



## *The Practicality of Geometry Learning Media based on Augmented Reality*

### **Praktikalitas Media Pembelajaran Bangun Ruang Sisi Datar Berbasis *Augmented Reality***

<sup>1</sup>Nilam Permatasari Munir, <sup>2</sup>Aswar Anas, <sup>3</sup>Lilis Suryani, <sup>4</sup>Fairus Suryani Munir

<sup>1</sup>Pendidikan Matematika, Fakultas Tarbiyah dan Ilmu Keguruan, IAIN Palopo

<sup>2</sup>Teknik Informatika, Ilmu Pendidikan dan Keguruan, Universitas Cokroaminoto Palopo

<sup>3</sup>Pendidikan Guru Madrasah Ibtidaiyah, Fakultas Tarbiyah dan Ilmu Keguruan, IAIN Palopo

<sup>4</sup>Pendidikan Bahasa Inggris, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Pohuwato  
Kampus I-B Institut Agama Islam Negeri Palopo, Jl. Bitti, Palopo, Sulawesi Selatan, 91914

Email: [1nilam\\_peermatasari@iainpalopo.ac.id](mailto:1nilam_peermatasari@iainpalopo.ac.id)

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#### **Abstract**

*Augmented reality geometry applications are developed based on today's learning needs, AR is able to present visualizations of building spaces from the virtual world to the real world through the android camera to the marker. The purpose of this study was to determine the practicality of geometry learning media assisted by the AR android application. This type of research is descriptive quantitative, with a practical questionnaire research instrument. The population of this study were all students of the mathematics study program, 408 students with a simple random sampling technique of 30 students. The technique of analyzing the practicality test data is descriptive statistical analysis. The results show that geometry learning media based on AR android by paying attention to the 6 (six) practical aspects, namely aspects of learning design, media display, software, materials, and benefits are in the very practical category, with a percentage of 94 %. This shows that AR media is very practical for learning.*

**Keywords:** *Augmented Reality; Geometry; Practicality.*

#### **Abstrak**

*Aplikasi geometri augmented reality dikembangkan berdasarkan kebutuhan pembelajaran dimasa kini. AR mampu menghadirkan visualisasi bangun ruang dari dunia maya ke dunia nyata melalui kamera android ke marker. Penelitian ini bertujuan untuk mengetahui praktikalitas media pembelajaran bangun ruang sisi datar berbantuan aplikasi android AR. Jenis penelitian ini adalah deskriptif kuantitatif, dengan instrumen penelitian angket praktikalitas, populasi dalam penelitian ini adalah seluruh mahasiswa program studi pendidikan matematika sebanyak 408 orang dengan teknik pengambilan sampel simple random sampling sebanyak 30 orang. Teknik analisis data uji praktikalitas yaitu analisis statistik deskriptif. Hasil penelitian ini menunjukkan bahwa media pembelajaran bangun ruang sisi datar berbantuan aplikasi Android AR dengan memperhatikan ke-6 (enam) aspek praktikalitas yaitu aspek desain pembelajaran, tampilan media, software, materi, dan manfaat, berada pada kategori sangat praktis, dengan persentase sebesar 94%. Hal ini menunjukkan media AR ini sangat praktis digunakan dalam pembelajaran.*

**Kata Kunci:** *Augmented Relaity; Geometri; Praktikalitas.*

## Introduction

The era of the industrial revolution 4.0 is a new technological advancement that integrates the physical, digital and biological worlds, where there is a fundamental change in the way human life works. With the development of technology that is growing rapidly which has experienced breakthroughs in all disciplines, not least in the field of education. Welcoming Era 5.0, conceptually, the relationship between the industrial revolution 4.0 and Society 5.0 does not have a significant difference, but society 5.0 focuses more on the context of humans, directing how we use technology itself and every order in society's needs will be human-centered (human-centered, centered) and based on technology (technology based).<sup>1</sup> Therefore, the world of education must also be able to face this very fast technological change. Educators like it or not, like it or not, have to innovate and be creative in integrating learning with technology. Innovating in developing learning media.

