# *DEVELOPING AUGMENTED REALITY-BASED LEARNING MEDIA ON VOLUME AND SURFACE AREA OF SPACE GEOMETRY FOR STUDENTS GRADE VIII*

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***Abstract***

*The aim of this research was to develop augmented reality-based learning media on volume and surface are of space geometry subject for grade VIII. In particular, the purpose was describing the feasibility of learning media in terms of validity, practicality, and effectiveness aspect. This R&D (Research and Development) method used 4D development model, i.e. define, design, development, and dissemination. The last step not carried out due to time limitations. The subjects of study were VIII-1 and VIII-4 students of SMP N 8 Yogyakarta. The instruments used were questionnaires for media experts, material experts, teachers and students to asses the learning media. The questionnaires for expert were based on three quality categories such as goal and content, instructional, and technical quality. The results of the assessment of learning media by experts showed that the validity of the learning media was* ***valid*** *with a score 4.7 from maximum score 5, practically aspect was* ***practical*** *with a score 3,23 from maximum score 4, and the effectiveness aspect was* ***effective*** *based on the average score test gained in the class was more than KKM, that was 80.*

## INTRODUCTION

Learning media is one of important component that must be prepared by teacher learning activity. Now days, there are many kinds of learning media that is used in learning activity. Book or printed learning media is one of learning media which is used in common. This kind of media more popular as it is more practical and adaptable, but sometimes it is has limitations for visualizing specific objects such as 3D objects, animation, or video. An example of learning that require visualization of three dimensional objects is volume and surface area of space geometry for grade VIII.

Based on the observation in the printed media that already exist, for space geometry object such as a cube, a prism, and pyramid are commonly represented in a two-dimensional object on paper. Based on interview with a math teacher in SMP N 8 Yogyakarta, it is not enough to visualize the objects because students need more visualization to get engaged in learning about this kind of material. As Piaget (Rita Eka Izzaty, *et al.*, 2008:34-35) stated in his cognitive theory which leaners develop knowledge according to the their ages, student in grade VIII especially, is on transition of operational concrete to operational formal level. Student can construct knowledge formally in this stage, but they still need help of concrete and visual object. Therefore, the use of learning media is required to help students understand the material.

One of popular learning media that can be used today is learning media based on information and communication technology. In line with current technological development, the appearence of high computer technology that is known by augmented reality (AR) gives a chance to develop an interesting and motivating application for learning. It is also enrich the function of printed-based learning media. This technology gives us possibility to collaborate the virtual and real object in real time that can both facilitate and attract student to learn (Anggi

Andriyadi, 2011:9). This technology has capability to display information such as labels or virtual objects, like 3-D objects, that can only be seen with a camera of smartphone or computer. According to Lee (2012:20), this technology is potential in attracting, inspiring, and motivating student to do exploration from many kind of perspective in education.

One of media that can be integrated with Augmented Reality is book. Clark and Dunser (2012:10) stated that student can interact and attracted by book content using AR As a result, using AR–based media can help student which has problem to understand the text-based learning media. This technology also developed in making multimedia presentations for teacher as a tool in the learning process in the classroom, and does not replace the teacher as a whole.

In Indonesia, some research and development in the field of education, has given positive result, AR which can be applied well in class as learning media (Aries Suharso, 2012). However, the development of AR in Indonesia as learning media is only for desktop application, it means this kind of media needs PC or extension camera. This certainly reduces its practicability. By the presence of technology development, this can be overcome by using smartphone as AR learning media. Based on its characteristics, learning media based on AR can be use as mobile application. It also will give possibility to user to use this kind of media everywhere.

The high improvement of technology today is also followed by the improvement of people needs of technology in their hand. It can be seen from the increasing of smartphone and tablets users in Indonesia. Yahoo! dan Mindshare publish their findings in 2013 that there is arround 41.3 million people in Indonesia use smartphone. It is also supported by the result of questionnaires given to 63 students of grade VIII SMP N 8 Yogyakarta, obtained information that 91% of students have a smartphone with Android operating system, which is used to support communication and entertainment, the rest is used to access the internet and gather information. Unfortunately, this finding evince that the use of smartphone for productive activity is very low, especially for educational activities. Whereas the use of technology is one of the principle of learning in the Kurikulum 2013 has been used by some schools in Indonesia. The use of technology has been regulated in the regulation no. 65 of Menteri Pendidikan dan Kebudayaan Republik Indonesia about standard process that in Kurikulum 2013 technology had a role in obtaining independence of students to learn.

