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Developing Instructional Materials onBuffer Solutions BasedonProblem Based Learning Model AtSMA Negeri 1 Indralaya

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ABSTRACT

Development of teaching material in buffer solution based on problem based learning had been conducted and implemented in the second grade in class of SMA Negeri 1 Indralaya. This research was conducted by ADDIE design and formative evaluation Tessmer method. The validity of teaching material is assessed by three experts; material expert, pedagogic expert, and design expert. The validity of material is 3.75 which is categorized as very valid, the validity of pedagogical value is 3,32 which is categorized as very valid, and the validity of design is 3.20 which is categorized as valid. The Practicality of teaching material seen from the average score questionnaire in one-to-one or small group phase. In one-to-one phase, the practicality score is 3.30 which is categorized as practical and in small group, the practicality score is 3.85 which is categorized as very practical. The effectiveness of this teaching material is evident from test study which is implemented at field test phase. Based on that test, score gained is 0.69 which is categorized as the moderate. It indicates that the teaching material is effective to be used in buffer solution.

Keywords: Development, teaching material, acid base solution, problem based learning, valid, practical,effective

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INTRODUCTION

Curriculum 2013 is a curriculum that demands independence, understanding, characters and skill of the students. In the curriculum 2013, learning activity is student centered. Student centered shows the dominance of students during the learning activities and teacher as facilitators, mentors and leaders. The main problem in organizing learning activityis teaching material that is not optimally used by student. Instructional materialis an important component in the learning process for teaching material because it can help student to learn (Aguswuryanto, 2010). Teachersmust be able to arrange teaching materials well and directed so that student can understand the provided subject materialeasily.

Based on the interview with the second grade classchemistry teacher inSMA Negeri 1Indralaya, it is obtained that some students have textbooks and teacher also use worksheet as teaching materials in the classroom. However, the worksheet used is not in accordance with curriculum 2013 and the teaching materialthat provided is notinteresting so thatit makes student discourage to learn. In addition, based on the result of questionnaires that distributed to 67 students (second grade class), it is found that 68.7% of the students feel that teaching materials that they used do not make them understand the concept of problems such as exercises in material subject and 79,1% of the students stated that teaching materials that they

used are not related to daily life yet. Based on the interview with the second grade chemistry teacher in SMA Negeri 1 Indralaya, it is obtained that the most difficult material in chemistry in second grade science is acid-base solution because there iscalculation that it makes student hard to understand the material.

Based on the result of teacher interview and student questionnaires found that the school needs development of teaching material. Teaching materials which can be developed are printed teaching materials such as films, audio tapes, video tapes, maps, globes, and charta(Suparwoto, 2007). Development of teaching materials should be done in accordance with the strategy learning or model learning(Abidin, 2014). Based on the result of questionnaires that distributed to 67 students (second grade class),it is obtained that 88.1% of students are interested if the chemistry lesson is given based on the problems that associated with daily life. The learning model which can encourage students to relate the concept of material with phenomena in the daily life is Problem Based Learning Model Budiasih dan Widarti, 2004).

Problem Based Learning is a modelof studentcentered learning. It is called as "The four Cs of 21st Century Skill, that are Critical Thinker (Solving Problem), Communicator (Understanding and Communication Ideas), Collaborator (Working with Other), and Creator (Producing High Quality Work). The Problem Based Learning a series of activities, there are five steps in problem based learning model, Orienting students to problems,Organizing students to learn,Help independent inquiry,Develop and present the work,Analyze and evaluate the problem-solving process.

