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Augmented Reality-based Media on Molecular Hybridization Concepts Learning

Ferli Septi Irwansyah*, Efa Nur Asyiah, Ida Farida
Faculty of Education and Teacher Training, UIN Sunan Gunung Djati Bandung, Indonesia

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***Correspondence Address:**
ferli@uinsgd.ac.id

Abstract: Students' problems in understanding of the hybridization process need to be overcome by using interactive media. Therefore, this study aimed to analyze the results of the validation test and the feasibility test of learning media based on Augmented Reality (AR) on the concept of hybridization. The research method used was the Design-based Research (DBR) method based on technology that supports the learning process within two stages, namely the analysis stage and the design and development stage. Data collecting instruments used were a validation test questionnaire and a limited trial sheet. The media was validated by 3 expert lecturers and 10 respondents of Chemical Education Department students at UIN Sunan Gunung Djati Bandung, Indonesia. Overall validation test results obtained an average value of $r_{observed}$ of 0.88. The validation test obtained a value above 0.30, which showed that the learning media was valid and can be used for the limited trial. The limited trial obtained an average value of 88.59 % within a feasible category. This research concluded that AR learning media on the concept of hybridization is appropriate to be used as teaching material in the learning.

INTRODUCTION

The development of science and technology impacts the world of education (Ciffolilli & Muscio, 2018; Grover, 2019; Wijayati, Kusuma, & Sumarti, 2019), this resulted in competition between students globally (Ayu, Susanti, & Wiyono, 2019; Suprapto, 2018). To face this challenge, an effective learning media is required (Bintang, Danial, & Ramlawati, 2019; Khaldun, Hanum, & Utami, 2019; Rahim, Suherman, & Murtiani, 2019), as well as constructive learning processes so students can compete in the era of globalization (Jatmiko et al., 2018; Susanti & Iskandar, 2019).

Science and technology are closely related in modern life, one of which is chemistry (Faeha, Wahid, & Udaibah, 2019; Pagliaro, 2019). Chemistry is a science that focuses on studying matter and energy in terms of structure, composition, characteristics, and energy changes (Liniarti, 2013; Suyati & Sutiani, 2018; Van Duzor, 2012). Therefore, students need to study chemistry (Ahyar, Masykuri, S, & Saputro, 2019; Siahaan & Marjan, 2019). However, several concepts in chemistry are abstract and complex that is difficult to understand (Irwansyah, Ramdani, & Farida, 2017; Sem, Iskandar, & Rahayu, 2019). One reason is the inaccurate use of instructional media used by teachers (Agustin, Bektiarso, & Bachtiar, 2018). Thus, it causes students' difficulty in learning the concept of chemistry (Arifin, Yanti, Silaban, &

Tarigan, 2019; Melati, 2011; Quílez, 2019). Efforts in overcoming this are optimally improving the quality of learning (Rahma, Solehah, & Mashuri, 2019).

Students can understand chemistry conceptually if they can translate chemical phenomena into macroscopic, submicroscopic, and symbolic representations (Helsy & Andriyani, 2017; Safitri, Nursa'adah, & Wijayanti, 2019). Submicroscopic visualization is very important, so students understand the concept of chemistry as a whole (Kelly & Hansen, 2017). One concept that requires submicroscopic visualization is hybridization. The hybridization process produces orbital hybrid that is difficult for students to imagine (Salah & Dumon, 2011). For this reason, three-dimensional submicroscopic representation is needed so that the delivery of information will become clearer by displaying objects in three dimensions (Rajmah, Adrian, & Sanjaya, 2017). Submicroscopic visualization can utilize tools called learning media (Mahnun, 2012). Learning media can be in the form of conventional learning media or the form of computer technology. However, learning with conventional media is limited to understanding material without rational reasoning (Smiar & Mendez, 2016).

