Analyzing scientific approach and problem solving in salt hydrolysis topic

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Abstract. This study aimed to analyze the suitability of materials teaching with aspects found in the scientific approach, and the steps of problem solving model. The sample of this research was three textbook materials of class XI chemistry. It was used by some high schools in Klaten Regency. The analysis was conducted on three teaching materials that were coded X, Y, and Z. The result of the research showed that the compatibility toward the scientific approach of textbook X and Y was sufficient category, textbook Z was very poor category. Conformity to problem solving model step sample X was poor category, sample Y was sufficient category, and sample Z was very poor category. These chemistry book materials which used in the high school should be added according to aspects of the scientific approach and problem solving steps that have not been listed.

1. Introduction
Education in Indonesia currently uses curriculum 2013. The curriculum suggests that students are subjects who have the ability in learning, actively seek, process, construct, and use knowledge. In order to truly understand and apply knowledge, students need to be invited to solve problems, find everything for themselves, and strive to realize their ideas. Students are expected to be more active, creative, and innovative in solving any problems encountered.

Chemistry includes product (cognitive), process (psychomotor), formation of scientific attitude (affective), and application. To understand chemistry requires the ability to describe three representations of macroscopic, microscopic, and symbolic [1]. The presentation of chemical concepts with three levels of representation simultaneously is an important aspect to be considered by teachers in the chemistry learning process. But in reality, many students do not understand and cannot use the three representations (macroscopic, microscopic, and symbolic) in explaining a phenomenon [2]. Therefore, chemistry is often referred to as one of the difficult subjects.

The teachers tend to focus more on the procedural learning in calculation aspect than the conceptual aspect in explaining the chemistry [3]. As a result, students have difficulty understanding the concepts in chemistry correctly. Chemistry contains concepts that are sequential and tiered [4]. If students do not understand the basic concept, then students will have difficulty in understanding the concept further [5]. Student-centered learning can be implemented by applying a scientific approach. The scientific approach has five aspects that can be applied in the learning process. Aspects of a scientific approach include, observing, questioning, collecting information, processing information, and communicating results. Indicators of the five aspects of the scientific approach used in this study are in accordance with the
descriptions of the scientific approach aspect of the approach by Harlen (2006) and Permendikbud 81 A 2013 about Implementation of Curriculum.

Problem Solving model is one of the learning models that suit the scientific approach. Problem Solving learning is more emphasized on the students' activity, while the role of teachers as mentors who direct students to solve problems. Problem-solving syntax includes: (1) Defining the problem; (2) Diagnose the problem; (3) Formulating alternative strategies; (4) Determining and implementing strategies; (5) Evaluate the success of the strategy [6].

Learning resources or teaching materials that are often used in teaching learning are textbooks such as textbook lessons, modules, and student worksheets (LKS). The book is an instructional aid in the teaching and learning process and should be in accordance with the curriculum of the objectives, content, and teaching methodology of each subject [7]. Therefore, teaching materials should be in accordance with the applicable curriculum for the purpose of learning to be achieved.

This study aims to analyze the suitability of chemical resources used in several high schools in Klaten District with a scientific approach and Problem Solving learning model. The process of analysis of teaching materials was done on salt hydrolysis as teaching material for class XI. The analysis was conducted on three teaching materials that were coded X, Y, and Z.

2. Methods
The selection of teaching materials analyzed in this study was adapted to the teaching materials which used in five high schools in Klaten District. Based on the results of interviews and observations, there are three teaching materials used by teachers which is mostly owned by students in the five high schools. The three teaching materials are coded X, Y, and Z.