The research about Problem Based Learning have been done by Kanli & Yabagasan, Hardiansyah, Muchlas. Based on the resultof research(Kanli and Yagbasan, 2007), there is an increase in the process skill and mastery of students concepts and studentswere more delighted with laboratory management if it is usingproblem based learning model. In addition, the result of research(Hardiansyah, 2010) showed that by applying the problem based learning model, it can improvethe mastery of the concept student on cognitive aspects; C2, C3, C4, and increase the student's critical thinking skill for each indicator. The result of research inproblem based learning modelwhich isdone by Muchlas (2015) showed that the application of the problem based learning model can improve learning outcomes in chemistry subject. The research about teaching material based on problem based learning model have been done by Ghaliyah and Permatasari (2015). Based on the result of research on the development ofteaching material which is done byGhaliyah (2015), it is produce modulebased problem based learning, it shows that module is eligible theoretically and empiricallyand it received a good response from the student activity that it is categorized as very feasible. In addition, research (Permatasari, 2015) which produce module with video-assisted based problem based learning, it can increase studentmotivation in second grade class of senior high school.

Based on the background, the development of teaching materialbased on problem based learning modelin buffer solution in second grade class of senior high school is needed.

The purpose of this research is to develop and produce teaching material based problem based learning inbuffer solution material for student in 2nd grade class of senior high school has valid, practical, and effective criteria.

MATERIAL AND METHODS

The development model used is ADDIE model development. In Addie, there are five steps. They are analysis, design, development, implementation and evaluation. Evaluation is done by using Tessmer formative evaluation. The subject of this research is teaching material based on problem based learning in buffer solution learning. The validators for teaching material based on problem based learning are design expert, material expert, and pedagogic expert.

The subjects of this research to test the practicality of teaching material are students from second grade class of SMA Negeri 1 Indralaya. In one to one evaluation phase, it involved three students fromsecond grade class. In small group evaluation, it involved nine students from second grade class. The subject for testing the effectiveness of teaching material is thirty students from second grade class of SMA Negeri 1 Indralaya.

The data collection was done by expert validation test (walkthrough), questionnaire, and achievement test. The procedures of development researchare analysis, design, development, implementation and tessmer evaluation. In tessmer evaluation, there are five steps. They are self evaluation, expert review, one to one evaluation, small group evaluation, and field test. The data analysis were done by analyzing the validation sheet (walkthrough), questionnaire data, and achievement test data.

Analysis of data validation sheet according to the design expert, pedagogic, and material are calculated using this formula(Widoyoko, 2012).

$$X = \frac{\sum x}{n}$$

Information:
X = average of validator's assesment result; Σx = Total value of research result; n = number of indicators

Table 1. The Score Criteria of Validation

Average of answer score	Criteria	Information
3,25 < v ≤ 4,00	Very good	Very valid
2,50 < v ≤ 3,25	Good	Valid
1,75 < v ≤ 2,50	Less good	Lessvalid
v ≤ 1,75	Not good	Notvalid

Analysis of the data test are analyzed by using a Likert scale. The formula is Widoyoko, 2012.

$$X = \frac{\Sigma x}{n}$$

Information:
X = average result of student assessment; Σx = Total value of research result; n = number of indicators

Table 2. The Score Criteria of Practicality

Average of answer score	Criteria	Information
3,25 < v ≤ 4,00	Very good	Very practical
2,50 < v ≤ 3,25	Good	Practical
1,75 < v ≤ 2,50	Less good	Less practical
v ≤ 1,75	Not good	Not practical

Analysis of data testfrom student learning outcome can be doneby first giving scores to the student's answer corresponding benchmark score which has been predetermined, then converted it into a range of 1-100. To determine the effectiveness of teaching material based on problem based learning is made, it is use N-gain. The gain can be calculated using theformula(Hake, 1998).

$$< g >= \frac{<\%Sf> - <\%Si>}{(100 - <\%Si>)}$$

Information :
g = average of score gain normalized
Sf = final score (post-test)
Si = a score initial (pre-test)

