DEVELOPMENT OF MEDIA INTERACTIVE BASED ON AUGMENTED REALITY ON CHEMICAL BONDING MATERIALS

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Abstract: *This study aims to produce interactive learning media based on augmented reality technology on the concept of chemical bonds and determine student responses to the media. The research method used is the R & D method. The instruments used are material expert validation sheets, media expert validation sheets, and student response questionnaires. The data obtained were analyzed descriptively. Based on the results of material expert validation, an average of 80.41% (feasible category) was obtained and the media expert validation results obtained an average of 90.92% (very feasible category). The results of the limited trial received positive responses from students with details of the percentages obtained, namely 85.75% for the usability aspect, 81.80% for the illustration use aspect, 74.57% for the future impact aspect. 79.64% for the aspect of material usefulness, and 77.20% for the grammatical aspect. Overall, the augmented reality interactive learning media developed received a positive response from students with a percentage of 79.78% and suitable for use in learning.*

Keywords: *Interactive Learning Media; Augmented Reality; Chemical Bond*

INTRODUCTION

The development of science and technology can improve performance and allow various activities to be carried out quickly and will increase productivity in various aspects of life [1] and education is no exception. Therefore, a paradigm shift in the learning process, especially regarding the concept of how people learn and how teaching materials are delivered effectively, needs to be done. The shift in the role of the teacher, which had been considered the only source of learning, was also changed to that of a facilitator.

In addition to the development of science and technology, one of the challenges of 21st century education is to build a knowledgeable society that has ICT and media skills, critical thinking skills, problem solving skills, effective communication skills and collaborative collaboration skills [3].

The development of information and communication technology in the world of education is certainly a curriculum demand. So that the development of technology as a learning medium must be in line with the applicable curriculum. Currently, Indonesia is implementing the 2013 curriculum which emphasizes the student center by applying the use of ICT as a learning medium.

SMAN Tangsel is one of the high schools that has implemented the 2013 curriculum since the 2013-2014 school year. Based on the observation of the availability of learning media, this school is quite adequate but its utilization is not optimal. Therefore, learning media innovations are needed that are able to make students learn actively and interactively.

Augmented reality in the world of education that allows users to interact in real with the system, augmented reality can combine the real world with a virtual world created by computers. This technology is expected to be a solution in educational problems, especially chemistry subjects. Augmented reality can stimulate and motivate students to explore classroom materials from different angles, help teach subjects where students cannot get first-hand experience in the real world, increase cooperation between students and instructors and between students, foster student creativity and imagination, help students take control of their learning at their own pace and on their own path, and create an authentic learning environment suitable for a variety of learning styles [5].

The 3D object in question can be a model of atoms and bonds that can concrete chemical

molecules in the form of 3D and 2D molecular objects so as to help students understand microscopic chemical material. With the augmented reality technology, the learning process in schools can be "modern-modern", namely the learning media used are modern with interactive and cutting-edge learning methods.

In Indonesia, augmented reality has become known in the last seven years. Just like in other countries, some research and development in the field of education has also been carried out. Student learning outcomes have increased significantly after using augmented reality-based learning media on particle dynamics [6]. Efficient augmented reality media helps students in understanding the spatial relationships between 3-dimensional molecules [7]. However, in Indonesia there are still few scientific studies that specifically examine the application of augmented reality as an interactive learning medium on chemical bonding material [7].

Appropriate and varied use of educational media can be overcome by the passive attitude of students. In this case the educational media is useful for: 1) Generating the excitement of learning. 2) Allows more direct interaction between students with the environment and reality. 3) Allows individual learning, according to the abilities and interests of students [8].

Chemical bonding material is a fairly difficult material based on the findings of the analysis of try out questions at SMAN Tangsel, which is only 53.55% of students who are able to answer correctly on the indicator determining pairs that form ionic bonds. High school level National Examination.

Chemical bonding is a microscopic subject matter, so modeling is needed in the learning process so that students can see and understand concrete lessons. Students at lower levels will more easily understand and understand abstract concepts [1]. Augmented reality application in the field of chemical education includes AR books, molecule structuring, reactions in augmented reality environment [10]. This strengthens the reason for the researchers to apply augmented reality technology to chemical bonding materials.

METHOD

The research method used is the R & D method which includes 3 stages, namely the preparation, production, and evaluation stages [4]. The product development process was carried out from September 2014 to May 2015. The limited trial was carried out on May 17, 2015 at SMAN Tangsel.