Learning media plays an important role in the learning process. The results of Safril's research, et al. show that learning mathematics will be more interesting and memorable if educators have the will and creativity in making various learning media.<sup>2</sup> Mathematics is a science which can lead to both anxiety in children and teaching difficulties in teachers. Together, these two difficulties can increase the time spent in teaching and learning mathematics.<sup>3</sup> Therefore, media is needed to facilitate students in understanding concepts, so that learning objectives can be achieved.

Augmented Reality (AR) is the current trend, AR is a technology that combines a two-dimensional/three-dimensional virtual world into a real environment by visualizing it in real time.<sup>4</sup> By the end of 2020, AR active devices are expected to increase to 598 million units and are projected to grow to 1.73 billion by 2024.<sup>5</sup> Pokemon-Go which has been downloaded

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<sup>1</sup> Program Studi Administrasi Pendidikan Sekolah Pascasarjana UPI Berkerjasama dengan Dinas Pendidikan Kabupaten Purwakarata, *Impressive Emphatic Dalam Edifikasi Kepemimpinan Inovatif Menyongsong Era 5.0*" Purwakarta, 2019.

<sup>2</sup> S Syafril et al., "Designing Prototype Model of Virtual Geometry in Mathematics Learning Using Augmented Reality," *Journal of Physics ...*, 2021, <https://iopscience.iop.org/article/10.1088/1742-6596/1796/1/012035/meta>.

<sup>3</sup> M Hraste et al., "When Mathematics Meets Physical Activity in the School-Aged Child: The Effect of an Integrated Motor and Cognitive Approach to Learning Geometry," *PLoS One* (journals.plos.org, 2018), <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0196024>.

<sup>4</sup> B H Kim et al., "On Developments of Teaching-Learning Contents and Constructivist Teaching Methods Using Mobile Applications Based on Augmented Reality in Mathematics ...," *Communications of ...*, 2019, <https://www.koreascience.or.kr/article/JAKO201928862523325.page>.

<sup>5</sup> Gokul Krishnan, "Augmented Reality Trends 2021: What to Expect from AR This Year," 2021.

more than 1 billion times <sup>6</sup> one answer is AR. AR is a technology that breaks through the real world. It adds to the reality through digital means.<sup>7</sup> Therefore, AR also needs to be utilized to its "greatness" in the world of education through learning media. Digital media applications generated by Augmented (AR) have begun to find their way into a multitude of areas related to teaching and learning.<sup>8</sup>

The results of research by Raul Lozada Yones, et al show that a computer system called "Kinect-Based Augmented Reality Mathematics Learning System - KARMLS", whose design and development uses Augmented Reality technology and motion sensors implemented on the MS-Kinect camera which is applied, has a positive effect on learning when used as a medium and it is more effective on its performance, and is more motivated and gives a positive response to the use of AR.<sup>9</sup> In line with Ilyas Akkus' research, it shows that AR applications developed for geometry learning using gadgets can develop spatial intelligence and contribute positively to students' academic success.<sup>10</sup> Another study was also conducted by Guntur and Setyaningrum whose research results showed that AR is very suitable to be developed on geometric materials but does not rule out the possibility to be developed on different materials such as vectors, algebra, and others.<sup>11</sup>

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<sup>6</sup> Novina Putri Bestari, "Game Nomor 1 Di Dunia? Simak Nih!," *CNBC Indonesia*, September 21, 2021, <https://www.cnbcindonesia.com/tech/20210921131404-37-277927/game-nomor-1-di-dunia-simak-nih>.

<sup>7</sup> A H Lubis, "... , MN (2017). Augmented Reality Story Book: Innovative Media on Primary School Mathematics Learning. *International Journal of Education in Mathematics ...*," *Azmilprimaryeducation.Blogs.Uny.Ac* ..., n.d., <http://azmilprimaryeducation.blogs.uny.ac.id/wp-content/uploads/sites/15702/2018/03/Augmented-Reality-Story-Book.pdf>.

<sup>8</sup> I Kazanidis and N Pellas, "Developing and Assessing Augmented Reality Applications for Mathematics with Trainee Instructional Media Designers: An Exploratory Study on User Experience.," *J. UCS*, 2019, [http://jucs.org/jucs\\_25\\_5/developing\\_and\\_assessing\\_augmented/jucs\\_25\\_05\\_0489\\_0514\\_kazanidis.pdf](http://jucs.org/jucs_25_5/developing_and_assessing_augmented/jucs_25_05_0489_0514_kazanidis.pdf).

