The Development of Monograph with 3-Dimentional Illustrations Titled "Augmented Chemistry: Hydrocarbon"as Learning Enrichment Materials

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Abstract. The development of 3D technology provides more advantages in education sectors. In chemistry, the 3D technology makes chemistry objects look more tangible. This research developed a monograph titled "Augmented Chemistry: Hydrocarbon" as learning enrichment materials. The development model consisted of 5 steps, which were the adaptation of the ADDIE model. The 3D objects of chemistry were built using the computer applications of ChemSketch, and Google SketchUp with ARPlugin. The 3D objects were displayed by relevant markers on the texts of the monograph from which the visualizations of the 3D objects appeared when they were captured by digital camera of laptop or smartphone, and were possibly viewed with free-rotation. Not only were 3D chemistry objects included in the monograph, but also graphics, videos, audios, and animations, which facilitated more fun learning for readers of the monograph. After the reviews by the experts of subject matter, of media, of instruction, and by peers, the monograph was revised, and then rated by chemistry teachers. The analysis of the data showed that the monograph titled "Augmented Chemistry: Hydrocarbon" was in the criteria of very good for the enrichment materials of Chemistry learning.

1. Introductions

The use of technology in education enables the learning process to be more active, motivating, attractive, meaningful, even brings new psychological influence to the student. Augmented Reality (AR) is an advanced technology that enables user to interact between virtual and real world in real time [1]. Augmented Reality can display the real world although the multimedia of text, graphic, video and audio that can improve learning experience of student [2]. The another advantage of the use of AR into learning was the ability of AR to display data and information in real time to enhance 3D perspective skill of users [3].

In chemistry, AR technology makes chemistry objects look more tangible, especially in learning and understanding molecular structures. Molecular structure can be visualized in 3-dimention, which adds real sensation and experience for students. Students enjoyed it and gained more knowledge of molecular structures. It substantially improves their spatial intuition and learns to better understand visual cues [4].

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The purpose of this research is developing monograph titled "Augmented Chemistry: Hydrocarbons" as enrichment materials. "Augmented Chemistry" is the use of AR technology in chemistry. "Hidrokarbon" is chemistry concept. The book is meant to be intuitive and include 3D modeling, video, audio and the discussion of broader and deeper. With integrated AR technology into the book, that can solve disadvantage of 2-dimention representation on the book. So, it is expected that the book make hydrocarbon concepts is able to clear and more tangible.

2. Theoritical background

2.1. Chemistry learning

Learning is essentially a process of interaction between students with the environment, which changes the behavior of students going to a better direction. Learning interactions influced many factors both internal factors of the individual and the external factors of the environment. In learning, the most important of teacher's task is to condition the environmental in order to support behavior change for student [5].

Chemistry is an abstract and imaginative knowledge, but very useful for human life. Chemistry is the knowledge that involves skill and reasoning to searching for answers to the what, why, and how natural phenomena are interrelated [6].

Chemistry learning is giving learning experiences that involve the skills and reasoning to reveal how natural phenomena are interrelated. Chemistry learning can be effective if it takes place in interactive learning activities.

2.2. Learning media

Media is the mean for transmitting or delivering messages. Media is also to delivering content to student, to achive effective instruction [7]. Learning should manipulate the resource and processes, so the learning objective can be achived effectively. Therefore, teachers should use suitable instructional media to facilitate student as subject learning and teacher as the subject of educator [8].

Instructionall media are a variety of things that are used by teachers which can delivering the message, stimulating thoughts, feelings, and the willingness of students to encourage the learning process on the students.

2.3. Augmented reality (AR)

AR is real visualization methods that enable natural interaction to improve the user experience. The another advantage use AR was to improve 3D perceptive skills of the user by displaying the data in real-time information [3]. AR at simplifying the user's life by bringing the virtual information to immediate surroundings and the real-world environment, like live-video stream [9].

The advantages that are possessed by AR technology are the interaction seems so real, less expensive implementation, system delays shown fewer possibilities, user's imagination are more increased. In addition to the various advantages, AR technology still has some shortcomings, such as technology can only be used on a few specific Operating Systems, technology is currently developing more profitable Virtual Reality, users cannot distinguish between virtual objects and real objects with ease, the production facilities of the design as a whole are less supportive environments [10].

