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DEVELOPMENT OF STUDENT WORK SHEET TO IMPROVE HIGHER ORDER THINKING SKILLS ON CHEMICAL EQUILIBRIUM MATERIAL

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ABSTRACT
This study aims to develop learning media for Student Worksheets (LKPD) using the Problem-Based Learning (PBL) model on chemical equilibrium material that is valid and effective. The research uses the 4D model R&D method, but the research steps carried out are only up to 3D, namely Define, Design, and Develop. The instruments used were non-test instruments in the form of validation sheets under BSNP standards and questionnaires for teacher and student responses to the developed LKPD. The results showed that the developed LKPD met the eligibility criteria according to the BSNP standards which were validated by the material expert validator and the media expert validator who is a Universitas Medan (UNIMED) chemistry lecturer by obtaining an average percentage score from the material expert validator of 82.69% with the "decent" criteria. and the average percentage of media expert validators is 94.63% with the criteria of "Very feasible". Meanwhile, based on the results of the teacher's response questionnaire to the designed LKPD, the average percentage result was 85.83% with the "High" criteria and the average percentage of student response questionnaires was 92% with the "Very Interested" criteria. So that the LKPD developed to improve higher-level thinking skills is appropriate for use in the chemistry learning process, especially in chemical equilibrium material.
Keywords: *4D, Development, Student Worksheets, Higher Order Thinking Skills, Thermochemical Topic*

1. INTRODUCTION
Education plays an important role in preparing high-quality human resources. Therefore, education should be developed, both in terms of quality and quantity (Anggraeni et al., 2018). According to the Minister of Education and Culture No. 21 of 2016 concerning Content Standards for Elementary and Secondary Education states that the future competency needs of students are students who can have high-order thinking skills (HOTS). The 2013 curriculum that is currently applied in Indonesia is designed to increase students' ability to think critically and creatively (Fitria et al., 2020). However, in reality, students are still less directed to be able to master higher-order thinking skills. HOTS directs students to understand and interpret information. HOTS makes students able to become active learners. Although active learning is a challenging lesson, it can be packaged in an exciting and interesting concept (Conklin & Materials, 2012).

Chemistry is one of the subjects that is considered difficult for students. The causes of difficulties in learning chemistry include the many chemical concepts that not all students can think well about, from simple concepts to more complex concepts, it requires a correct understanding of the basic concepts that build these concepts. (Hapsah et al., 2019). One of them is chemical equilibrium material according to the statement of Kadhafi, et al (2013) which states that one of the chemical materials whose concepts are mostly abstract is chemical equilibrium, which makes it difficult to observe with the naked eye (microscopic level). The characteristics of chemical equilibrium material which are abstract are likely to cause students to experience difficulties in understanding the concepts contained therein, as well as the lack of media that helps to learn makes it increasingly difficult for students to understand the material in equilibrium.

To help the learning process of chemistry can be assisted by using media. According to Muson (2010), media is a container for messages that the source or distributor wants to forward to the target or recipient of the message. Therefore, to increase the effectiveness and efficiency of learning, it is necessary to develop various creative and innovative learning media. This needs to be done so that the learning process does not seem less interesting, monotonous, and boring so as not to hinder the learning process. Therefore the role of the media in the learning process is important because it will make the learning process more varied and not boring. Besides that, the use of media also aims to convey learning messages, to achieve the goals obtained from the learning process that has been carried out.

One of the media that can be used to help to learn is the Student Worksheet (LKPD). According to Prastowo (2015), LKPD is a sheet in the form of materials, summaries, and instructions in the form of steps to be able to complete assignments that must be carried out by students. Therefore, in the learning process, worksheets are needed that are following the conditions of students and the condition of existing schools. In addition, LKPD must be interesting, and easy to understand by linking existing concepts and by everyday life to provide meaningful learning (Lathifah et al., 2021).

The learning model that is suitable and can be implemented in student worksheets that are following the demands of the 2013 curriculum is Problem-Based Learning (PBL). According to Sani (2014), the PBL model is learning in which delivery is carried out by presenting a problem, asking questions, facilitating investigations, and opening dialogues. The problems studied should be contextual problems found by students in everyday life.

