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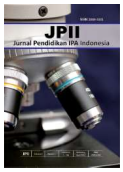

THE DEVELOPMENT OF INTERACTIVE*E-BOOK* BASED CHEMISTRY REPRESENTATIONS REFERRED TO THE CURRICULUM OF 2013

L.Tania[1], N.Fadiawati[2]

Chemistry Education Study Program, Universitas Lampung, Indonesia

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ABSTRACT

This research aimed to develop an interactive e-book based representations of chemistry; describes the characteristics of the interactive e-book developed; the teachers responses in content suitability with curriculum and graphics aspects; and student responses in readibility aspects. The method used was research and development. The characteristics of interactive e-book: it was developed referring to the core competencies (KI) and basic competence (KD) in the curriculum 2013, allowed active interaction between students and e-book, completed with pictures, animations or videos in three levels of the chemical representation. Teachers' responses to the content suitability and graphic aspects were very good with the percentage of each 98.46% and 97.5%. The students' responses in readibility aspects was very good with percentage of 88.5%.

Keywords: interactive e-book, chemical representation, curriculum of 2013

INTRODUCTION

Curriculum of 2013 mandates a learning process that involves interaction among learners, between learners with educators and learning resources in certain learning environment (Tim penyusun, 2013). The learning resource is meant to facilitate an effective learning and to help achieving learning objectives. The most common resource usedby teachers in learning teacher is the books. Booksare still functioned asthe main learning resources and the most effective learning support and resources beside the teachers.

Recently, education undergoes a significant transformationalong with the emergence of digital technology, such as: internet, laptops, mobile phones and the most recent one wasthe so-called electronic book or e-book (Daniel & Woody, 2013). In an article by Manley & Holley (2012), e-book is defined as the book available in electronic form through four different methods: downloadable e-book, restricted e-book; online e-book reader; and e-book accessed via the web. E-book definition changes along withthe market trends. Students who understand those emerging technologies think of themselves as more capable learners who those who do not understand the development of technologies such as e-book (Johnson, 2015).

E-book has many advantages compared to printed books including small physical size, can be stored in the hard disk, CD or flash disc; removable; ageless; easy to process; easyto be duplicate; easy todistribute; as well as supporting reforestation (Harris, 2011). Jamali expressed the advantages of e-books that it can be accessed online, easyto search, low cost, and easy to carry (Doering et al., 2012). The Ministry of Education and Culture (Kemdikbud) has facilitated the teachers and students by publishing some electronic textbooks that can be downloaded for free on the official website of Ministry of Education and Culture.

Based on preliminary studies with chemistry teachers of high school as its respondents,

***Correspondence Address:**
Lisa Tania
E-mail: lisa.tania@fkip.unila.ac.id

it is known that the printed book is still the main source of learning used by teachers and students. Afterbeing analyzed, the booksonly possess two representative levels, the macroscopic and symbolic. The submicroscopic level is proven to be not-existent in the book. The absence of representative factor in submicroscopic level often cause students poorly trained or are not able to represent chemical phenomena in submicroscopic level. These obstacles can obstructthe ability to solve problems related to the phenomenon of macroscopic and symbolic representations. Chemistry is a field of study in which some of the material are abstract and they emphasize the mastery of concepts to the microscopic (molecular) and symbolic level, thus chemistry should be presented in three levels, the representation of macroscopic, submicroscopic and symbolic levels (Chittleborough & Treagust 2007). The success in chemistry learning includes the construction of mental association between the macroscopic, submicroscopic and symbolic levels from representations ofscience phenomena using different modes of representations. (Cheng & Gilbert, 2009).

Based on above conclusion, we need to innovate learning resources so that it can involves all three levels of representations and interaction of students with learning resources, so as to help the students to understand the concept of the chemistry. With appropriate choice of media or learning resources, it can affect the ability of students to engage in learning through interaction with the media (Kizito, 2003).

In the acid-base materials and chemical equilibrium in class XI, many concepts require not only symbolic representation, but also submicroscopic. Research conducted by Wu (2003) showed that the level submicroscopic and symbolic were difficult to understand by students as both representations cannot be seen and abstract, while students' understanding toward chemistry usually depend on the acquisition of information that can be seen literally. System of symbols which cannot be presented in the classroom can be designed in a way that it can be presented through the features of the program, thus students can use the aforementioned features to gain understanding of the basis of chemistry (Kozma & Russell, 1997). The effectiveness of teaching chemistry in schools depends on the teacher's ability to communicate and explain the abstract and complex concepts and students' ability in grasping the explanation (Treagust et al., 2003).

