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Mobile Augmented Reality Media Design with Waterfall Model for Learning Geometry in College

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Abstract

Learning geometry became one of the subjects that are very complicated for students at the University of PGRI Semarang because it requires high cognitive abilities and spatial skill from students, it takes a learning medium that is capable of displaying 3D objects and specifically customized in learning geometry, one of them is mobile augmented reality media, that able to issue a nice and interesting three-dimensional object. The purpose of this study is to make Mobile Augmented Reality Media Applications with Waterfall Model in the subject of Geometry. As for the specific targets to be achieved in this research is generating Mobile Augmented Reality applications that is valid to use in learning geometry courses for students in Mathematics Education Study Program of University of PGRI Semarang.

The model of this media creation application software uses the waterfall model, by systematic as the following : (1) requirements, (2) design, (3) Implementation, (4) Verification, (5) Maintenance, after the mobile augmented reality media design done. it is then validated by subject matter experts and media experts with an average score of 93 and 92.75, meaning that the Augmented Reality mobile media has been categorized as very feasible to use in the learning process.

Keywords: Mobile Augmented Reality, Waterfall Model, Geometry Learning

INTRODUCTION

The Rapid technological advancements have now made a significant impact to the learning process, both in schools and universities. The effects of renewable technologies such as mobile phones, tablets and other communication media has influenced their learning style. As today, there are various mobile phone features offered. Mobile Phone features are now even more diverse and sophisticated, for example, mobile phone are now supported with camera, Short Message Service (SMS), music, video player, games, voice and video recorder, radio, web portals, video calls and Multimedia Message Service (MMS). These features are also supported with Internet capabilities that allow the user to show some kind of digital media (images, sound, animation, and video) to be used as a learning tool for students wherever and whenever they are. (Herrington: 2009).

In accordance to the development of technology to help the learning process should be changed to fit the student's character and the characteristics of the subjects studied. in a cluster of math courses in college, there are several cluster of course that is very difficult to be understood its material by the students, one of which is a family of geometry. geometry is part of the mathematical sciences field that need a strong delicate and abstraction analysis on both field, space and analitical thinking, in which according to Travers (1987) that: "geometry is the study of the relationships Among points, lines, angles, surfaces, and solids. "Geometry is a science which deals with the relationship between points, lines, angles, fields and 3D Objects.

In United States, there are only about half of the students there who took lessons of formal geometry (Bobango, 1993: 147). In addition, the achievement of all students in issues related to geometry and measurement is still low (Bobango, 1993: 147). Furthermore, Hoffer states that the students in United States and the Soviet Union both have difficulty in learning geometry (Kho, 1996: 4). the Low mastery of geometry are not only happened to students, but also happens to the teachers of middle schools who participates in preservice and inservice in Illinois USA (Swafford, Jones, & Thornton 1997), and many universities there also got a tendency of a decline in interest in geometry (Perry: 1992)

The student's low achievement in geometry are also occurred in Indonesia. Empirical evidence on the ground shows that based on experience, observation and research conducted found out that the students' ability to see three-dimensional objects are still low (Madja, 1992: 6). Even from various studies, they found out that some students still consider the geometry image as 2D Objects, and still having difficulty to

determine the difference between intersect and intersecting lines, and having unable to use the acquisition geometry to solve the problems of the geometry of spatial in high school level (Budiarto, 2000: 440). Later research conducted by Muin et al (1997) showed that the mastery of the concept of geometry of space for new students of Faculty of Mathematics and natural sciences (FPMIPA) on Teachers' Training College, Faculty of teaching and science education in University, and Public and Private teaching and science education profession school on East Java resulted on a range from 7.14% to 80% which means that the mastery of geometry concepts of students are still not optimal. Then Suparyan study (2007) showed that the Semarang State University's math students are weak in mastering geometry of space material course and especially in spatial abilities.