The object of this research is an interactive learning media based on augmented reality on chemical bonding material. The research subjects consisted of 2 material experts, 2 media experts, 2 lecturers for validating research instruments, and 40 students of class X IPA SMAN Tangsel.

The instruments used are observation sheets, documentation guidelines, interview guidelines, material expert validation sheets, media expert validation sheets, and student response questionnaires. Observation sheets are used to determine the availability and use of media in schools. The interview guide was used for needs analysis and was conducted with only one chemistry teacher. Documentation guidelines in the form of student learning outcomes data. The material expert validation sheet is used to validate the suitability of the material in the media. The material validation sheet grid can be seen in Table 1. below [4]

Table 1. Material Validation Sheet

No	Aspect	∑Item
1	Material accuracy	3
2	Depth and breadth of material	9
3	The suitability of the material with the indicator	9
4	Visual fit with material	22
5	Material sufficiency	9
6	Updating	8
	Total	61

The media expert validation sheet is used to validate the suitability and quality of the media. The grid of media validation sheets can be seen in Table 2. The following [4]

Table 2. Media Validation Sheet

No	Aspect	∑Item
1	Attractiveness	33
2	Readability and benefits of captions	11

3	Image sharpness	4
4	Visual compatibility	9
5	Music	6
6	Technical	9
	Total	72

The student questionnaire was used to determine student responses to augmented reality-based interactive learning media on chemical bonding material. The questionnaire was prepared using a 5 option Likert Scale (1, 2, 3, 4, 5). The grid of student questionnaires can be seen in Table 3. The following [14]

Table 3. Student Questionnaire

No	Aspect	∑Item
1	Usability	8
2	Future impact	7
3	Material benefits	9
4	Use of illustrations	11
5	Grammarly	5
	Total	40

The data obtained were analyzed descriptively quantitatively. Student response data were categorized into very good (81-100%), good (61-80%), sufficient (41-60%), poor (21-40%), and very poor (0-20%) scales [11]. While the data from the validation of materials and media are categorized into a very feasible scale (81-100%), decent (61-80%), quite feasible (41-60%), less feasible (21-40%), and very less feasible (0-20%) [11].

RESULTS AND DISCUSSION

One of the objectives of this research is to produce interactive learning media based on augmented reality technology on chemical bonding material. This media was developed through 3 stages, namely: the design stage, the production stage, and the evaluation stage [4].

In the design phase, at this stage, 3 steps of analysis are carried out as planning for making media, namely needs analysis, drafting an outline of the content of the material and the description of the material, and preparing the manuscript. The field survey was carried out as a needs analysis to raise problems, namely by observing the availability of learning media in schools and interviews with chemistry teachers. Based on the results of observations in the field, it is known that the availability of multimedia types of learning media available in the form of web and flash. Meanwhile, the development of computer-based learning media at SMAN Tangerang Selatan has supported the availability of computers, webcams, infocus in the classroom with projection screens for infocus, as well as the availability of internet network (wifi). Furthermore, the results of the interviews with chemistry subject teachers concluded that subject teachers needed interactive and innovative learning media to help them teach in the classroom but teachers did not have enough ability to develop it and the time the teacher had to develop learning media was not enough because of their busyness with assignments. - the task of the teacher at school. Whereas students are required to have the skills to use computers in classroom learning.

Based on the data from the needs analysis regarding the availability of learning media and analysis of media needs, the next stage is student analysis. Student analysis was conducted to determine the students' initial behavior and student characteristics. This stage is carried out by analyzing the test documents for student learning outcomes in schools, namely the results of the National Examination try out in class A and B at SMAN Tangsel, totaling 78 people. The analysis was carried out on the matter of chemical bonds only, namely in numbers 4, 5 and 6. The results found that 53.55% of students who answered questions correctly on the indicators determined the pairs that formed ionic bonds, 92.17% of students answered correctly on the indicators. determine the form of a compound formed from an element, and 46.10% of students who are able to answer questions correctly on the indicator determine the shape of a molecule formed from an element whose configuration is known.

