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DEVELOPMENT OF CRITICAL THINKING ABILITY ORIENTED TEXTBOOK ON ELECTROLYTE AND NON-ELECTROLYTE SOLUTION MATERIALS

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Abstract

This study aims to produce electrolyte and non-electrolyte textbooks oriented to critical thinking skills through a problem based learning model that will measure the level of feasibility, response to students and their level of effectiveness. This research refers to the research and development model recommended by Borg & Gal. Data on feasibility rate and response of students are obtained in the form of quantitative data which is converted by the percentage scale of product quality according to the Likert scale. The effectiveness of the book is measured using the average value of N-Gain. The conclusions of this study are textbooks for electrolyte and non-electrolyte solutions with feasibility rate of 95.11% criteria "very high", the response rate of students in the early field test 86.92% and the main field test 87.11% in "very high" category, level book effectiveness with the N-Gain average of 0.62 in "medium" category.

Keywords: *Textbooks, critical thinking, problem based learning, electrolyte and non-electrolyte solution.*

INTRODUCTION

In the learning process of 2013 curriculum, particularly Chemistry, teachers are expected to facilitate and encourage students to think critically, logically, and systematically, and have high order thinking skills. Students are expected to be capable of cultivating critical thinking skills and scientific attitudes. It is significant to provide of teaching materials that can facilitate students to achieve these goals.

The importance of critical thinking skills is agree with the results of Karakoc's research (2016), which states critical thinking skills are very important for students in following modern learning approaches, especially in the last few decades. According to Murawski (2014), students who develop critical thinking

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skills tend to have broad perspective and improve their navigation in making important decisions both in learning and life.

Critical thinking is an act of thinking in cognitive system by comparing some existing knowledge to solve problem (Cahyono, 2017). Critical thinking skills often appear after someone encounters problem. Saraswati (2020) stated that questions with analytical category (C4) in Bloom's taxonomy could train critical thinking skills. Rofiah, Aminah & Ekawati in Hidayati (2017) classifying aspects of critical thinking including analyzing (C4) and evaluating (C5). So that the teaching materials used must contain questions with C4 and C5 category (HOTS). It could be improve students' critical thinking skills.

The result of research conducted by Rasmawan & Hairida (2015) on 28 students regarding the critical thinking skills of class XI MIA students at SMAN 2 Pontianak showed that most of the students were in the less and unskilled category. Tathahira (2020) stated that education in Indonesia is still teacher-centered and learning based on memorization. It does not train critical thinking skills. The low critical thinking skills of students can be caused by the lack of teaching materials facilitating students to practice critical thinking skills independently. The results of interview with chemistry teacher at MAN 2 Pontianak on May 16, 2018 stated that the teaching materials available at school only refer to low level thinking skills. Sample questions and practice questions do not refer to everyday problems and do not train high level of thinking skills such as the ability to think critically.

In addition, the low results of Indonesia in PISA 2009 and 2012 indicate that the higher order thinking skills of Indonesian students are still low (Pratiwi, 2019). This is agree with Fathani (2016), said the results of survey conducted by the Program For International Student Assessment (PISA) in 2015, Indonesia was ranked 69th out of 79 countries. Based on the results of PISA, it was identified that one of the difficulties experienced by Indonesian students is in generalizing and using information based on investigations and modeling of complex situations or problems. This is indicate that students' high-order thinking skills are still low, including critical thinking, particularly in problem solving.

The importance of teaching and developing critical thinking skills must be seen as something urgent and cannot be underestimated. Cabrera in Marwan (2016) states that mastery of critical thinking skills is not only to serve as a mere educational goal, but also as a fundamental process that allows students to overcome future uncertainties. The ability to think critically has been identified as an important life skill. This is in accordance with the UNODC statement that problem solving and critical thinking are two of the ten main life skill strategies and techniques. According to Prayogi (2018), critical thinking skills are one of the competencies that students must have to be able to adapt to the development of science and technology in the 21st century. One strategy to improve students' critical thinking is to grow the desire and train students to think critically.

The 2013 curriculum suggests several learning models, one of which

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is a problem based learning model (Yulisman, 2019). According to Maryati (2018), Problem Based Learning is used to stimulate higher order thinking in problem-oriented situations and through scientific steps. Problem Based Learning Model is an approach that uses real-world problems as context that can stimulate critical thinking skills and problem-solving skills in understanding the essential concepts and principles of the subject (Rahmadani, 2017). This is agree with Ariani (2020), Problem Based Learning is a learning model that requires students to think critically in solving problems. One of the materials that can use PBL model is electrolyte and nonelectrolyte solutions materials which is found in everyday life.