In contrast, based on the results of interviews with professors of literature cluster of geometry and Academic Information System data of PGRI Semarang University discovered that the average results of student learning of mathematics education courses in 2014 in the subject of geometry is 66 point. The low value is due to several things: (1) the weak students skill in sketching both flat and geometry, (2) the provision of student knowledge about 2D material geometry and space is very weak esecially at the middle school level, (3) lecturers that teach geometry are still only using the media for simply sketching or drawing, and there is still few lecturers who use software-based media which facilitate the abstraction of subjects for students (4) the student are still weak in solving problems related to the geometry which arrives from daily life. This shows that both the faculty and students of the University of PGRI Semarang experiencing similar problems with other college-related in learning geometry. In order to solve the lack of mastery of geometry requireds a breakthroughs in learning in order for the students to obtain a maximum spatial ability, Nemeth (Nemeth: 2007) explains in his research finding that the importance of real spatial ability is needed in the engineering sciences and mathematics, especially geometry. This ability was found to be inherited but as a result of a long learning process. For that the need of an instructional media to help students in mastering the material in a practical and effective geometry is a must.

As for the learning media mentioned which is suitable with the characteristics of geometry subjects are augmented reality media. Augmented reality media is a learning media that combines printed and computer technology (Craig: 2013). Augmented Reality which also called augmented reality technology is used to combine objects 2D / 3D from virtual world to the real world in real-time (Kauffman: 2000). While Mobile Augmented Reality is based on Augmented instructional media where some pages are marked so that it can display a three-dimensional models through webcamera by integrating the applications that have been designed previously in cell phones or computers.

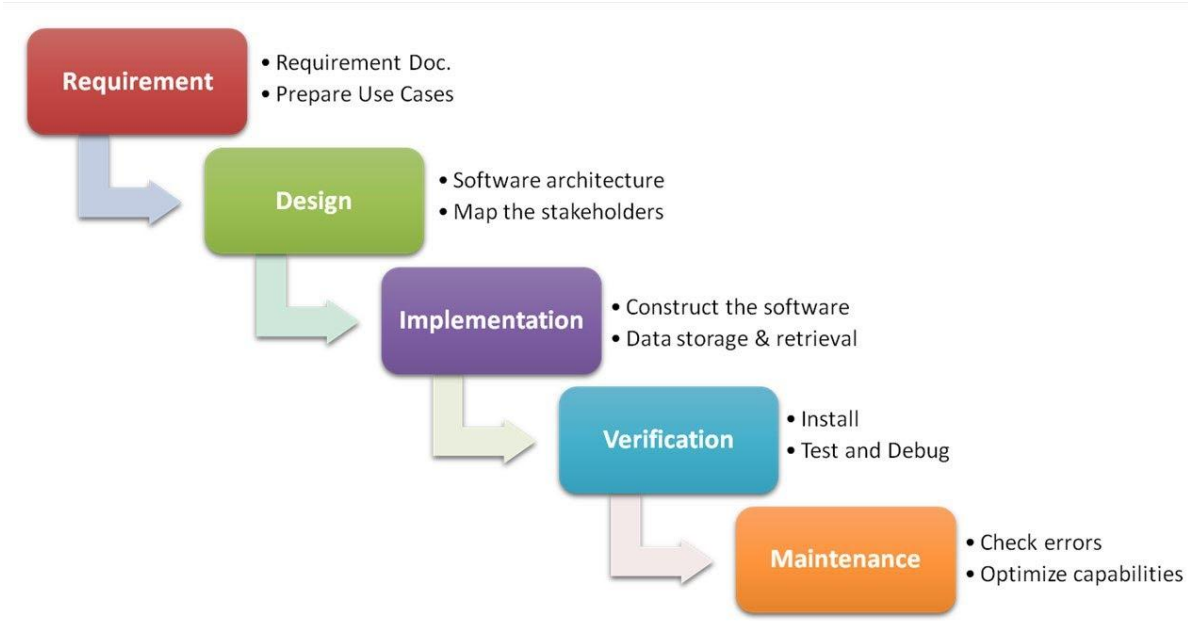
Based on the results of research on the effects of augmented reality geometry media on learning outcomes and student motivation and student in Indonesia and in abroad acquired by Subagyo et al (2015) showed that the introduction of formulas of 3D objects by augmented reality in primary schools around Kudus Regency really assist students in the process of abstraction or spatial abilities greatly so that students are more enthusiastic in following the study, this was confirmed by Estapa's research (2015) that using the augmented reality media shows a very significant impact on motivation and the learning outcomes of primary school students in the United States, while according to Yingprayoon (2015), augmented reality geometry in secondary schools and higher education in Thailand is able to improve the ability of pupils and students in understanding the geometry material, it is then supported by Coimbra et al (2015) which shows that the use of augmented reality geometry in college Portugal was very helpful for engineering students to understand the material of spatial geometry. Among the various products of augmented reality whether it is in the outside or inside the country still has not yet been packaged as a whole in an application for learning the courses of geometry in the classroom, therefore it is necessary to develop a geometry materials based on mobile augmented reality that can be used for students flexibly whenever and wherever he or she is.