Computer models, animation, and simulation materials will be very helpful in learning process where the access to physical models and data from scientific instruments is limited (Mahaffy, 2006). E-book is one of the innovations of learning resources that can be used as a solution in the chemistry teaching in schools. E-book allows students to explore further, broaden their understanding of the topic and a different way of thinking (Doering et al., 2012). E-book allows the presentation of all 3 levels of phenomena in chemistry representation.

E-book that is going to be developed is the e-book which can involve the students in its use or in other words, the interactive e-book. Interactive e-book can help students to achieve better understanding toward the topic because they can create and share the contents, as well as the involvement and interaction as the two main supportive reasons to their understanding (Beemt et al., 2010; Lim & Hew, 2014). The interactive e-book can also facilitatelong-distanced learning because it encourages interaction between teacher-student, within students and student-content. Interactive e-books make learning remains student-centered, so they can understand the content well (Zhang, 2005). These type of e-book improvesstudents' learning experience by allowing engagement and interraction from and within the students (Lim and Hew, 2014).

Through interactive e-book, students can learn actively and all 3 levels of the chemical representation can be presented simultaneously so that they can play significant role in assisting studentsto understand the material well. Accordingly, we need to develop interactive e-book based on chemistry representationswhich refer to the curriculum of 2013.

METHOD

The method used in this study is the research and development (R&D) that was conducted during the initial field test phase (preliminary field testing) until the revision of the results of the test product (main product revision) on a limited basis. The location of this research is the Metrocity in Lampung province. The interactive e-book based on representation of chemistry is the main subject of this research.

In the preliminary study we carried out a need analysis through field studies conducted in four high school in the Metro city and literature review. Instruments used to obtain data wereinterview guidelines and questionnaires. The questionnaires were distributed to 40 students of class XII and the interview guidelines were given to 4 chemistry teachers at those four high school.

Questionnaire was conducted in order to determine what kind of e-book used to aid learning process. Next we analyzed the teaching materials of chemistry used by teachers and students. The conducted analysis were to identifyall possible advantages and disadvantages related with chemistry representative based learning resources.

Results of the need analysis done during preliminary study then were positioned as the reference in planning and development of interactive e-book. After the draft was completed, it was validated by experts. The validation of interactive e-book consists of validating the suitability of the content of the materials, construction, and readability analysis by education experts.

After being validated by experts, the design of the product was revised in accordance with the advice given by the experts. Soon after, we conducted limited testing to determine the responses of teachers and students on the aspect of conformity betweencontents, curriculumand graphics as well as the responses of students on the readablity aspect of the developed product in one of the high schools in Metro. This step applied a questionnaire for teacher and student responses toward the product.

After several phases were conducted, the final stage of this study was the revision and refinement of interactive e-book. Revisions were made based on consideration of the results of responses of teachers and students from the questionnaire, especially on theconclusion of conformity aspects between contents and the curriculum, graphic aspectassessment by teachers as respondent, and readability aspectby students as respondents.

The techniques to analyze questionnaire data in preliminary study includes classifying data from each question on the questionnaire, calculating the frequency of response, and calculating the percentage of answers. The formula used to calculaterespondents' answers for each item were as follows:

$$\%J_{in} = \frac{\sum J_i}{N} \times 100\%$$

$\%J_{in}$ is the percentage of each answer choice of the questions on the questionnaire. $\sum J_i$ is the number of respondents who answered the answer i and N is the amount of all respondents (Sudjana, 2005).

Analysis of the questionnaire data for validation expert, teacher response and student response begins by calculating the percentage score for each answer on the questionnaire by using the following formula:

$$\%X_{in} = \frac{\sum S}{S_{maks}} \times 100\%$$

$\%X_{in}$ is the percentage of answer for each question. $\sum S$ is the answer scores and S_{maks} is the expected maximum score. After that, we calculated the average score for each question item in questionnaire by following formula:

$$\overline{\%X_i} = \frac{\sum \%X_{in}}{n}$$

$\overline{\%X_i}$ is the average percentage of each question in the questionnaireinteractive e-book based on representations of chemistry, $\sum \%X_{in}$ adalah jumlah persentase tiap butir pertanyaan pada angket *e-book* interaktif berbasisrepresentasi kimiais the percentage of each of the question in the questionnaire for interactive e-book based on representations of chemistryand n is the number of statements(Sudjana, 2005). After that, we interpreted the percentage score for each question in the questionnaire as a whole by using interpretation (Arikunto, 2008) as shown in Table 1

Tabel 1. Interpretation of the Score (%) of Questionnaire

Score (%)	Criteria
80,1 – 100	Very high
60,1 – 80	High
40,1 – 60	Medium
20,1 – 40	Low
0 - 20	Very low

RESULTS AND DISCUSSION

Interactive e-book based representation of chemistry developed in this study consists of two materials for class XI of high school, the reaction force and chemical equilibrium. The compilation of materials on e-book were constructed based on core competences and basic competencesfor chemistry subjects in curriculum of 2013.