From the statements above a media development will be carried out, namely LKPD, bearing in mind that LKPD is something that must be owned by teachers and students in the learning process,

where the LKPD developed is LKPD based on PBL, this is done because the learning process with PBL will be able to activate students in answering or solving every problem that exists in the LKPD presented and the problems are also related to the context of everyday life, one of which is chemical equilibrium material so that students will be happier in these learning activities, and have an impact on the improvement of critical thinking skills during the process of solving the problem. In learning it is important to develop worksheets based on HOTS to train students in developing their thinking skills and as critical and creative educational subjects to get used to solving questions that fall into the categories of analyzing, evaluating, and creating. indirectly making students able to face future challenges in the global competition for the decision-making process and solving a problem (Noprianda & Soleh, 2019).

2. LITERATURE REVIEW

2.1 Learning Media

According to AECT (Association of Education and Communication Technology) quoted by Basyaruddin (2002), "media is any form used for the process of disseminating information". Meanwhile, according to (Adam et al., 2015) that learning media is everything both physical and technical in the learning process that can help teachers to facilitate the delivery of subject matter to students to facilitate the achievement of predetermined learning objectives.

The role of learning media in the learning and teaching process is very important for educators to carry out at this time, because role of learning media can be used to channel messages from senders to recipients, and learning media can also help students to explain something conveyed by educators. With the use of these tools teachers and students can communicate more steadily and lively and the interaction is multidirectional. The media contains messages as learning stimulants and can foster learning motivation so students do not become bored in achieving learning goals (Putra Sumberharjo, et al, 2015).

2.2 Student Worksheets

Student worksheets are a learning tool that can be used by teachers to increase student involvement or activity in the teaching and learning process (Noprianda & Soleh, 2019). LKPD is a type of learning aid. In general, worksheets are learning tools as a complement or a means of supporting the implementation of learning plans. LKPD is in the form of sheets of paper in the form of information and questions (questions that must be answered by students (Hamdani, 2011).

Thus, it can be concluded that LKPD is a learning resource in the form of assignment sheets, instructions for carrying out tasks, and learning evaluations that must be done by students which are made on the basic competencies that must be achieved (Pawestri & Zulfiati, 2020).

2.3 Problem-Based Learning Models

PBL is a learning method that is triggered by problems, which encourages students to learn and work cooperatively in groups to find solutions, think critically and analytically, and be able to determine and use appropriate learning resources. Problem Based Learning is curriculum development and learning process. In the curriculum, problems are designed that require students to gain important knowledge, make them proficient in solving problems, and have their learning strategies and skills to participate in teams. The learning process uses a systemic approach to solving problems or challenges that are needed in everyday life (Hotimah, 2020).

The PBL model is characterized by the use of real-life problems as something that students have to learn. With the PBL model, students are expected to gain more skills than memorized knowledge. Ranging from problem-solving skills, critical thinking skills, skills to work in groups, interpersonal and communication skills, as well as skills in searching and processing information (Amir, 2007).

2.4 Higher-Order Thinking Skills

HOTS is a characteristic including critical thinking and creative thinking. Critical and creative thinking are two very basic human abilities because critical thinking and creative thinking can encourage a person to always look at every problem faced critically, and try to find solutions creatively so that new things are obtained that are better and more useful for their lives (Zaenal & Heri, 2015). In addition, HOTS have characteristics, such as the definition expressed by Resnick, namely non-algorithmic, complex in nature, multiple solutions (having many solutions), involving variations in decision making and interpretation, application of multiple criteria (many criteria), and effortful (requires a lot of effort) (Zaenal & Heri, 2015). According to Bloom, Kratwhwol, & Anderson, there are six levels of students' thinking in thinking, namely remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6).

3. METHODS

Research and development (R & D) methods are research methods used to produce certain products and test the effectiveness of these products. (Sugiyono, 2012: 407). The research method used in this research is the research design of the 4-D model development (Four D Models). This includes 4 stages, namely the define, design, develop and disseminate stages, which in this study the researchers only carried out until the development stage. which can be explained as follows:

In this definition stage it is useful to determine and define the needs in the learning process and to collect various information related to the LKPD that will be developed. This stage is divided into several steps, namely:

1. Front-end Analysis

At this stage, an analysis of the curriculum was carried out, because the learning process carried out was guided by the curriculum, namely the 2013 curriculum, where the 2013 curriculum itself prioritized understanding, skills, and character education, where students were required to understand the material, be active in the process of discussion and presentation. Then the analysis is based on the learning process, especially on chemical equilibrium material taught by lecture and discussion methods. For average use of media, not all schools provide projector and the number of projectors is still lacking.