In the making this design of mobile augmented reality media refers to the waterfall model based on the assumption of the analysis of the problems and needs through and thorough interviews and direct observations to obtain a perfect problem-solving in the learning process of geometry. Based on the background explained above and this very reason, it is necessary that Mobile Augmented Reality Media Design with Waterfall Model on the subject of Geometry at the University of PGRI Semarang become valid to use.

METHOD

Type Of Research

In developing the mobile augmented reality applications, we use the Waterfall Model development method. This model is a systematic approach and sequence starting from the system of level requirements and then headed to the stage of analysis, design, coding, testing / verification, and maintenance. it is called waterfall because it consists of stage by stage sequence through which must wait for the completion of the previous stage in order to start the next stage. For example for the design stage to be able to start must wait the completion of the previous phase ie the requirements stage. In general, the stages in the waterfall model can be seen in the following figure:



Picture 1. Waterfall Model Process

Below is an explanation of the steps taken in the waterfall model according to Pressman (2007):

1. Requirements. In this stage, the search process is intensified and focused on the needs of the software. To know the nature of the program to be made, the software engineer must understand the information domain of the software, for example, the functions needed, user interface, etc. This 2 activity (search the system requirements and software) must be documented and presented to the customer.
2. Design. This stage process is used to change the above necessities as a representation in the form of "blueprint" software before the coding begins. The design must be able to implement the requirements mentioned in the previous stage. Like the two previous activity, this process must also be documented as the configuration of the software.
3. Implementation. To be understood by the machine, in this case a computer, the design had to be transformed into a form that can be understood by machines, ie into the programming language through the coding process. This stage is the implementation of the technical design phase which will be done by the programmer.
4. Verification. As anything made must be tested first. Likewise with software. All software functions must be tested, so that the software is free from error, and results should be strictly in accordance with the needs that have been defined previously.
5. Maintenance. A software maintenance is required, including the development, because the software that being made are not always just like that. When it runs, it may still have some small errors that are not found before, or if there is the rise of the needs of an additional features that did not exist in the software before. a Development is required when a change of external companies such as when there is a change on the operating system, or other device.

Reasons to Use Waterfall is its advantages of the method for the application of this model which is easy to use, also by using this model, when all the system requirements can be defined as a whole, explicit, and right at the beginning of the project, then the products can run well and without problems. Although the often needs of the system can not be defined as explicitly as desired, but at least, the problem on the system requirements in the early project are more economical in terms of money (cheaper), effort, and time wasted when compared to the problems that arise at later stages ,

Subject

The subject to try of this research is student of mathematics education of (FPMIPATI) of University PGRI Semarang on their first semester, in the course of Geometry which consists of 245 students, and then use a randomly selected sampling from 1E class of 32 students.