Along with the development of science and technology, computer technology is currently widely used in various fields, such as information, education, business, and communication. It is related to computer technology that is educational or developed in learning (Fadloli, Kusumo, & Kasmui, 2019; Sulthoni & Ulfa, 2019). Only a few studies of molecular hybridization learning media have been carried out, such as displaying hybridization molecules in computers (Nassabeh, Tran, & Fleming, 2014) and Macromedia flash learning media (Wijayanti, 2018). Therefore, we need a hybridization learning media based on technology to make the learning process more interactive. The technology that is increasingly being developed is a technology using smartphones (Anshari & Almunawar, 2017). The use of smartphones in learning activities can affect student academic performance (Han, 2018). Students show a positive attitude when learning using a smartphone and this makes it easier for students in the learning process (Zan, 2015).

One technology that uses smartphones is AR technology or Augmented Reality (Kamelia, 2015). AR can be operated simply in a smartphone (Cochrane, Narayan, & Antonczak, 2016). AR is the interaction between humans, computers, and virtual objects presented in the environment that feels real by combining the two worlds, the real world and the virtual world (Cai, Wang, & Chiang, 2014). AR is a technology that can be described sub-microscopically with a 3D display (Irwansyah et al., 2017). AR can also be used for difficult teaching, and abstract concepts that will make breakthroughs in education (Oh & Byun, 2012) and AR is also interactive (Carmigniani et al., 2011). Although AR has been around for a long time, this technology can be utilized in improving the learning process (Bicen & Bal, 2016). The improvement is in the interest and motivation during learning (Oh & Byun, 2012). Previous studies have shown that AR is suitable to be used as a learning medium in the concept of metal structures (Irwansyah et al., 2017) and the concept of molecular geometry (Irwansyah, Yusuf, Farida, & Ramdhani, 2018). Therefore, researchers researched developing an AR learning media through the feasibility test and the validation test of learning media on the concept of hybridization.

METHOD

The research method used was the modified Design-based Research (DBR) method. This method is a design-based research method based on technology that supports the learning process within two stages, namely the analysis stage and the design and development stage (Herrington, Mckenney, Reeves, Herrington, & Mckenney, 2007). The research procedure can be seen in Figure 1.

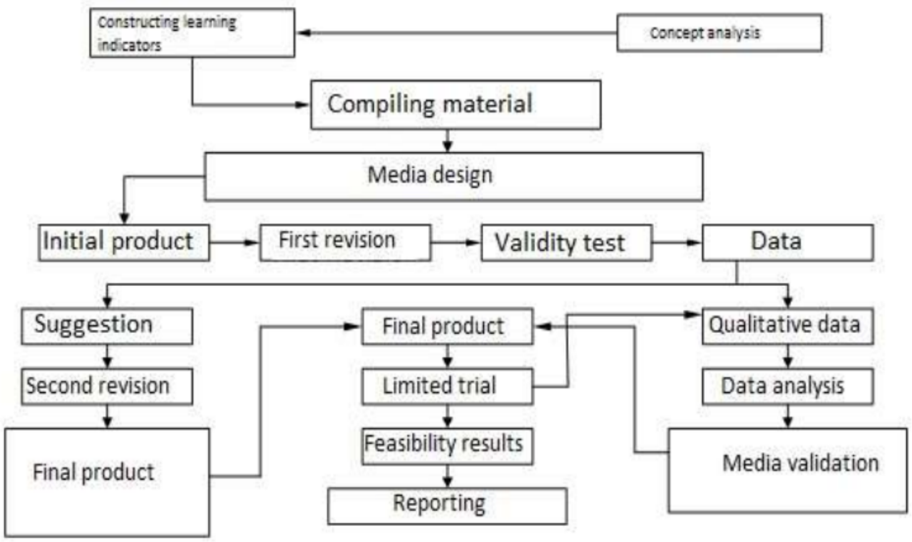

Figure 1. Research Procedure

The Analysis Stage

To obtain the function accuracy, before the learning media was developed, several things need to be prepared. Identification of problems contained in various sources such as journals and textbooks, a competency analysis, concept analysis, concept maps, source collection, and selection of supporting AR media software.