Based on the results of the needs analysis of 80 respondents stated that 70.00% did not focus while studying, 78.00% felt bored while studying and 86.00% students were more interested in learning by using the media. This makes it clear that in general students need new ways of learning with the help of innovative learning media to overcome student boredom and unfocused learning. The next indicator states that students can use a computer by 72.00% and 83.00% of students state that they have a computer or laptop. So that it can support the implementation of computer-based learning media. In the next indicator, it can be seen that students like learning by reading books by

72.00%, by watching practicum videos 84.00% and by practicing questions by 64.00%. After doing student analysis and having determined the material, namely chemical bonds, the next stage can be carried out, namely task analysis.

Compilation of the outline of the content of the material and the description of the material in the form of content structure analysis which serves to determine learning indicators. Referring to the analysis, it was also found that chemical bonding material was divided into 5 learning activities, namely elemental stability, ionic bonds, covalent bonds, polar and non-polar compounds, and metal bonds. So that we get an overview of the contents of augmented reality learning media. To detail the general description of the contents of the augmented reality learning media, a description of the material is carried out. Armed with indicators and materials, the formulation of learning objectives is carried out. Learning objectives are set in each learning activity. Based on the formulation of learning objectives along with brief information about the material to be delivered step by step, then the design phase of learning media can be carried out to be more detailed, systematic, and have an attractive design.

In the production phase, at this stage three activities are carried out, namely the preparation, implementation and completion of the production of augmented reality applications and marker books as interactive learning media based on augmented reality technology on chemical bonding material. The interactive learning media based on augmented reality technology in this chemical bonding material includes the type of design media. Therefore, it needs to be designed and prepared specifically for certain learning purposes (media by design) [12].

The preparation activities at the production stage of the augmented reality application were chosen by the openspace3D software as the augmented reality builder because it has advantages in PC-based use compared to other software such as ARtoolkit, Nyartoolkit or Vuforia SDK which have advantages in their respective fields. Furthermore, 3Ds Max software was also chosen for the manufacture of three-dimensional models because it is more varied in making the modeling so that it is closer to the original. For example, making models of hydrogen gas cylinders, dry ice and gold bars.

The selection of information type formats that are integrated in making applications include .PNG for images. Image is an effective visual medium because it can visualize objects more concretely, more realistically and more accurately, and overcomes space and time. Pictures can replace verbal words, concretize the abstract and overcome human observations [13]. Next format. Mesh and .scene for three-dimensional objects. Although 3-dimensional objects only emphasize the power of the sense of sight, the power of images lies in the fact that most people are visual thinkers by nature. Next is the .wav format for audio. The integrated audio is a type of background music and sound effects.

Munadi said, "background music is music that is used to accompany it as a pressure, nuance and most importantly to arouse the emotions of the listener." The background music used is instrumental music. The use of background music is not louder or as loud as the accompanying music, but also not too weak and does not change from loud to weak or vice versa [13]. The type of music for marker interaction is a type of sound effect. Sound effects are sounds that will be included in the program to support the creation of a certain atmosphere or situation [13]. The addition of sound effects on augmented reality media as an emphasis to show the detection of markers by the program with the appearance and disappearance of the objects displayed. The next format is .swf for animation files. The animation that appears is in the form of a chemical bonding process that takes place. Then format.exe to auturn the finished application packaged in a compact disk (CD) which indicates that the file can be installed on the computer

The production of marker books is carried out by making preparations in advance, namely preparing a systematic format for writing marker book formats. The paper format used is A5 for the sake of the economy of duplicating the marker book. The typeface used is century gothic so that the appearance of writing in the book is attractive. The letter size provisions are used in accordance with the proportional layout of the marker book. The implementation of making marker books is carried out in line with the creation of augmented reality applications with suggestions and input from various parties.

The packaging of the marker book is printed using 260 grams artcartoon paper one face and using spiral binding.

Evaluation stage, at this stage there are two activities, namely media validation and limited trial. The data from the validation of the material can be seen in Table 4. Below

Table 4. Material Validation Result

No	Aspect	%	Category
1	Material accuracy	86.66	Very decent
2	Depth and breadth of material	72.22	Worthy
3	The suitability of the material with the indicator	84.28	Very decent
4	Visual fit with material	81.76	Very decent
5	Material sufficiency	80.00	Worthy
6	Updating	77.50	Worthy
	Average	80.41	Worthy

The data from the media validation results can be seen in Table 5 below

Table 5. Media Validation Result

No	Aspect	%	Category
1	Attractiveness	94.24	Very decent
2	Readability and benefits of captions	87.27	Very decent
3	Image sharpness	90.00	Very decent
4	Visual compatibility	92.22	Very decent
5	Music	90.00	Very decent
6	Technical	97.78	Very decent
	Average	91.92	Very decent

Researchers distributed questionnaires to get student responses to the media they used. The questionnaire that was distributed contained 40 statements and was given to 40 respondents, namely students of class X IPA 4 SMAN Tangsel, which included aspects of usability, future impact, material benefits, material clarity, use of illustrations and grammar. The results of the student response questionnaire are presented in Table 5.

