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Development of Monograph Titled "Augmented Chemistry Aldehida & Keton" With 3 Dimensional (3D) Illustration as A Supplement Book on Chemistry Learning

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Abstract. Integration of information technology in education more rapidly performed in a medium of learning. Three-dimensional (3D) molecular modeling was performed in Augmented Reality as a tangible manifestation of increasingly modern technology utilization. Based on augmented reality, three-dimensional virtual object is projected in real time and the exact environment. This paper reviewed the uses of chemical learning supplement book of aldehydes and ketones which are equipped with three-dimensional molecular modeling by which students can inspect molecules from various viewpoints. To plays the 3D illustration printed on the book, smartphones with the open-source software of the technology based integrated Augmented Reality can be used. The aims of this research were to develop the monograph of aldehydes and ketones with 3 dimensional (3D) illustrations, to determine the specification of the monograph, and to determine the quality of the monograph. The quality of the monograph is evaluated by experiencing chemistry teachers on the five aspects of contents/materials, presentations, language and images, graphs, and software engineering, resulted in the result that the book has a very good quality to be used as a chemistry learning supplement book.

Keywords: Augmented Reality, three-dimensional, 3D, aldehydes and ketones, chemical learning

INTRODUCTION

Science and technology continues to evolve and changes. Its impact various aspects of human life, one of them is education. Currently, education entered the era of the media, where the learning activities demanding reductions in lecture and replaced by the use of media in the learning process [1]. Media education therefore aims to develop a board-based competence, not just in relation to print, but also in these other symbolic systems of images and sounds [2].

Information technology in the learning process in the classroom has become a necessity once the demand in this global era [3]. However, the use of media in learning is still considered less than the maximum. The use of instructional materials and textbooks in learning more dominant when compared with the slides, the Internet, computers, and more [4].

Most of the material in textbooks still abstract or difficult to understood. Then it will be better if visualized becomes something concrete through the use of interactive media, so things that are abstract can be explained significantly with animated [5]. Chemistry subjects contain a lot of material that is abstract, so students tend to just memorize the sub microscopic and symbolic representation [6]. This makes the learners have difficulty in understanding the real shape of a given compound in the print media some of the material in chemistry is presented in narrative form sentences.

Based Education Minister Regulation No. 2 of 2008 on Books, Article 6, paragraph 1, text books used as reference required by educators and learners in the learning process [7]. However, some of the learning resources are less attractive, so it can't increase the motivation and the achievement of the students in learning process. McBeath and Mortimore stated that the purpose of the use of learning resources among others to lead to motivation, provide information, facilitate troubleshooting, and to master certain skills [4]. In addition to textbooks, required learning resources to support learning and broaden learners, such as supplement books and reference books, as stated in the Regulation of the Minister of Education No. 2 of 2008 on Books, Article 6,

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paragraph 3, to add to the knowledge and insights of learners , educators can encourage students to read books and reference books enrichment which can be classified into three types, namely knowledge, skills, and personality in the form of biographies and monographs [7]. The monograph is a single issue that is complete in one volume and unsustainable [8].

This research develops a monograph by blending virtual objects and real objects with marker techniques with 3D modeling based on Augmented Reality. According to Azuma, Augmented Reality systems can be defined as those that allow real and virtual objects to coexist in the same space and be interacted with in real time [9]. Virtual objects in AR technology can be text, images, audio, video, and 3D animation that is packaged in the form of marker.

AR objects can be recognized by the AR Player camera. The camera will detect the marker, then the camera or webcam will do a comparison with a database owned. If the database is not available, then the marker information will not be processed, but if the database as the marker information will be used to render and display 3D objects or animations that have been made previously [10].

Monograph "*Augmented Chemistry* Aldehida & Keton" developed in Indonesian, contains material of the aldehydes and ketones are designed to be intuitive, accompanied by images of molecules with 3D modeling and more in depth discussion. 3D objects displayed through a mobile phone with AR Player application. This monograph is expected to be a supplement book for teacers, students and readers, thus more motivated to study, especially on the material aldehydes and ketones.

The aims of this research were to develop the monograph with 3D illustrations, to determine the specification of the monograph and the quality of the monograph. The monograph was completed by 3D illustration based on Augmented Reality and used as a supplement book on chemistry learning. The quality was based on the evaluation of senior high school chemistry teachers.

METHOD

The research and development adapting ADDIE model. ADDIE model of instructional design is a method developed by Dick & Carry which consists of 5 stages, namely analysis, design, development, implementation, and evaluation.

Analysis

At this stage, we analyzed the core competence and the basic competence of aldehydes and ketones in high school. Analiysis of the components that must be included in the monograph, including the components of contents/materials; presentations; language and images; graphs; and software engineering as the guide in the preparation of monographs and research instruments.