<sup>9</sup> R Lozada-Yáñez, N La-Serna-Palomino, and ..., "Augmented Reality and MS-Kinect in the Learning of Basic Mathematics: KARMLS Case.," *International Education ...*, 2019, <https://eric.ed.gov/?id=EJ1226579>.

<sup>10</sup> İ Akkuş and U Özhan, "Augmented Reality Applications in Mathematics and Geometry Education," *İnönü University Journal of the Graduate ...* (researchgate.net, 2017), [https://www.researchgate.net/profile/Ilyas\\_Akkus/publication/322081486\\_Matematik\\_ve\\_Geometri\\_Egitiminde\\_Artirilmis\\_Gerceklik\\_Uygulamalari/links/5a48ddf00f7e9ba868ac639e/Matematik-ve-Geometri-Egitiminde-Artirilmis-Gerceklik-Uygulamalari.pdf](https://www.researchgate.net/profile/Ilyas_Akkus/publication/322081486_Matematik_ve_Geometri_Egitiminde_Artirilmis_Gerceklik_Uygulamalari/links/5a48ddf00f7e9ba868ac639e/Matematik-ve-Geometri-Egitiminde-Artirilmis-Gerceklik-Uygulamalari.pdf).

<sup>11</sup> M I S Guntur and W Setyaningrum, "Augmented Reality: The Potential in Mathematics Education," ... *Education as a Challenge in the ...*, 2020, <https://books.google.com/books?hl=en&lr=&id=VoMEEAAAQBAJ&oi=fnd&pg=PA83&dq=augmented+reality+mathematics&ots=SKGYm4iP2U&sig=x3KodTYpFHcPK2XD3Qf6ag5Wyzc>.

Geometry as one of the branches of mathematics has an important role in the study of mathematics.<sup>12</sup> One of the importances of learning geometry in mathematics providing oppurtunities for students to engage in hih level reasoning activities using various.<sup>13</sup> Learning geometry for example cube, prism, pyramid, requires media to explain the concept because of its 3D nature, based on the researcher's interviews with several lecturers in geometry courses, that to explain the concept of geometry, lecturers usually use ppt, make learning videos, or use teaching aids in the laboratory. AR learning media has never been used before. Therefore, we designed and designed AR media and this media has been validated by 2 lecturers of geometry experts and 2 lecturers of media experts. So the purpose of this further research is to find out the practicality of the geometry learning media based on the augmented reality android application..

### Method

This research is a quantitative descriptive study, the research subjects are all students of the mathematics education study program for the 2021/2022 academic year as many as 408 people, with the sampling technique being simple random sampling, as many as 30 students were selected with the criteria of having programmed the geometry course. The technique of collecting data is by using a practicality questionnaire. Practical indicators are shown in table 1.

Table. 1 Practicality Instrument

No	Aspect	Statement Items
1	Learning Desain	1,2,3
2	Media Display	4,5,6,7,8,9,10,11,12,13,14
3	Software	15,16,17
4	Theory	18,19,20,21
5	Benefit	22,23, 24

<sup>12</sup> M R Ramdhani, B Usodo, and S Subanti, "Discovery Learning with Scientific Approach on Geometry," *Journal of Physics ...*, 2017, <https://iopscience.iop.org/article/10.1088/1742-6596/895/1/012033/meta>.

<sup>13</sup> Fitri Umardiyah dan M.Farid Nasution, *Scaffolding Dalam Pembelajaran Geometri Berdasar Taksonomi Solo* (Lembaga Penelitian dan Pengabdian Masyarakat Universitas KH.Abdul Wahab Abdullah, 2020).

The data analysis technique used is descriptive statistics including the mean, median, and standard deviation

$$Percentage(\%) = \frac{\sum \text{items score}}{\sum \text{maksimum score}} \times 100\%$$

The percentage of categories is then categorized into practicality categories as shown in table 2.