2. Learner Analysis

The characteristics of students are not only seen in their grades, but from the attitudes, they show during learning. The results of observations in class show that students tend to be passive in participating in learning. Students are busy taking notes on the material presented by the teacher and after the teacher finishes

explaining, the students change to being busy doing the exercises given by the teacher. Students tend to be passive and follow monotonous learning scenarios. Students rarely ask questions because they do not have the opportunity to ask questions.

3. Task Analysis

Task analysis is analyzing Core Competencies (KI), Basic Competencies (KD), and subject matter so that learning indicators can be formulated. Based on the identification results (KD) and (KI) contained in the syllabus, several learning indicators are described. For the learning indicators that have been described, the researcher designed worksheets based on the PBL model that can help teachers and students in the learning process of chemical equilibrium.

4. Concept Analysis

Concept analysis is the identification of the main concepts in the material that will be discussed. The main concept to be discussed is chemical equilibrium material. The main concepts identified are dynamic equilibrium, shifts in the direction of equilibrium, and equilibrium constants (Kc and Kp).

5. Specifying Instructional Objectives

Based on the task analysis and concept analysis, the learning objectives can be formulated. This analysis is used as a basis for constructing the learning media that is developed. The learning objectives are as follows: 1. Students can explain the concept of reversible and irreversible chemical equilibrium after watching the experimental video correctly 2. Students can explain homogeneous and heterogeneous equilibrium after watching the experimental video correctly 3. Students can explain the characteristics of dynamic equilibrium after watching the experimental video correctly 4. Students can determine the price of the equilibrium constant based on concentration (Kc) 5. Students can determine the price of the equilibrium constant based on pressure (Kp) 6. Students can determine the relationship between Kc and Kp 7. Students can determine the degree of dissociation (á) 8. Students can analyze the effect of concentration on shifts in the direction of equilibrium after carrying out practicum 9. Students can analyze the effect of temperature on shifts in the direction of equilibrium after carrying out practicum 10. Students can analyze the effect of pressure and volume on shifts in the direction of equilibrium after seeing video 11. Students can analyze the application of chemical equilibrium in the body 12. Students can analyze the application of chemical equilibrium in the industrial field.

Next is the design stage where after the learning indicators are formulated, and the concepts are defined, the next step is to design PBL-based chemistry learning media, namely as follows: (a) Designing LKPD which is carried out by selecting a format that is under the BSNP standard writing format (b) Determine the title of the subject matter to be developed by the LKPD based on the PBL model. (c) Determine the Basic Competence to be developed by PBL-based LKPD. (d) Based on the results of KD identification, the next step is to describe the learning indicators to be achieved. (e) Designing a model that is following the learning indicators to be achieved. (f) Based on the model presented in the LKPD, key questions are made so that students can find concepts by observing and investigating the model given. (g) Further training is given which is a direct application of the concept, so it can help students in strengthening the concept.

After the defining and designing phases of LKPD have been completed, it is necessary to take the next step, namely the development stage. At the development stage, several steps need to be taken, namely, LKPD validation, namely material validation, and media validation carried out by experts, then distributing response questionnaires to teachers and students.

After the data is obtained, then data analysis is carried out. The goal is to process data into information so that the characteristics of the data become easy to understand and also useful for finding solutions to research problems. Thus, the data analyzed in this study were the results of the expert team's validation of the PBL-based LKPD on chemical equilibrium material and the results of the questionnaire/response of students and teachers to LKPD via questionnaires.

LKPD validation and distribution of teacher and student response questionnaires were carried out to show compatibility between the drafting theory and the compiled LKPD, determining whether the LKPD that had been made was sufficiently feasible, feasible, or not feasible. Whether or not an LKPD is appropriate is determined by the suitability of the validation results with the specified validity criteria. LKPD validation was carried out by 4 lecturers where 2 lecturers for subject validation and 2 lecturers for media validation, and for responses from 2 chemistry teachers. The LKPD validation sheet and student response questionnaire contained 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 x 100%.