Based on those issues, there will be given an alternative solution that can be done to address them. The high improvement and development of technology and the high need of technology give a chance to use technological based aids to improve learning media, especially to enrich the function of printed-based media. Thus, it is important to develop augmented reality-based learning media for space geometry subject. This learning media contains of printed-based learning media such as student worksheet and augmented reality application for android. This technology is not widely used in the field of education in Indonesia, so that the development of augmented reality-based learning media is expected to be an innovation in the development of the learning media especially for mathematics learning.

## RESEARCH METHODS

### Type of The Reseacrh

This research is using R&D (Research and Develop) method with 4D model research (Trianto, 2012:93-96) consisting of 4 stages, namely define, design, develop, and disseminate.

### Time and Place of Research

The research conducted on April-May 2015 at SMP N 8 Yogyakarta.

### Subject of Research

The subjects were 63 students of class VIII-1 and VIII-4 SMP N 8 Yogyakarta, a media expert, a material expert, and a mathematics teacher from SMP N 8 Yogyakarta

### Procedure

Define phase include: curriculum, students' characteristics, environmental, and technology analysis. Stage design include: drafting worksheet and application design, drafting assessment instrument, questionnaire and achievement test for students. Develop phase include: development of product formats initial, assessment of learning media, product validation and revision, and learning media trial.

### Data, Instrument, and Data Collecting Technique

Type of data used in this research and development are qualitative and quantitative data. The qualitative data obtained from define, design, and develop stage such as collecting reference, design of learning media, validation of assessment instrument, and the assessment result and suggestion.

Quantitative data covers the quality of learning media in term of validity, practicality, effectiveness aspect. The data is derived from the result score from the experts, students' questionnaires and test score.

The instrument used was a questionnaire assessment of learning media by experts based on the quality of the content and purpose, constructional and technical quality, the students' response questionnaires and achievement test.

### Data Analysis Technique

1. Validity Analysis

Assessment of the validity aspect obtained from the assessment of learning media by the experts. The steps are as follows:

a. Tabulation or calculation results by changing the assessment resutl in the form of qualitative to quantitative.
b. Calculating the average score.
c. Change the average score into the qualitative data based on criteria on Table 1 (S. Eko Putro Widyoko, 2013:110-115).

**Tabel 1. Validity Criteria**

| Interval Rata-Rata Skor | Kriteria |
|---|---|
| $4{,}3 < \bar{X}$ | Very Good |
| $3{,}4 < \bar{X} \leq 4{,}3$ | Good |
| $2{,}6 < \bar{X} \leq 3{,}4$ | Enough |
| $1{,}7 < \bar{X} \leq 2{,}6$ | Less |
| $\bar{X} \leq 1{,}7$ | Very Less |

d. The learning media stated as valid if and only if the assessment result from the experts is at least good.

2. Practicality Analysis

Assessment of the practicality aspect derived from the students' response questionnaires analysis. It covers 11 positive and 11 negative statements. The steps of analysis are as follows:

a. Tabulation or calculation results by changing the result of questionnaire in the form of qualitative to quantitative.

**Tabel 2. Guidelines for Questionnaire Response Assessment**

| Statement | | Score |
|---|---|---|
| **Positive** | **Negative** | |
| Strongly Agree | Strongly Disagree | 4 |
| Agree | Disagree | 3 |
| Disagree | Agree | 2 |
| Strongly Disagree | Strongly Agree | 1 |

b. Calculating the average score.

c. Change the average score into the qualitative data based on criteria on Table 3 (S. Eko Putro Widyoko, 2013:110-115).

**Tabel 3. Practicality Criteria**

| Range Score | Criteria |
|---|---|
| $3{,}4 < \bar{X}$ | Very Good |
| $2{,}8 < \bar{X} \leq 3{,}4$ | Good |
| $2{,}2 < \bar{X} \leq 2{,}8$ | Enough |
| $1{,}6 < \bar{X} \leq 2{,}2$ | Less |
| $\bar{X} \leq 1{,}6$ | Very Less |

e. The learning media stated as practical if and only if the assessment result from the experts is at least good.

3. Effectiveness Analysis

Effectiveness analysis is obtained from the average score of the classical test results after using the learning media. If the average classical test score is over KKM, i.e. 80, it is stated the learning media is effective.