Tabel.2 Practicality Categories

Percentage	Category
0-20	Not Practical
21-40	Less Practical
41-60	Practical enough
61-80	Practical
81-100	Very Practical

### Result and Discussion

The implemented augmented reality geometry learning media are: (1) Augmented reality application in the form of the vuforia application which can be downloaded for free on Android smartphones on the link drive <https://bit.ly/AugmentedRealityBRSD>, the size of the application capacity is 60 MB. It looks like in Figure 1 and Figure 2.

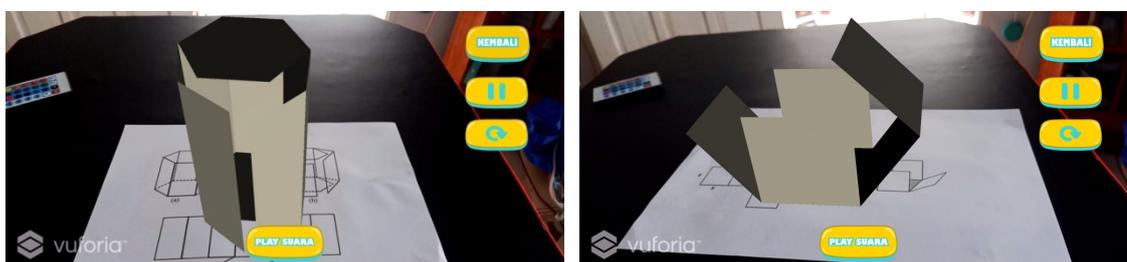


Figure 1. AR Display of Prism and Cube Nets



Figure 2. AR Display of Prism and Pyramid Elements

(2) Augmented Reality Books downloaded on the application, through the “Help” feature. AR book, used as the basis for taking marker objects on the AR application camera, the book consists of 4 chapters, namely: a. Chapter I. The Cube, Chapter II. Beams, Chapter III. Prism, Chapter IV. Pyramid. An example of an AR Book used is shown in Figure 3:

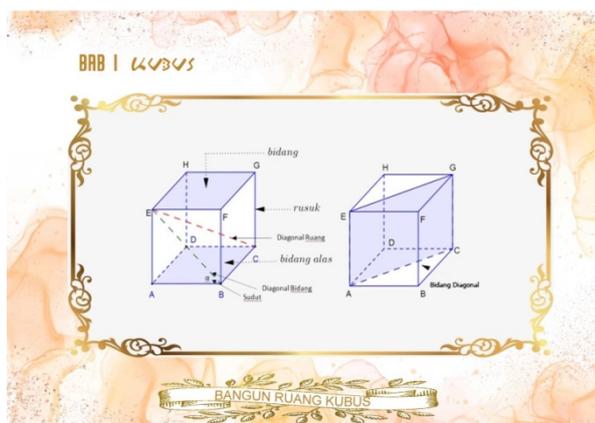


Figure 3. AR Book Chapter I. Cube

Results practicality of AR learning media geometry:

a. Learning Design

The learning design of AR learning media for flat-sided building materials refers to 4 (four) indicators, namely: 1) the suitability of the material with the RPS, 2) interactive, 3) media flexibility.

Table 3. Categories of Learning Design Aspects

Indicator	Score	Interpretation
Material Suitability	92	Very Practical
Interctive	90	Very Practical
Media Flixibility	98	Very Practical

b. Media Display

Media display consists of 6 (six) indicators, namely: 1) grammar, 2) display design, 3) text and sound, 4) image quality, 5) navigation buttons, and 6) user instructions.

Table 4. Category of Media Display Aspects

Indicator	Score	Interpretation
Grammar	96	Very practical
Display Design	100	Very practical
Text and Voice	94	Very practical
Image Quality	94	Very Practical
Navigation Keys	94	Very practical
Instructions for use	88	Very Practical

c. Software

The Software aspect consists of 2 (two) indicators, namely: 1) smooth operation, 2) and ease of running AR.

Table 5. Software Categories

Indicator	Score	Interpretation
Smooth in operation	89	Very practical
Ease of running AR	98	Very practical

d. Geometry

The material aspect consists of 4 (four) indicators, namely: 1) geometry definition, 2) geometry elements, 3) geometry surface area, and 4) geometry volume:

Table 6. Material Categories

Indicator	Score	Interpretation
Definition of geometry	98	Very practical
Elements of geometry	98	Very practical
Surface Area of geometry	98	Very practical
Volume of geometry	92	Very practical

e. Benefit

The benefit aspect consists of 2 (two) indicators, namely: 1) motivation, and 2) learning independence.