Table 3. Acquisition Criteria of Gain Score

Criteria	Category
g ≥ 0,7	High
0,3 ≤ g < 0,7	Moderate
g < 0,3	Low

RESULTS AND DISCUSSION

The analysis in this researchare the analysis of need and characteristic of students.Based on interview with the second grade chemistry teacher inSMA Negeri 1 Indralaya, it is obtained information that some students have textbooks and teacher also use worksheet as teaching material in the classroom. However, worksheetis used not in accordance with curriculum 2013Revise 2016 and teaching material that provided is not interesting so it makes students discourage to learn. In addition, students hard to understand chemistry concept such as counting material especially calculation inbuffer solution. Based on the questionnaire of 67 students of the second grade class in SMA Negeri 1 Indralaya, it is obtained information that 55.2% of the students like chemistry, 88.1% of students interested in chemistry if chemistry lessons related to daily life, 88.2% of students prefer to work together a group rather than alone, 68.7% of the students feel that teaching materials that they used do not make them understand the concept of problems such as exercises in material

subject and 79,1% of the students stated that teaching materials that they used are not related to daily life yet.

In the design step, teaching material that arranged was adapted to the basic competence, namely KD 3:12 Analyzing the characteristic of buffer solution, and the concept of pH of the buffer solution and KD 4:12 Asking idea about using right indicators to crease the buffer solutions. The arrangement of teaching material follow the eligibility standards of content on BSNP is teaching materials described in the chapters that contain study material, student activities and exercises that are suited toindicators. Teaching material is presented in accordance with problem based learning. There are five steps in problem based learning. They are Orienting students to problems,Organizing students to learn,Help independent inquiry,Develop and present the work,Analyze and evaluate the problem-solving process.In the development step, teaching material is developed with formative evaluationThere are four steps of evaluation. They are self-evaluation the expert review,One to One and small group. In the self evaluation, we evaluate our own products that we have been made. The results of self evaluation phase include improving the text, images, sentence structure and punctuation, and overall look of teaching material. Expert review step is to test the validity of the first prototype which has been through a phase of self evaluation. Validators who validate the design of these materials consist of validator design, material and pedagogic.

Table 4. Validation result of pedagogic, material, desain

No.	Validation	Score	Category
1.	Pedagogic	3,32	Very valid
2.	Material	3,75	Very valid
3.	Desain	3,20	Valid
	Average	3,42	Very valid

Assessing the feasibility of teaching material based problem based learning from design aspects include a cover page design, color, writing, images and view of teaching material. The design expert will give comments and suggestions about the design of teaching material. First, the cover page of teaching material design, it isobtained average score is 3.20 with valid category. Second, the color of teaching material, it is obtained average score is 3 with valid category. Third, the writing of teaching material, it is obtained average score is 3.5 with very valid category. Fourth, in the image of teaching material, it is obtained average score is 3.25 with valid category. Fifth, the views of teaching material, it is obtained an average score is 3 with valid category.

The highest score of design criteria of teaching material is in writing aspect. The score is 3.5. It can be seen from the acuracy of writing selection, suitability election of font size, acuracy of text color selection and suitability of the design which shown in the writing of teaching materialbased on problem based learning. Based on the assessment of design expert, it is obtained an overall average score is 3.20 with valid category.

Assessing the feasibility of teaching material based on problem based learning viewed from the aspects of pedagogic learning competencies. They are components, compliance with the rules writing of Bahasa Indonesia correctly, the use of communicative language, the ability to motivate students, foster curiosity. First, the components of competence, it is obtained average score is 3.5 with very valid category. Second, in conformity with the rules writing of Bahasa Indonesia, it is obtained average score is 3 with a valid category. Third, the use of communicative language, it is obtained average score is 3.25 with valid category. Fourth, the ability to motivate students, it is obtained average score is 3.5 with very valid category. Fifth, the foster curiosity, it is obtained average score is 3.25 with valid category. The highest score of pedagogic is components of competence aspect. The score is 3.5. It can be seen from the suitability of the material solution with core competencies, basic competencies, indicators of learning, and the learning objectives in teaching material basedon problem based learning. In addition, the highest score also of pedagogiccriteria of teaching material is the ability to motivate students' aspect.

