA 2 SMA Kartika I-2 Medan. In this student response test, an assessment was carried out using a questionnaire instrument with 15 statements which were divided into 3 aspects, namely aspects of interest, subject matter aspects, and language aspects. The student response test stage is carried out directly (face to face) by distributing the Google Form link to XI IPA 2 students.

The percentage obtained on the interesting aspect was 91.33%, the subject matter aspect was 91.33% and the language aspect was 92.67% with a total average percentage of 91.78% in a very good results category. This indicates that the student's response to the developed LKPD has a positive response so that the acid-base LKPD can already be used in the learning process. Based on student assessments, it can be concluded that students are interested in this LKPD so students' interest in learning also becomes higher.

Based on the results of the research and analysis that has been carried out, it can be concluded that the Acid-base Student Worksheets have met the eligibility criteria according to the BSNP (National Education Standards Agency) based on the aspects of content eligibility, presentation eligibility, and language eligibility which obtained an average percentage of 87.35% in the very proper category and the graphic aspect which obtained an average percentage of 95.85% in the very decent category and received a positive response from students by obtaining an average percentage of 91.78% in the very good category.

5. CONCLUSION

Based on the results of the research and analysis that has been carried out, it can be concluded that the Acid-base Student Worksheets have met the eligibility criteria according to the BSNP (National Education Standards Agency) based on the aspects of content eligibility, presentation eligibility, and language eligibility which obtained an average percentage of 87.35% in the very proper category and the graphic aspect which obtained an average percentage of 95.85% in the very decent category and received a positive response from students by obtaining an average percentage of 91.78% in the very good category. Suggestions from the research that has been done are that it is necessary to follow up or implement the Student Worksheets that have been developed so that these LKPDs can be used as learning materials in chemistry learning.

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