



THE DEVELOPMENT OF SYSTEMIC MULTIPLE CHOICES QUESTIONS (SMCQS) ON REDOX AND ELECTROLYTE-NONELECTROLYTE SOLUTION CONCEPTS IN CHEMISTRY TEACHING AND LEARNING

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Abstract

Nowdays, systemic approach are used widely in chemistry teaching and learning. The aims of this study were (1) to examine the feasibility of the SMCQs, (2) to examine the validity and reliability of the SMCQs, and (3) to analyze the level of difficulty of the SMCQs. The SMCQs was developed using R and D model. The research instruments was formed of questionnaire to assess the quality of the questions and multiple choices questions based on the systemic approach to test the validity, reliability, and item difficulty. Data analysis was performed using the method of Winstep application through Rasch statistical method. Based on the study, the quality of the SMCQs is excellent (88.46%) which consists of 30 items valid with high reliability. Meanwhile, the difficulty level of the questions were 66.67% easy, 23.33% moderate, and 10% difficult

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INTRODUCTION

There are several instruments to measure the academic achievement of students in chemistry teaching and learning, such as multiple choices question, true-false question, etc. These kinds of this instruments can be categorized in two models, which are paper based question and computer based question.

Multiple choices question is one form of evaluation that the answer can be obtained by selecting one of the answers that have been provided. This kind of evaluation consists of two parts, which are a problem (stem) and a list of suggested solutions (alternatives)^[1]. The basic form of a stem is a question or an incomplete statement. Moreover, the list of the alternatives contains of the best answer (or the correct answer) and a number of incorrect answer or inferior alternatives (distractor).

Multiple choices question can be used to measure various levels of cognitive knowledge, which are related to Bloom's taxonomy of educational objectives (knowledge, comprehension, application, analysis, synthesis, and evaluation). The strengths of this type question^[2] :

1. Learning outcomes from simple to complex can be measured.
2. Highly structured and clear tasks are provided.
3. A broad sample of achievement can be measured.
4. Incorrect alternatives provide diagnostic information.
5. Scores are more reliable than subjectively scored item (e.g. essay).
6. Scoring is easy, objective, and reliable.

7. Item analysis can reveal how difficult each item was and how well it discriminated between the strong and weaker student in the class.
8. Performance can be compared from class to class and year to year.
9. Can cover a lot of material very efficiently.

As an instrument for evaluation, this model has limitations^[2], e.g.:

1. Constructing good items is time consuming.
2. It is frequently difficult to find plausible distractors.
3. It is ineffective for measuring some types of problem solving and the ability to organize and express ideas.
4. Scores can be influenced by reading ability.
5. Often focus on testing factual information and fails to test higher level of cognitive thinking.
6. Sometimes there is more than one defensible “correct” answer.
7. Does not provide a measure of writing ability.
8. May encourage guessing.

Usually, multiple choice questions have not been able to reveal the chemistry concepts in a comprehensive manner. As a result, students are less able to think constructively and tend to forget the basic chemistry concepts they have learned previously^[3]. Therefore, it is required a new approach in developing a multiple choice questions.

In this study, the multiple choice questions were developed using a systemic approach. Therefore, this type of question is namely systemic multiple choice questions (SMCQs). The systemic approach is an approach in teaching and learning where multiple components are connected to each other by a mutual relationship^[4]. The alternatives of SMCQs consist of three concepts in chemistry which are connected to each other.

This study was developed SMCQs on redox and electrolyte – non electrolyte solution concepts. The aims of this research were (1) to examine the feasibility of the SMCQs, (2) to examine the validity and reliability of the SMCQs, and (3) to analyze the level of difficulty of the SMCQs.

METHOD

This kind of study was a research and development (RnD) that adapted the stages presented by Gall, *et al*^[5], which are :

1. Research analysis, needs assessment, and proof of concept
2. Product planning and design
3. Preliminary product development
4. Preliminary field testing
5. Product revision
6. Main field testing
7. The final product revision

The SMCQs were developed by considering the cognitive level according to Bloom's taxonomy, i.e. remembering, understanding, applying, analyzing, evaluating, and creating^[6]. Preparation of the test items adjusted to basic competence in chemistry syllabus in Kurikulum 2013.

The instruments of this study were questionnaire and also the SMCQs. Expert judgement was conducted on the instrument that has been made. A 15 high school chemistry teachers assessed the quality of SMCQs using questionnaire which consists of three aspects, i.e. construct, structure of the question, and chemistry concept. Each aspect is divided into a number of indicators.

The SMCQs tested to 160 students to determine the validity and reability. The test results are used to determine the level of difficulty of the SMCQs. The data was analysis using Winstep application through Rasch model.

