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Research Article

The Development of Chemical Impacts Based on Drawing Processes on Electrolite and Non-Elektrolite Materials for Learning in SMA

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Abstract: **This thesis constitutes research and development which aims to produce a textbook based image process appropriate to study chemistry in High School. The process-based chemistry textbook is a textbook that displays some illustrations with a series of procedural images that display a particular process of changing something from one state (object, object, event, or phenomenon) to the next. The eligibility of textbooks is demonstrated by its validity (content and construct), its practicality, and its effectiveness for chemistry learning in secondary schools. In the validation process, the average scoring result of two expert validators and one user validator stated that the resulting book product is valid for chemistry learning in high school with an average score of 4.05. The product practicality test received a positive response from the students as the product users of 3.60% in the first and 3.75% trials in trial II with "good" criteria. The effectiveness of the textbook was done through a test on a sample size of 10 students and using the pretest and post-test design for class X MIPA 4 SMAN 1 Bangorejo during the semester of 2017 on the topic of the electrolyte solution and nonelectrolyte solution. The result of the effectiveness test was found by using a normalized gain able to increase the understanding of electrolyte and nonelectrolyte solution material 0.58 in the medium category with students' learning completeness equal to 85.29% with a mean value equal to 78.09% and student retention equal to 99.42% which resulted in highly positive results. The result of the research shows that the Chemistry Image Book Model is feasible to be used as print media for learning the material of electrolyte and nonelectrolyte solution in SMA.**

Keywords: Chemistry Textbook, Process Image, Electrolyte and nonelectrolyte solution

PRELIMINARY

Classroom learning has the potential to be effective and self-reliant with the additional presence of the chemical image book model. The student will receive a stronger impression with this model as opposed to only learning through a teacher's verbal explanation which is also common in a teacher-centered classroom environment. But it should be noted the selection of books as a source of learning should take into consideration suitability of teaching materials with the aim of teaching being to maximize achieved learning as well as providing facilities that promote a sustainable learning environment. Some of the requirements needed to make the book a learning resource are: easy access to students, the effectiveness of material and meeting the needs of students who consider themselves self-reliant learners.

One of the aspects that play a role in improving learning effectiveness is textbook quality. High-quality textbooks will help students understand the concepts of learning and support contribute space for students to explore information independently so that teacher-centered classrooms can be reduced. High-quality textbooks should be able to motivate learners by making use of visual aspects such as pictures, illustrations, and case examples. As well as, having sufficient material to support teaching, and using to support problem-solving activities to supplement lessons. Textbooks are useful for developing insights into the learning process which provides students with proper learning materials and operational steps to more thoroughly understand the standard material.

Development of standard textbooks through chemical learning innovation, by integrating various aspects of chemical science characteristics can reduce the barriers of learning chemistry. According to Middlecamp & Kean (1985) and Arifin (1995), there are several causes of the occurrence of obstacles in studying chemistry including difficulty understanding the terms, difficulty understanding the concept of chemistry and difficulty with mathematical equations which are commonly used in chemistry. The most common problems experienced by students is the lack of understanding abstract chemical concepts which require the ability to think formally and minutely. The level of formal thinking that is required for chemistry is not often found among most students due to lack of understanding. For instance, when trying to describe how chemical reactions occur, how electrons are released or used together when atoms create chemical bonds and how the reaction takes place in the cathode or anode. Also, chemistry education in schools is still dominated by theories and is less concerned about the relationship of science concepts to

technology and the environment. As a result, the study of chemistry is still regarded as a highly strenuous task for students (Johnstone, 2000). This may cause students to be unable to link chemistry concepts they learn to problems or phenomena that occur in everyday life; it lacks real-world application.

The facts in the field show that the chemistry textbook used by the students is still focused on explanative material and complex problem solving without the aid of visuals. Chemistry textbooks provide a mass amount of descriptive material but lack imagery that would help students understand the more complex subject materials. In my experience and through the results of my statistical research abstract chemical characteristics have not been concretized by students, so most students still have difficulty describing and explaining some of even the more basic chemistry concepts.