The availability of facilities that support students to practice critical thinking skills can be done by developing teaching materials in the form of textbooks. Textbook is learning unit that contains information, discussion and evaluation (Kusuma, 2018). Textbooks that are systematically arranged will make it easier for students in the material so that it supports the achievement of learning objectives. Textbooks can be used as source of reference for educators in carrying out the learning process (Nurrita, 2018).

Electrolyte and nonelectrolyte solutions material in chemistry lessons is real material that is found in everyday life (Khodriah, 2016). According to Mutiara (2014), In the electrolyte and nonelectrolyte solution material, students are invited to observe the phenomenon of electrolyte and nonelectrolyte solutions in everyday life, try to conduct electrical conductivity experiments, and reason by answering questions. The availability of tools and materials used in practicums that are easily obtained makes it easier to do practicums while learning at home during this pandemic. There are many chemical problems in everyday life that show the role of electrolyte and nonelectrolyte solutions, so that it could trigger students to think critically and solve the problem. This is in line with the opinion of Changwong (2018), that problem solving will require the ability to think critically.

Based on the description above, it is important to develop textbooks oriented to critical thinking skills on electrolyte and nonelectrolyte solutions material.

The aims of this study were 1) to determine the feasibility of the electrolyte and nonelectrolyte solution textbooks; 2) to determine students response to electrolyte and nonelectrolyte solution textbooks; 3) to determine the effectiveness of electrolyte and nonelectrolyte solution textbooks.

METHODS

The type of research used in this research is Research and Development, which is a process to develop a new product or improve an existing product and can be accounted for. This research refers to the research and development (R&D) model suggested by Borg & Gall (Emzir, 2010).

Understanding development research according to Borg & Gall is process used to develop and validate educational products. The product developed is in the form of electrolyte and nonelectrolyte solution textbooks oriented critical thinking skills

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through problem based learning models.

The main steps in the research according to Borg and Gall are shown in Figure 1. The research stage carried out in this study was only to determine the level of effectiveness of the books developed.

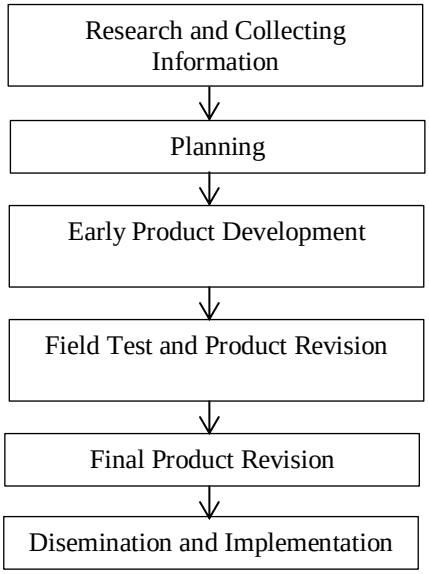

Figure 1. The main steps of Borg and Gall's research

In the research and collecting information stage, researcher identified the needs and conduct field studies related to the problems being studied. In the planning stage, the objectives and components of the product being developed are drawn up. In the early product development stage, researcher develops the product and conducts a feasibility test on the book. In the field test and product revision, researcher tested the response levels of teachers and students and made revisions to the product. After the final product revision stage, researcher tested the effectiveness of the book.

The research subject is a textbook of electrolyte and nonelectrolyte solutions. The test of feasibility level of textbooks in this study was carried out through filling out the validation sheet. The assessment is carried out on three aspects, namely material aspects, language aspects and graphic aspects which refer to the appropriateness standards of teaching materials according to the National Education Standards Agency (BNSP, 2006), which are filled out by 3 experts for each aspect. The validation sheet used consists of material, language and graphic validation sheets with 4 alternative answer choices, namely 4 (Very Good), 3 (Good), 2 (Poor) and 1 (Very Poor).

Testing of student response rate to textbooks is carried out by filling out response questionnaire that has been validated by 2 validators. The assessment of the questionnaire was carried out on three aspects, namely material aspects, language aspects and graphic aspects. The questionnaire used consisted of positive statements and negative statements with 4 alternative answer choices, namely SS (Strongly Agree), S (Agree), TS (Disagree) and STS (Strongly Disagree). The data in this study will be analyzed qualitatively descriptive.