Method of this research was content analysis, which used a coding qualitative and quantitative analysis. The data collecting technique used documentation method. Data analysis is the assessment of compatibility of teaching materials according to scientific approach and according to the steps in problem solving learning model. The research instrument is the form of table consisting of elements of scientific approach or problem solving learning models in the first column, the second column shows the characteristics of elements, third and fourth column contain textbook contents which is compatible or not. Qualitative data obtained from the checklist on the form. Quantitative data is derived from the score of the calculation of the percentage of the teaching materials calculated using the following equation:

The compatibility of teaching materials with aspects of a scientific approach

\[ \text{%PS} = \frac{KM}{K} \times 100\% \]

The compatibility of teaching materials with Problem Solving model step

\[ \text{%MPS} = \frac{SS}{S} \times 100\% \]

Information:
\% PS : Percentage of scientific approach
KM : Total of the compatibility aspects
K : The total number of aspects
\% MPS : Percentage of Problem Solving model
SS : Total of the compatibility syntax
S : The total number of syntax

As the provision in giving meaning and decision-making above calculation results can be interpreted with a range as in table 1.
3. Results and Discussion

The result of compatibility of teaching materials according to scientific approach can be found in the table. There are four learning indicators of salt hydrolysis in the first column and five aspects of scientific approach in the next column. This research consisted of five aspects of scientific approach which analyzed its compatibility with teaching materials. The five aspects of a scientific approach include observing, questioning, experimenting, associating, and communicating. The results of the analysis on materials teaching X, Y, and Z are respectively shown in table 2, table 3, and table 4.

| Learning Indicators | Scientific Approach | % |
|---------------------|---------------------|---|
| Grouping salt types based on their acid-base formers | √ | √ | √ | √ | √ | 100 |
| Determine the type of hydrolysis reaction that occurs in a salt | - | - | - | - | - |
| Determine the character of the hydrolyzed salt solution | √ | √ | √ | √ | √ | 100 |
| Calculate pH of hydrolyzed salt solution | - | - | - | - | - |

Average 50

Textbook X there are only 2 learning indicators that compatibility with five aspects of scientific approach. Aspect observed that students are given the opportunity to make observations through activities: viewing, listening, and reading. Teachers facilitate students to make observations. The observing aspect is an object image as well as a clue for students to observe the object. The aspect of the questioning can be done with the teacher guiding the students to ask questions related to the observation. Aspect of experimenting or collecting information is to experiment and collect as much information as possible related problems. Experimenting aspect is contained in textbook X in the form of instructions or tasks for students to conduct an inquiry to answer questions. Associating aspect or processing information is to find patterns of information interconnected with each other and take the conclusions of the patterns found. The activities of communicating aspect is writing or telling the results found and assessed by the teacher as a result of

| Table 1. Categories of Compatibility Assessment of Materials |
|---------------------------------|
| Percentage | Quality Categories of compatibility |
| 81 < % ≤ 100 | Very Good |
| 71 < % ≤ 80 | Good |
| 41 < % ≤ 70 | Sufficient |
| 21 < % ≤ 40 | Poor |
| ≤ 20 | Very Poor |

| Table 2. Result of Compatibility of textbook X with Scientific Approach |
|---------------------------------|
| Learning Indicators | Scientific Approach | % |
|---------------------|---------------------|---|
| Grouping salt types based on their acid-base formers | √ | √ | √ | √ | √ | 100 |
| Determine the type of hydrolysis reaction that occurs in a salt | - | - | - | - | - |
| Determine the character of the hydrolyzed salt solution | √ | √ | √ | √ | √ | 100 |
| Calculate pH of hydrolyzed salt solution | - | - | - | - | - |

Average 50
learning. Communicating aspect is also contained in the form of commands for the task of preparing reports and presenting them. Based on the calculation, the percentage of compatibility of textbook X with scientific aspect is 50%, sufficient category.