The interview results of some chemistry teachers from the MGMP of Banyuwangi Regency show that teaching materials such as textbooks and LKS used in chemistry lessons tend to present material reviews with sentence descriptions while lacking displays in the form of drawings and procedural imagery. As a result, students are unable to properly understand chemistry concepts because students tend only to memorize sub-macroscopic and symbolic representations that are abstract (in the form of description of words), resulting in the inability to visualize the process and structure of a reacting substance.

The results of observations at SMA Negeri 1 Bangorejo Banyuwangi, (with special attention to the grade X students of MIPA 4) indicate that the learning process of chemistry has not been optimized according to their needs. There are still some problems faced by teachers in the class, such as lack of student participation, and lack of student application and interactiveness in the classroom. The learning process is still centered on the teacher as the main source of knowledge, so students are less motivated to maintain attentiveness on the lessons. The students' activity level has not been optimal in asking questions, answering, responding to questions, or expressing ideas or reasons. They may acknowledge the instructional media but are less interested and less stimulated to learn because their books tend to feature more descriptive as opposed to visual aides. They also acknowledged that the answers to the various questions related to the concept in the textbook came only from the memorization of the theory and lack of understanding of the intentions embedded in the chemical concept. Also, books that are used as a source of learning tend to require a high study and an even higher level of understanding because it is presented in a descriptive form with images that lack the appropriate presentation of the process of reactive and chemical events that occur.

Therefore, in order to understand chemistry comprehensively, the students require all four levels of chemical representation including; the macroscopic aspects (observable phenomena), the microscopic aspect (the use of diagrams or images showing phenomena at the molecular or atomic level, ions), symbolic aspects (use of chemical equations and chemical symbols to describe a phenomenon) and mathematical aspects (mathematical calculations that accompany a phenomenon) (Rahayu 2002: 277). It is necessary to develop learning media in the form of creative and innovative teaching materials. The innovation of teaching materials as outlined in textbooks can provide better learning outcomes, improved instructional efficiency and improved effectiveness of learning (Folb et al: 2011; Goto et al: 2010). Quality teaching materials should be able to present teaching materials by the demands of the curriculum, following the development of science and technology (IPTEK) which bridge learning for the established competencies that need to be achieved (Situmorang, 2013). Therefore, by looking at the various observations of teaching materials used in the current chemistry learning process, and at the various problems faced by teachers and students, there is a need for chemistry textbooks which provide improved development of teaching materials. Based on this, the researcher considers it important to conduct research and development of textbooks based on process drawing. In this study, the focus of subject is the process of the electrolyte solution and nonelectrolyte solution. The process-based chemistry textbook is a chemistry textbook that presents a series of modeling images (objects, events, or phenomena) that are relatively different from one image to another in terms (state, position, shape, and combination) of a coherent stage and is a unified whole about the event. The concept of electrolyte and nonelectrolyte solutions such as chemical reaction processes and chemical events are common in abstract chemistry thus the addition of visual aid will help students to more easily understand the concepts of chemistry through simple image observation made available through improved textbook materials. It is hoped that with the assistance of visual aids, improved textbook materials and student-centered classrooms chemistry can become a concept that is more easily grasped by students. The purpose of this research is to encourage the development of more sustainable teaching methods in textbooks through the addition of procedural and process imagery which are valid, practical and effective for high school chemistry application. The benefits of this research are: 1) to facilitate the students in understanding the topic of chemistry 2) to increase the knowledge of chemistry knowledge to students at a higher level, 3) to facilitate teachers in improving the learning process 4) Facilitate the opinion that learning chemistry is not arduous and tedious but in fact, easy and enjoyable.