For high school chemistry teachers, the monograph can be used to develop the material that is taught in the learning and the media, in this case the 3D models based AR, can help teachers explain the concept of molecular forms of aldehydes and ketones to the students. While for students, the books and media produced in this research can enrich the knowledge of the aldehydes and ketones, so it is not just limited to the core competence and basic competence, as well as for the readers.

Design

The monograph "*Augmented Chemistry* Aldehida & Keton" is designed by preparing the materials of aldehydes and ketones will be published in the book from some references relevant to the material, including university chemistry books, research, and scientific journals. The material contained in the book includes material about the aldehyde and ketone compounds, nomenclature, physical properties, synthesis, carbonyl group, reactions, tautomerizations, analysis aldehydes and ketones, compound of aldehydes and ketones often found, aldehydes and ketones compound in nature, and some evaluation for the readers relating to the material aldehydes and ketones.

3D models are designed by Chem Sketch application with molecular storage format (.mol) for some compounds aldehydes and ketones. In the format of .mol, the 3D model has been created with Chem Sketch can be used to develop Augmented Reality (AR). There are 45 3D molecular models with the format ".armedia".

Marker for the entire molecular model created using GIMP 2 of the template provided by AR Plugin with the size of 512x512 px. Templates are exported in GIMP 2 as a layer or first layer, and then fitted with a picture of the structure of each compound aldehydes and ketones as a second layer to produce a marker with a black frame as in Figure 1. Marker is a part of the Augmented Reality function as a marker to be detected by the camera AR Player so 3D objects containing molecular model can be seen through the camera AR Player.

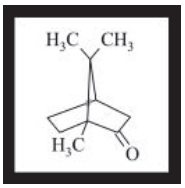

FIGURE 1. Tampilan Bentuk *Marker* of Camfor

Questionnaire instrument for the assessment of the quality of products produced is created in this step. Assessment instrument of this study consisted of a sheet input for peer reviewers, subject matter experts and media experts as well as a questionnaire in the form of a checklist for the evaluation by 5 teachers that have been validated by the supervisor. Assessment instrument contains components used as guidelines in the preparation of monographs. The instrument contains five components with the number of assessment criteria as shown in Table 1.

TABLE 1. The number of assessment criteria of each component on the instrument

Components	Number of criteria	Number
Contents/materials	7	1 – 7
Presentations	10	8 – 17
Language and images	11	18 – 28
Graphs	5	29 – 33
Software engineering	4	34-37

Development

The development is the stage of preparation of monographs accordance with the components of quality assessment and manufacture AR. Monograph prepared also comes with images related to the topic of learning and include markers of 3D molecular models to be displayed.

The next step is made AR by Sketch Up. Manufacture the marker and 3D molecular model which has been prepared at the design stage. 3D model put in Sketch Up through molecular importer. Furthermore, the installation of markers with marker creation of 3D models through the Plugins menu, and then setting a marker on the Setup menu. After a 3D molecular shape and customizable marker, AR storage is done by way of export (export) in the format ".armedia". The development of Augmented Reality by Sketch Up is shown in Figure 2.

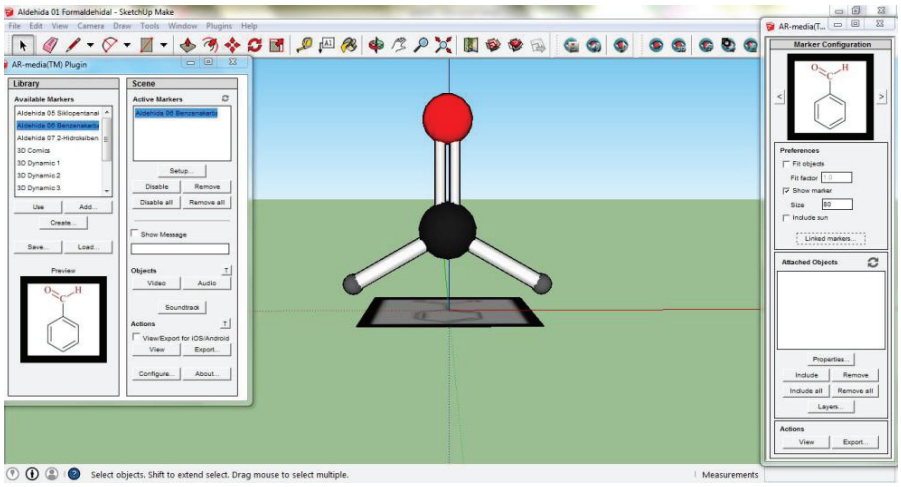

FIGURE 2. Development of Augmented Reality by Sketch Up

The materials of the monograph are evaluated by the supervisor, peer reviewer, chemical materials experts, and media experts. The supervisor and chemical materials experts evaluated monographs the materials, while the media evaluated by media experts associated with all aspects of multimedia in the book, especially on 3D models and AR. Peer reviewer evaluated all of the aspects, both in the media and materials.