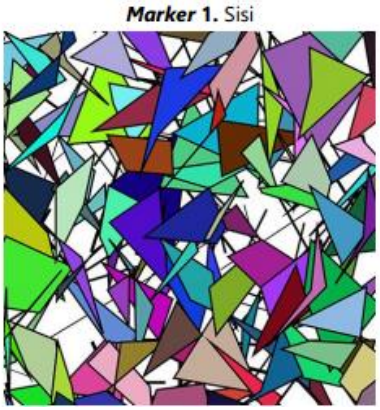
## THE RESULT OF RESEARCH AND DISCUSSION

The development research procedure is using 4D development model;

1. Define
   a. Curriculum Analysis; The curriculum used is Kurikulum 2013 with the first basic competencies; determine the volume and surface area of flat surface space geometry, such as cube, cuboid, prism, and pyramid.
   b. Students' Characteristics Analysis; (a) They are interested in using learning media to study b) like bringing smartphone or tablet to school and use it for learning activity but only for finding information from the internet, (c) not familiar with augmented reality technology, (d) different in ability to understand the material, (e) enjoying learning in groups but still a few who were actively involved to express an idea or making a presentation in front of the class.
   c. Environmental Analysis; most of students are android user.
   d. Technology Analysis; software used for the developement are Microsoft Word, Corel Draw X4, Photoshop CS 6, 3DS Max, and Unity 3D. Android device used minimal configuration android 4.0 (Ice cream sandwitch), 512 MB RAM, and 2 MP camera.
2. Design
   a. Drafting the worksheet
   b. Design the application
   c. Design assessment instruments
   d. Design students' response questionnaire
   e. Drafting the student achievement test.

3. Develop
    a. Worksheet development; consists of four sub materials namely cuboid, cube, prisms, and pyramid. Each sub materials include properties, nets, surface area, and volume. The approach used is scientific and consists of a variety of features such as observing, asking questions, gathering information, associating, and communicating. There are also 22 markers printed on the worksheet. Each markers serve to show visualization of 3D objects, animations, and video. The worksheet is also equipped with 22 marker cards to support the user's flexibility to use the learning media.

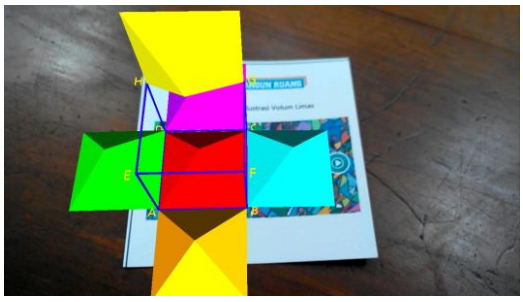

**Picture 1. Worksheet Cover**




**Picture 2. Example of Marker**

    b. Application development; the application consist of (1) Main Menu, consists of 3 main button go to augmented reality, help function, and about developer function, (2) Augmented Reality function to activate the camera and display the object if it is directed to marker, (3) Help function, covers how to use the leaning media, (4) About Developer contains some information about developer. This media running on mobile devices with a minimum screen resolution of 480 x 800 px and goes offline (not connected internet). It is running on android operating system with a minimum version 4.0.1 (Ice Cream Sandwich). The type of application is *.apk*, for easy installation. This application needs 31.32 Mbyte for internal storage in smartphone.


**Picture 3. Main Menu**



**Gambar 4. Augmented Reality Function**


**Picture 5. Help Function**


**Picture 6. About Developer Function**

c. Validation and Revision

The learning media is validated by a media expert, a material expert, and a mathematics teacher. After the media was revised in accordance with the advice given.

d. Learning Media Trial

It is conducted on May 2, 2014 until May 30, 2015 and lasted for 5 sessions that consist of 4 meetings for the learning process using the media and a meeting for students' achievement testing and filling questionnaire responses.

In general, the process of learning media trials went well. However, due to the augmented reality-based learning media is a new thing for students, on 30 April 2015 held the introduction of augmented reality technology in advanced. It aims to familiarize the students who will be using augmented reality-based learning media.

The learning media consists of printed media in the form of worksheets that comes with the card marker and augmented reality applications on android. The use of augmented reality-based learning media will be optimal when used as a single unit, it means that the use of both support each other.

The role of teachers in the use of instructional media is as a companion and guide. One of them is by providing opportunities for students to utilize instructional media to learn independently or in groups.

