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Buffer Solution Analysis in 11th Grade Chemistry Textbook Using 4S TMD Selection Criteria

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Abstract

The analysis of the material on buffer solutions in SMA/MA class XI Chemistry textbooks was carried out by referring to the selection criteria of 4S TMD, with the aim of evaluating the suitability of the material. There are three criteria in the 4S TMD selection stage, namely consistency with the curriculum, concept accuracy, and value education. Evaluation of the consistency of the material with the curriculum was carried out by considering the scope of the material and the depth of the concept. The analysis showed that books A and B both had six appropriate concept labels, but book B had one concept label that was too general. In the evaluation of concept depth, book A has two concepts that lack depth and four appropriate concepts, while book B has one concept that lacks depth, five appropriate concepts, and one concept that is too deep. The analysis of the correctness of the concept shows that both book A and book B meet the concept standard. The results of the analysis of value planting in book A include six values, such as discipline, hard work, responsibility, friendly/communicative, love to read, and curiosity. Meanwhile, book B instills eleven values, including hard work, independence, responsibility, discipline, creativity, democracy, friendly/communicative, love to read, respect for achievement, curiosity, and honesty. From the analysis, it can be concluded that the buffer solution material in book A meets the criteria better than book B.

Keywords: Buffer solution; 4S TMD; Text book

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1. Introduction

In education, the terms learning and learning are known. According to Oemar Hamalik (Sutiah, 2016) learning is the modification or strengthening of behavior through experience. In the learning process itself, there are three main components, namely teachers, learners, and teaching materials. The three components are very related to each other. Teaching materials are one of the important components that need special attention, it is because there are still many teaching materials both in breadth and depth that are not in accordance with student development and make it difficult for students to understand. Therefore, research related to teaching materials is very important to do, as according to Anwar (2015) who states that even though the techniques and strategies applied are good and correct without the support of good teaching materials, learning will not get maximum results (Anwar, 2015)

Chemistry is one of the materials from the field of science that explains the nature, structure of matter, composition of matter, changes in matter into new substances, and an energy accompanied by change (Djarwo, 2019). Chemistry itself has certain

characteristics, one of which is abstract, quite a lot of chemical material contains abstract concepts. Students' difficulties in understanding chemistry material can also be caused by the learning process, but besides this, one of the other difficult factors faced by students is the role of textbooks used in the learning process (Rusianti, S., Fatah, H., 2019). A quality learning process requires an appropriate learning resource, one of which is a textbook (Kemendikbud, 2013). In the 2013 curriculum, all student textbooks are replaced with books that have been adapted to the 2013 curriculum.

To achieve an optimal teaching and learning process, quality teaching materials are essential. However, in reality, many teaching materials are not aligned with the knowledge level of students. Currently, textbooks circulated in schools are often criticized for their alignment with curriculum guidelines and the accuracy of the concepts. According to Muslich (in Anwar et al., 2017), there are several essential requirements that teaching materials must meet, one of which is the accuracy of concepts. Another issue frequently encountered in the learning process is that teachers often provide materials that are either too broad or too narrow, too deep or too shallow, and do not align with the competencies that students are supposed to achieve (Mudlofir, 2011).

Therefore, research related to teaching materials is very important, as stated by Anwar (2015), who emphasized that even if the techniques and strategies applied are good and correct, without the support of quality teaching materials, learning outcomes will not be optimal (anwar, 2015). When measuring the quality of teaching materials, it is crucial to consider several important aspects, one of which is the alignment of the teaching materials with the applicable curriculum. If the alignment between the teaching materials and the curriculum is low, it will be difficult to achieve the expected competencies. This happens when educators assume that the materials used are sufficient without conducting an analysis beforehand.

One method of analysis that can be done to overcome problems to assess the quality of textbooks can be done based on the selection stage criteria of the Four Steps Teaching Material Development (4S TMD) which is the development of Anwar (2015).

The analysis has three criteria, including conformity to the demands of the curriculum, the truth of the concept, and the values instilled in the textbook. The 4S TMD method itself is a method used to produce an ideal teaching material and can also be used in analyzing the content of textbooks at the selection stage, namely conformity to curriculum guidance, correctness of concepts, and instilling values (Anwar, S., Noviyanti, N., 2017).

