Development of Teaching Materials Based on Problem Based Learning (PBL) Models in Chemistry Materials for Grade XI SMA/MA

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Abstract. This research is development research the purpose of this study was to produce Problem Based Learning chemistry teaching materials with buffer solution materials. The development model used is the ADDIE model which is based on 3 stages namely (Analysis, Design, Development). The validators in this study were material expert lectures, media experts, and chemistry teachers. The results of the validation of this product have an average value that is classified as valid without the need for revision (3,68), while according to a review of 3 chemistry teachers, the average value is also valid without the need for revision (3 , 80). The results of the study indicate that the chemistry teaching materials in the buffer solution material were classified as valid to be used as a learning resource for students.

Keywords: teaching materials, Problem Based learning, Buffer Solutions, Validity.

1 Introduction

In the world of education, the government, especially the Ministry of Education and Culture or (Kemendikbud) always makes efforts to improve the quality of education globally, from the most beginner level, namely Kindergarten, Middle School/MTs, High School/MA to the highest, namely the Higher Education level [1]. One of the efforts made by the government is changing the curriculum which is expected to improve the quality of education in Indonesia, where the curriculum refers to the standard process of primary and secondary education, which regulates the planning of the learning process which provides conditions for teachers, namely in the development of lesson plans or learning resources.

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According to [2] the teacher is not only a learning resource that has an important role in implementing the learning process in achieving Core competencies (IC) and Basic Competence (KD). However, there are teaching materials that play an important role in achieving the KI and KD. Therefore, teachers are expected to be able to develop teaching materials that will be used as a source of learning.

In learning chemistry in class teaching materials such as handbooks owned by teachers and students tend to be the same. Generally, handbooks owned by teachers and students from several publishers contain more explanations of material or concepts, examples of questions and practice questions that students must do. And not yet integrated with science and technology. Existing sample questions also do not stimulate students' critical thinking skills, so that many students experience difficulties in solving practice questions[3].

Based on the observations of researchers at MAS Daarul Muhsinin, there are still very few students in school who have an interest in chemistry. This is due to the lack of teaching materials available at this school, and the teaching materials used are still not integrated with PBL, causing low student learning outcomes in the field of chemistry, and not many students have critical thinking skills.

According to[4] one of the efforts to improve the quality of education is to obtain quality learning resources, which can be achieved through quality teaching materials. Quality teaching materials must be able to convey material in accordance with the curriculum, follow the development of science and technology, and bridge learning so that the specified competencies can be achieved. Furthermore, integrating character into teaching materials through innovative learning and education can open up opportunities to improve the quality of good character education and advance national culture in Indonesia. Some of the qualities needed to make books a source of learning, such as their accessibility to students, can help students learn and meet their needs for independent learning. Good teaching materials must be able to stimulate students by incorporating interesting elements such as graphics, illustrations, and examples of problems (case studies), and have sufficient material to enable teaching and problem solving activities. Textbooks are useful for gaining insight into the learning process, as well as offering a roadmap for examined learning materials and practical methods for exploring standard information more thoroughly.

Learning innovation is very important to improve student achievement in chemical disciplines because it is related to the quality of education of graduates who have difficulty finding careers in chemistry as well as having enough material to enable teaching and problem-solving activities. Textbooks are useful for gaining insight into the learning process, as well as offering a roadmap for examined learning materials and practical methods for exploring standard information more thoroughly. Learning innovation is very important to improve student achievement in chemical disciplines because it is related to the quality of education of graduates who have difficulty finding careers in chemistry as well as having enough material to enable teaching and problem-solving activities. Textbooks are useful for gaining insight into the learning process, as well as offering a roadmap for examined learning materials and practical methods for exploring standard information more thoroughly. Learning innovation is very important to improve student achievement in chemical disciplines because it is related to the quality of education of graduates who have difficulty finding careers in chemistry [5] two Methods.

