

# Developing Instructional Materials on Acid-Base Solutions based on 7E Learning Cycle Model at SMA 1 Muhammadiyah Palembang

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**Abstract**— Development of teaching material in acid-base solution based on learning cycle model 7e had been conducted and implemented in the second grade in a class of SMA 1 Muhammadiyah 1 Palembang. 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 3.81 which is categorized as very valid, the validity of pedagogical value is 3,30 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 the one-to-one or small group phase. In one-to-one phase, the practicality score is 3.53 which is categorized as very practical and in a 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 acid-base learning solution.

**Keywords**— *Development; teaching material; acid-base solution; learning cycle model 7e; valid, practical; effective*

## I. 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 activity is teaching material that is not optimally used by the student. Instructional material is an important component in the learning process for teaching material because it can help the student to learn [1]. Teachers must be able to arrange teaching

materials well and directed so that student can understand the provided subject material easily.

Based on the interview with the second-grade chemistry teacher in SMA 1 Muhammadiyah Palembang, it is obtained that some students have textbooks and teacher also use the worksheet as teaching materials in the classroom. However, the worksheet used is not in accordance with curriculum 2013 and the teaching material that provided is not interesting so that it makes student discourage to learn. In addition, based on the result of questionnaires that distributed to 67 students (XI MIA 1 and XI MIA 2 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 Muhammadiyah 1 Palembang, it is obtained that the most difficult material in chemistry in second-grade science is an acid-base solution because there is a calculation 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, videotapes, maps, globes, and chart [2]. Development of teaching materials should be done in accordance with the strategy learning or model learning [3]. Based on the result of questionnaires that distributed to 67 students (XI MIA 1 & 2 class), it is obtained that 88.1% of students are interested in 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 Learning Cycle Model 7E [4].

Learning cycle model 7e is a model of student-centered learning. It is called as a series of activities (phases) which is organized so it makes student can understand the competencies which must be achieved in learning in an active way [5]. There are seven steps in learning cycle model 7e. They are elicited (bring prior knowledge), engage (intrigue), explore (probe), explain (explain the concept), elaborate (apply the concept), Evaluate (evaluate), extend (extend the concept). Learning cycle model 7E gives an opportunity for students to think, explore, discover, and explain the example of the application of concept which they have learned and can stimulate students to remember the subject matter which they have learned.

The research about learning cycle model 7e have been done [6]. Based on the result of research [6], there is an increase in the process skill and mastery of students concepts and students were delighted with laboratory management if it is using learning cycle model 7e. In addition, the result of research [7] showed that by applying the learning cycle model 7e, it can improve the 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 in learning cycle model 7e which is done [8] showed that the application of the learning cycle model 7e can improve learning outcomes in chemistry subject. The research about teaching material based on learning cycle model 7e has been done [9]. Based on the result of research on the development of teaching material which is done [9], it is produced module based learning cycle model 7e, it shows that module is eligible theoretically and empirically and it received a good response from the student activity that it is categorized as very feasible. In addition, research [10] which produce the module with video-assisted based learning cycle model 7e, it can increase student motivation in second grade class of senior high school.

Based on the background, the development of teaching material based on learning cycle model 7e in acid solution in second grade class of senior high school is needed. The purpose of this research is to develop and produce teaching material based on learning cycle model 7e in acid-base material for the student in the 2nd-grade class has valid, practical, and effective criteria.

## II. 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 learning cycle model 7e in acid-base solution learning. The validators for teaching material based on learning cycle model 7e are design expert, material expert, and pedagogic expert.

The subjects of this research to test the practicality of teaching material are students from XI MIA OI class and XI MIA 4 class of SMA Muhammadiyah 1 Palembang. In one to one evaluation phase, it involved three students of XI MIA OI class. In small group evaluation, it involved nine students of XI MIA 4 class. The subject for testing the effectiveness of teaching material is thirty-four students of XI MIA 2 SMA of SMA 1 Muhammadiyah Palembang.

The data collection was done by expert validation test (walkthrough), questionnaire, and achievement test. The procedures of development research are analysis, design, development, implementation, and evaluation. In the evaluation, there are five steps. They are a self evaluation, expert review, one to one evaluation, small group evaluation, and field test. The data analysis was 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 is calculated using this formula [11].