The data processing of the validation results is carried out using data analysis steps according to Riduwan (2008), namely calculate the frequency of assesment score for each item/statement; calculate the total score of each item/statement; calculate the percentage of score for each item; calculate the average percentage of the feasibility of teaching materials and determine the eligibility criteria for teaching materials.

Data processing on the effectiveness test uses the N-Gain

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formula according to Sudjan. The steps in determining the level of effectiveness are calculating the pretest score of each student; calculating the posttest value of each student; determining the N-Gain of each student and determining the average N-Gain.

RESULTS AND DISCUSSION

The research and collecting information stage aims to conduct initial research by identifying needs assessment for product development. The result of literature study are shown in Table 1. In field study conducted by interviewing chemistry teachers at MAN 2 Pontianak, it was found that one of the reasons of the low ability of students to work on HOTS questions was the lack of materials that could train students' abilities, where available teaching is still limited and still centered on low-level thinking skills.

Table 1. The result of literature study

Researcher	The result
Sianturi (2018)	Learning with problem based learning models can improve students' mathematical critical thinking skills.
Kurniahtunnisa (2016)	Problem based learning model has an effect on increasing critical thinking skills.
Rosita (2016)	Problem-based learning on electrolyte and nonelectrolyte solutions material can improve students' scientific attitudes.

The planning stage in this study was carried out in 3 steps, namely the formulation of learning objectives, determining product users, and determining the components of textbook to be developed.

The learning objectives in the developed book are 1) Students can classify compounds based on the properties of electrical conductivity; 2) Students can classify compounds based on the strength of electrical conductivity; 3) Students will be able to distinguish between electrolyte and nonelectrolyte solutions; 4) Students can conclude the effect of ions on the nature of their electrical conductivity and 5) Students can explain the effect of the number of ions on the strength of their electrical conductivity.

The early product development stage conducted by two steps, namely early product design and validation test. The design is conducted by formulating the contents of each stage, making enrichment questions and designing the cover and components of the book.

The next step is validity test to determine the feasibility rate of the book. The results of content validation test are shown in Table 2.

Table 2. The validity result of textbook's feasibility rate

Aspect	Percentage (%)	Criteria
Content feasibility	95,14	Very High
Content display feasibility	95,83	Very High
Language feasibility	92,5	Very High
Graphic feasibility	96,97	Very High

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The average of validity rate of textbooks based on the assessment of 3 experts in 3 aspects is 95.11% with very high criteria. These results indicate that the electrolyte and nonelectrolyte solution textbooks oriented to critical thinking skills through problem based learning models are suitable for use in the field (trial to schools) with improvements.

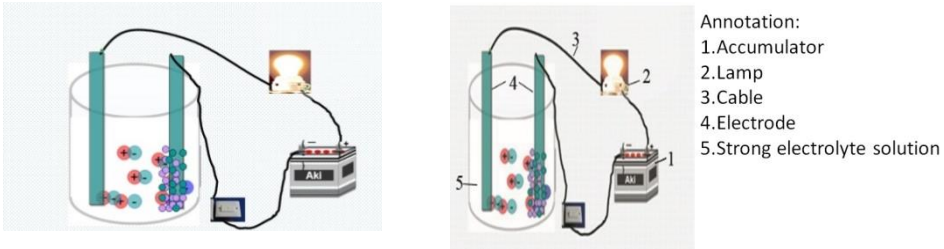
Improvements to the material aspects of textbooks by adding the value of difference in electronegativity to distinguish polar covalent compounds and nonpolar covalent compounds; addition of the cause of the emergence of bubbles in the conductivity test.

Improvements to the language aspect of textbooks by improvements to the titles of book components such as preface, table of contents, bibliography and others using capital letters in the middle position; spaces in the bibliography are changed to one space in accordance with Indonesian rules. In addition, improvements were made to some words.

Improvements to the graphic aspect of the textbook by adding logo, changing the layout and adding annotation to the pictures contained in the book. The results of the improvements in Figures 2 and 3 are shown below.

(a) (b)

Figure 2. Book cover design improvement, (a) before and (b) after.



(a) (b)

Figure 3. Addition of annotation to the picture, (a) before and (b) after.

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Validity tests were also carried out on the research instruments, namely response questionnaires, lesson plan (RPP), pretest and posttest questions. The results of instrument validation are shown in Figure 4.