Instrument Data Collectors

This development instrument uses tools such as questionnaires, observations and interviews which developed by the researcher

Data analysis

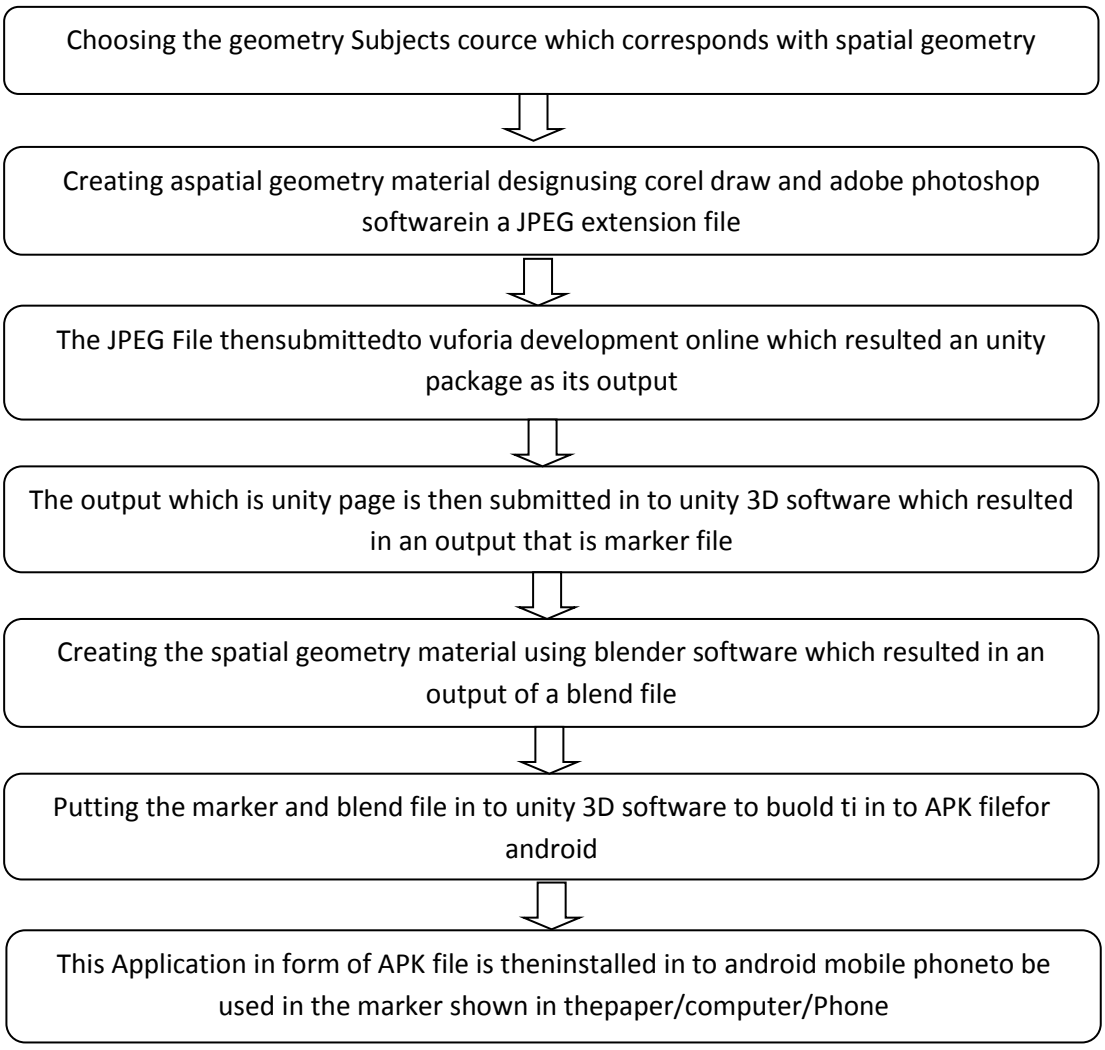
The data gathered through this study is a data on: (1) the attractiveness of the program offered to students; (2) the relevance of the material being studied; (3) the usefulness of media and materials to study; and (4) the suitability of the material to be examined with the ease of access to materials for students. (5) The questionnaire responses by subject matter experts and media experts to the Mobile Augmented Reality media.