The type of research used is Research and Development Research and Development (R&D). This research refers to the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). However, this research only reached the development stage. In the Analysis stage, at this stage the researcher conducts an analysis of the teaching materials used and makes observations regarding what teaching materials are needed at school, then the researcher conducts the research stage, namely at the Design stage, at this stage a design is carried out regarding the teaching materials to be made and then the Development stage, namely development of teaching materials, validation tests by experts, and teachers. Data collection in this study was carried out using a validation test analysis questionnaire by experts. The questionnaire was prepared based on the student teaching material assessment instruments issued by the BSNP. The questionnaire was made using a 4-level Likert scale, with criteria 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. The results of the data obtained will be calculated using the formula:

$$P = \frac{\sum q}{\sum r}$$

Where:

P = Score obtained, in this case is the percentage component of the standard assessment of innovative teaching materials according to BSNP.

$\sum q$= Number of concepts marked with (√) in innovative chemistry teaching materials for SMA/MA class XI even semester.

$\sum r$= The number of concepts in the innovative chemistry teaching materials for SMA/MA class XI even semester.

Then the results are interpreted using a rating scale, to indicate the level of feasibility of teaching materials with the following assessment criteria.

Table I. Criteria for the validity of the average value analysis

Average	Interpretation
3.26 - 4.00	Valid and does not need to be revised (feasible)
2.51 – 3.25	Valid enough and does not need to be revised (decent enough)
1.76 – 2.50	Invalid, some of the contents of teaching materials need to be revised (less feasible)
1.00 – 1.75	Invalid and needs to be totally revised (not feasible)

3 Results and Discussion

3.1 Analysis Phase

The result of the development carried out by this researcher is to produce teaching materials based on problem based learning. This research and development was carried out using the development procedure according to Sugiyono which was carried out from stage 1 to stage 7. The initial stage was carried out, namely the researcher collected information relating to the

constraints that existed in the school. The researcher also interviewed one of the chemistry teachers and students and collected books, materials and journals related to the module. The results of the interviews also concluded that the chemistry learning process carried out by the teacher in the classroom generally still uses chemistry learning, still uses direct learning and tends to use the lecture method, giving examples on the blackboard, asking questions and continuing with assignments. The process of learning chemistry in the classroom tends to be theoretical, memorizing or factual knowledge only and pays little attention to students' critical thinking skills. According to K-13 learning, teachers are required to innovate in learning. Where one of the innovative learning models in the 2013 curriculum is problem-based learning or called Problem Based Learning this model is an approach that presents authentic problems so that it can stimulate students to learn[6]

The next step in this study was to analyze two books of high school chemistry class XI, coded A and B. The researchers analyzed the books using the BSNP instrument. The following presents the results of the percentage analysis of the feasibility of textbooks.

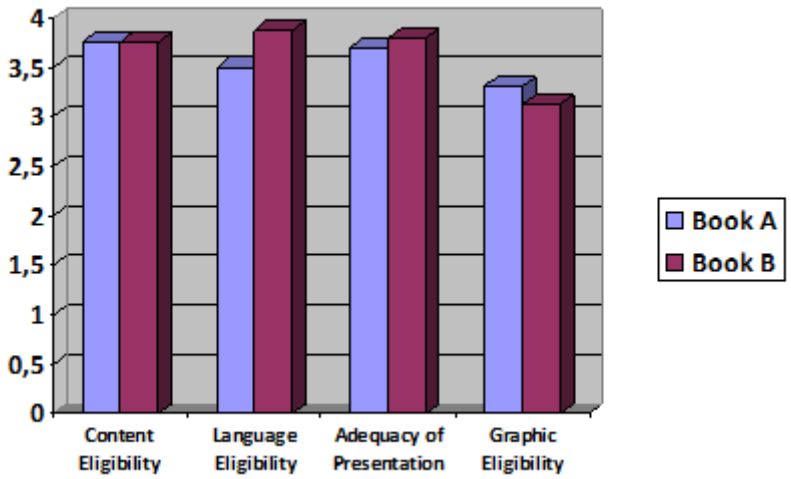

Figure 1. The results of the percentage analysis of the feasibility of two chemistry textbooks

From the results of the percentage analysis of the chemistry textbooks above (Figure 1) the researcher tabulated the results of the analysis of the two chemistry textbooks used in schools. Then the researcher determines the things that are developed in PBL-based teaching materials, the data tabulation can be seen in table 2.