RESEARCH METHODS

The research and development of textbooks which incorporate the drawing process of electrolyte and nonelectrolyte solution material consists of three stages adapted from sugiyono (2011), namely: (1) preliminary stage, (2) design stage, (3) development stage; and test the effectiveness of the product. To produce the textbook they used analytical research derived from a needs assessment that helped predict and explain the possible effectiveness of the product.

Preliminary Phase

The purpose of the preliminary stage is to collect various information and documentation studies which are used as a reference in making product development, namely; 1) conducting field studies, aiming to discover the real conditions related to learning and the characteristics of students. Data was collected using observation sheets, questionnaires, and interviews. 2) examine core competencies, basic competencies, learning indicators, and analysis of the concept of electrolyte and nonelectrolyte solution materials by using a checklist. 3) Documentation study conducted on research findings that have been done and used as reference material for the development of chemistry textbooks based on the drawings of the process of electrolyte and nonelectrolyte solutions. Based on the results of this preliminary study, we have derived the advantages of using visual aides in chemistry materials based on the results of using visual aides assist when explaining the process of electrolyte and nonelectrolyte solution developed compared to existing textbooks which do not contain them.

Stage Design

The purpose of the design stage is to formulate, prepare and create an initial draft of textbooks based on the drawing of materials of electrolyte and nonelectrolyte solution according to the findings in the introduction stage. Activities are undertaken by researchers at the design stage include; 1) drafting an early textbook based image showcasing the process of electrolyte and nonelectrolyte solutions. 2) make the instrument of observation sheets of learning implementation, such as RPP and concept comprehension test. 3) observe learning activity sheet instrument, user response questionnaire sheets (student and teacher), and interview sheet.

Development Stage

The purpose of the development stage is to obtain research, criticism, and input about the draft based on the process of electrolyte and nonelectrolyte solution materials that have been prepared, so that information about the weakness and strength of the textbook is obtained. Criticisms and suggestions were used to revise the textbooks of image-based chemistry textbooks until a final valid, practical, and effective process-based chemistry textbook was produced. The activities are undertaken at the development stage include;

a. Create a text-based chemistry textbook that was drafted at the planning stage. After the draft is considered sufficient, the researchers prepare a textbook which contains a visual aide for certain complex chemical processes which will be named Draft I.

b. Carries out validation test (rational) textbook based on Draft I. At this stage, the researcher submits draft I of the chemistry textbook to three validators, namely two graduate lecturers of science education who have been recommended by the main supervisor and one chemistry teacher at SMAN I Bangorejo who teaches class X MIPA. The validation test aims to obtain data in the form of assessment, opinions, criticism, and suggestions on the textbooks of the chemistry-based drawing process. If the visual aide assisted chemistry textbook is declared valid, then the book can be tested. If a process-based chemistry textbook is declared invalid or valid with a record, then the book is revised again on a component that is otherwise insufficient and is consulted again on the validator. If the visual aide assisted chemistry textbook is declared valid by the three validators, the process-based chemistry textbook is then called draft II and will be tested on a limited scale (Test I).

c. Implementing Trial I

The test I conducted on ten students of class X IPA 4 SMAN I Bangorejo. Experiment I aims to; (1) checks whether the process-based chemistry textbook can be read, worked out and completed according to the planning and time allocation provided, (2) obtaining suggestions and inputs from students collected through questionnaires and interviews. The test results from data I obtained can then be analyzed. If the results of the analysis are well stated, then they can proceed to a later stage. If the analysis results are not well stated, then the components which require more improvement can be further revised. After the revision, the book is called draft III chemistry textbook based image process and ready for use in trial II.

d. Carry out trial II

Trial II was conducted in class X MIPA 4 SMAN I Bangorejo Lesson Year 2017/2018 which amounted to 34 students. Trial II begins with a pretest and ends with a post-test. This research design is known as a one group pretest-posttest design (Sugiyono, 2011) according to Figure 1.

