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DEVELOPMENT OF AUGMENTED REALITY ASSISTED LEARNING MEDIA TO IMPROVE CONCEPT UNDERSTANDING OF CHEMICAL BONDING TOPICS

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Abstract

The chemical bonding is one of the topics of discussion in chemistry that studies atomic and molecular structures that are difficult for students to understand because of their microscopic nature. Augmented Reality (AR) technology can combine three-dimensional virtual world objects into a real three-dimensional environment. Therefore, learning media were developed with the help of Augmented Reality (AR) for chemical bonding materials. This research is a research and development (R&D), with a modified 4D development model by Thiagarajan. The stages starting from define, design and develop. The data collection instrument used the material expert validation test instrument, the media expert and readability test to students. The data analysis technique used percentage descriptive analysis. The validity test of the material, media and readability test showed that the results of the media percentage were 87.9%, 79.87% and 87.6%, respectively. This percentage is included in the very valid category without revision.Thus, it can be concluded that the Augmented Reality media in the Chemical Bond material developed is declared very suitable for use in learning.

***Keywords**: Learning Media, Augmented Reality, Chemical Bonds*

Abstrak

Materi ikatan kimia merupakan salah satu topik pembahasan dalam ilmu kimia yang memelajari struktur atom dan molekul yang sulit dipahami mahasiswa karena sifatnya yang mikroskopis. Teknologi Augmented Reality (AR) dapat menggabungkan objek dunia maya tiga dimensi menjadi lingkungan tiga dimensi yang nyata. Oleh karena itu, dikembangkanlah media pembelajaran dengan bantuan Augmented Reality (AR) untuk materi ikatan kimia yang bertujuan dapat menampilkan bentuk ikatan kimia secara 3 dimensi. Penelitian ini merupakan penelitian dan pengembangan (R&D) dengan model pengembangan 4D oleh Thiagarajan yang telah dimodifikasi. Tahapan yang dilakukan mulai dari pendefinisian kebutuhan, perancangan dan pengembangan media. Instrumen pengumpulan data menggunakan instrumen uji validasi ahli materi, ahli media dan uji keterbacaan ke mahasiswa. Teknik analisis data menggunakan analisis deksriptif persentase. Uji validitas ahli materi, media dan uji keterbacaan menunjukkan hasil persentase media berturut-turut adalah 87.9%, 79.87% dan 87.6%. Persentase tersebut termasuk dalam kategori sangat valid tanpa revisi Maka, dapat disimpulkan bahwa media Augmented Reality pada materi Ikatan Kimia yang dikembangkan dinyatakan sangat layak untuk digunakan dalam pembelajaran.

***Katakunci**: Media Pembelajaran, Augmented Reality, Ikatan Kimia*

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INTRODUCTION

There are 4 principles of the Industrial Revolution 4.0, namely interconnection, transparency of information, decentralization decisions, and technical assistance (Hermann et al., 2016). The whole principle is no longer carried out by humans to humans, but robots or man-made products to humans. The industrial revolution indirectly changed all structures of society, whether they accepted it or not. The fundamental thing that is affected is of course related to the delivery pattern in obtaining information (Purwandini & Irwansyah, 2018). The industrial revolution 4.0 targets applied technology that has a direct impact on society by utilizing a tool.

The existence of this industrial revolution era caused technology and information to develop rapidly. This development has impacts, one of which is in the world of education where education will rely on the need to meet future needs by utilizing technology (Harris et al., 2016). Thus, it is necessary to prepare a generation capable of mastering technological developments (Subekt et al., 2017).

In the era of the industrial revolution, there are five areas of challenges that will be experienced, namely in the fields of science, technology, economy, social and politics (Zhou, 2015). To overcome these challenges, competent human resources are needed, one of which is technological literacy (Yuliati & Saputra,

2019). Technological literacy can be honed and instilled in students in schools as provisions for facing the industrial revolution era.

Chemistry is a branch of science that studies the existence of matter in terms of its structure, properties, changes and changes in energy (Jespersen et al., 2012). Chemical bonding is one of the topics contained in chemistry. In studying chemical bonding, students need to have extra understanding (Saidin et al., 2016). This is because students have not been able to clearly imagine the structure of the microscopic chemical bonds (Wulandari et al., 2018). In addition, teachers do not show pictures as a medium that can help learning chemical bonding topic clearly (Anisa & Yuliyanto, 2017). Chemical bonding is difficult to imagine, so students will find it difficult to learn the theory more realistically (Dwinata et al., 2016). Therefore, tools or media are needed to help students learn these abstract and microscopic concepts (Ristiyani & Bahriah, 2016).

