



## Planetarium Glass Based on Augmented Reality to Improve Science Literacy Knowledge in Madura Primary Schools

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DOI : [10.33086/cej.v3i1.1768](https://doi.org/10.33086/cej.v3i1.1768)

Submission: September 17, 2020

Revised: Mei 3, 2021

Accepted: Mei 4, 2021

### Keywords:

*Augmented Reality,  
Literacy Sains,  
Planetarium Glass*

### Abstract

One of the important branches of science on an international scale is scientific literacy. This study aimed to increase the science literacy knowledge of elementary school students on the material of the solar system. This study uses the ADDIE type Research and Development (R&D) method, starting from analysis, design, development, implementation, and evaluation. Expert testing of a learning product was carried out by users of the Planetarium Glass application, namely grade VI students of SDN Patengteng 2. The results of this media trial on 22 respondents showed 80% effectiveness. This research instrument uses an online questionnaire to users to determine the effectiveness of this learning media. The final result of the Planetarium Glass application media based on augmented reality is an application format that can be used by utilizing an android-based smartphone. This media provides information about the material of the solar system in the form of 3D virtual animation (3 dimensions) accompanied by an explanation of each object in audio form and is equipped with an application usage module. This media is designed to facilitate students' understanding in understanding the material of the solar system effectively and efficiently because students can see directly the material conveyed via the smartphone they use. Learning using the Planetarium Glass application can be used as an alternative learning media in increasing science literacy knowledge of elementary school students, especially in Madura.

**Kata Kunci:**

*Augmented Reality,  
Literasi Sains,  
Madura, Planetarium  
Glass.*

**Abstrak**

Salah satu cabang ilmu penting dalam skala Internasional adalah literasi sains. Tujuan penelitian ini untuk meningkatkan pengetahuan literasi sains siswa sekolah dasar materi tata surya. Penelitian ini menggunakan metode *Research and Development (R&D)* tipe ADDIE yang di mulai dari *analysis, design, development, implementation* dan *evaluating*. Uji ahli sebuah produk pembelajaran ini dilakukan oleh pengguna aplikasi *Planetarium Glass* yaitu siswa kelas VI SDN Patengteng 2. Hasil uji coba media ini pada 22 responden menunjukkan efektivitas sebanyak 80%. Instrumen penelitian ini menggunakan angket secara daring kepada pengguna untuk mengetahui efektifitas media pembelajaran ini. Hasil akhir dari media aplikasi *Planetarium Glass* berbasis *augmented reality* merupakan sebuah format aplikasi yang dapat digunakan dengan memanfaatkan *smartphone* berbasis android. Media ini memberikan informasi mengenai materi tata surya dalam bentuk *animasi virtual 3D* (3 dimensi) disertai penjelasan tiap objek dalam bentuk audio dan dilengkapi dengan modul penggunaan aplikasi. Media ini di rancang untuk mempermudah pemahaman siswa dalam memahami materi tata surya secara efektif dan efisien karena siswa dapat melihat secara langsung materi yang di sampaikan melalui *smartphone* yang mereka gunakan. Pembelajaran menggunakan aplikasi *Planetarium Glass* dapat dijadikan sebagai alternatif media pembelajaran dalam meningkatkan pengetahuan literasi sains siswa sekolah dasar khususnya di Madura.

**A. Introduction**

The government's attention to scientific literacy does not appear to be directly proportional to programs in literacy and numeracy. Many of us find various government programs that focus on literacy and numeracy. The government also needs to seek specific strategies that are more effective for optimal learning outcomes for scientific literacy. Scientific literacy can be defined as the ability to understand science in the process of identifying problems and drawing conclusions based on evidence to understand the universe (American Journal of Sociology, 2019). The urgency of scientific literacy skills at the elementary school level should be a priority program, provided that learning can be carried out in real terms as effective and meaningful learning. I referred to the elementary school Natural Sciences learning objectives, namely, developing knowledge and understanding of science concepts that are useful and can be applied in everyday life.

According to data from the Program for International Student Assessment (PISA), the fact is that Indonesia's level of scientific literacy is still lagging and has not yet developed. As well as the data from The Organization for Economic Co-operation and Development (OECD), Indonesia's ranking on PISA in 2009 was 57th from 65 countries. Then, in 2012 it was ranked 64th out of 65 countries, and in 2015 it was rated 64th out of 72 a country. Indonesia became lower in 2018 with 66th place out of 72 countries with 379 points, and China achieved first place with 591 points. This is evident that the literacy skills of Indonesian students are still far below the international standard score established by the OECD (American Journal of Sociology, 2019).