Table 2. Content Feasibility Aspect Analysis

No	Content Eligibility Aspects	Analysis Results	Development Solutions
1	Material Coverage	The material presented in the material has not focused on indicators and learning objectives to be achieved.	Include indicators and learning objectives based on the basic competencies of class X chemistry material so that the material presented can achieve the learning objectives.
2	Material Accuracy	The accuracy of the concepts presented is in accordance with the field of knowledge, does not lead to many interpretations, and the examples presented are in accordance with reality but have not been able to increase user understanding.	Add life facts that cannot support understanding of the concept to materials or examples to increase user understanding.
3	up to date	The material presented is in accordance with current developments in chemistry, but there are still supporting materials for achieving learning objectives that have not been conveyed.	Include up to date materials that support learning objectives and update examples and exercises to make them more interesting and innovative.
4	Growing Student Productive Character	It is enough to increase student activity to participate in learning activities, but the media is less able to increase student activity in finding answers because the exercise is only in the form of a few questions.	Modify the media by adding interactive exercises to make it more interesting and foster student activity in learning.
5	Stimulate Curiosity	Descriptions, examples and exercises are not able to stimulate students to think further because the content of the media has not been able to involve students directly in learning.	Modifying media content that can involve students directly in using media and get feedback from what they have done as well as new innovations that can stimulate students' curiosity regarding chemistry learning material.

Based on the results of the analysis of the four aspects of the assessment, namely content feasibility, language feasibility, presentation feasibility and graphic feasibility of the teaching materials that are often used, namely text textbooks. So it can be said that the teaching materials used are appropriate, but the textbook needs to have a textbook companion that is innovated.

3.2 Design Stages

After the analysis phase was carried out, the researcher continued the next stage, namely the design stage. At this stage the researcher collects sources or references related to the even semester class XI material and designs the initial teaching materials based on Problem Based Learning. At this stage, the format selection and initial product design are carried out in accordance with the opinion[7] The material that will be included in this teaching material is in accordance with the learning objectives and achievement indicators that have been determined, the researcher also collects images, animations, websites that will later be visited as additional references.. The design made can be seen in Figure 2.

Figure 2. Preliminary design of teaching materials

3.3 Development Stage

At this development stage, the product to be developed is made, namely teaching materials based on Problem Based Learning. On research [8] states that the teaching materials to be used must have valid criteria from expert validators so that they are ready for use. Based on previous research at the development stage, teaching materials must be valid before being used. There are also activities carried out, namely compiling material, apperception, questions so that they are systematic and in accordance with predetermined indicators. After everything is finished, combine all the teaching materials that have been prepared using the Canva and Ms. Word applications. The problem-based teaching materials that will be developed follow the syntax of problem-based learning, which begins with problem orientation, organizing students, guiding investigations developing and presenting work and finally analyzing and evaluating the problem-solving process. The syntax of problem-based learning is incorporated into the developed teaching materials. Material validation was carried out by five Chemistry Education lecturers at Medan State University and three teachers using a feasibility questionnaire instrument based on the BSNP. The aspects tested to see the feasibility of a

media consist of content eligibility, language eligibility, presentation feasibility and graphic feasibility. The results of the feasibility test of material experts and teachers on Problem Based Learning-based teaching materials can be seen in Figure 3.