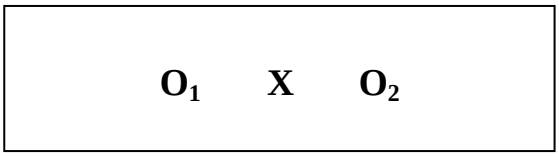

Figure 1 Research Design In Trial II

Information

O_1 = pretest values before learning using textbooks of image-based chemical processes

O_2 = posttest value after learning using textbook of image-based chemical process

The second trial of application is done by teachers who previously taught used class X MIPA 4 while being observed. Trial II aims to; (1) to know the user's response, that is teacher and student after using the book, (2) studying the textbook of chemistry based on the drawing of a practical process, (3) studying an effective process-based chemistry textbook by looking at the initial test and final test through N analysis - gain. The data obtained is then analyzed to find out if the

textbook of the image-based chemistry textbook is practical and effective. To check students' ability to retain knowledge in the brain (retention) after a certain time interval of the post-test, a retest is performed. According to the theory of information processing, the knowledge gained from students can be retained as long-term memory to be recalled and excluded when encountered by stimuli. Students' ability to process information can affect their ability to collect or receive stimuli from the environment, organize data, solve problems, discover concepts and use verbal and visual symbols. Retest in this study was conducted three weeks after the post-test.

RESULTS AND DISCUSSION

Development and Validity of Textbooks

After the draft I Chemistry textbook based on the material process of electrolyte and nonelectrolyte solution surpassed the preliminary stage and design stage, the next stage is the development stage. The first development stage is validation. This includes internal and logical validation (construct validation and content validation). Internal validation is fulfilled if the instrument has been compiled in accordance with relevant theory and provisions. Internal validation testing is done by experts (expert judgment), namely two graduate lecturers of science education and a chemistry teacher at SMAN 1 Bangorejo. The results of the validator research showed that the draft I chemistry textbook based on the process of electrolyte and nonelectrolyte solution materials which includes the content feasibility, presentation components, language, and feasibility of the craft fulfilled the valid criteria with the average score of 4.05 as shown in Table 1.

Table 1 Recapitulation Result of Chemical Textbook Based Validation Image Process Material of Electrolyte and Nonelectrolyte Solution

No	ASPECT ASSESSMENT	SCORE			Average Interval	Criteria
		Validator 1	Validator 2	Validator 3		
A.	Feasibility of Content	4.20	3.80	4.20	4.15	Valid
B.	Serving Components	4.13	3.88	3.75	3.88	Valid
C.	Language	4.00	4.00	4.33	4.17	Valid
D.	Channel Feasibility	4.00	4.00	4.00	4.00	Valid
	Average	4.08	3.92	4.07	4.05	Valid

Trial I

The test I conducted on ten students of class X MIPA 4 SMAN 1 Bangorejo Banyuwangi. The experiment I aims to determine legibility and examine whether textbooks for the image-based process of electrolyte and nonelectrolyte solution materials can be read, worked out and completed according to the planning and time allocation provides. The trial I was also conducted to obtain suggestions and feedback from students. Feedback from students is collected through questionnaires of student responses and interviews.

Based on the result of experiment I, it was found that textbook of the chemical process of electrolyte and nonelectrolyte solution materials still requires more revision and repair. In general, students responded positively to the visual aide assisted textbooks of electrolyte and nonelectrolyte solution processes. Although there were students, who commented about the obscurity of the images which were still considered too complex. Questionnaire responses of students in experimental I chemistry textbook based on the material process of electrolyte and nonelectrolyte solution are presented in Table 2 and the mean of student response questionnaire in Figure 2.

Table 2 Results Recapitulation Questionnaire Student Questionnaire In Test I.