Design and Development Stage

At this stage, a technology-based AR media design was carried out. The media design in the form of a basic picture and operational steps often referred to as storyboards and flowcharts, were developed. Then an application was made that contains learning materials in the form of text, 3D objects, animation, and sound. After the application had been made, then testing was done in the form of a product assessment or a validation test. After that, the media that had been revised was tested for its feasibility through limited trials to students by employing limited trial questionnaires. Then, the data analysis and report compilation were carried out.

The data source for the validation test was obtained from three expert lecturers in the field of education and learning media as the validators and data sources for the feasibility test were obtained from ten Chemical Education Department students at UIN Sunan Gunung Djati Bandung through limited trials. The acquired data needed to be analyzed to determine the validity by calculating the validation test by giving a score for each item based on Table 1.

Table 1. Information Score

Score	Information
5	Excellent
4	Good
3	Moderate
2	Bad
1	Poor

The total score from each examiner was calculated and then compared to its validity value (r) to a predetermined critical value (Sugiyono, 2012). The formula used for the value of validity (r) is:

$$r = \frac{x}{N . n}$$

Description:
r = validity value
x = weight of respondents' answers
N = maximum score
n = number of respondents
(Sugiyono, 2012).

After calculating the data using the formula, the calculated results were compared. The observed is said to be valid if it exceeds the $r_{critical}$ of 0.30 (Sugiyono, 2012). Data analysis of respondents' assessment instruments was carried out to determine the score or statement points, which could be categorized as strongly disagree, disagree, agree, and strongly agree. By using quantitative calculations that are adjusted to the weight of the score, the percentage of feasibility can be obtained.

$$P = \frac{Score}{Ideal\ Score} \times 100\%$$

Description:
P = Percentage
Ideal Score (Highest score x number of respondents x number of questions)

RESULT AND DISCUSSION

Based on research, the AR application display that displays the 3D objects is shown in Figure 2.

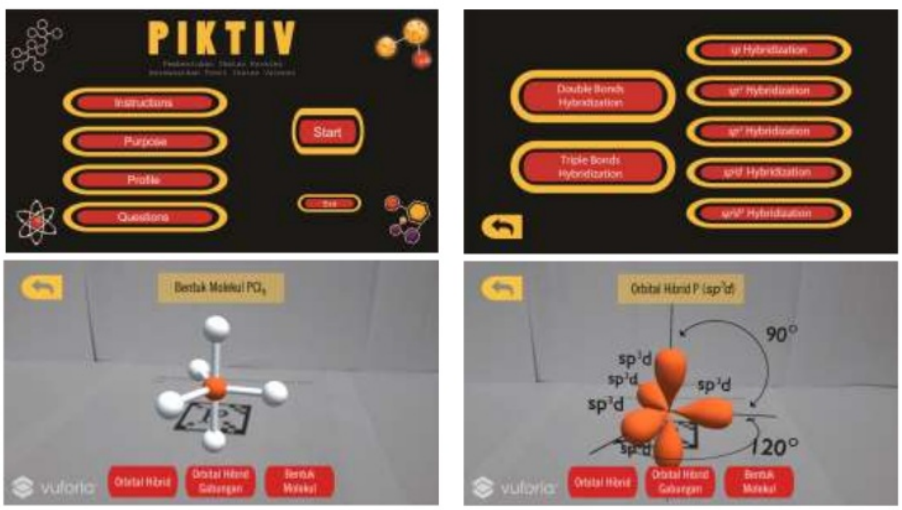

Figure 2. Display of AR Learning Media

The validation was done by showing the developed learning media and providing validation questionnaire sheets to the experts. The results of media validation can be seen in Table 2.

Table 2. The Results of Validation

No	Aspect	$R_{observed}$	$r_{critical}$	Results
1	Learning	0.87	0.30	Valid
2	Material substance	0.80	0.30	Valid
3	Visual communication	0.96	0.30	Valid
4	Software engineering	0.88	0.30	Valid
	Average	0.88		

Based on Table 2, the obtained average of $r_{observed}$ for each aspect is 0.88. According to Sugiyono (2012), the media can be said to be valid if the $r_{observed}$ is more than 0.30. In general, the learning media was declared as valid with some suggestions for improvement on the initial menu display, 3D object axis display, and animation display.

