



## THE DESIGN OF ELECTROLYTE AND NON ELECTROLYTE SOLUTION TEACHING MATERIALS WITH MULTI REPRESENTATION

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### Abstract

The limited resources for learning chemistry and the lack of application of multiple representations in schools are a problem for students in understanding chemistry at the molecular level. This study aims to obtain a multi-representation-oriented teaching material design that is feasible to use. Development of teaching materials using the 4D Thiagarajan et al, this is because this model is specifically for book development. The design of electrolyte solution and multi-representation-oriented teaching materials is assessed by five experts consisting of three FKIP lecturers and two chemistry teachers. The results of judgment on aspects of material feasibility, presentation of material, and language each get a percentage of 83%; 83.9%; 83.9% the three into the very decent category. While the results of the multi-representation aspect of judgment consist of five criteria, namely 1) the type of representation, the type of representation (C1), the interpretation of features (C2), the relationship with the text (C3), the description of the image (C4), the degree of connectedness (C5) has been met according to the criteria specified used. In the readability test, the teaching materials developed are categorized as easy to understand for students and independent categories, then received a positive response from students.

**Keywords:** teaching materials; multi-representation; electrolyte and non-electrolyte

## INTRODUCTION

Chemists study and describe the behavior of matter and energy in three different fields: macroscopic, microscopic, and symbolic. These domains provide different ways of considering and describing chemical behavior (William R. Robinson, 2015). When compared to other subjects, chemistry is considered more difficult. This is because the characteristics of chemistry are very broad and abstract (Kean and Middlecamp, 1985). In addition to its abstract nature, there are other things that distinguish chemistry from other sciences, namely chemistry is an interaction at the macroscopic, submicroscopic, and symbolic levels. Therefore, to make it easier for students to learn chemistry, according to Johnstone (1991), a multi-representation method is needed in explaining chemical concepts with macroscopic, submicroscopic, and symbolic images. Examples can be pictures, text, diagrams, equations, and so on. The use of these multi-representations can be poured into the teaching materials used in a lesson. However, some schools in Cirebon Regency only use teaching materials in the form of textbooks from the government. There are no other supporting teaching materials, the textbook is the only source of student learning. It also causes low learning motivation of students, due to the lack of variety of teaching materials used.

In a study, teaching materials are needed so that the learning carried out is more effective and efficient. According to Prastowo (2015) good teaching materials are teaching materials that can present material that connects abstract things with concrete things, so that abstract concepts become easier to understand by students. Abstract and concrete concepts can be connected with multiple representations. One of the chemical materials that requires a multi-representation role is electrolyte and non-electrolyte solutions which are included in the type of abstract concept with concrete examples. According to Farida (2010), the concept is an easily recognizable concept, but in it there are attributes that are difficult to understand, making it difficult to distinguish between examples and non-examples. Therefore, the material for electrolyte and non-electrolyte solutions can be more easily understood by students by connecting and presenting the material with a multi-representation orientation. The use of multi-representation-oriented teaching materials also has been proven to improve student learning outcomes, this is evidenced in Kamila's research (2019) which states that there are significant differences between the posttest scores of students' conceptual understanding and those in the experimental class and control class. Significant

differences in posttest scores are shown from the average posttest value of the experimental class of 84.7 while the class control of 79.6. Therefore, research is needed to develop multi-representation-oriented teaching materials, which include macroscopic, submicroscopic, and symbolic representations of electrolyte and non-electrolyte solutions. The development of multi-representation-oriented teaching materials is expected to increase students' understanding and learning motivation.

## METHOD

The research method used is research and development (R&D). The development research model used is the 4-D Thiagarajan model which consists of define, design, develop, and disseminate stages, but this research is limited to develop. This research method is closely related to the field of learning technology. Research in the field of learning technology is related to product development and design issues, especially learning media in the form of books.

### Research Design

This research was conducted with a 4D model which was limited to develop. At the defined stage, it is carried out to identify the needs of students and learning requirements. At the design stage, the preparation of teaching materials is carried out starting from the preparation of tests, media selection, format selection, to the initial design. The last is the develop stage, at this stage an assessment is carried out by experts which is then revised and limited trials.

### Research Target

This research was conducted in Cirebon district, during the 2020/2021 academic year. The research subject here is multi-representation-oriented teaching materials. The participants involved in this study are 12 students aged around 15-16 years consisting of male and female, 3 FKIP lecturers aged around 30-40 and female, and 2 chemistry teachers aged around 40-50 years old male and female gender.