To solve the problem above, a medium that can display chemical bond structures in three dimensions is needed. Because this media aims to help students in learning chemical bonds, then choosing the type of media that students favour now are media that can be used on cellphones. This is based on the current conditions in the field that people at student age like to spend time on their cellphones (Pandia, 2014).

Augmented Reality (AR) is one of the technological developments in the current industrial revolution era (Zheng & Waller, 2017). Augmented Reality (AR) is an application that connect the real world to the virtual world, both in two and three dimensions (Singhal et al., 2012). This process is done by simultaneously projecting an image in the real environment. Augmented Reality (AR) can be applied to computers and cellphones. Some of the uses of Augmented Reality (AR) are mobile navigation, medicine, robot planning and learning media (Mustaqim & Kurniawan, 2017). One of the applications of Augmented Reality (AR) as a learning medium is researched by Supriono & Rozi (2018) which is applied to chemical molecules.

Based on the description above, research was carried out in the form of learning media development assisted by Augmented Reality (AR) on chemical bonding topic. It is hoped that by using this media students will be interested and can easily understand the concepts of chemical bond because it can display three-dimensional (3D) images of the structures of various types of chemical bonds.

METHODS

This study was included in research and development method (R&D) because the research objective is to produce products in the form of learning media (Purnama, 2013). This research was conducted for 7 months, from April to August 2020. The development model used the 4D development model by Thiagarajan, but was modified into 3D. The research stages are as follows:

1. Define

At this stage, literacy studies from various research journals were carried out regarding the facts of chemistry learning in the field, difficulties experienced by students, factors that influenced student difficulties and the media that students were currently interested in. Next was the determination of the type of product to be developed.

2. Design

At this stage, a product design or instructional media design was made. Things that needed to be designed start from the Augmented Reality application storyboards and book storyboards. Apart from that, the preparation of the material content and the selection of 3D images for each type of chemical bond was also carried out.

3. Develop

At this stage, the selection of the necessary material tools, product manufacturing and product testing (validity testing by material experts, validity testing by media experts, and due diligence on targets) was carried out. If the validity test results were declared invalid, a product revision would be made.

The sample in this study were 28 students from science education program. The data collection technique in this study was to fill out a validity questionnaire by media and content experts, as well as a feasibility test questionnaire by students. The research instruments were the validity instrument of teaching materials by media experts, validity instrument of teaching materials by content experts, and a questionnaire instrument for student feasibility tests. The data analysis technique used was the percentage technique. This technique was done by comparing the percentage of the total score obtained with the maximum total score. The qualification of teaching materials were determined based on the percentage in the table below:

Table 1. Qualification Percentage of Validation Test Results

Percentage	Qualification	Explanation
75%-100%	Very valid	Worth using, without revision
50%-75%	Valid	Worth using, minor revision
25%-50%	Invalid	Not worth using
0%-25%	Very invalid	Forbidden to use

Source: Hanafi (2017)

RESULTS AND DISCUSSION

This developmental research aims to produce learning media assisted by Augmented Reality (AR) on the chemical bonds topic. The following were the stages that have been carried out in this research:

1. Define

The results of a literature study shown that chemical bonding material was difficult to understand because it was abstract and microscopic (Ristiyani & Bahriah, 2016). In attempted to help this understanding process, there were learning media that could be used to present abstract concepts and microscopic concepts. Augmented Reality (AR) based teaching materials were chosen because Augmented Reality (AR) technology could help users (students) provided a clear three-dimensional picture of examples of types of chemical bonds. Augmented Reality (AR) technology in the form of an application on Android was also chosen because children of student age liked to spend time playing on their cell phones. It would also increase student interest as it was easy to use and more similar to a mobile game.

2. Design

The material in the learning media that would be displayed in 3D images in the Augmented Reality (AR) application was starting from 3 examples of ionic bonds, metal bonds, polar covalent bonds, nonpolar covalent bonds, single covalent bonds, double covalent bonds and coordination bonds.

3. Develop

This learning media consisted of books and applications installed on mobile phones. In the book, there were various types of chemical bonds, with each type of chemical bond consisting of 3 samples equipped with a barcode. This barcode could be scanned within the application and then generated a three-dimensional image of the chemical bond structure of the sample. The following was an image of one of the book's page views which was equipped with a barcode sample of chemical bonds and an image of the application display used to scan the barcode and then displayed a 3D image of chemical bonds.