Table 1. LKPD Validation Sheet

No.	Percentage Range (%)	Criteria
1	85% - 100%	Very Worth it
2	70% - 85%	Worthy
3	50% - 70%	Not Worth It
4	1% - 50%	Not feasible
5	<15%	Very unworthy

To obtain data on the results of questionnaires on teacher and student responses to the developed LKPD, a questionnaire was used which was circulated to teachers and students. The questionnaire aims to find out the response of teachers and students in using worksheets in the learning process. After the data has been analyzed, then the data is presented in percentage form (%) to the questionnaire assessment percentage table with the following categories:

Table 2. Teacher and Student Response Questionnaire

No.	Percentage Range (%)	Criteria
1	81-100%	Very interested
2	61-80%	Interested

3	41-60%	Less Interested
4	21-40%	Not interested
5	< 21%	Very Disinterested

4. RESULTS & DISCUSSION

PBL-based LKPD on chemical equilibrium material is validated by providing material and media instrument sheets to the material expert and media expert validators. In the subject and media instruments, researchers used a Likert scale with a range of 1-5. To get the results of eligibility according to BNSP, the total score of answers can be used to obtain the percentage of validation answers for each aspect which will be divided by the expected maximum score which will be multiplied by 100%, then the percentage analysis validation criteria is obtained. Below are the results of the validation on chemical equilibrium material.

Subject expert validation instruments were given to material expert validators, namely two UNIMED chemistry lecturers. The results of the presentation assessment of subject validation assessment of student worksheets by lecturers under BSNP standards can be seen below.

Table 3. Subject expert validator assessment results

No	Assessment Aspects	Average Percentage (%)		Average (%)
		Lecturer 1	Lecturer 2	
1	Content Eligibility Aspects	93.33	81.67	87.50
2	Presentation Feasibility Aspects	78	72	75.00
3	Aspects of Language Feasibility	91.11	80.00	85.56
Average (%)				82.69
Results Criteria				Worthy

From Table 3, we can conclude that the assessment of material validation based on BSNP on LKPD based on the PBL model on chemical equilibrium material obtained an average of 82.96. The average value was obtained based on the UNIMED chemistry lecturer's assessment so that it was stated that the LKPD was suitable for use according to the BSNP.

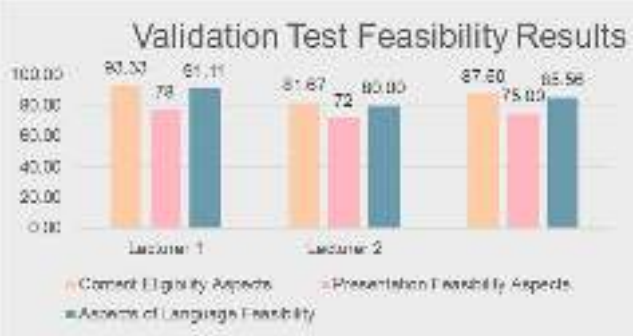

Figure 2. LKPD Assessment Diagram by the subject Expert Validator

Based on the results of the research that has been shown in the form of the diagram above based on aspects, namely the content feasibility aspect with an average value of 87.50, the presentation feasibility aspect with an average value of 75.00, and the language feasibility aspect with an average value of 85.56 which has been given by the subject expert.

Media expert validation instruments were given to media expert validators, namely two UNIMED chemistry lecturers. The results of the presentation assessment of the validation assessment of student worksheets courses by lecturers according to the BSNP standards can be seen below.

Table 4. Media Expert Validator Assessment Results

No	Assessment Aspects	Average Percentage (%)		Average (%)
		Lecturer 1	Lecturer 2	
1	LKPD size	100	100	100.00
2	LKPD Cover Design	94.29	85.71	90.00
3	LKPD Content Design	93.33	94.44	93.89
Average (%)				94.63
Results Criteria				Very Worth it

From Table 4, we can conclude that the assessment of media validation based on BSNP on LKPD based on the PBL model on chemical equilibrium material obtained an average of 94.63. The average value was obtained based on the assessment of the UNIMED chemistry lecturer so that it was stated that the LKPD was very suitable for use according to the BSNP.

Figure 3. LKPD Assessment Diagram by Media Expert Validator

Based on the results of the research that has been shown in the form of a diagram above based on aspects, namely the size of the LKPD with an average value of 100.00, the cover design of the LKPD with an average value of 90.00, and the design of the contents of the LKPD with an average value of 93.89 which has been given by media expert.