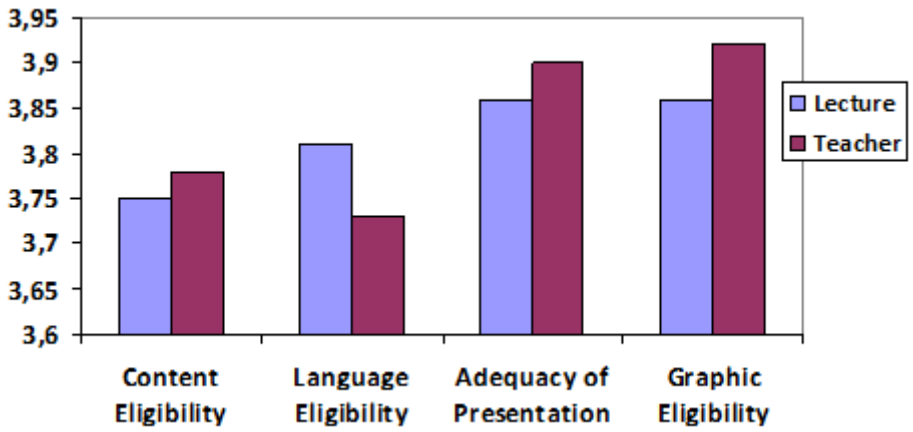

Figure 3. The results of the feasibility test percentage of teaching materials based on Problem based learning by the material expert validator

Based on the validation results of problem-based teaching materials by the material expert validator. data obtained average percentage of 3.86 (chemistry lecturer) and 3.73 (chemistry teacher). From the results of the validation above, it can be seen that the problem-based teaching materials developed have fulfilled the validity criteria, namely they are very suitable for use without revision. After being validated and given input by expert validators, problem-based teaching materials are obtained that are suitable for use without revision. The following shows the problem-based teaching materials that have been developed.

Figure 4. Display of teaching materials/modules based on Problem Based Learning

The feasibility test was carried out to determine the percentage of eligibility of the developed teaching materials. The Problem Based Learning-based chemistry teaching materials developed were validated by 8 expert validators (5 chemistry lecturers and 3 chemists in Langsa City) using the BSNP questionnaire. Qualitative analysis techniques were obtained from assessments on a questionnaire containing standard BSNP teaching materials (Appendix

3). Teaching materials that have been developed are validated and analyzed using descriptive analysis.

1. Content Eligibility

The results of the analysis of Problem Based Learning-based teaching materials that have been developed based on the feasibility aspect of the content by lecturers and teachers as expert validators can be seen in Figure 5.