(a) (b) (c)

Figure 1. a) Sample Book Page Views of Covalent Bond Type Coordination, (b) Display of Application Main Menu, and (c) Display of Barcode Scanning

After the validation test was carried out, the content expert validation data and book media are shown in tables 2 and 3 below, respectively.

Table 2. Results of Content Expert Validation Test on Books

No	Indicator	Percentage
1	Book eligibility	80.53%
2	Truth of concepts	86.6%

Table 3. Results of Media Expert Validation Test on Books

No	Indicator	Percentage
1	Book cover	80%
2	Foreword	62.5%
3	Instructions for use	87.5%
4	Table of contents	66%
5	The first page of each sub content	75%
6	Concept maps	83%
7	Barcode	75%
8	reference list	87.5%

The content and media expert validation data for the application are shown in tables 4 and 5 below, respectively.

Table 4. Results of Content Expert Validation Test on Content

No	Indicator	Percentage
1	Grammar eligibility	83%
2	Truth of concept	91.5%

The media expert validation data for the application shows the following:

Table 5. Results of Media Expert Validation Test on Applicaton

No	Indicator	Percentage
1	Opening	75%
2	Main menu	100%
3	Application button	100%
4	Metal chemical bond objects	75%
5	Polar covalent bond object	91.6%
6	Nonpolar covalent bond object	91.6%
7	Single covalent bond object	91.6%
8	Double covalent bond object	93%
10	Triple covalent bond object	93%
11	Coordinate covalent bond object	93%

The data readability test results for students show the following:

Table 6. Media Readability Test Results to Students

No	Indicator	Percentage
1	Book design	84.2%
2	Book clarity	89%
3	Material explanation	79%
4	Application design	91.4%
5	Clarity of instructions for use	88.5%
6	Ease of use	88.5%
7	Use of media to understand concepts	89.2%
8	Media attractiveness	90%

The percentage of media attractiveness of Augmented Reality (AR) on Chemical Bonds had a high yield, namely 90%. This was the same as in Supriono & Rozi's (2018) research which states that Augmented Reality integrated in learning media will increase motivation in learning because the media used is attractive.

Based on validation test data by book and application material experts, book and application media experts, and due diligence on students, the final result was an average of 87.9% for material, 79.87% for media and 87.6% for readability to students . If this percentage value was compared with the percentage qualification table based on Hanafi (2017), the Augmented Reality (AR) media developed was declared very valid for use and without revision. The comparison of the percentage value of the validity test could be seen in Figure 2 below.

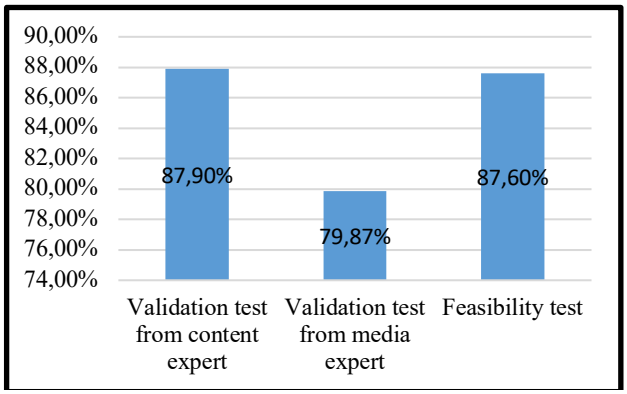

Figure 2. Result of Percentage of Content, Media and Feasibility Test Validation

CONCLUSION

This development research produced a product in the form of Augmented Reality (AR) assisted learning media on chemical bonding material. The development stage includes the preproduction and production stages. This learning media was in the form of books and applications on mobile phones. The features in this application were scanning as the main feature, and other features, namely help, info and exit. By pointing the camera at the scan feature to the marker on the book, it could display images of three types of chemical bonds on the screen display. After testing the material validation, media and readability to students, it shows that this learning media was categorized as very feasible and did not need to be revised with the percentages respectively 87.9%, 79.87% and 87.6%. This research and development was still in the production stage, to produce suitable learning media. Therefore, it was hoped that the next stage will be carried out, namely the dissemination of development results to the target. In addition, it is hoped that there will also be the development of learning media assisted by Augmented Reality (AR) in other science materials.

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REFERENCES

Anisa, F., & Yuliyanto, E. (2017). Analysis of Factors Affecting Learning Chemistry at Teuku Umar Senior High School Semarang. *Seminar Nasional Pendidikan, Sains dan Teknologi*, 476–482.

Dwinata, R. A., Efendi, R., & S, S. P. Y. (2016). Application Design of Periodic Table of Elements and Formulation of Chemical Compounds from Basic Chemical Elements Based on Android. *Rekursif*, *4*(2), 177.