RESULT AND DISCUSSION

The result of this research is about the mobile augmented reality media designon geometry subjects course which has been suited in to waterfall model as seen below :

1. Requirements.

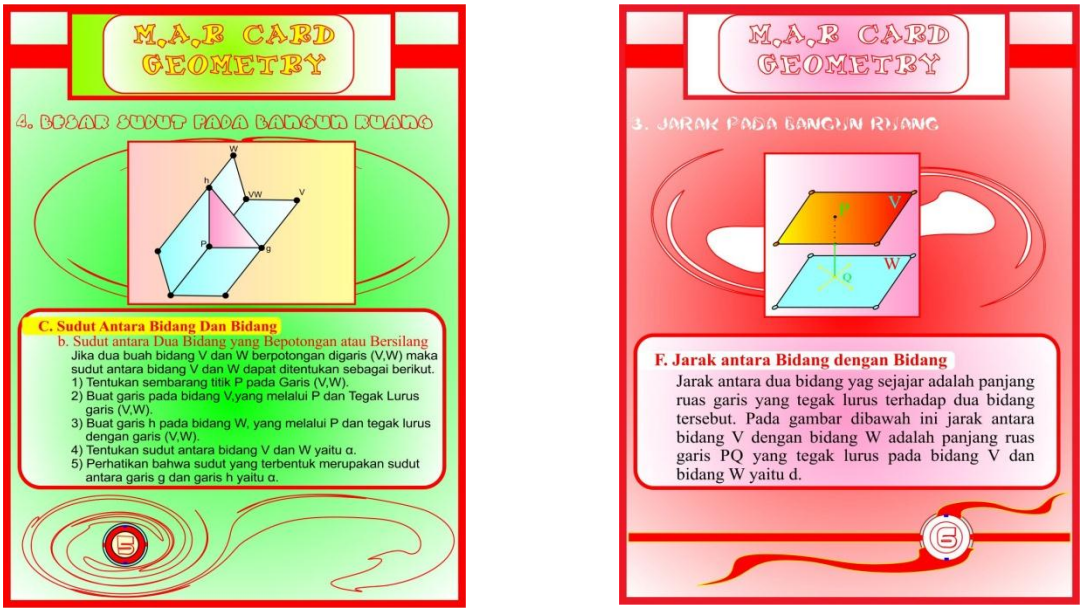
   In order to support the development of the mobile augmented reality media on geometri subjectsit is then use the corel draw, software Unity 3D, Vuforia development andBlender software.As for the step by step of this development of the Mobile Augmented Reality MediaAs seen below:



Picture 2. Stages of Mobile Augmented Reality MediaDevelopment

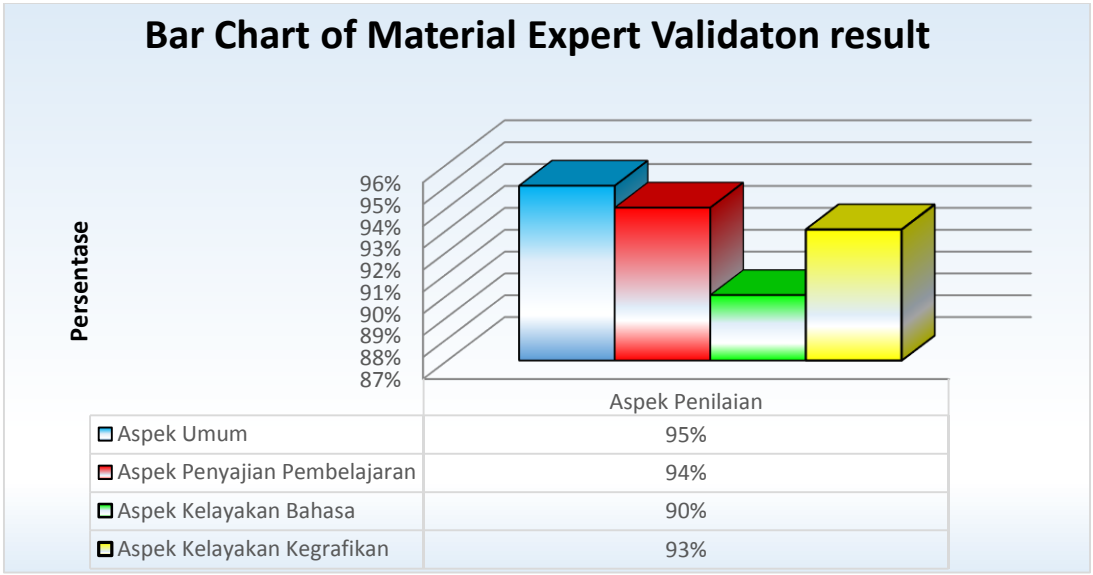
2. Design.