Table 7. Benefit Categories

Indicator	Score	Interpretation
Motivation	94	Very practical
Independent learning	88	Very practical

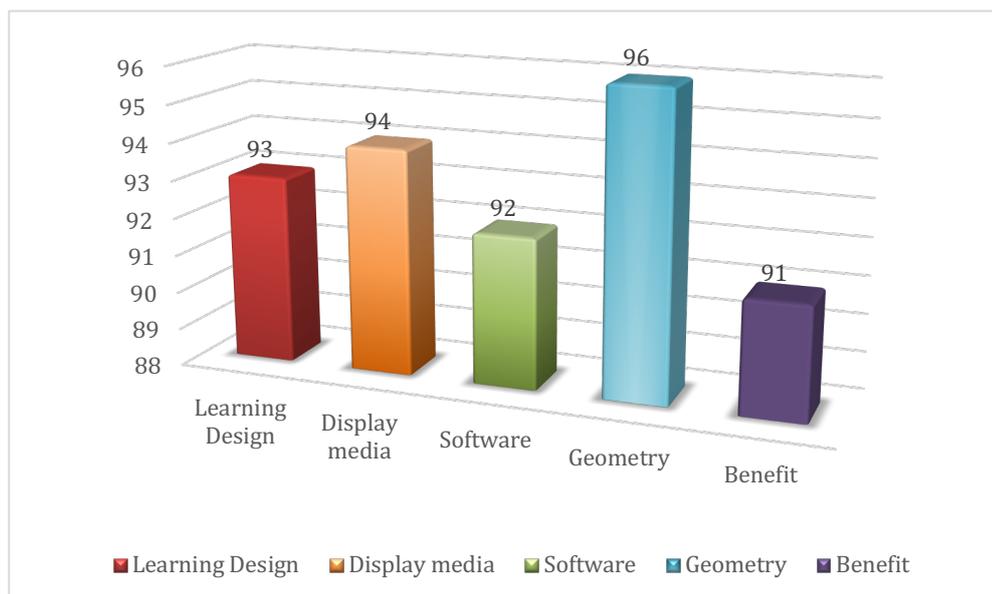


Figure 4. The Practicality Aspect of Learning Media assisted Augmented Reality

Overall, the average practicality questionnaire score of 94 is in the very practical category, this shows that augmented reality geometry learning media is very practical to use. In line with the research conducted by Hanafi, et al, the results of his research show the importance of using appropriate learning applications, especially mobile applications, in teaching and learning technology in the classroom such as Mathematics.<sup>14</sup> However, these findings imply that students should be given more flexibility to get used to the practice of using AR media. The research result of Babinska et al. is the application of augmented reality (AR) in teacher training programs at universities. Opportunities for prospective mathematics teachers (students) at the Faculty of Mathematics, Physics and Informatics of the Comenius University in Bratislava to work with digital technologies. The results support the suitability of the selected application and AR in general. However, the implementation must be precise, with carefully selected and formulated tasks to solve.<sup>15</sup>

<sup>14</sup> HF Hanafi et al., "The Effectiveness of Teaching Aid for a Mathematics Subject via Mobile Augmented Reality (Mar) for Standard Six Students," *Int. J. Recent Technology. Eng.*, 2019.

<sup>15</sup> M Babinská, M Dillingerová, and L Korenova, "Augmented Reality and Future Mathematics Teachers," *Augmented Reality in ...*, 2019, <https://brill.com/view/book/edcoll/9789004408845/BP000020.xml>.

## Conclusion

Learning Media geometry assisted by Augmented Reality applications by paying attention to 6 (six) practical aspects, namely aspects of learning design, media display, software, materials, and benefits, are in the very practical category, with a percentage of 94%. This shows that AR media is very practical to use. Therefore, it is highly recommended for educators to use this media in learning, and are expected to be able to develop it in other materials so that students are more motivated and enthusiastic in learning mathematics.

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