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

Information:

X = average of validator's assesment result;  $\sum x$  = Total value of research result; n = number of indicators

TABLE I. THE SCORE CRITERIA FOR VALIDATION

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

TABLE II. THE SCORE CRITERIA OF PRACTICALITY

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

Analysis of data test from student learning outcome can be done by 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 learning cycle model 7e is made, it is used N-gain. The gain can be calculated using the formula [12],

$$\langle g \rangle = \frac{\langle \%Sf \rangle - \langle \%Si \rangle}{(100 - \langle \%Si \rangle)}$$

Information :

g = average of score gain normalized

Sf = final score (post-test)

Si = a score initial (pre-test)

TABLE III. ACQUISITION CRITERIA OF GAIN SCORE

Criteria	Category
$g \geq 0,7$	High
$0,3 \leq g < 0,7$	Moderate
$g < 0,3$	Low

### III. RESULTS AND DISCUSSION

The analysis in this research is the analysis of need and characteristic of students. Based on the interview with the second-grade chemistry teacher in SMA Muhammadiyah 1 Palembang, it is obtained information that some students have textbooks and teacher also use the worksheet as teaching material in the classroom. However, the worksheet is used not in accordance with curriculum 2013 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 in acid-base solution. Based on the questionnaire of 67 students of the second grade class in SMA Muhammadiyah 1 Palembang, 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 3:10 Analyzing the characteristic of solution based on the concept of acid-base and/or pH of the solution and KD 4:10 Asking idea about using right indicators to determine the acidity of acid/base titration or acid/base. 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 to indicators. Teaching material is presented in accordance with learning cycle model 7e. There are seven steps in learning cycle model 7e. They are elicited (bring prior knowledge), engage (intrigue), explore (probe), explain (explain the concept), elaborate (apply the concept), Evaluate (evaluate), extend (extend the concept ). In the development step, teaching material is developed with formative evaluation There 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 at 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 IV. VALIDATION RESULT OF PEDAGOGIC, MATERIAL, DESAIN

Validation	Score	Category
Pedagogic	3,30	Very valid
Material	3,81	Very valid
Desain	3,20	Valid
Average	3,45	Very valid

Assessing the feasibility of teaching material based on learning cycle 7e model 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 is obtained average

score is 3.25 with the valid category. Second, the color of teaching material, it is obtained average score is 3 with the valid category. Third, the writing of teaching material, it is obtained average score is 3.5 with the very valid category. Fourth, in the image of teaching material, it is obtained average score is 3.25 with the valid category. Fifth, the views of teaching material, it is obtained an average score is 3 with the 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 accuracy of writing selection, suitability election of font size, the accuracy of text color selection and suitability of the design which shown in the writing of teaching material based on learning cycle model 7e. Based on the assessment of design expert, it is obtained an overall average score is 3.20 with the valid category.

Assessing the feasibility of teaching material based on learning cycle model 7e 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 a 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 a valid category. Fourth, the ability to motivate students, it is obtained average score is 3.5 with the very valid category. Fifth, the foster curiosity, it is obtained average score is 3.25 with the 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 based on learning cycle mode 7e. In addition, the highest score also of pedagogic criteria of teaching material is the ability to motivate students aspect.

The score is 3.5. From language aspect, teaching material based on learning cycle model 7e 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 learning cycle model 7e. Besides that, teaching material based on learning cycle model 7e in accordance with the Ministry of Education (2004) which explains that the words which are used should use simple language so it makes the reader easy to read. One thing which is needed to improve is the arrangement of teaching material based on learning cycle model 7e. It replaces 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 [13].

The feasibility assessment of teaching material based on learning cycle model 7e from the material aspects includes the suitability of curriculum, the truth of material, the accuracy of the material, the recency of material, and suitability with the learning cycle model 7e. First, on the suitability of the curriculum, it is obtained average score is 4 with a very valid

category. Second, the truth of the material, it is obtained average score os 3.75 with a very valid category. Third, the accuracy of the material, it is obtained average score is 3.75 with a very valid category. Fourth, the recency of material, it is obtained average score is 3.5 with a very valid category. Fifth, suitability with learning cycle model 7e, it is obtained average score is 4 with a very valid category.

The highest score of material criteria of teaching material is in the suitability of curriculum and learning cycle model 7e and the recency of material. The score of them is 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 learning cycle model 7e. They are elicited (bring prior knowledge), engage (intrigue), explore (probe), explain (explain concepts ), elaborate (apply the concept), evaluate (evaluate), extend (extending the concept). The highest score shows that the material in the acid-base solution of teaching material based on learning cycle model 7e in accordance with the curriculum and the learning cycle models 7e. Based on the material expert, it is obtained average score is 3.8 with a very valid category.