### Data Collection Technique

The data analysis technique of judgment results is to calculate the average score of each aspect using the formula (Sugiyono, 2016):

$$\bar{x} = \frac{\sum x}{n} \times 100\% \quad \dots (1)$$

Description:

$\bar{x}$  : average score

$x$  : total score

$n$  : total assessors (expert validators)

For the feasibility of teaching materials, it is done by changing the average score into a percentage.

The percentage of eligibility is interpreted with the eligibility criteria according to Khoirot (2015):

**Table 1.** The percentage of eligibility

Percentage	Criteria
> 80% - 100%	Excellent
> 60% - 80%	Good
> 40% - 60%	Fair passable
> 20% - 40%	Poor
> 0% - 20%	Extremely Poor

Questionnaire data on student responses to the teaching materials obtained are then converted into scores using a Likert scale with the provisions

of the score according to Sugiyono (2016) as follows.

**Table 2.** Likert scale with the provisions of the score

Description	Score
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

Next, the percentage of student responses is calculated. Then the percentage results are

interpreted with the criteria according to Akbar (2013) in the following table

**Table 3.** Student response criteria

Persentase (%)	Description
$81,25 < x < 100$	Very Good
$62,5 < x < 81,25$	Good
$43,75 < x < 62,5$	Poor

As for the results of the paragraph readability test, the percentage can be directly seen in the results of the Google Form. For the readability of the main idea, the first is to give a score of 1 for each correct answer to the main

idea. Then calculate the percentage of answers to the main idea. Then the results of the students' answers obtained were interpreted with the criteria of Rankin et al, (1969) as follows.

**Table 4.** Readability Paragraph

Persentase (%)	Description
$0 \% < x < 40\%$	Low (Difficult kategori)
$40\% < x < 60\%$	Average (Instructional Category)
$x > 60\%$	Almost half

The feasibility of teaching materials is measured based on the results of judgment by experts, while student responses are measured based on the questionnaire scores obtained.

study are in the form of KI and KD analysis which are then used to make task analysis, concept analysis, and analysis of the representation of textbooks used in the school.

**RESULTS AND DISCUSSION**

**Define**

The results of the research at the defined stage consist of the results of the literature study and the results of observations. The results of the literature

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unclear images, and there are no indicators to be achieved. In addition, there are no other supporting books to support learning. So the lack of variety of teaching materials makes students' learning motivation too.

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### Design

At this stage, the preparation of the selection of suitable media, the selection of the format of the teaching materials, and the preparation of the initial design of the teaching materials are carried out. At this stage, the initial design of teaching materials is produced. The teaching materials developed consist of three parts, namely introduction, content, and closing. The introductory part consists of a cover, foreword, table of contents, basic competencies (KD), learning objectives and indicators. The differences in the design of teaching materials developed with other teaching materials are: 1) Each sub-chapter in describing each concept is equipped with multi-representation-oriented pictures. 2) Multi-representation-oriented pictures are complemented by text explanations. 3) Teaching materials present the phenomena of electrolyte and non-electrolyte solutions in everyday life and also present the benefits of electrolyte and non-electrolyte solutions in the chemistry subchapter around us. This is in line with the opinion of Hudiyono (2021) which states that displaying chemical phenomena in everyday life is a form of apperception. 4) Provide practice questions in each sub-chapter that can measure students' understanding in understanding each material presented. This is in line with the opinion of Prastowo (2015) that the existence of practice questions in teaching materials is needed to train and assist students in achieving the expected competencies. 5) Practical activities presented in teaching materials can be done in face-to-face or online learning activities. Because the teaching materials utilize the virtual laboratory features in the Kemendikbud learning house. 6) The

evaluation questions presented are also multi-representation oriented so that the evaluation questions can measure students' understanding of the three levels of chemical representation both macroscopic/ submicroscopic/ and symbolic. This is in line with Widyoko (2015) that the evaluation in this teaching material is in the form of test questions that can be used as a tool to measure students' understanding abilities. 7) This teaching material is equipped with an answer key so that students can learn independently.

Multi-representation-oriented teaching materials present material using more than one level of representation, both macroscopic, submicroscopic, and symbolic. An overview of the presentation of the material can be seen in Figure 1.



Figure 1. Presentation of Material on Teaching Materials

### Develop

At this stage, judgment is made on the developed teaching materials and limited trials. Judgment aims to get input, criticism, and suggestions from experts on the teaching materials developed. Meanwhile, a limited trial was conducted to obtain the results of the readability test. The results of the judgment on the feasibility aspects of the material, presentation of the material, and language successively can be seen in Figure 2.