This stage resulted monograph "*Augmented Chemistry* aldehyde and ketone" in Indonesian with 3D molecular models of aldehyde and ketone based on Augmented Reality.

Implementation

The implementation was conducted for students during the learning material of aldehydes and ketones. Students also tried the media, from installation until the display of Augmented Reality. Here're the steps to display the Augmented Reality:

1. Download AR Media Player in Google Play Store, then install the Application on smartphone,
2. Create a folder named "ARmedia_player" on the internal storage of the smartphone,
3. Open the disk attached to the book, then move files from "AR Media Player Android" folder to "ARmedia_player" folder you have made on smartphones,
4. Run AR Player by click on the icon on the smartphone AR Player,
5. Select the menu library (box of dots and lines) under the symbol of ARPlayer,
6. Select one of the models Augmented Reality by clicking one of the models,
7. Click on the symbol ARPlayer under the title of the model. Symbols marked with eye,
8. Point the smartphone camera to the marker in a book or on a card that has the name in accordance with 3D model (eg marker 01. Formaldehyde), so the 3D illustration will be displayed on smartphone, and
9. Rub your fingers on the smartphone screen to zoom in, zoom out, rotates the 3D model.

The students showed an interest in learning the resulting media and knowledge about the material aldehydes and ketones increases. The result of the implementation conducted for students learning is being reported for other publication.

Evaluation

After the stage of the implementation, then produce the monograph as a product that evaluated by 5 High School chemistry teachers using assessment questionnaire which refers to the components of the feasibility of the contents/materials, presentations, language and images, graphs, and software engineering with input sheet. Data were analyzed to determine the quality of product. Input from the evaluation stage used for the evaluation and improvement of the final product "*Augmented Chemistry* Aldehida & Keton".

RESULT

The result of the research and development is monograph "*Augmented Chemistry* Aldehida & Keton" as a supplement book for high school students, teachers, and the general. This monograph is produced full color with a paper size of 21 cm x 27 cm and a thickness of 80 g/m2 which consists of 94 pages, equipped with a 3D molecular modeling based Augmented Reality which can be seen with the aid of markers of each model of molecules through AR Player on a smartphone based on Android. The example of Augmented Reality display with 3D model of molecule can be seen in Figure 3.

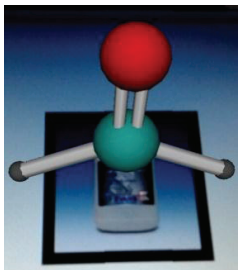

FIGURE 3. Augmented Reality display with a 3D model of a molecule

The monograph is evaluated by 5 High School chemistry teachers in Yogyakarta using product quality assessment instruments. The assessment data obtained in the form of quantitative data used to determine the quality of the monograph as a source of chemistry learning. The data obtained from the evaluation is converted into a score based on data analysis techniques, then tabulated and analyzed for each component of the assessment. The average score earned is converted into qualitative data that indicates the quality of the monograph. The quality data scores of the monograph are displayed in Table 2.

TABLE 2. Quality data scores of the monograph

Reviewer	Contents/ Materials	Presentations	Language and Images	Graphs	Software Engineering	Total
1	31	47	53	24	19	174
2	33	47	47	24	20	171
3	30	47	46	21	17	161
4	30	44	45	22	18	169
5	30	44	48	22	17	161
Total Score	154	229	239	113	91	826
Average	30.80	45.80	47.80	22.60	18.20	165.20

DISCUSSION

Based on data analysis, the monograph "*Augmented Chemistry* Aldehida & Keton" had an average score of 165.20 out of 185.00 and an ideals percentage of 89.30% that are in the Very Good category. Thus, the monograph can be used in chemistry learning. Table 3 bellow displayed the data of ideals percentage of the monograph.

TABLE 3. The Ideal Percentage of Monograph in Each Components.