From the description above, there are several problems related to textbooks, including the suitability of textbooks with curriculum guidance, the truth of concepts, and also the cultivation of values in textbooks. There are results of research on textbook analysis that has been carried out using 4S TMD at the selection stage, including research conducted by Dewi (2016), which concluded that the buffer solution material in the book under study was not fully in accordance with the demands of the curriculum. In terms of breadth, the material was concluded to be less broad and too broad (Dewi, 2016). This is because it does not discuss the four concept labels required by the learning indicators. In terms of depth, there are seven concepts whose discussion is less deep, besides that there is also one concept whose discussion is too deep. A study using the 4STMD selection stage was also conducted by Susila (2019), who concluded that in the acid-base solution material, the teaching materials were not fully aligned. It was observed that in terms of content scope, it was considered insufficient, as the research object did not include four standard concept labels. The results of the study indicated that the content suitability in high school/Islamic high school chemistry textbooks still showed significant discrepancies with curriculum demands, incorrect concepts, and a lack of instilled values. Therefore, it is essential to analyze

textbooks based on the 4S TMD selection criteria (Susila, 2019). According to stephanie et al (2019) buffer solution material is material that requires students to have good mastery of concepts and mathematical abilities. this is also due to the buffer solution material entering into the concept of solution, so that the need for an initial understanding of the concept of equilibrium, the concept of acid base and stoichiometry so that the understanding of buffer solution material can be understood properly (Stephanie, N., 2019).

The purpose of this study is to determine the suitability of the material based on curriculum guidance, the truth of the concept, and the cultivation of values on the buffer solution material in SMA / MA class XI chemistry textbooks based on the 4S TMD selection stage criteria.

2. Research Method

This research uses a qualitative approach. In the research conducted using the documentation study method, where the data sources of this research are transcripts of the 2013 curriculum, transcripts of indicators of character education values by balitbang (2010), buffer solution material from SMA / MA class XI chemistry textbooks publisher A and publisher B, and international general chemistry textbooks (textbooks).

Research subject

The research subjects are lecturers who are experts in the field of analyzing buffer solution material in SMA/MA class XI chemistry textbooks based on the 4S TMD selection stage.

Object of research

The object of this research is the buffer solution material in chemistry textbooks that meet the requirements set by the Indonesian Ministry of Education and Culture's Decree No. 148/P/2016 on approved high school/Islamic senior high school textbooks for specialization groups. These include: Textbook A, "Chemistry for 11th Grade High School/Islamic High School, Mathematics and Natural Sciences Specialization Group" and Textbook B, "Active and Creative Chemistry Learning for 11th Grade High School/Islamic High School, Mathematics and Natural Sciences Specialization Group".

Research Focus

In this study, the focus of the research is the buffer solution material in SMA/MA class XI chemistry textbooks which is analyzed based on the criteria for the selection stage of the 4S TMD method, including the suitability of the material with curriculum guidance, the truth of the concept, and the cultivation of values.

Data Collection Technique

In the research conducted using the documentation study method, where the data sources of this research are transcripts of the 2013 curriculum, transcripts of indicators of character education values by Balitbang (2010), buffer solution materials from SMA/MA class XI chemistry textbooks, as well as international general chemistry textbooks (textbooks).

2.1. Analysis of material suitability with curriculum guidance

The analysis of conformity with the demands of the curriculum required data are basic competencies in the cognitive aspect (KD 3) of Curriculum 2013 according to the material under study, standard concept labels of valid learning indicators, explanations of standard concepts in international general chemistry textbooks (textbooks), explanations of concepts in the object of research, and concept labels on the object of research. The data is used to analyze the breadth and depth of concepts on the object under study by comparing the object of research with standard concepts. In the material breadth analysis, the data used are standard concept labels and research object concept labels. Then in the concept depth analysis, the data used is the explanation of the standard concept and the explanation of the concept of the object of research

2.2. Concept Correctness Analysis

In the truth of the concept, the data needed to analyze the truth of the concepts in the

research object are standard concept labels, standard concept explanations, and concept explanations on the research object. The truth of the concept on the object of research is done by comparing the explanation of the standard concept with the explanation of the concept on the object of research.

2.3. Value Planting Analysis

The data analysis technique used to examine value instillation in the research object is the content analysis method, involving systematic and objective document analysis. Text sections containing explicit or implicit value instillation are analyzed for their relevance to the value descriptions and indicators of value instillation based on the Balitbang (2010) guidelines.

3. Result and Discussion

Planning Stage

In the planning stage, the textbook used is a class XI chemistry textbook on buffer solution material which has been declared feasible by the Minister of Education and Culture of the Republic of Indonesia No. 148/p/2016. The books used are textbook A published by Erlangga and textbook B published by Grafindo (Kemendikbud, 2016).