Based on preliminary studies, the majority of teachers did not know about the chemistry representation and the importance of the presen-

tation of chemical phenomena in all three levels of representation, thus the learning so far has not been supported by learning resources based chemistry representation yet. Only 25% of teachers had ever used e-book downloaded from the Internet. All respondentsnever developed e-book. According to respondents, if the learning use interactive e-book as the resource, students' insight and learning interest will increase drastically, especiallyreaction force and chemical equilibrium because the e-book is equipped withimages, animations or video based chemistry representation. The whole features will cause the learning activities become more innovative.That is why the teacher stated that interactive e-book based chemistry representative was highly needed. Furthermore, when we asked about the obstacles that might be encountered when using interactive e-book as a learning resource in the implementation of lesson, all teachers stated that the problems lay within the infrastructures, in which not all students have notebooks.

In the preliminary study we also conducted analysis of the three e-book for chemistry class XI published by several publishers in the form of BSE (electronic school book). Those e-bookswere still in the form of conventional books in which the books were simply transferred intoelectronic forms that can be displayed using PC or notebook.

Within the first and second e-book, these e-books were not yet supported with phenomenain the daily life of students. Each sub-material was not yet fully equipped with pictures or animations that meet all level of representations that it had not completely helped chemistry students in understanding the materials. We only found a few examples that fulfill the symbolic level such as graphics and chemical equation. In the third e-book, acid-base materials and the chemical equilibrium are equipped with the phenomena of the material relates to everyday life that can be observed by students. In addition, a few materials in the book are equipped with an image that meets one of the chemistryrepresentation level such as the image forms of a molecule (sub-microscopic level) and chemical equations and graphs (symbolic level), yet it has not covered all of the materials.

Based on the analysis, the published and used e-books are generally less helpful in learning activities based on scientific approach as mandated by the curriculum of 2013, listed in the Standard Process. In addition, the reaction force and chemical equilibrium materials in the circulated e-book are still less fitted with pictures or animations that can represent all three levels of the chemical representations to help students to understand those materials easily. The language used in the e-book is less communicative so that students found it difficult to understand, as well as the evaluation questions has less varied view and not interactive.

The interactive e-book based chemistry representation we developed consists of four parts: the preliminary, the introduction, content and closing partswhich is made using flipbook maker program. The contents consist of six parts: the basic competences in accordance with the curriculum of 2013, indicators, context, material descriptions, summaries and interactive exercises. Within the materials, chemical phenomena are presented through images, animation or video that meet all 3 representation levels of chemistry for being observed by students as in Figure 1.

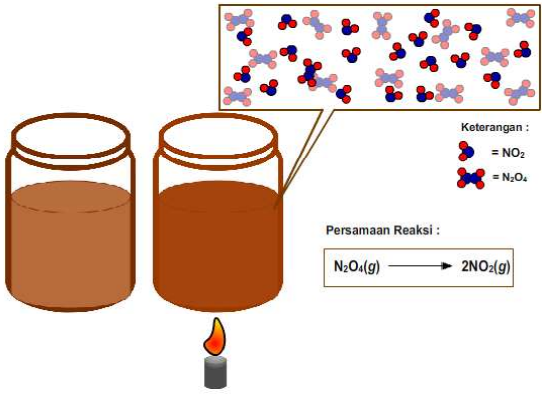

Figure 1. Animation of the material equilibrium (effect of temperature on the equilibrium shifts toward the 3 level of chemsitry representation)

Furthermore, students will be given the question in the column of questions related to the observation of the phenomenon and they must provide answers on the answer column or columns for identification result. Then the students can see a detailed explanation on the explanation part that will appear after they have filled the answers inanswer column. After seeing the detailed explanation, the students are asked to write the conclusion that they discover in a conclusion column to see whether they have written the right conclusion, students can get the correct answer in the teacher conclusion column.