RESULTS AND DISCUSSION

This research has developed 30 items of SMCQs on redox and electrolyte-non electrolyte solution. For each question, there was 5 alternatives. The example of part of SMCQs is shown in Figure 1 below.

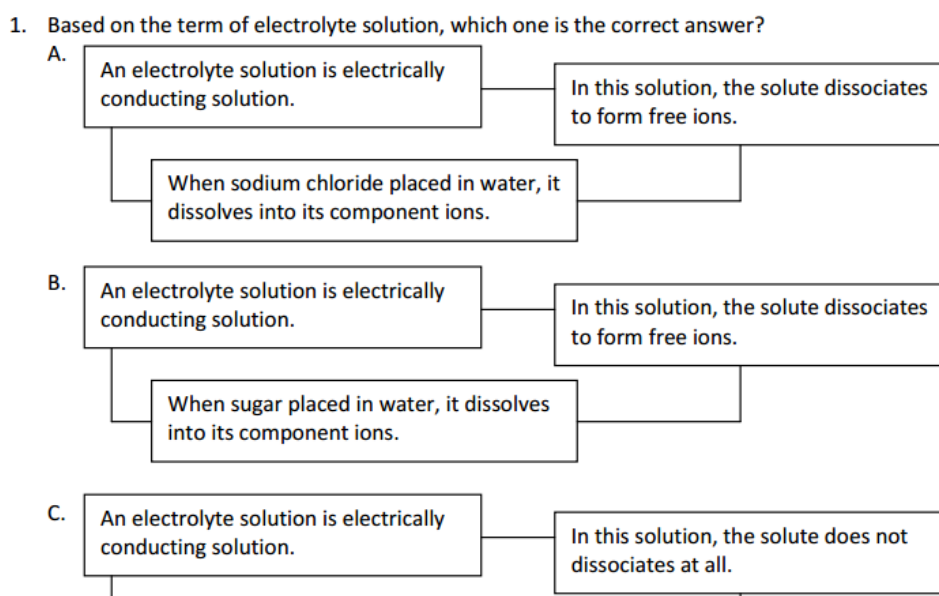


FIGURE 1. A part of a SMCQs on redox and electrolyte – non electrolyte solution concepts.

After the SMCQs were arranged, it was followed by a review from the judgement expert. Furthermore, the advices from experts are used for the revision of the SMCQs. The quality of SMCQs determined based on teacher assessment through the instrument that has been made. The assesment result of SMCQs is shown in Table 1 below.

TABLE 1. The assesment result of SMCQs on redox and electrolyte - non electrolyte solution concept.

	Aspects			
	Construct	Structure of the Question	Chemistry Concept	Average
Quality (%)	88.00	90.66	88.00	88.46
Category	Excelent	Excelent	Excelent	Excelent

Although the calculation indicate that SMCQs category excelent, during the data collection process there were some reviewer stating that this type of question are too difficult to student. In their opinion, the student would not be able to understand the alternatives.

The validity of an instrument indicates the level of accuracy of an instrument to measure what should be measured. The validity of items obtained through testing MCQs to the students. There were 160 students of high school as subject for validation of the SMCQs. Data were analyzed using Winstep applications toward Rasch analysis method. The analysis showed that all items, 30 questions, were valid category.

Reliability associated with a level of confidence. A test have a high level of confidence that if these tests provide consistent results. Reliability of the SMCQs determined using Winstep applications. Is is obtained that the realibility value of SMCQs is 0.95. This value is classified as a special category based on the criteria analysis with Rasch models^[6].

A test should not be too easy, and also should not be too difficult. An item that is too easy to be answered correctly by all students is not a good item. Similarly, the items that are too difficult so it can not be answered by all students is also not a good item. So the good items are items that have a certain degree of difficulty^[7]. The level difficulty of SMCQs was analyzed using Variable Maps on Winstep application. Based on the analysis, the distribution of level difficulty given in Table 2 below.

TABLE 2. Level diiculty of SMCQs on redox electrolyte - non electrolyte solution concept.

	Level difficulty		
	Easy	Moderate	Difficult
Number of items	20	7	3
Percentage (%)	66.67	23.33	10

Based on students and reviewers testimony, the strength of the SMCQs:

1. Can help students not to forget the chemistry concepts that have been studied previously.
2. Making easier for students to understand the chemistry concepts without ignoring the concept that has been studied previosly.
3. Can stimulate the curiosity of students to the relationship of chemistry concepts.

CONCLUSION

The result of this study showed that the quality of the SMCQs is excellent (88.46%) . The SMCQs on redox and electrolyte – non electrolyte solutions consists of 30 items valid with high reliability. Meanwhile, the difficulty level of the questions were 66.67% easy, 23.33% moderate, and 10% difficult.

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