After the PBL model-based LKPD on chemical equilibrium material was validated by the validator then a limited trial was carried out to find out the teacher's and students' responses to the LKPD made by the questionnaire given to two teachers and 10 class 11 students MIA 1 private Kartika I-2 Medan. The questionnaire uses a Likert scale of 1-4 for teachers, while for students 1-5. The following is the result of the presentation of the assessment of the teacher's and students' responses to the PBL model-based LKPD on chemical equilibrium material.

The teacher's response questionnaire was given to the teacher, namely two high school teachers from the presentation results of the media response questionnaire assessment in the form of LKPD by the teacher which can be seen below.

Table 5. Percentage of Teacher Response Assessment Results

No	Evaluator	Average Percentage (%)
1	Teacher 1	91.67
2	Teacher 2	80.00
Total Average Percentage (%)		85.83
Results Criteria		Very interested

From Table 5, it can be seen that the results of the teacher's response to the PBL model-based LKPD on chemical equilibrium material obtained an average of 85.33. From these data, it can be seen that the teacher's response was very high.

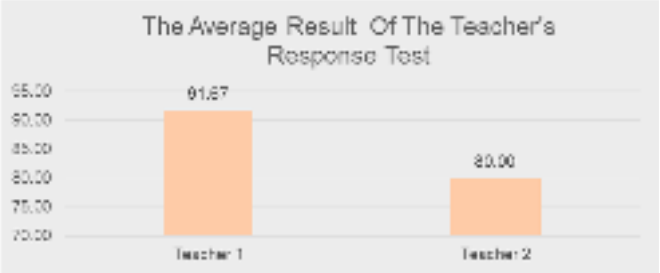

Figure 4. Teacher Response Assessment Diagram

Based on the results of the LKPD research which has been shown in the form of the diagram above which has been given to teachers where the results of the teacher 1 response questionnaire have a value of 91.67, and teacher 2 has a value of 80.00.

Student response questionnaires were given to students, namely 10 high school students from the presented results of the media response questionnaire assessment in the form of LKPD by students which can be seen below.

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Table 6. Percentage of Student Response Assessment Results

No	Assessment Aspects	Average (%)
1	Interest	91.00
2	Subject Matter	89.67
3	Language	95.33
Total Percentage (%)		92
Results Criteria		Very Worth it

From Table 6, we can conclude that the questionnaire assessment of student responses to LKPD based on the PBL model on chemical equilibrium material obtained an average of 92. From this average value, it can be seen that student responses are very interesting, students are expected to understand more when using the PBL model-based LKPD on chemical equilibrium material.

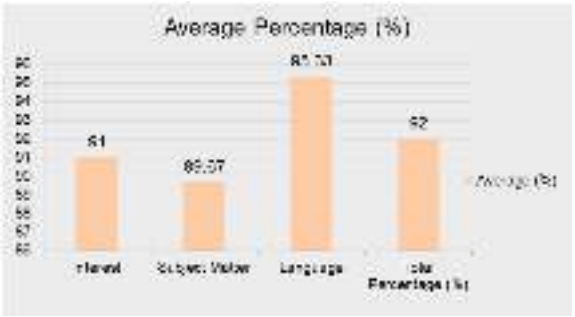

Figure 5. Student Response Assessment Diagram

Based on the results of the research that has been shown in the form of a diagram above based on aspects, namely interest with an average score of 91.00, subject matter with an average score of 89.67, and language with an average score of 95.33 which has been given by students.

This shows that the LKPD based on the PBL model developed has a positive response, and is good in every aspect. so, it can be concluded that the LKPD based on the PBL model is suitable for use as a learning medium based on the results of the percentage values of LKPD validation by experts, and the results of the percentage values of teachers and student.

5. CONCLUSION

Based on the results of the PBL model-based LKPD development research on the R&D research method, this research focuses on the "define, design, and develop" stages. This research has produced a product in the form of PBL-based worksheets to improve the high-level thinking skills of 11th-grade high school students. LKPD based on the PBL model on the chemical equilibrium material that has been compiled already meets the eligibility criteria according to the BSNP standard based on the eligibility aspects of the content eligibility aspects of presentation eligibility aspects and language eligibility aspects obtained an average presentation of 82.69% with valid/decent criteria and based on the eligibility aspect of the media, an average percentage of 94.63% is obtained with valid/decent criteria. Student responses to LKPD based on the PBL model on chemical equilibrium material for chemistry learning were very high with an average percentage of 92%.

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