Implementation Stage

a. Analysis of Material Suitability to the Curriculum

The suitability of the material with curriculum guidance is measured by analyzing the breadth of material and the depth of concepts. In analyzing the suitability of the material, KD, GPA, and standard concept labels are needed in accordance with curriculum guidance.

Material Breadth Analysis

Based on the results of the analysis of the breadth of buffer solution material in textbook A, there are 6 concept labels that are declared in accordance with curriculum guidance. Table 1 is the result of the analysis of the breadth of buffer solution material in textbook A.

Table 1. Analysis of the breadth of buffer solution material in textbook A

Standard Concept Labels From the Standard Book	Concept Labels on Research Objects Book A	Extent			Description
		LE	S	TW	
Definition of buffer solution	Definition of buffer solution		√		The research object contains all standard concept labels
Components of Buffer Solution	Composition of buffer solution		√		Research object contains all standard concept labels
Buffer Solution Capacity	Effectiveness of buffer solution		√		The research object contains all standard concept labels
How buffer solution works	Working principle of buffer solution		√		The research object contains all standard concept labels
Calculation of pH of buffer solution	pH value of buffer solution		√		Research objects load all standard concept labels
The role of buffer solution	Buffer solution in daily life		√		The research object contains all standard concept labels

Description: LE: Less Extensive, S : Suitable , TW : Too Wide

Based on the results of the analysis in Table.1 regarding the breadth of buffer solution material on the object of research book A obtained zero (0) concept labels that are less extensive, six (6) concept labels included in

the appropriate criteria and zero (0) concept labels that are too broad.

Table 2. Analysis of the breadth of buffer solution material in textbook B

Standard Concept Labels from the Standard Book	Concept Labels on Research Object Book B	Extent			Description
		LE	S	TW	
Definition of buffer solution	Definition of Buffer Solution	-	√	-	The research object contains all standard concept labels
Components of Buffer Solution	Properties of buffer solution	-	√	-	The object of study contains all standard concept labels
-	Making buffer solution with specific pH	-	-	√	The research object contains concept labels that are not contained in the standard concept labels
Buffer Solution Capacity	Buffer Solution Capacity	-	√	-	The research object contains all standard concept labels
How buffer solution works	Working Principle of buffer system	-	√	-	The research object contains all standard concept labels
Calculation of pH of buffer solution	Calculation of pH of buffer solution	-	√	-	The research object contains all standard concept labels
The role of buffer solution	Buffer solution in the body of living things	-	√	-	The research object contains all standard concept labels

Description: LE: Less Extensive, S : Suitable , TW : Too wide

Based on Table.2 regarding the results of the breadth of buffer solution material on research object B shows that there are zero (0) concept labels that are less broad, six (6) concept labels that fall into appropriate criteria, and one (1) concept label that is too broad. From this identification, the concept that is stated to be too broad is because the concept in the object of research book B on buffer solution material contains material that is not contained in the standard concept, as for the concept label that is too broad, namely making a buffer solution with a specific pH.

From these results it can be compared that for the breadth of book A on buffer solution material falls into the appropriate criteria, while in book B on buffer solution material the breadth of material is too broad.

2. Concept Depth Analysis

The depth of a concept should be presented efficiently; insufficient depth may lead to misconceptions, while excessive depth increases students' learning burden. The analysis of concept depth includes three categories: Less Deep, Suitable, and Too Deep.

Based on the results of the analysis that has been carried out on object A on buffer solution material, two (2) concepts are obtained which include less deep criteria, there are four (4) concepts that are included in the deep criteria and there are zero (0) concepts that include criteria that are too deep. Can be seen in Table 3.

Table 3. Concept depth analysis of buffer solution material in book A

Concept Label Book A	Depth		
	LD	S	TD
Definition of buffer solution	✓	-	-
Composition of buffer solution	-	✓	-
Effectiveness of buffer solution	✓	-	
Working principle of buffer solution	-	✓	-
pH value of buffer solution	-	✓	-
Buffer solution in daily life	-	✓	-

Description: LD; Less Deep, S; Suitable, TD; Too Deep

On the object of book B of buffer solution material, one (6) concept is obtained which includes deep criteria, one (1) concept that is too deep, and one (1) concept that is less deep. The results of the analysis can be seen in Table 4.

Table 4. Concept depth analysis of buffer solution material in book B

Book Concept Label B	Depth		
	LD	S	TD
Definition of Buffer Solution	-	✓	-
Properties of buffer solutions	-	✓	-
Making buffer solution with specific pH	-	-	✓
Buffer Solution Capacity	✓	-	-
Working Principle of buffer system	-	✓	-
Calculation of pH of buffer solution	-	✓	-
Buffer solution in the body of living things	-	✓	-

Description: LD; Less Deep, S; Suitable, TD; Too Deep

Based on the analysis of concept depth for both research objects, it was found that Book A falls into the insufficient depth category, while Book B falls into the depth not yet appropriate category.