The score is 3.5.From language aspect, teaching material based onproblem based learning use communicative language so it makes students easily to understand the material. The accuracy of using language can help students in understanding the questions in teaching learning based on problem based learning. Besides that, teaching material based on problem based learning in accordance with the Ministry of Education (2004) which explains that the words which is used should use simple language so it makes the reader easy to read. One thing which is needed to improve is in the arrangement of teaching material based on problem based learning. Itisreplace the right word so it makes the reader can capture thoughts and ideas from the author. The accuracy of the word is a word to evoke the same idea in the reader's imagination, such as something which is thought and felt(Tessmer, 1993).

The feasibility assessment of teaching material based on problem based learning from the material aspects include the suitability of curriculum, the truth of material, the accuracy of material, the recency of material, and suitability with the problem based learning.First, on the suitability of the curriculum, it is obtained average score is 4 with very valid category. Second, the truth of the material, it is obtained average score os 3.75 with very valid category. Third, the accuracy of the material, it is obtained average score is 3.75 with very valid category. Fourth, the recency of material, it is obtained average score is 3.5 with very valid category. Fifth, suitability with problem based learning, it is obtained average score is 4 with very valid category.

The highest score of material criteria of teaching material is in suitability of curriculum and problem based learning model and the recency of material. The score of them are 4. It can be seen from the suitability of the view of the material with the basic competencies, indicators, objectives and presentation of the material has correct steps in problem based learning. They areOrienting students to problems,Organizing students to learn,Help independent inquiry,Develop and present the work,Analyze and evaluate the

problem-solving process.The highest score shows that the material in buffersolution of teaching material based on the problem based learning in accordance with the curriculum and the problem based learning. Based on the material expert, it is obtained average score is 3.75 with very valid category.

Therefore, teaching material based on the problem based learninghas the valid criteria and worthy tested. Furthermore, the one-to-one evaluation. The trial was conducted at three students of scond year inSMA Negeri 1 Indralaya. The score of practicality in this step can be seen in Table 5 below.

Table 5. The Practicality score of teaching material in one to one

No.	Aspect	Score
1.	The Cover of teaching material	3,30
2.	Display the contents of teaching material	3,60
3.	The language used	3,00
4.	Can motivate students	3,30
	Final score	3,30

From the results of the questionnaire practicality, students stated that the teaching material is interesting so it makes students add their interest to read it. Suggestions received are necessary to add the column“do you know” and inventor information and consider neatness of writing and conformance with the rules writing of Bahasa Indonesia correctly. The practicality score of teaching material is 3.30. It shows that the teaching material basedon the problem based learningis practical.

The next is a small group evaluation. At this step, the evaluation was done by nine students of scond class inSMA Negeri 1 Indralaya. The practicalityscore can be seen in Table 6 below.

Table 6. The Practicality score of teaching material inSmall Group

No.	Aspect	Score
1.	The Cover of teaching material	3,78
2.	Display the contents of teaching material	3,83
3.	The language used	3,94
4.	Can motivate students	3,85
	Final score	3,85

From the results of the practicality questionnaire, students stated that the teaching material is interesting and complete. However, there is a student who stated that there is some writing in teaching material is not clear. It also needs to be added to the sample exercises and their answers. This has been corrected in order to facilitate the students to understand the

material in teaching materials. The results of student assessment to the practicality of teaching materials in the amount of 3.85 stated very practical.

Field test step was conducted in scond year of SMA Negeri 1 Indralayahas 30 students and it done with two meetings. Learning outcomes were measured using a pre-test and post test. The score of pre test is 38.85% and post test is 81.17%. The value of learning outcomes can be seen in Graph 1 below.