Some obstacles encountered while testing the augmented reality-based learning media is the media does not function optimally on some android owned by students. Constraints that occured when the camera is directed at the marker, but the object did not show up. This problem could be due to the lack of light existing around the marker. Light is an important factor in augmented reality to display objects (Sylva, R., et al., 2005), so that when the light around the marker is limited, it causes marker becomes darker. Such obstacles can be overcome by providing light around the marker. Another obstacle was when the application is running slow, it is because the application is large enough to require the appropriate memory. In addition to constraints on the application, also happens students lost marker card, but this is not too intrusive because the markers are also printed on the worksheet.

After going through the learning process using the learning media, students were taking an achievement test. The tests result used for

the analysis of the effectiveness of the learning media. Furthermore, the learning media media that have been used in the learning process assessed using students' response questionnaire that the results will be used for the analysis of the practicality of the learning media.

Based on the analysis provided by the assessment result of material expert, media specialists and teachers, it was found that the validity score of augmented reality-based learning media is 4.7 with a **valid** category. This score is the average of three aspects based on the quality of the content and purpose, instructional, and technical quality.

**Table 4. Validity Assessment result**

| Aspect | Score | Cateogory |
|---|---|---|
| Content & Pupose Quality | 4.69 | Very Good |
| Instructional Quality | 4,63 | Very Good |
| Technical Quality | 4,79 | Very Good |
| **Average Score** | **4,7** | **Very Good** |

In terms of practicality augmented reality based learning media assessed as **practical** based on the students' questionnaire responses with an average score of 3.23 in a good category. The highest response result contained in the aspects of easiness with an average score of 3.60 with a very good category. Based on these results it can be said that the learning media is very easy to use by students. The next highest response result is an interest in learning media that is equal to 3.54. Based on these results can be stated that augmented reality-based learning media is very attractive to students. Meanwhile, the aspect with the lowest average score was liveliness that is equal to 2.94. This can happen due to the lack of students' encouragement to make a presentation in front of the class.

**Table 5. Practicality Assessment Result**

| Aspect | Average Score of Each Aspects | Category |
|---|---|---|
| Easiness | 3,60 | Very Good |
| Assistance | 3,29 | Good |
| Practicality | 3,26 | Good |
| Glad | 3,18 | Good |
| Interest | 3,54 | Very Good |
| Motivation | 3,02 | Good |
| Liveliness | 2,94 | Good |
| Curiosity | 3,23 | Good |
| Passion | 2,99 | Good |
| **Average Score** | **3,23** | Good |

Results of students' achievement test are also showing good results. This is indicated by the average value of classical learning outcomes using augmented reality based learning media more than the specified minimum value (KKM), i.e. 80. The average score achieved by two classes are 88 and 86. Thus, it can be said that the augmented reality-based learning media is **effective** to use in school.

In general, the development of research results are (1) augmented reality based learning media conceived and developed with 4D model of development, (2) learning media received a positive response both from and teachers, and instructional media expressed **valid, practical**, and **effective**, so that the media can be used as a learning source for students.

## CONCLUSION AND RECOMMENDATION

### Conclusion

Based on the research and discussion of the instructional media are developed, it can be concluded as follows.

1. The results of this research and development is augmented reality based learning media for volume and surface area of space geometry for grade VIII. The learning media trial is done to 63 students in two different classes in five meetings. The research and development carried out by the 4D development model, namely define, design, develop and disseminate. Because of time constraints, the disseminate phase was not carried out.
2. The quality of learning media is **valid** in terms of validity aspect obtained a score of 4.7 out of a maximum score of 5 with very good category. Quality practicality is **practical** expressed in terms of an average score of 3.23 out of a maximum score of 4 in good categories. The effectiveness categorized **effective** because the two classes as the object of research get an average score of 88 and 86. It is more than the specified minimum value (KKM), i.e. 80, which means that augmented reality-based learning media that have been developed can be used either for class VIII or another with similar characteristics.

### Recommendation

Here are recommendation based on research that has been conducted, particularly in the development of augmented reality based learning media.

1. Development of learning media with augmented reality applications should not only available on android platform.
2. Marker should be adjusted to shape the image that will be displayed.
3. Development of learning media with augmented reality applications should not only on the volume and surface area geometry only, but can be expanded to the other relevant topics.
4. Augmented reality based learning can be an alternative media that can be used in schools.

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