Components	Average Score	Ideals Percentage	Quality
Contents/materials	30.80	88.00 %	Very Good
Presentations	45.80	91.60 %	Very Good
Language and images	47.80	86.90 %	Very Good
Graphs	22.60	90.40 %	Very Good
Software engineering	18.20	91.00 %	Very Good
Total	165.20	89.30 %	Very Good

The component of contents/materials has an average score of 30.80 from the highest scores of 35 and the ideals percentage of 88.00%. The material presented in this monograph correspond with reality and is closely connected with the critically and creatively thinking characteristics as the statements of Greene and Patty (in Maman Suryaman) that textbooks must have a clear viewpoint and updated beside contains material which allows students to have the opportunity to tickle his mind's eye on things that have been learned [11]. The monograph improved the knowledge of aldehydes and ketones, in accordance with the truth of science, and is associated with innovative thinking. Chemical materials presented in chemistry textbooks should be completed, systematic, easy to understand, interesting, innovative, self-motivated learning, in line with the achievements competencies contained in the curriculum [11].

The components of presentations given score 45.80 out of 50 with the ideals percentage of 91.60%. This shows that the teaching materials developed enrichment has a very good quality in terms of presentation. The presentations of the materials in monograph are accepted by readers because it is logical and not only narrative because it is equipped with an image that can clarify the matter. The print media present a message through letters and pictures illustrated to further clarify the message or information presented [12]. The material is presented in a logical and accuracy of electoral illustrations on every material explanation can make readers tend to do things that are positive, one of them an interest to study in depth the contents of the book.

The average score on the language and images components is 47.80 out of 55 with the ideals percentage of 86.90%. With the acquisition of scores, supplement books developed that are in the category of Very Good. Selection of color in the images used in monographs interesting because it is served with relatively high resolution and in accordance with the original color of an object contained in the image. The print media will be more attractive if they are equipped with a color image [12]. Monograph prepared with a good and correct language to be easily understood by the reader. Good language is a language that formulation requires communicative, raw or use the Indonesian language is good and true, do not give rise to a double interpretation, and does not offend learners [7].

Graphs feasibility components obtained an average score of 22.60 out of 25 with the ideals percentage of 90.40%. Selection of color pictures, illustrations, and writing the book was rated very well so as to increase the attractiveness of the reader when viewed in terms of appearance monographs. Selection of color pictures, illustrations, and writing the book was rated very well so as to increase the attractiveness of the reader if viewed in terms of the appearance of the book. Layout of the textbook contains conformity with the teaching materials, presentation of illustrations, tables and pictures, aphorisms, and user interactive learning as a means of communication between students and teachers [11].

Software engineering components obtained an average score of 18.20 out of 20 with the ideals percentage of 91.00%. Augmented Reality has not been developed in the world of learning, especially in the development combined with the books. It is an indicator of underlying level of creativity and innovation in learning media. Quality teaching materials should be able to follow the development of science and technology [11]. Although the operation of AR is quite complicated because through several steps that must be done in a coherent and required the installation of multiple applications and the distribution of AR file storage into a smartphone, but this relatively new technology has a great chance to be developed as a better learning medium.

All of the ideals percentage of each component in the monograph has Very Good quality. The comparison of the ideals percentage of each component is shown in Figure 4.

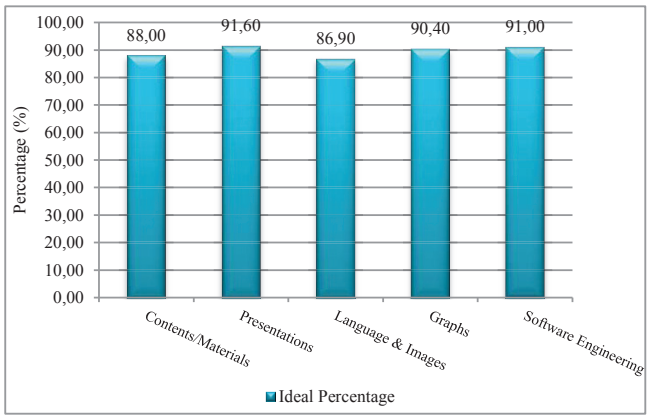

FIGURE 4. Chart of Ideals Percentage of the Monograph

Note:

Very Good = $84.20\ \% < \bar{X}$

Good = $68.00\ \% < \bar{X} \leq 84.20\ \%$

Medium = $52.00\ \% < \bar{X} \leq 68.00\ \%$

Bad = $35.80\ \% < \bar{X} \leq 52.00\ \%$

Very Bad = $\bar{X} \leq 35.80\ \%$

The quality of monograph has been developed is Very Good with percentage of ideals 89.30 % (higher than 84.20 %).

CONCLUSION

The results of this research and development is the monograph "*Augmented Chemistry* Aldehida & Keton" with 3D illustration as a supplement book on chemistry learning. This monograph is based Augmented Reality, equipped with a 3D molecular modeling that can be displayed with the help marker. The quality of monograph based on the evaluation of 5 high school chemistry teacher is very good. Thus the supplement book is worth to use as a source of chemistry learning in high school.

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