2.4. The role of 3-dimentional monograph

To increase knowledge and insight of students, teachers can teach students to read reference and enrichment books [11]. Enrichment books became one of the companion books to be a supplement for teaching materials that are still restricted to textbooks. enrichment books its enrich of certain aspects of

the textbook, the material does not directly tied to the curriculum but still supports, as well as the target or group of readers cannot be classified explicitly [12]. The characteristics of enrichment books are the material does not have to be tied directly to the curriculum; target readers are not explicitly restricted although aspects of the look and content of eligibility envisaged readership; the presentation can be prose with pictures; generally use popular language; the material grow and develop cognitive, skills, attitudes, moral, and personality aspects.

These books contain broaden and deepen material, illustrations, sheet activities and exercises which support the current curriculum. Based on the contents of the book student can develop active thinking and motivate interest in independent study

3. Research methods

This development adopts ADDIE model. ADDIE model is a method of instructional design developed by Dick & Carry which consists of five stages.

3.1. Analysis

In this step analysis is the determination of the benefits and goals of monographs, a review of standard competence and basic competence of chemistry learning especially to hydrocarbon concept, analyzing basic competence became indicators and referencing.

3.2. Design

This step is about making monograph storyboard, preparation of resource materials, and manufacture marker by GIMP 2 and 3D molecular models by ChemSketch, and making research instruments.

3.3. Development

In this step, drafting monograph using Adobe InDesign; making object 3D by SketchUp; combine the Augmented Reality file, marker, and monographs; reviewed by the supervisor, expert of subject matter, of instruction, of media, and by peers to get a correction and suggestion. After that, product revised and print to assess by high school chemistry teacher.

3.4. Implementation

Rate the quality of products by 5 high school chemistry teachers using a quality assessment questionnaire of product and suggestion sheet. Assessment questionnaire consists of 6 aspects such as the feasibility of the subject matter, presentation, layout, language, software design and visual communication. These aspects are translated into 33 indicators.

3.5. Evaluation

The data from implementation stage is analyzed to determine the quality of products "Augmented Chemistry Hidrokarbon". The correction and suggestion data from chemistry teachers used to enhance final product "Augmented Chemistry Hidrokarbon".

4. Result and discussion

The result of this research was monograph entitled "Augmented Chemistry Hidrokarbon" provided 3D visualization that can be displayed through ARPlayer. Based on data, the average score of the book was 142.2 with percentage of ideality 86.67%. Teaching materials are feasible as learning sources if it has percentage of ideality at least 51% -75%. So the book can use as source of chemistry learning. The percentage of ideality for each aspect can be seen at Figure 1.

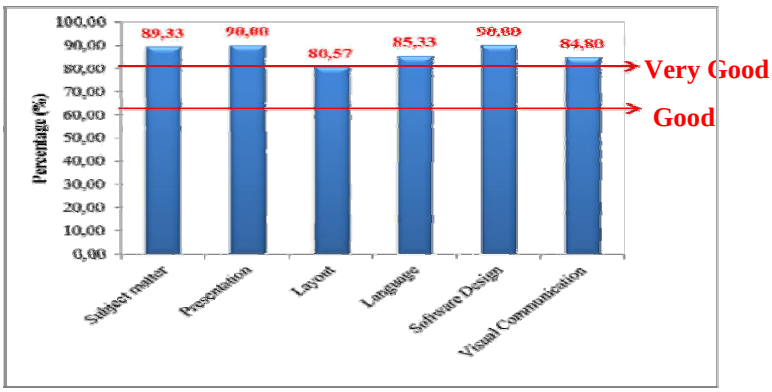

Figure 1. The percentage of ideality for each aspect.

Subject matter aspect consisted of suitability of the material with basic competence, the depth of the material, accuracy of the concepts and definitions, the breadth of material, actual, and the accuracy of the term. Reference [13] subject matter aspect which are generally assessed based on its relevance to the curriculum, the relevance of the material with the purpose of education, truth in terms of linguistics and humanities, and its compliance with the cognitive development of students.