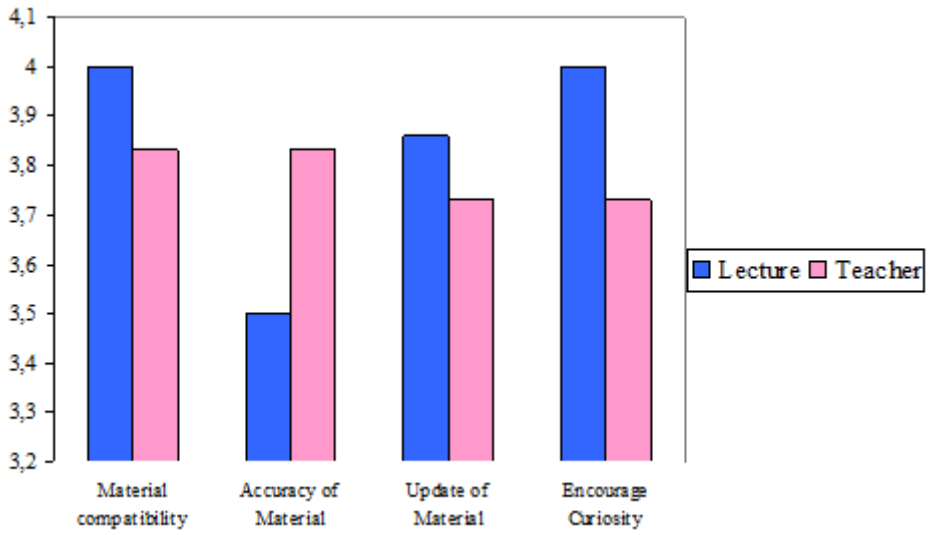

Figure 5. Graph of Feasibility Analysis Results of Developed Teaching Materials

The content feasibility aspect is in accordance with the modified BSNP standard, there are 4 indicators. Based on the results of the analysis, the feasibility value of the content on the aspect of suitability of the material with Basic Competency (KD) has the highest score of 4.00 in the valid category without revision, and encourages curiosity to get a score of 4.00. This shows that the content of the material in teaching materials developed has covered all the material contained in Basic Competency (KD). Other indicators, namely material harmony, material up-to-date and encouraging curiosity, have an average value of 3.50; 3.86 and 4.00; all have valid categories without the need for revision.

2. Language Eligibility

The results of the analysis of Problem Based Learning-based teaching materials that have been developed based on aspects of language feasibility by Lecturers and Teachers as expert validators can be seen in Figure 6.

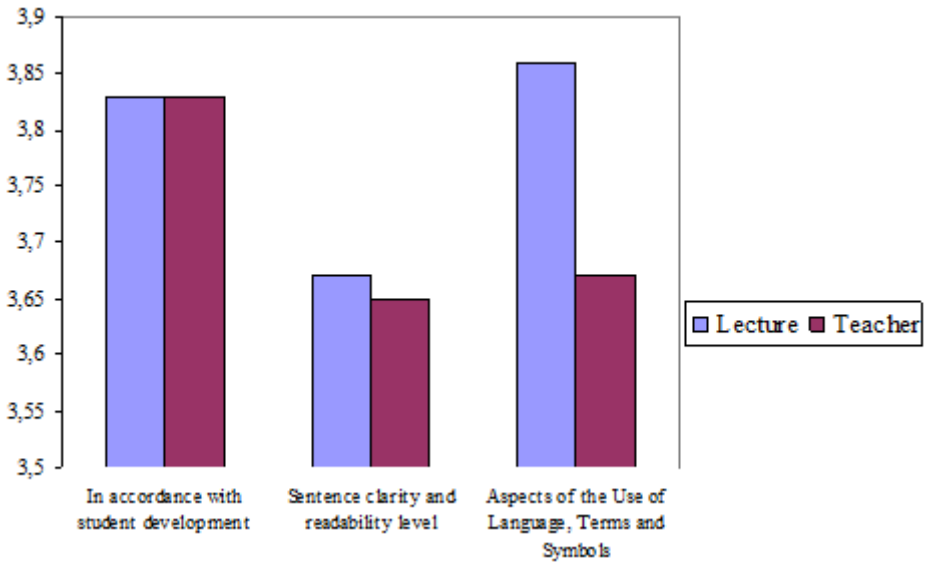

Figure 6. Graph of Feasibility Analysis Results of Language Teaching Materials developed

Aspects of the feasibility of the language used include four indicators, namely aspects according to the development of students, clarity of sentences and levels of readability, aspects of writing the contents of teaching materials and aspects of language use, terms and symbols. The highest aspect is the clarity of sentences and the level of readability, namely 3.67, which is in the valid category without the need for revision. This shows that the Problem Based Learning-based teaching materials that have been developed have good sentence clarity and legibility and are expected to make it easier for students to easily understand the contents of the teaching materials. The results of the analysis for other aspects, namely the aspect of writing the contents of teaching materials and aspects of using language, have an average value of 3.67; 3.86 . These three aspects are included in the valid category without the need for revision.

3. Adequacy of Presentation

The feasibility of the presentation used includes four aspects of assessment, namely presentation techniques, presentation support, module presentation and evaluation. The results of the analysis of the feasibility of presenting problem-based learning-based teaching materials are presented in Figure 7.