B. Analysis of Conceptual Correctness in Textbooks

The following are the results of the conceptual correctness analysis which can be seen in Table 5 and Table 6.

Table 5. Analysis of the correctness of the concept of buffer solution in textbook A

Label Konsep Buku A	S	NyA
Definition of buffer solution	✓	-
Composition of buffer solution	✓	-
Effectiveness of buffer solution	✓	-
Working principle of buffer solution	✓	-
pH value of buffer solution	✓	-
Buffer solution in daily life	✓	-

Table 6. Analysis of the correctness of the concept of buffer solution material in book B

Book Concept Label B	S	NyA
Definition of Buffer Solution	✓	-
Properties of buffer solution	✓	-
Making buffer solution with specific pH	✓	-
Buffer Solution Capacity	✓	-
Working Principle of buffer system	✓	-
Calculation of pH of buffer solution	✓	-
Buffer solution in the body of living things	✓	-

Description: S : Suitable, NyA: Not yet Appropriate

In the identification of concept accuracy analysis for research object A, as shown in Table 5, there are six (6) concepts with appropriate characteristics and zero (0) concepts with inappropriate characteristics. For Book B, as shown in Table 6, there are seven (7) concepts with appropriate characteristics and zero (0) concepts with inappropriate characteristics. Therefore, it can be concluded that both books have accurate concepts.

c. Analysis of Value Planting of buffer solution material in textbooks

In the analysis of value planting in research object A and research object B is done by analyzing the buffer solution material in each part of the book. After the material is analyzed, the values embedded in the material are identified by referring to the standards in the form of descriptions and indicators of value planting from the Ministry National Education and Balitbang (2010). Based on the results of the analysis of the buffer solution material and based on the reference of the value planting of the Ministry of National Education and Research and Development (2010), research object A and research object B found different value planting .

The following Table 7 shows some of the results of the identification of values embedded in the research objects.

Table 7. Table of Relationship between Solution Concentration and Acidity Level

No	Textbook A	No	Textbook B
1	Discipline	1	Hard work
2	Hard work	2	Independent
3	Responsibility	3	Responsibility
4	Friendly/communicative	4	Discipline
5	Love to read	5	Creative
6	Curiosity	6	Democratic
		7	Friendly/communicative
		8	Love to read
		9	Respect for achievement
		10	Curiosity
		11	Honest

Based on the results from the tables above, it can be observed that both Book A and Book B contain varying values. Book A includes 6 values: discipline, hard work, responsibility, friendliness/communication, love for reading, and curiosity. Meanwhile, Book B includes 11 values: hard work, independence, responsibility, discipline, creativity, democracy, friendliness/communication, love for reading, appreciation for achievement, curiosity, and honesty.

4. Conclusion

Based on the results of the analysis of buffer solution material in textbook A and textbook B SMA/MA class XI based on the selection stage criteria of 4S TMD it can be concluded that, for the suitability of buffer solution material in textbook A forMA/MA class XI with curriculum demands 6 concept labels are appropriate. In terms of breadth, in textbook A there are 6 concept labels that match the breadth. In terms of depth, there are 2 concept labels that are declared less deep, 4 concept labels that are declared appropriate. As for the suitability of buffer solution material in textbook B for SMA/MA class XI with the demands of the curriculum, 6 concept labels are appropriate and 1 concept label is not appropriate because it is not included in conformity with the curriculum. In terms of breadth, the material of buffer solution is stated that 6 concept labels are appropriate and there is 1 concept label that is stated to be too broad. In terms of depth, there is 1 concept label that is stated to be less deep, 5 concept labels that are stated to be appropriate and there is 1 concept label that is stated to be too deep. So in terms of the breadth of the object of research book A is more suitable than the object of research book B and for the depth of buffer solution material in the object of research both book A and book B are still not appropriate. From these results the recommended book is book A. The truth of the concept of textbook A and textbook B of buffer solution material is stated to be scientifically appropriate. The value instilled in the buffer solution material of textbook A there are 6 values instilled, namely the value of discipline, hard work, curiosity, love of reading, friendly/communicative, and responsibility. While the value instilled in the buffer solution material of textbook B there are 11 values instilled, namely, discipline, hard work, curiosity, friendly/communicative, independent, creative, democratic, love to read, respect for achievement, honesty, responsibility.

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