Presentation aspects consisted of presenting examples of questions; exercise; conformity with the answer key practice questions; and cohernly presentation of learning indicators. Presentation aspects has very good quality and appropriate as learning materials for students. Presentation aspect which assessed in terms of the inclusion of learning objectives, learning stages, the attractiveness for students, easy to understand, ability to raise student activity, connectivity between the material and the availability of questions and exercises [13]. Materials of the monograph explained deductive, meaning that the material presented from easy to get a more difficult matter. This is expected to facilitate the learners in understanding the overall concept.

Layout aspect consisted of the suitability the size of the module; the letters color; layout front cover, back and spine; typeface, font variations, the field of print and margins; and the accuracy of the pictures, diagrams, and illustrations. The size of the book is A4 with 80 gsm of thickness. The size and the thickness selestion of the paper based on the effectiveness of using teaching materials in the classroom. The size of A4 is the standard size of ISO and 80 gsm is an ideal thickness of paper, so the paper does not easily tear if repeatedly inverted by students [14]. Layout design of cover, back and spine were harmonious. The colors used are orange. The aim is to attract student from the beginning through the cover books.Color is one of methods used as a guiding tool and attract the reader's attention [15]. Cover layout can be seen in Figure 2**.**

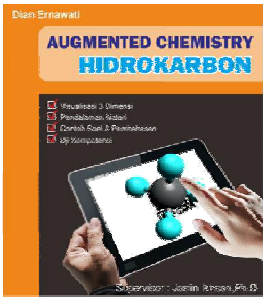

Figure 2. Cover layout.

Typing field were 1.5 cm from the bottom and 2.5 cm from the top, the right and the left edges of the paper. Line spacing was 1.5 cm. Font style use varied, but the majority used Times New Roman with 12 pt. Good font size for text (text book or handbook) is 12 pt [15]. Selection of the text colors, images, and illustrations in the book ware good so its increase the attractiveness of the reader when see the monograph. A book will be more attractive if they are equipped with colors and pictures. [16]

Language aspects of consisted of suitability the materials with knowledge level of students; communicative; and unambiguous. This book used communicative language according with the level knowledge of students, does not cause a double interpretation and used scientific language but not rigid, so it's flexible. That mean, not all parts of this book uses scientific language. It aims to facilitate students in understanding the material. The scientific language deemed not familiar described in the glossary. Language categorized good if it was arranged by Communicative sentence, using good and true Indonesian, does not cause a double interpretation, and does not offend the student[11].

Software design aspect consists of media effectiveness, reliability; compatibility; clarity of the instructions for use of media, creativity and innovation, usability, clarity workflow application usage; and opportunities to the development of science and technology. Augmented Reality technology has not been widely used in education, especially in the utilization combined with printed books. Quality teaching materials should be able to follow the development of science and technology [17], and in the use of media-based instructional technology, the software should be easy to use [18]. The use of AR Technology are very promising when it used in education.

Visual communication aspect consisted of communicative applications; suitability of audio; the attractiveness of the animation; function of navigation buttons; and clarity of illustration. This product ware combines text, graphics, animation, sound, and video. The 3D model visualization can be seen in Figure 3.

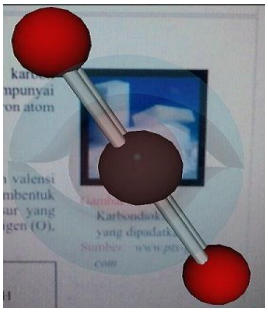

Figure 3. 3D model visualization

Varied media applications can present the information in a form that is fun, exciting, easy and clear to understand. Information will be easy to understand for as many senses, especially the eyes and ears, used to absorb the information [15]. The use of multimedia in this book is expected to increase the level of knowledge the students to understanding hydrocarbons concept.

5. Conclusion

This research produce of monographs "Augmented Chemistry Hydrocarbon" as a chemistry enrichment book. Monographs are include with 3D objects visualization that can be displayed using a computer, laptop, or smartphone at least version 4.0.3. Based on the assessment by senior high school

chemistry teacher, it can be concluded that the monograph has a very good criteria to used as learning resources.

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