   The making of the design is done in a systematic way and is validated by subject matter experts and instructional media professors and doctors in the field of mathematics and technology-based learning, so that the mobile augmented reality product can be used in the real learning process for subjects of geometry, as for the initial design is as the following :



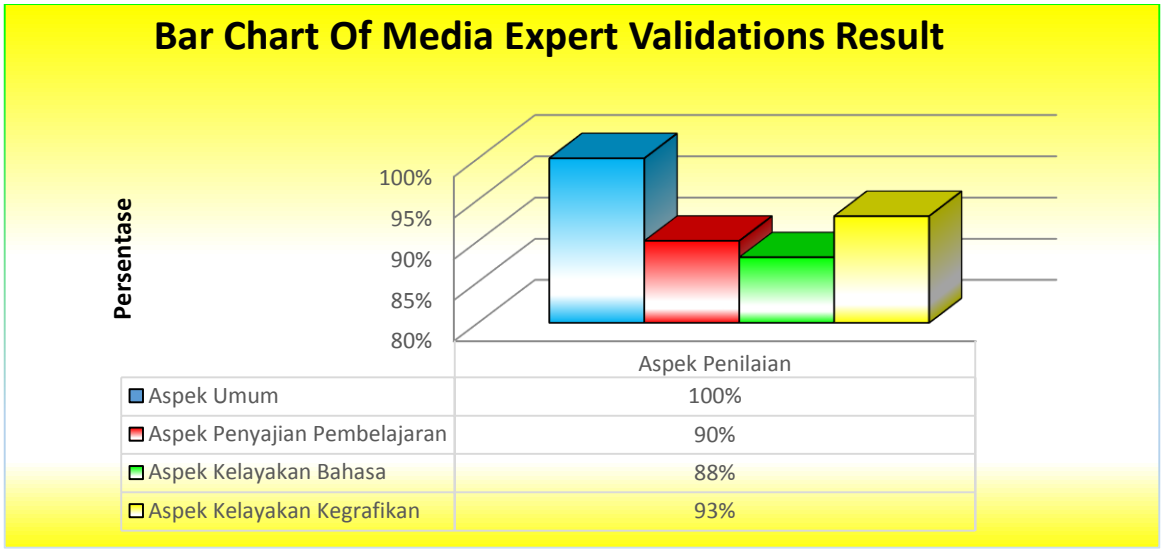
Picture 3. Mobile augmented reality design for geometry material

In figure 3, the related materials describes the angles and distances in three-dimensional space, where students are expected to describe the location of the position of points, lines and areas properly, the design is then added with corel draw software design in order to look more attractive and elegant.Then the product was validated by experts in their fields, the validation results are : the subject matter experts provide a total value of 93 and media experts give 92.5. it means that the two experts stated that the product is fit for usein the classroom, while the input of experts is the needs of an instrumental music in mobile augmented reality application to make the learning atmosphere more fun and also the augmented reality view of the 3D objects instudent smartphones and mobile augmented reality cards should be larger. Here are the results of expert assessment of materials and media experts :



Picture 4. Bar Chart of Material Expert Validaton result

The result of material expert's assessment of the material showed that the material presentation of the material is already good, the language used is also good, while the drawing of the material are well-structured.