### Table 3. Result of Compatibility of textbook Y with Scientific Approach

| Learning Indicators                                      | Scientific Approach | %  |
|----------------------------------------------------------|---------------------|----|
| • Grouping salt types based on their acid-base formers   | √ √ √ √ √           | 100|
| • Determine the type of hydrolysis reaction that occurs  | - √ - √ √           | 60 |
|   in a salt                                               |                     |    |
| • Determine the character of the hydrolyzed salt solution| √ √ √ √ √           | 100|
| • Calculate pH of hydrolyzed salt solution                | - - - - -           |    |

Average 65

Three learning indicators in book Y are in accordance with the aspects of the scientific approach. The introduction to this textbook is the question "what if acid or alkaline or salt substances are dissolved in water?" then continued with observation activities. Indicator “Grouping salt types based on their acid-base formers” is presented with a table of some salt then students are asked to guess the forming acid and base. Indicator “Determine the character of the hydrolyzed salt solution” is the investigation of the character of some salt solutions using litmus paper. Experimenting, associating, and communicating aspects in textbook Y appear in instructions or assignments for students to conduct investigations and discussions then answer questions and make reports. Unfortunately on indicator “Determine the type of hydrolysis reaction that occurs in a salt” there are no aspects of observation and experimentation. On this indicator only preliminary questions are given but there is a full explanation and students are asked to complete and conclude. Indicator “Calculate pH of hydrolyzed salt solution” of textbook Y only presents formulas and sample questions without involving students directly. The percentage of compatibility of teaching materials Y is 65% including the sufficient category.

### Table 4. Result of Compatibility of textbook Z with Scientific Approach

| Learning Indicators                                      | Scientific Approach | %  |
|----------------------------------------------------------|---------------------|----|
| • Grouping salt types based on their acid-base formers   | - - - - -           |    |
| • Determine the type of hydrolysis reaction that occurs  | - - - - -           |    |
|   in a salt                                               |                     |    |
| • Determine the character of the hydrolyzed salt solution| √ - √ √ √           | 80 |
| • Calculate pH of hydrolyzed salt solution                | - - - - -           |    |

Average 20
In textbook Z shows that the application of the scientific approach is less compared to textbook X and textbook Y. This textbook presents material without preliminary questions that can stimulate students to active. Associating aspect is present in the three materials teaching, but the materials teaching X and Y have a more complete command than the teaching material Z. The materials teaching X and Y have commands to create patterns against the observations, explain them and make conclusions and link the results with relevant concepts, while the materials teaching Z there are only commands to make a conclusion. The percentage of compatibility of teaching materials Z is 20% including very poor category. Materials teaching that are still not in accordance with aspects of a scientific approach should be added to the appropriate aspects. Materials teaching that fit the scientific aspect are expected to help teachers in the learning process, because through the application of this materials teaching teachers have implemented the curriculum 2013. Use of materials teaching with constructivism (scientific approach) proved better when compared with the traditional approach [8]. Learning by scientific approach on chemicals is effective in improving argument analysis skills, learners will be more active in asking, expressing opinions, and increasing students' curiosity about learning materials [9]. Chemical modules based on an effective scientific approach improve student achievement from aspects of students' knowledge, attitude, and skills [10].

| Table 5. Results of Compatibility of Textbook X with Problem Solving |
|-------------------------------------------------------------|
| Learning Indicators                                       | Problem Solving |
|                                                           | A | B | C | D | E | % |
| Grouping salt types based on their acid-base formers      | √ | √ | - | - | - | 40 |
| Determine the type of hydrolysis reaction that occurs in a salt | - | - | - | - | - |   |
| Determine the character of the hydrolyzed salt solution   | √ | √ | √ | √ | √ | 100|
| Calculate pH of hydrolyzed salt solution                   | - | - | - | - | - |   |
| Average                                                   |   |   |   |   |   | 35 |

| Table 6. Results of Compatibility of Textbook Y with Problem Solving |
|-------------------------------------------------------------|
| Learning Indicators                                       | Problem Solving |
|                                                           | A | B | C | D | E | % |
| Grouping salt types based on their acid-base formers      | √ | √ | √ | √ | √ | 100|
| Determine the type of hydrolysis reaction that occurs in a salt | - | - | - | - | - |   |
| Determine the character of the hydrolyzed salt solution   | √ | √ | √ | √ | √ | 100|
| Calculate pH of hydrolyzed salt solution                   | - | - | - | - | - |   |
| Average                                                   |   |   |   |   |   | 50 |
Table 7. Results of Compatibility of Textbook Z with Problem Solving