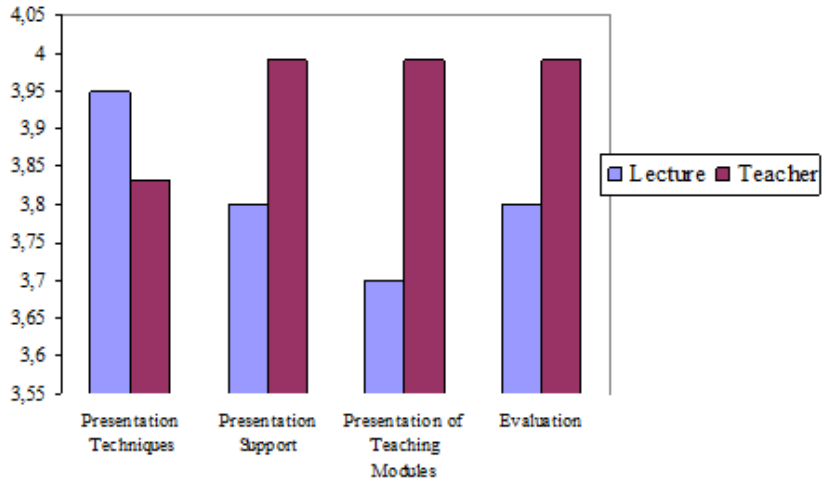

Figure 7. Graph of Feasibility Analysis Results for Presentation of Teaching Materials developed.

All aspects of presentation feasibility have an average value of 3.77 including valid categories without the need for revision. This shows that based on the feasibility aspect of presenting teaching materials based on Problem Based Learning that has been developed it is suitable for use in chemistry learning for class XI even semester.

4. Graphic Eligibility

The graphical feasibility aspects used include three aspects of assessment, namely module size, module cover design and module content design. The results of the analysis of Problem Based Learning-based teaching materials developed on the graphical feasibility aspect can be seen in Figure 8.

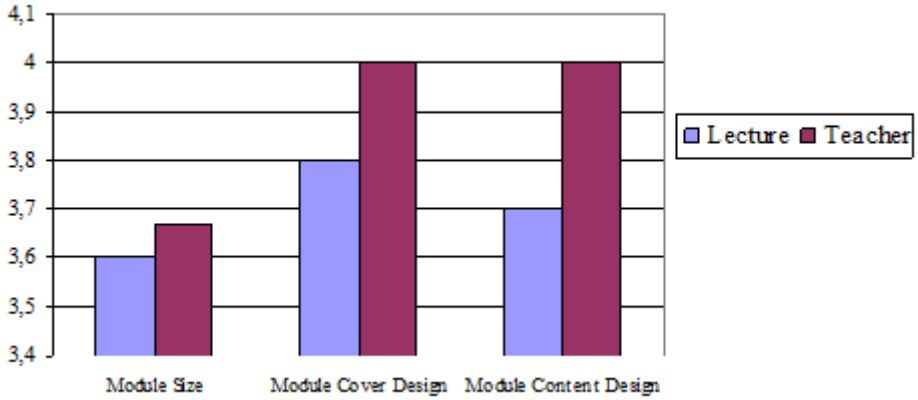

Figure 8. Graph of Feasibility Analysis Results of Developed Teaching Material Graphics

Based on the results of the analysis that has been carried out on the graphical feasibility aspect, the average value for each indicator is 3.68; 3.70 and 3.75. All indicators on this aspect

of graphic feasibility are in the valid category without revision. . This shows that based on the feasibility aspect the developed teaching materials are suitable for use in chemistry learning for class XI even semester.

4 Conclusion

Based on this research, it can be concluded that this research and development produces a product in the form of problem-based learning-based teaching materials in even semester XI class chemistry material. This research is developed using research and development or can be called (R&D). Teaching materials developed through the validation stage by three experts as validators, namely a chemistry lecturer and three chemistry teachers.The results of the feasibility analysis of the problem-based teaching materials developed obtained an average score of 3.86 (chemistry lecturer) and 3.73 (chemistry teacher) with valid categories without the need for revision and suitable for use in chemistry learning class XI even semester.

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