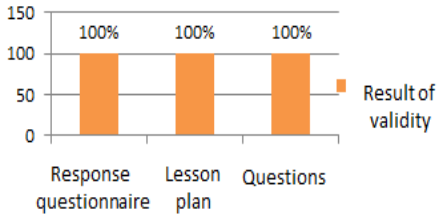


Figure 4. Graph of instrument feasibility rate

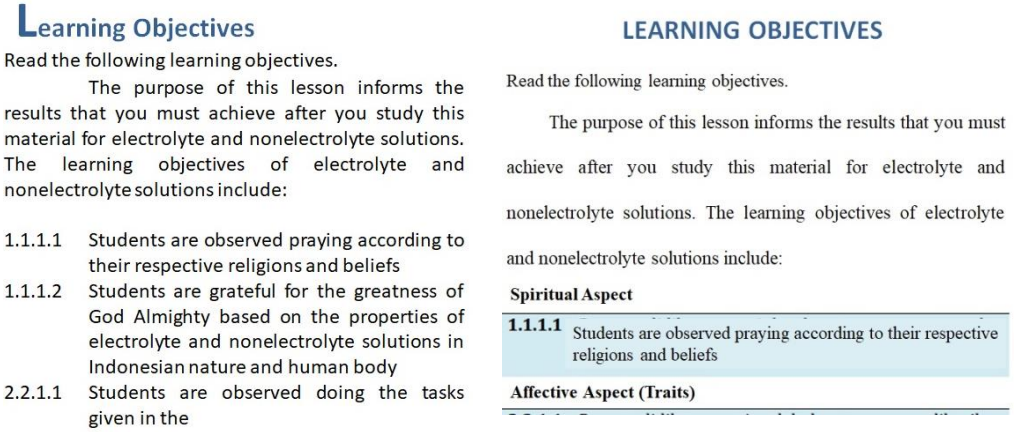
The student response test in this study was carried out in 2 stages, namely early field test and the main field test. In the early field test, filling out the response questionnaire was carried out by 12 students of class XI MIPA MAN 2 Pontianak from 4 different classes and were representatives of the upper, middle and lower classes.

The results of early field test are shown in Table 3 below. The results obtained from the test showed that the average student response was 86.92% with very high criteria.

Table 3. The result of early field test

Aspect	%P	Criteria
Material	88,19	Very High
Language	85,41	Very High
Graphic	87,15	Very High
Average	86,92%	Very High

The textbook was then revised according to the comments and suggestions from the students. Improvements to the textbook are by adding information on aspects and displaying learning objectives which are shown in Figure 5. The next step is to carry out main field test.



Learning Objectives

Read the following learning objectives.

The purpose of this lesson informs the results that you must achieve after you study this material for electrolyte and nonelectrolyte solutions. The learning objectives of electrolyte and nonelectrolyte solutions include:

1.1.1.1 Students are observed praying according to their respective religions and beliefs

1.1.1.2 Students are grateful for the greatness of God Almighty based on the properties of electrolyte and nonelectrolyte solutions in Indonesian nature and human body

2.2.1.1 Students are observed doing the tasks given in the

LEARNING OBJECTIVES

Read the following learning objectives.

The purpose of this lesson informs the results that you must achieve after you study this material for electrolyte and nonelectrolyte solutions. The learning objectives of electrolyte and nonelectrolyte solutions include:

Spiritual Aspect

1.1.1.1 Students are observed praying according to their respective religions and beliefs

Affective Aspect (Traits)

(a) (b)

Figure 5. Improvement of learning objectives display, (a) before and (b) after.

In the main field test, the response questionnaire was carried out by 36 class XI MIPA MAN 2 Pontianak from 4 different classes and were representatives of the upper,

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middle and lower classes. The main field test results are shown in Table 4.

Based on the test results, it is obtained that the average student response is 87.11% with very high criteria, this shows that research can be continued on trials of using textbooks in learning.

Table 4. The result of early field test

Aspect	%P	Criteria
Material	86,92	Very High
Language	85,41	Very High
Graphic	89	Very High
Average	87,11	Very High

Improvement of textbooks in the main field test was carried out based on the suggestions and comments of students in the response questionnaire. Improvements to the textbook by adding 2 HOTS questions to the enrichment questions which shown in Figure 6.