Therefore, teaching material based on learning cycle model 7e has the valid criteria and worthy tested. Furthermore, the one-to-one evaluation. The trial was conducted at three students of XI MIA Ol class in Muhammadiyah 1 senior high school Palembang. The score of practicality in this step can be seen in Table 5 below.

TABLE V. THE PRACTICALITY SCORE OF TEACHING MATERIAL IN ONE TO ONE

Aspect	Score
The Cover of teaching material	3,67
Display the contents of teaching material	3,67
The language used	3,16
Can motivate students	3,56
Final score	3,53
Category	Very practical

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 3.53. It shows that the teaching material based on learning cycle model 7e is very practical.

The next is a small group evaluation. At this step, the evaluation was done by nine students of XI MIA 4 class in SMA Muhammadiyah 1 Palembang. The practicality score can be seen in Table 6 below.

TABLE VI. THE PRACTICALITY SCORE OF TEACHING MATERIAL IN SMALL GROUP

Aspect	Score
The Cover of teaching material	3,78
Display the contents of teaching material	3,83
The language used	3,94
Can motivate students	3,85
Final score	3,85
Category	Very practical

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 practically.

Field test step was conducted in XI MIA 2 class of SMA Muhammadiyah 1 Palembang has 34 students and it did 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 Figure 1 below.

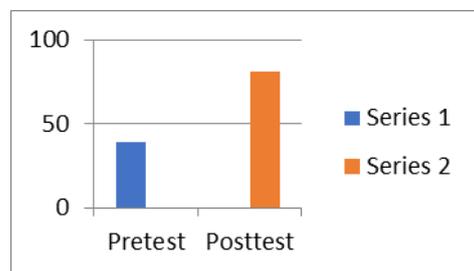


Fig. 1. Result of Field Test

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[14].

The 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 on learning cycle model 7e is effective for learning. Therefore, this research shows that by using teaching material based on learning cycle model 7e take a good place in chemistry learning. Based on the results of the validation and testing of the product, teaching material based on learning cycle model 7e has valid, practical, and effective criteria.

Based on the results of research, teaching material which is developed has advantages: (1) the teaching material make student easy to learn and it gives a lot of information related to the concept of material and discuss 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 the positive response. They stated that learning by using teaching material is more interesting because it is presented with the view and interesting pictures so it can increase student's comprehension. 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 [14].

In addition to the use of teaching material, students are also interested to participate in learning cycle model 7E. At the time of experiment activities, the student more active than only listen to the teacher's explanation. Application of the learning cycle can increase the activity of students in both the experiment activity and class discussion [15], and the application of the learning cycle approach in learning Analysis Instrumentation experiment can improve the quality of the learning process, both in terms of qualitative and quantitative aspects [4]. 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 listening to the teacher's explanation.

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

#### IV. CONCLUSIONS

Based on the results of this research, it concluded that:

Teaching material based on learning cycle model 7e in acid-base solution for the second grade in the science of Muhammadiyah 1 senior high school Palembang has score pedagogic, material, and design. The score of pedagogic is 3.30 (valid), the score of material is 3.81 (very valid) and the score of design is 3.20 (valid). It states that teaching material in acid-base solution for the second grade in the science of Muhammadiyah 1 senior high school Palembang 7e is valid.

Teaching material based on learning cycle model 7e in acid-base solution for the second grade in the science of Muhammadiyah 1 senior high school Palembang has score practicality in the one-to-one and small group. The score in one-to-one is 3.53 (very practical) and a small group is 3.85 (very practical). It states that teaching material in acid-base solution for the second grade in the science of SMA 1 Muhammadiyah senior high school Palembang has the practical category.

Teaching material based on learning cycle model 7e in acid-base solution for the second grade in the science of

Muhammadiyah 1 senior high school Palembang has the gain score. The score is 0.69 (moderate score). It states that the effectiveness of teaching material based on learning cycle model 7e in acid-base solution for the second grade in the science of Muhammadiyah 1 senior high school Palembang has the medium category.

Teachers are expected to use teaching material based on learning cycle model 7e in acid-base solution. For other researchers expected that there is further research on teaching materials based learning cycle models 7e valid, practical, and effective with different materials.

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