To measure their ability to solve problems relatedwith the material, we provide evaluation questions on the closing part. These evaluation are made using iSpring application quiz maker where the students can immediately know the

answer and the score they obtain.

Interactive e-book we designed is referred as draft 1 and then validated by experts. Validation was performed to assess aspects of the construction, the suitability of the contents of interactive e-book with the curriculum, and aspects of readability. Validation was conducted by providing printouts and interactive e-book. Expert validation results are presented in Table 2.

Table 2. Results of Expert Validation

No	Evaluated Aspects	Percentage	Criteria
1	Construction	98,82	Very good
2	Uniformity between contents and curriculum	95,38	Very good
3	Keterbacaan	97,1	Very good

Based on the results of expert validation, it can be seen that in the construction, the appropriateness of the content with the curriculum and readability aspects of developed interactive e-book scored very good. Overall,the presented materials had been described through 3 chemistry representations (macroscopic, submicroscopic and symbolic representations) according to the validator. From the aspect of readability,the image quality, fontvariety and font size are well applied. The language used in content parts of the interactive e-book is communicative, easy to understand, do not raise double meanings (clear objectives and purposes) and in accordance with the grammars of Bahasa Indonesia. The validator criticised the exercises made using iSpring quiz maker program because they encountered many problems when opened in flipbook maker application. We improve the exercises using Macromedia Flash 8 program.

After being validated by expert, the e-book then revised and referred as draft 2 characterizedwith the materials contain indicators of learning, core competences, and basic competences based onthe curriculum of 2013, enabling active interaction between students with e-books, encouragingthe studentsto do independent study. The draft 2 contains lesson materials divided into subsections material to ease students to learn and to understand the material gradually. It is systematically arranged and fostering reading interest in students. This e-book comes with phenomena in everyday life to help students basic concept of certain material. To relate with chemistry representations, the e-book is equipped with images, animations or videos that meet the three levels of the chemical representation to support the explanation of the material and equipped with instructions for use which aimed to help students to operate the interactive e-book that they usemore easily. This creation comes with answer column, identification column and conclusion columnfor students to help themto build concept, equipped with the explanation column to provide detailed explanation about the material being studied. This literature also gives off interactive exercises and evaluation.

Subsequently, we conducted limited testing in SMA 5 Metro with sample a chemistry teacher and 20 students of class XI. The teacher assessed the aspect of the uniformity between the curriculum and the content of the material and graphic aspect, while the students evaluated the readability aspect.. Percentage results of the teacher and students responses toward the interactive e-book is shown in Table 3.

Based on the results of teacher responses to the suitability aspect between the content with the curriculum and the graphic aspectsof the interactive e-book based chemistry representations, those 2 aspects scoredvery good. When responding to aspects of graphic in interactive e-book, especially in the chemical equilibrium material the teacher adviced us to givebrighter and striking color combination on the columns of the interactive e-book that the students are more interested in reading it.

Table 3. Percentage of Teacher and Students' Response Result

No	Aspect	Response Percentage	Criteria
1	The uniformity between content and curriculum	98,46	Very Good
2	Graphic	97,5	Very Good
3	Readability	88,5	Very Good

The readability aspects are divided into sub-aspects of the ease and attractiveness. Most of the students stated that the size of the font on the outside and the contents of interactive e-book is appropriate and can be read properly and clearly;the combination of text color on the outside and the contents of interactive e-books are already in harmony between one another and can be read properly; variations in shape and typeface is appropriate, interactive and can be read properly; the size of the image / table on the outside and interactive e-book contents can be clearly viewed

by the reader;the quality of the image / table on the outside and interactive e-book contents can be clearly seen by the reader;and the layout of the image / table with the words / text are also appropriate and can be seen clearly. The figures and tables displayed in the e-bookease the students to grasp the material and give them extra motivationto learn the material. Students stated that interactive e-book that has been developed is attractivefor the reader to read and to learn. Intrinsic motivation such as an interest or desire to learn is an indication of better learning achievement than extrensic motivations such as the desire to get high scores (Pulfrey et al. 2013).

CONCLUSION

Based on the results of research and discussion, we can conclude that the developed e-book has characteristics ofreferring to core competences and basic competences in the curriculum of 2013, enabling active interaction between students with e-book. It is also equipped with pictures, animations or videos that meet all three levels of chemistry representation. Teacher responses toward the suitability aspect of the content of the material of the curriculum and the graphic aspect belonged to very good category with the percentage of 98.46% and 97.5% respectively. The response of students to readability aspect reachedvery good category with a percentage of 88.5%.

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