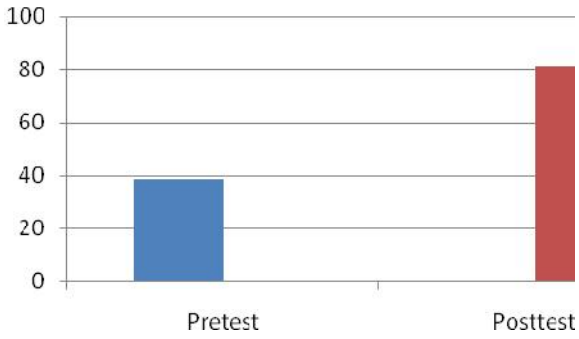

Figure 1. Result of Field Test

The Improvement learning outcomes supported by the teaching material in acid base which can increase student's interest towards the materials which they studied, which in turn will help students understand the material, states that teaching material has good quality and worthy life will be able to support the achievement of learning goals (Sujana and Rivai, 2005).

N-Gain value which is obtained is 0.69 with the medium category. Based on the value of N-Gain known that teaching material based onthe problem based learningis effective for learning. Therefore, this research shows that by using teaching material based on the problem based learning take good place in chemistry learning. Based on the results of the validation and testing of product, teaching material based on the problem based learninghasvalid, practical, and effective criteria.

Based on the results of research, teaching material which is developed hasadvantages: (1) the teaching material make student easy to learn and it gives a lot of information related to the concept of material and discuss about the phenomenon in daily life, (2) images in teaching material can attract students to learn it, (3) there are many additional information such as the recent discovery about chemistry, character information which add student knowledge and information about the concept.

After the learning process by using teaching material which is developed in acid base material,students give positive respond. Theystated that learning by using teaching material is more interestingbecause itis presented with the view and interesting pictures so it can increase

student'scomprehension. The use of images can give a visual representation of the material described, in the arrangement of teaching material and teaching aids can make student easy to understand and with illustrations or pictures that visually can give a real description of the substance which is studied.

In addition to the use of teaching material, students are also interested to participate in teacing material or modul on the problem based learning. At the time of experiment activities, student more active than only listen to the teacher's explanation. Application of the problem based learningcan increase the activity of students in both the experiment activity and class discussion (Fajaroh and Dasnah, 2003), andthe application of the the problem based learning modelin learning Analysis Instru-mentation experiment can improve the quality of the learning process, both in terms of qualitative and quantitative aspects(Budiasih and Widarti, 2004). At the time of discussion, student activity can be improved because students can be creative convey their idea freely with a group and not monotonous than they were just listen to the teacher's explanation.

Students gave a positive response to the chemistry learning that using teaching material inbuffer solution. Students also stated that they liked the teaching material in buffer solution. Students feel motivated by this teaching materialbecause it makes they easy to understand the material of of buffer solution. Thus, teaching material which is developed can apply to the school.

CONCLUSIONS

Based on the results of this research, it concluded that:Teaching material based on the problem based learninginbuffer solutionfor the second grade in science of SMA Negeri 1 Indralayahas score pedagogic, material, and design. The score of pedagogicis 3.32 (valid), the score of material is 3.75 (very valid) and the score of design is 3.20 (valid). It states that teaching material in buffer solutionfor the second grade in science of SMA Negeri 1 Indralaya is valid.Teaching material based on the problem based learning in buffer solutionfor the second grade in science of SMA Negeri 1 Indralayahas score practicality in one-to-one and small group. The score in one-to-one is 3.30 (practical) and small group is 3.85 (very practical). It states that teaching materialin buffer solutionfor the second grade in science of SMA Negeri 1 Indralayahas practical category.Teaching material based on the problem based learningin buffer solutionfor the second grade in science of SMA Negeri 1 Indralayahas gain score. The score is 0.69 (moderatescore). It states that the effectiveness of teaching material based on the problem based learningin buffer solutionfor the second grade in science of SMA Negeri 1 Indralayahas medium category.Teachers are expected to use teaching material based on the problem based learning in buffer solution. For other researchers expected that there is further research on teaching materials based the problem based learning valid, practical, and effective with different materials.

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