Hanafi. (2017). Konsep Penelitian R & D dalam Bidang Pendidikan. *Saintifika Islamica: Jurnal Kajian Keislaman*, *4*(2), 129–150.

Harris, J. L., Al-Bataineh, M. T., & Al-Bataineh, A. (2016). One to One Technology and its Effect on Student Academic Achievement and Motivation. *Contemporary Educational Technology*, *7*(4), 368–381. https://doi.org/10.30935/cedtech/6182

Hermann, M., Pentek, T., & Otto, B. (2016). Design Principles for Industries 4.0 Scenarios. *2016 49th Hawaii International Conference on System Sciences (HICSS)*, 3928–3937. https://doi.org/10.119/HICSS.2016.488

Jespersen, N. D., Brady, J. E., & Hyslop, A. (2012). *Chemistry: The Molecular Nature of Matter*. John Niley and Sons Inc.

Mustaqim, I., & Kurniawan, N. (2017). Pengembangan Media Pembelajaran Berbasis Augmented Reality. *Jurnal Edukasi Elektro*, *1*(1), 36–48. https://doi.org/10.24252/lp.2018v21n1i6

Pandia, I. (2014). The Using of Smartphone in Supporting Student Learning Achievement in SMPN 1 Kubung of Solok District at West Sumatera. *Jurnal Penelitian Komunikasi Dan Pembangunan*, *15*(2), 122–135.

Purnama, S. (2013). Research and Development Methods. *Literasi*, *4*(1), 19–32.

Purwandini, D. A., & Irwansyah. (2018). Corporate Communication in The Industry Era 4.0. *Jurnal Ilmu Sosial*, *17*(1), 53–69. https://doi.org/10.14710/jis.17.1.2018.53-63

Ristiyani, E., & Bahriah, E. S. (2016). Analisis Kesulitan Belajar Kimia Siswa di SMAN X Kota Tangerang Selatan. *Jurnal Penelitian dan Pembelajaran IPA*, *2*(1), 18–29.

Saidin, N. F., Halim, N. D. A., & Yahaya, N. (2016). Designing Mobile Augmented Reality (MAR) for Learning Chemical Bonds. *Proceedings of the 2nd International Colloquium of Art and Design Education Research (i-CADER 2015)*, 367–377. https://doi.org/10.1007/978-981-10-0237-3

Singhal, S., Bagga, S., Goyal, P., & Saxena, V. (2012). Augmented Chemistry: Interactive Education System. *International Journal of Computer Applications*, *49*(15), 1–5. https://doi.org/10.5120/7700-1041

Subekt, H., Taufiq, M., Susilo, H., Ibrohim, I., & Suwono, H. (2017). Developing Information Literacy through Stem Integrated Life-based Learning to Prepare Science Teacher Candidates for the Era of the Industrial Revolution 4.0: Literature Review. *Education and Human Development Journal*, *3*(1), 81–90. https://doi.org/10.33086/ehdj.v3i1.90

Supriono, N., & Rozi, F. (2018). Pengembangan Media Pembelajaran Bentuk Molekul Kimia Menggunakan Augmented Reality Berbasis Android. *JIPI (Jurnal Ilmiah Penelitian dan Pembelajaran Informatika)*, *3*(1), 53–61. https://doi.org/10.29100/jipi.v3i1.652

Wulandari, S., Nasir, M., & Mukhlis. (2018). Penerapan Model Pembelajaran Index Card Match pada Materi Hukum-hukum Dasar Kimia di Kelas X SMA Inshafuddin Banda Aceh. *Jurnal Ilmiah Mahasiswa Pendidikan Kimia (JIMPK)*, *3*(2), 85–93.

Yuliati, Y., & Saputra, D. S. (2019). Pembelajaran Sains di Era Revolusi Industri 4.0. *Jurnal Cakrawala Pendas*, *5*(2), 167–171. https://doi.org/10.31949/jcp.v5i2.1389

Zheng, M., & Waller, M. P. (2017). ChemPreview: An Augmented Reality-Based Molecular Interface. *Journal of Molecular Graphics and Modelling*, *73*, 18–23. https://doi.org/10.1016/j.jmgm.2017.01.019

Zhou, K. (2015). Industry 4.0: Towards Future Industrial Opportunities and Challenges. *Fuzzy Systems and Knowledge Discovery (FSKD) IEE 12M International Conference*, 2147–2152. https://doi.org/10.1109/FSKD.2015.7382284