Table 6. Student Questionnaire Results

No	Aspect	%	Criteria
1	Usability	85.75	Very good
2	Future impact	74.57	Good
3	Material benefits	79.64	Good
4	Use of illustrations	81.80	Good
5	Grammarly	77.20	Good
	Average	79.78	Good

Based on the data above, it can be seen that the usability aspect is the highest aspect with a percentage gain of 85.75%. Indicators of usability include easy access for students to use augmented reality (AR) interactive learning media and the time of using augmented reality (AR) interactive learning media in the classroom. The indicator of the highest usability aspect is the indicator of the ease of access of students in using augmented reality (AR) interactive learning media, which is 89.20% with very good criteria. This is because the media can be accessed easily by students because the instructions for using the media are clear, and the user has full control over the use by moving the marker at the desired point of view. The next highest indicator is the time to use augmented reality learning media, which is 80.00% with good criteria. This is because the augmented reality media makes the learning process of the material complete so that it is more effective. The results of a research questionnaire on user opinions on the designed system show that augmented reality is easy to use and users get a distinct impression after operating the system repeatedly [15].

The second highest aspect is the use of illustrations with a percentage of 81.80%. The highest indicator is the attractiveness of animation on the media by 82.50%. This is because the illustrations used are close to the original state. The next indicator is the attractiveness of three-dimensional objects on the media by 82.00%. This is because the three-dimensional shape makes the object displayed more real and can be exposed in all directions. The lowest indicator is illustration benefit of 81.00%. This is because illustrations make it

easier for students to understand chemical bonding material and the illustrations used relate to everyday life. This is in line with the research conducted by [16] on the interactive learning model of 3D building based on augmented reality.

The third highest aspect is the benefit of the material with a percentage of 79.64%. The highest indicator is the ease with which students understand the material with a percentage of 83.00%. This is because the media makes students learn easily and can interact actively. The next highest indicator is the clarity of the material presented at 76.29%. This is because the description of the material is accompanied by real examples in everyday life and is taken from clear sources and is the main chemistry book which is the source of chemistry books in schools. In line with the research conducted by, [18] entitled collaborative augmented reality for inorganic chemistry education, all the students surveyed considered that augmented reality was a good tool to help them understand the arrangement of 3-dimensional structures and some of them (70%) wanted to use it at home on their personal laptop.

The fourth highest aspect is grammar with a percentage of 77.20%. The highest indicator is text or writing with a percentage of 81.00%. This is due to the selection of letters and sizes according to the user so that they are easy to read. The last indicator is the use of language by 74.67%. This is because the use of spelling is in accordance with the appropriate EYD.

The lowest aspect is the future impact with a percentage of 74.57%. The highest indicator is creating a positive character, namely the percentage of 75.33%. This is because the media can trigger students to learn independently anywhere, and make them more active in studying chemistry. The lowest indicator is that the media can motivate students by 74.00% with good criteria. This means that learning with augmented reality learning media can motivate students to learn about chemical bonds well. This is in line with the results of research which states that Augmented Reality learning media can increase students' learning motivation and 4C skills [14].

CONCLUSION AND SUGGESTION

Conclusion

Based on the results of the research that has been carried out, it can be concluded that the interactive learning media based on augmented reality technology on the chemical bonding material produced in the form of applications and marker books developed are included in the feasible and usable category. The developed media also received positive responses from students by 79.78% and included in the good category.

Suggestion

Based on the conclusions of the results of this study, the researchers provide suggestions including: 1) This learning media should be developed again by adding 3-dimensional objects that can be displayed by the application because currently there are only a few objects. 2) It should be added to the final evaluation of learning exercises in marker books with augmented reality technology so that they can develop products to be more complete and better. 3) Extensive trials and further research should be conducted to determine the effectiveness of this media in learning. 4) There should be a chemical learning media similar to this research for other materials.

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