Response Criteria	Topic-1	Topic-2	Topic-3
Very good	0	1	2
Good	6	8	7
Pretty good	4	1	1
Not good	-	-	-
Not good	-	-	-

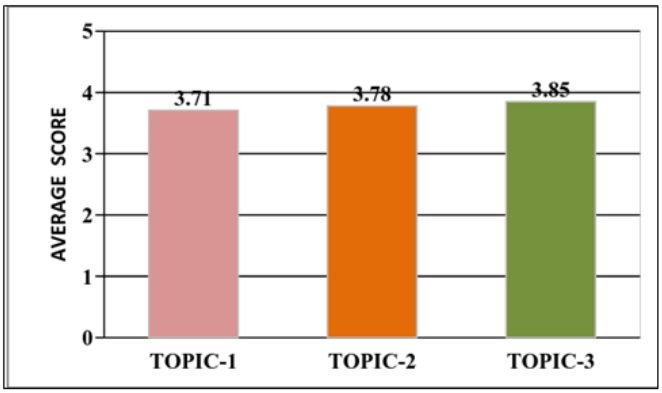

Figure 2 Average Score of Student Response On Trial I

Trial II

Revision of draft II experiment I of chemistry textbook based on the material process of electrolyte and nonelectrolyte solution was done based on the implementation of Trial I, student response questionnaire, an observation result. The result of draft revision II which is called draft III is used in trial II (Sekala class).

a. **Textbook Chemical Image-Based Process Materials of electrolyte and nonelectrolyte solutions are Practical**

Based on the questionnaire, a higher amount of gave positive responses to the chemistry textbook based on the process of electrolyte and nonelectrolyte solution materials. Recapitulation of response questionnaire can be seen in Table 3, and the mean of student response questionnaire in Figure 3 Learning Implementation Analysis Results are presented in Table 3.

Response Criteria	Topic-1	Topic-2	Topic-3
Very good	0	1	2
Good	6	8	7
Pretty good	4	1	1
Not good	-	-	-
Not good	-	-	-

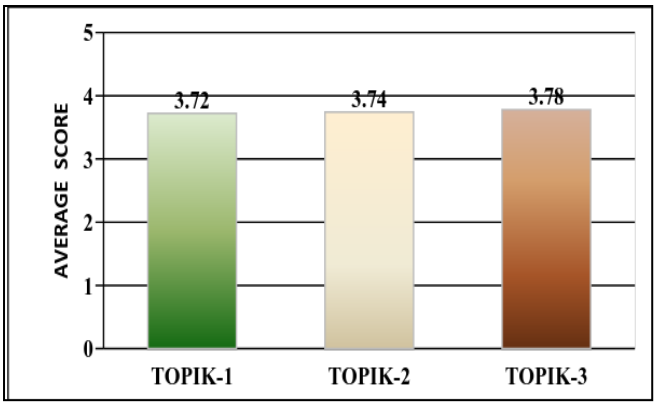

Figure 3 Average Score of Student Response On Trial II

Table 4 Learning Implementation Using Textbook Based Image Process Chemicals

NO	LEARNING ASPECT	LEARNING IMPLEMENTATION			AVERAGE
		TOPIC 1	TOPIC 2	TOPIC 3	
1	Students interested in starting lessons immediately take a chemistry-based textbook of the process that teachers share	5	5	5	5,00
2	Students interested in starting lessons immediately take a chemistry-based textbook of the process that is shared by the teacher Students seriously read the activity manual on the chemistry textbook marching the drawing process	4	4	5	4,33
3	Students read serious learning objectives on textbooks and ask if anyone has not understood	4	4	4	4,00
4	Students look serious to observe the drawings on chemistry textbooks based on process drawings	4	5	5	4,67
5	Less than three groups asked the teacher to observe the chemistry textbook picture during the lesson	4	4	4	4,00
6	All groups can solve problems on textbooks of photo-based chemistry processes on time	3	3	3	3,00
7	There are three or more groups who volunteered to present the results of their group discussions	3	3	3	3,00
8	The class discussion looks very active	4	3	4	3,67
9	Teachers as facilitators and motivators	3	3	3	3,00
10	Learning ends with a happy feeling by all students	4	4	4	4,00
11	Learning Time as planned	3	4	3	3,33
AMOUNT		41	42	43	42,00
PERCENTAGE OF IMPLEMENTATION		74,55	76,36	78,18	76,36

b. Textbook Chemical Image-Based Process Materials Effective electrolyte and nonelectrolyte solutions