Picture 5. Bar Chart Of Media Expert Validations Result

The results of media expert assessment of the media showed that the design of the display is good, color grading is already good, object of three dimensions that appears on the smartphone can also be seen clearly, while it still need improvement in the mobile augmented reality card design and the needs of instrumental music on the application to make it more attractive to students.

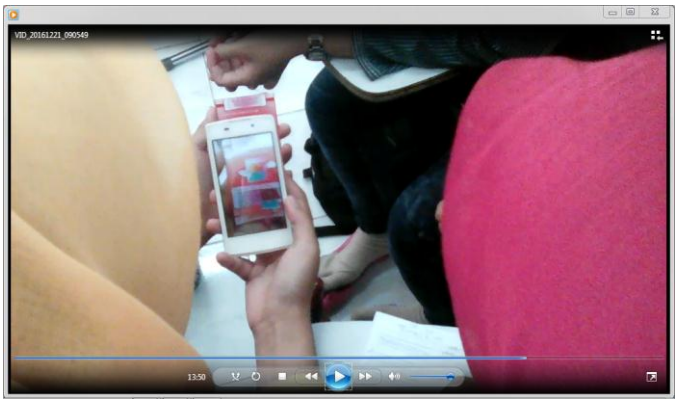
3. Implementation.

To be understood by the smartphone, in this case is the student's, the design had to be transformed in to the form of APK so that it can be understood and usable by smarthphone that is android-based, ie into the programming language through the coding process. In the implementation of mobile augmented reality media, lecturers provide technical way of use the media details, so students can use them properly, the easy way is to install APK in student's smartphone and directing the smartphone to MAR Card Geometry, so the 3D objects output can be helpful that the students understand the material abstraction of spatial geometry.

Gambar 5. Explanation on how to use the MAR Card Geometry

4. Verification.

   In this stage of verification of the Mobile Augmented Reality (MAR) Card Geometry product conducted after an observation in the classroom and interview after the use of MAR Card media, in order to know all the functions MAR Card that is free from error, and the result is totally in keep with the needs that have been defined in previous stage. The results of verification of the product showed that the MAR Card Geometry media are already eligible for use in the learning process geometry course, this is demonstrated by the success of all smartphones used by the students and all students easily understand the purpose of the three-dimensional objects that shown in student's smartphone.



Gambar 6.The verification of MAR Card Geometry interface

5. Maintenance.

In the maintenance of an application stage, require a check on the card MAR geometry Card that is the necessity to reprint the card so that the paper used was supportive to the smartphones used, because if the card MAR Card broke the smartphone can not detect the 3D object in MAR Card, including the possibility that there is small errors that are not found before, or are there additional features that did not exist before in the augmented reality mobile application.

CONCLUSION

From the research results related to the development of mobile augmented reality media design on geometry course shows that :

1. The mobile augmented reality Products in the geometry course are eligible for use in the learning process, especially at the University of PGRI Semarang
2. There has been made improvements related to the card view where the card size is now larger MAR Card
3. It is now added an instrumental music in the application which helps students in their learning atmosphere to be more interesting and more fun.
4. The needs of further development in order for the MAR Card media product in geometry can fit for use not only in Indonesia in particular but also the world in general.

REFERENCES

[1] Anglin,(1995) teaching whats its all about, new york harper & Row Publisher

[2] Azuma, R. A (1997), Survey of Augmented Reality. PRESENCE: Teleoperators and Virtual Environments, 6,(4), 355-385

[3] Buchori dkk (2013).Pengembangan Mobile Learning Materi trigonometri di SMA NASIMA Semarang, Jurnal pendidikan matematika vol. 2.no.2 hal 1-12 Universitas Muhammadiyah Semarang

[4] Budiarto, M.T..2000. Pembelajaran Geometri dan Berpikir Geometri.Dalam prosiding Seminar Nasional Matematika "Peran Matematika Memasuki Milenium III".Jurusan Matematika FMIPA ITS Surabaya. Surabaya, 2 Nopember.