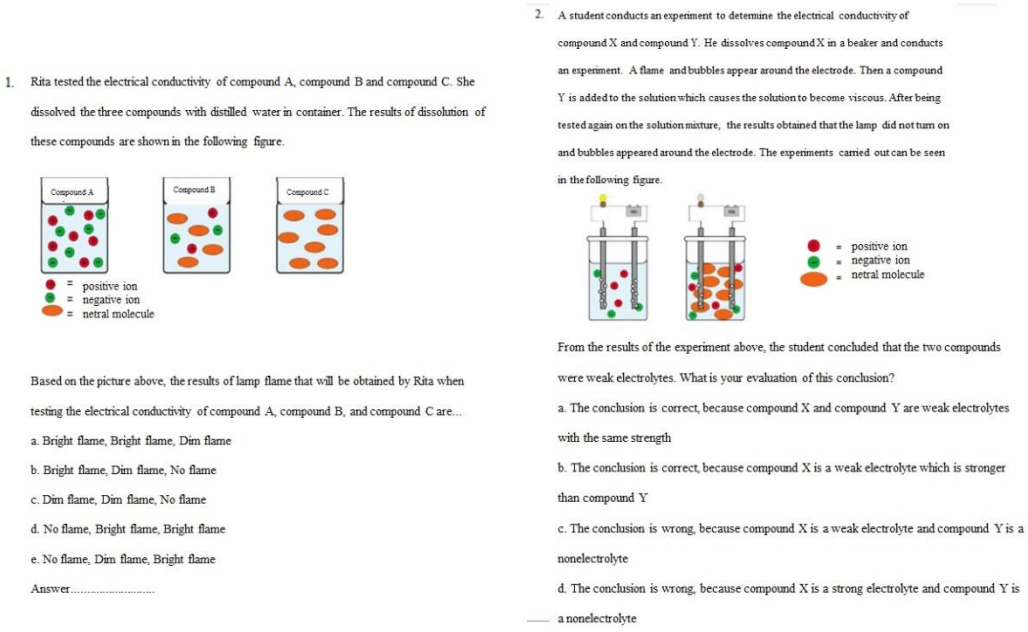

Figure 6. Addition of 2 enrichment questions.

Effectiveness test is carried out through the use of textbooks in the learning process. The rate of effectiveness of the book is determined based on the results of the students' pretest and posttest. In this test, the research subjects were 32 students of class XI MIPA 4 MAN 2 Pontianak and the learning process was carried out for 2 x 45 minutes referring to the lesson plan (RPP) that had been previously validated.

Effectiveness test data processing is carried out using the N-Gain formula. The results of the textbook effectiveness test are shown in Figure 7.

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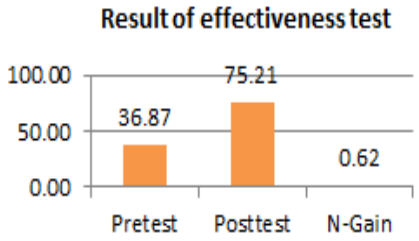

Figure 7. Graph of the average results of the pretest, posttest, and N-Gain of students.

Based on the N-Gain graph for each student above, it shows that each student has increased learning outcomes. The average N-Gain in this effectiveness test is 0.62 with moderate classification, this shows that textbooks can improve students' critical thinking skills which are reviewed through improving learning outcomes.

Results of effectiveness test showed that every student experienced enhancement. This is the result of using textbooks based on problem based learning models. These results are in line with Setyoko (2019) and Astuti (2018) which stated that teaching materials using problem based learning model are effective for improving critical thinking skills.

The orientation of problems in this book, which comes from the problems of electrolyte and nonelectrolyte solutions in everyday life, makes students have solutions to solve these problems. According to Herzon (2018), Students who have often felt bored with conventional learning models have become regular in the learning process because students will focus on problems and the motivation to solve these problems are also experienced enhancement. Independent problem solving makes students' critical thinking skills increase in the medium category. The availability of various questions with HOTS criteria in this book can also facilitate students to develop their critical thinking skills in accordance with the opinion of Islamiaty (2020) which states that giving HOTS questions to students can build their critical thinking skills.

CONCLUSION

Based on the research conducted, we obtained several results. The result of overall feasibility rate of textbooks are 95.11% with very high criteria and can be used in the field with revisions. The response rate of students in the early field test was 86.92% in the very high category and in the main field test was 87.11% in the very high category. The N-Gain level of effectiveness of textbooks is 0.62 with medium category.

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