Electrolytic and nonelectrolyte based on an improved understanding of the concept of electrolyte and nonelectrolyte solutions as measured by pretest values, and analyzed by normalized gain. The N-gain index with "moderate" to "high" criteria and classical learning completeness become an indicator of effectiveness. The learning completeness is classically achieved if 85% of students meet the minimum scores of completeness (KKM) that have been determined. The result of the pretest, post-test, and retest on trial II can be seen in Table 5, while the mean of pretest, post-test and retest value in Figure 4. A retest is done three weeks after posttest which aims to know the retention of students' understanding of the concept of electrolyte and nonelectrolyte solution materials. Based on the pretest and post-test results obtained the N-gain value of 0.58 which is in the medium criterion (appendix 10). Based on the value of post-test and retest, student retention is obtained by 99.42 very good criterion (appendix 11), but the average of students' conceptual understanding decreased by 0.74 (from 78,09 to 77,35) and also decreased by 2.94% (from 85.29 to 82.35) from 29 students to 28 students who experience complete.

Table 5 Recapitulation of Pretest, Post-test and Retest Value on Trial II

No	Description	*Pretest*	*Postest*	*Retest*
1.	Average	45,18	78,09	77,35
2.	The highest score	65,00	88,00	88,00
3.	Lowest Value	35,00	57,00	62,00
4.	Number of Students with a value of ≥ KKM	0	29	28
5.	Number of Students with <KKM	34	5	6
6.	Classical Exhaustiveness	0	85,29	82,35

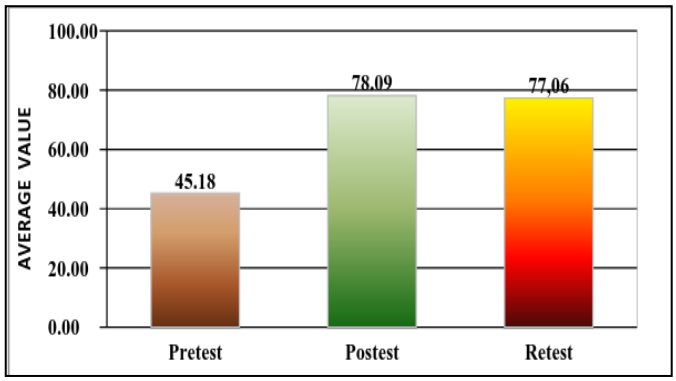

Figure 4 Average Pretest, Post-test and Retest Value in Trial II

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the results of research, data processing analysis, and discussion of research, the following conclusions can be drawn: 1) textbooks based on images of electrolyte and nonelectrolyte solution materials are considered valid based on an average score of 4.05. 2) chemistry textbook based on the material process of electrolyte and nonelectrolyte solution, which accrued a learning implementation equal to 76.36% received mostly positive responses from students. The product

usage was equal to 3.60% at trial I and 3.75% in trial II. 3) textbooks of the image-based process of electrolyte and nonelectrolyte solution materials was effectively based on an average N-gain test value with a 0.58 on medium criterion and the student's learning completeness equal to 85.29% with a mean value equal to 78.09% and student retention equal to 99.42%.

Suggestion

Chemical textbook based on the process of electrolyte and nonelectrolyte solution materials effectively improves students' understanding and fosters student-centered learning (SCL). Teachers are expected to develop textbooks with visual aide assistance for other chemicals processes. Electrolytic and nonelectrolyte-based photo chemistry books are advised to be developed on other materials tailoring to their characteristics. Further research is needed on the use of textbooks for the image-based chemistry of electrolyte and nonelectrolyte solution materials in other schools with a larger number of subjects and longer periods of time, thus providing implications for results that are different from the findings of this study.

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