| Learning Indicators                                      | Problem Solving | %  |
|---------------------------------------------------------|-----------------|----|
| • Grouping salt types based on their acid-base formers  | A   B   C   D   E |    |
| • Determine the type of hydrolysis reaction that occurs in a salt | -   -   -   -   - |    |
| • Determine the character of the hydrolyzed salt solution | -   -   -   √   √ | 40 |
| • Calculate pH of hydrolyzed salt solution               | -   -   -   -   - |    |
| Average                                                 | 10              |    |

Information:
A: Define the problem
B: Diagnosing problems
C: Formulate alternative strategies
D: Determine and implement strategy
E: Evaluate the success of the strategy

The syntax in the learning model is the learning steps that must be fulfilled and executed in order. Based on the results of the suitability of teaching materials with problem solving steps there are still steps that have not been fulfilled.

The first step in the problem solving model is to define the problem. Problem solving depends heavily on understanding the problem itself. Defining the problem can be done by presenting the event containing the problem according to the subsequent subject learners are asked to formulate the problem. Teaching materials X and Y each provide a dish of problems that can be understood learners and there are also commands and questions that stimulate learners formulate the problem. Teaching material Z there is no problem presented clearly so that students difficult to understand the problems encountered.

The second step, diagnose the problem that learners are asked to form a small group to discuss the causes of the problem. Teaching materials X and Y there is this step in the form of commands to discuss and seek related information that causes problems. The teaching material Z does not contain this step.

The third step, formulating an alternative strategy that the group finds some alternative problem solving. Teaching materials X and Y provide an opportunity to find an alternative problem solving one of them by asking learners to plan their own experiments.

Step four, define and implement strategy. The three materials teaching there is this step that there are experimental steps and tables of observations and related questions relevant to the material. The last is to evaluate the success of determining the effectiveness and truth of the experimental results and discussions with the related material. The three materials teaching there is this step is an invitation to create reports and class presentations so that teachers can guide learners to evaluate.

Based on the result of percentage calculation, it is found that the teaching material X has the suitability with Problem Solving step 35% including the poor category, the teaching material Y has the percentage of suitability 50% including the sufficient category, while the teaching material Z has 10% suitability including the very poor category. Materials teaching that are not in accordance with the steps of the Problem Solving model should be completed with steps and done in sequence. Applying the Problem Solving model to the learning will build students problem solving skills so that they are accustomed to apply the scientific step
when finding the problem and can solve it well [11]. Problem solving skills can be applied to various learning materials so it is best to model Problem Solving applied to school learning [12].

Application of learning through scientific approach and Problem Solving model is expected to improve the learning process of learners so that will improve learning outcomes and learning objectives in the 2013 curriculum can be achieved. Competence to be achieved is a balanced competency between attitude, skills, and knowledge. Teaching materials in accordance with the curriculum is expected to form a generation that characterize and reflect the personality of the nation. Students are expected to be more active, creative, and innovative in solving any problems encountered.

4. Conclusion

Based on the analysis that the conformity of scientific approach to the teaching materials X was the sufficient category, the percentage of conformity of teaching materials Y was sufficient category, and the conformity of teaching materials Z including the category is very poor. Conformity of Problem Solving model to teaching materials X including poor category, teaching material Y has sufficient category, while teaching material Z has very poor category.

Suggestion that can be submitted from this research is the need of addition of aspect and syntax at instructional material which not yet according to scientific approach and model of problem solving so that teacher can apply learning according to curriculum 2013 by following step on the instructional material. The need for the development of materials teaching in accordance with the curriculum 2013.

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