[5] Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H., dan Krathwohl, D.R. (1956). The Taxonomy of Educational Objectives The Classification of Educational Goals, Handbook I: Cognitive Domain

[6] Bobango, J.C.. 1993. Geometry for All Student: Phase-Based Instruction. Dalam Cuevas (Eds). Reaching All Students With Mathematics. Virginia: The National Council of Teachers of Mathematics,Inc.

[7] Craig A.B. (2013). Understanding Augmented Reality: Concepts and Applications. Newnes

[8] Coimbra (2015) Augmented Reality: an Enhancer for Higher Education Students in Maths learning? 6th International Conference on Software Development and Technologies for EnhancingAccessibility and Fighting Infoexclusion , Procedia Computer Science 67 (2015) 332 – 339

[9] Crowley, (1987). The van hiele model of development geometry though, NCTM edited by mary montgomery lindquist hal 1-16

[10] Fenrich, P. (1997). Practical Guidelines for Creating Instructional Multimedia Applications. Fort Worth, TX: The Dryden Press

[11] Heinich, Molenda, et. all (2005). Instructional Technology and Media for Learning. Ohio: Pearson Merrill Hall

[12] Herrington, A, Herrington, J and Mantei, J, (2009), "Design principles for mobile learning, in New technologies, new pedagogies: Mobile learning in

higher education, Faculty of Education, University of Wollongong, 4 (2) 138-145.

[13] Kemp & Dayton:1985)." Planning and producing instructional media, cambridge harper & row publisher new york

[14] Kaufmann, H., Schmalstieg, D., and Wagner (2000), M.Construct3D: A Virtual Reality Application for Mathematics and Geometry Education. Education and Information Technologies 5(4) 263-276.

[15] Kho, R..1996. Tahap Berpikir dalam Belajar Geometri Siswa-siswa Kelas II SMP Negeri I Abepura di Jayapura Berpandu pada Model van Hiele.Tesis tidak diterbitkan. Malang: PPS IKIP Malang.

[16] Kumar Behera Santosh. (2013), M-Learning: A New Learning Paradigm, International Journal on New Trends in Education and Their Implications, 4 (3), 24-34.

[17] Madja, M.S.. 1992. Perancangan dan Implementasi Perangkat Ajar Geometri SMTA. Tesis tidak diterbitkan. Jakarta: PPS UI.

[18] Muin dkk (1997) profile penguasaan geometri mahasiswa baru FPMIPA IKIP, FKIP UNIVERSITAS dan STKIP Ngeri Sasta di jawa timur, pusta penelitian surabaya

[19] National Academy of Science. (2006). Learning to Think Spatially, Washington DC: The National Academics Press

[20] Nemeth, B. (2007). "Measurement of the Development of Spatial Ability by Mental Cutting Test" dalam Annales Mathematicae et Informaticae, 3 (4): 123-128.

[21] Quinn, C. (2000). Mlearning, Mobile Wireless in Your Pocket Learning. [Online]. Tersedia:http://www.linezine.com/2.1/feature/cqmmwiyp.htm

[22] Shearer (2016) pengenalan mobile augmented reality di UGM.kompas media published (28 Maret 2016)

[23] Subagyo dkk (2015) pengenalan rumus bangun ruang matematika berbasis augmented reality pros iding snatif ke -2 tahun 2015 hal 29-32 UMK Kudus

[24] Suparyan (2007) . Kajian kemampuan keruangan dan kemapuan penguasaan materi geometri mahasiswa pendidikan matematika Universitas Negeri Semarang , Tesis Pascasarjana UNNES.

[25] Travers, Kenneth J. (1987). Geometry. Illionois: Laidlaw Brothers.

[26] Yingprayoon, (2015) .Teaching Mathematics using Augmented Reality Proceedings of the 20th Asian Technology Conference in Mathematics (Leshan, China, 2015) page 384-391