The feasibility test was done by conducting a limited trial aimed to determine the students' responses toward the learning media on the formation of covalent bonds based on valence bond theory.

The implementation of the limited trial began by distributing the application to students to be installed on their Android smartphone. Then, the students were given guidance to use the media. Furthermore, the students answered the questions contained in the media. Then the students were given a questionnaire to assess the learning media. The results of the limited trial can be seen in Table 3.

Table 3. The Results of Limited Trial

No.	Indicator	Question Number	Score	Criterion	Percentage (%)
1	The relevance of the media to the learning objectives	1, 6, 13	111	120	92.50
2	Efficient use of media in terms of time	2, 16	69	80	86.25
3	Effectiveness of the media to overcome the limitations of teaching aids	3, 14, 19	101	120	84.17
4	The flexibility of the media	8, 12	70	80	87.50
5	Media display	4, 9, 11	110	120	91.67
6	Increase students' motivation in learning	5, 18, 20	100	120	83.33
7	Ability to encourage students to study further	10, 15, 7	103	120	85.83
8	Prospects for developing other similar media	17	39	40	97.50
	Average				88.59

Based on Table 3, the percentage obtained can explain the feasibility of the developed learning media on each question. The learning media can be categorized into highly feasible, feasible, quite feasible, less feasible, or not feasible. The first indicator is the relevance of the media to the learning objectives which include the ability to analyze atomic and hybrid orbitals based on 3D objects, students can explain molecular hybridization using orbital diagrams based on 3D AR objects, and students can analyze sigma bonds and pi bonds based on 3D AR objects that obtained a percentage of 92.50 %. This percentage explains that in this indicator, the AR learning media was declared as highly feasible to be used in the learning process. This shows that AR media can be used to achieve learning objectives. The use of smartphones as a learning medium helps teachers in streamlining time following the results of the feasibility test on the efficiency indicators in terms of time, which is 86.25 %. This percentage value indicates that the AR media is feasible to streamline learning time.

The next indicator is the effectiveness of the media to overcome the limitations of visual aids. 3D objects displayed have the shape of objects that are adjusted to the prevalence of molecular shapes in terms of angles and colors. This gets a percentage of 84.17 %, which shows that the AR learning media is appropriate to be used. On the indicator of the flexibility, this AR media uses Android smartphone technology that most people have, so it is very easy to use if the learning media is installed in smartphones (Anshari & Almunawar, 2017). This indicator obtained a percentage of 87.50 % which shows that the AR learning media is feasible to be used. In the media display indicator, AR has several characteristics, namely attractive colors and displays and also interactive. In line with Blijlevens et al., who states that attractive color designs will give users aesthetic pleasure (Blijlevens, Thurgood, Hekkert, & Chen, 2017). This indicator obtained a percentage of 91.67 % which shows that the AR learning media is highly feasible to use.

On the indicator of increasing students' motivation in learning, AR has an attractive appearance so that it will increase motivation in learning (Kuswanto & Radiansah, 2018). This indicator obtained a percentage of 83.33 %, which shows that the AR learning media is highly feasible to use. On the indicator of the ability to encourage students to study further, the AR media was developed using attractive media display characteristics. An attractive media display will be able to provide stimulation of thoughts, feelings, attention, and interest toward information so that students will be encouraged to learn even farther (Nazmi, 2017). This indicator obtained a percentage of 85.83 % which shows that the AR learning media is highly feasible to use.

The indicator of prospect for the development of other similar media obtained a percentage of 97.50 %, which shows that the AR learning media is highly feasible to be used and it is hoped that the same media with different concepts can also be developed. From the limited trial stage, a percentage of 88.59 % was obtained which shows that this media is suitable to be used as a learning media.

CONCLUSION

Based on the results of validation and feasibility tests from the experts, it can be concluded that the Augmented Reality-based media can be used in Molecular Hybridization learning. The results of the limited trial also indicated that the Augmented Reality-based media makes it easy for students to learn concepts well, increase motivation, and effectiveness because it can be accessed with a smartphone. Further research is expected to be carried out to see how effective this media in improving students' learning outcomes.

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