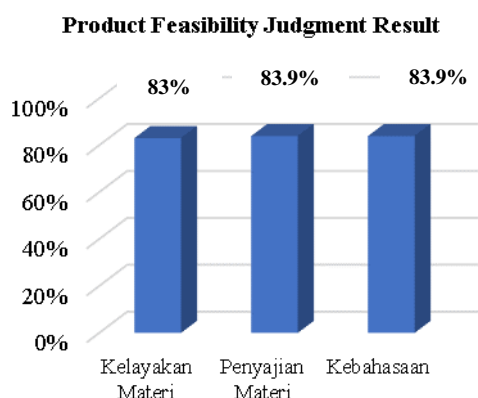


Figure 2. Teaching Material Eligibility Chart

The results of the judgment fall into the very decent category. This is in line with the eligibility criteria for the Khoirot product (2015) where the teaching materials developed have been included in the very feasible category, meaning that the material contained in it is in accordance with core competencies (KI) and basic competencies (KD), does not cause many interpretations, and presents phenomena. What can be observed is that the criteria are in accordance with the 2014 BSNP.

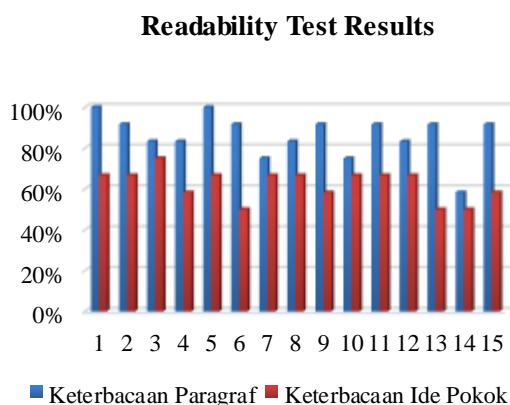


Figure 3. Graph of Readability Test Results

While the results of the readability test of teaching materials can be seen in Figure 3. In this study, there were two readability tests, namely the readability of paragraphs and the readability of the main idea. The results of the paragraph readability test got an average percentage of 86.1%, while the main idea readability got an average of 62.23%. The legibility of the main idea here is still low because the ability to determine the main idea of students is still very low, students tend to be only able to determine the main idea at the beginning of the sentence. The lowest readability test is in paragraph 14 which is material about ionic and covalent bonds, where the material is classified as

difficult material as in the research of Dewi et al. (2016).

While the results of student responses to the teaching materials developed can be seen in Figure 4. There are 10 questions distributed to students who make three aspects, namely material, presentation of material, and language. Each aspect gets a percentage of 90.8%; 88.3%; and 88.3% all three fall into the very good category.

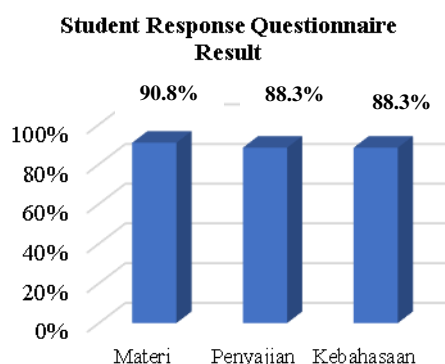


Figure 4. Graph of Student Response Questionnaire Result

The teaching materials developed are in accordance with the criteria for good teaching materials according to Wicaksono (2017) as follows: 1) In accordance with the learning objectives, the teaching materials used should support the learning carried out, 2) In accordance with the development of students, 3) Materials and use the language is easy to understand by students, 4) the teaching materials presented are arranged systematically and coherently. In addition, this is reinforced by the results of the readability test obtained, namely with a total score of 545 which is included in the very good category, meaning that the teaching materials developed are easily understood by students.

## CONCLUSION AND SUGGESTIONS

### Conclusion

Based on the results of the judgment and limited trials described above, it can be concluded that the multi-representation-oriented teaching materials developed are suitable for use and get very good responses from students.

### Suggestion

Suggestions that can be submitted based on the results of this study are as follows. 1) Electrolyte and non-electrolyte solution teaching materials oriented to multi-representation of development results need further research to determine the effectiveness of teaching materials on other variables. 2) Multi-representation-oriented teaching materials for electrolyte and

non-electrolyte solutions can be tested on students to continue the next stage, namely disseminate. 3) Teaching materials need to be developed on other chemical materials.

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