The data relating to the literacy of 34 provinces from the Ministry of Education and Culture in 2019 shows that nine provinces are in the medium category, 24 provinces are in a low category, and one province is very low. Of the 24 provinces that were declared low, Madura was

located in the northeastern part of Java, with an index score of 33.19 out of 34 provinces. This is a serious concern to increase the number of scientific literacy in Madura. A province is declared to have a high literacy level if the index score exceeds 60.01.

This fact is supported by Siedoo's (2020) data, which states that elementary schools that realize a culture of literacy and character based on the 2013 curriculum in the Bangkalan district are only 111 out of 702 elementary schools. Apart from inadequate facilities and infrastructure, the most fundamental reason is the lack of interest and interest of the Madurese people in literacy culture, according to Budi Asy'ari as head of the Pamekasan regional library and archives service (Madura, 2020; Fitriyah and Djazilan, 2020).

SDN Patengteng 2 is one of the primary school education institutions with a low level of scientific literacy. The lack of teachers in creating innovative and interactive learning media is a significant factor in the low scientific literacy of students. Teachers interpret scientific literacy as only reading books, so that literacy learning tends to be monotonous and boring. Actually, scientific literacy can be applied through student experiments with concrete objects so that learning becomes more meaningful and can be used in daily life.

Based on existing research, according to (Prihatiningtyas, S, T. Prastowo, 2013), the failure of science learning is due to no connection in everyday life, not using creative learning media, and only focusing on memorization. In addition, previous research quoted from (Munawaroh, Jayadinata, and Aeni, 2017) explains that scientific literacy only focuses on cognitive and final achievement in evaluating school exams. However, science learning must include three things, namely cognitive, affective and psychomotor. Thus the scientific literacy of elementary school students can increase.

Currently, Indonesia has entered a new era, namely, the era of revolution 4.0 marked by artificial intelligence, smart robots, genetic editing, and online learning (Gusmida et al., 2016). In this case, now the world of education can be combined using technological advances so that learning can keep up with the times. Recent studies have shown that the use of social media in learning is very beneficial for improving mental health and learning engagement (Ngussa, Fitriyah and Diningrat, 2021).

As for the challenges of education besides low scientific literacy, the challenges of education in the era of revolution 4.0, which will experience changes in learning methods, patterns of thinking, and experimenting in developing technology-based learning media innovations (Kurniawan et al., 2018; Effendi and Wahidy, 2019; Kusumaning Ayu, et al., 2019). Media is also part of achieving scientific literacy in elementary schools because innovative, interactive, and exciting media students will easily understand the material presented. Augmented Reality application is an application that combines real objects with 3-dimensional objects.

Based on Manso et al. (2019), this Augmented Reality application has been developed in an educational game but only focuses on planetary orbits and collecting points without conveying the material. Meanwhile, in Denmark, the Augmented Reality application has also been implemented to support elementary school learning in the solar system fabric. Still, it is only limited to 3D (3-dimensional) images without actual moving virtual animations and audio explanations (artificial computers) (Majgaard et al., 2017 ). The survey conducted by Azuma (1997) also explained that the Augmented Reality application still focuses on using distance search (GPS) and media aids.

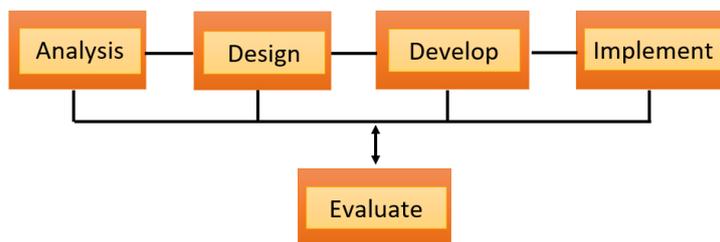
The formulation of the problem of this research is whether the Augmented Reality-based Planetarium Glass media can be effective in improving science literacy in elementary schools in

Madura? This study aims to overcome the low scientific literacy by creating a technology-based learning media for the solar system called Planetarium Glass. So that the existence of Augmented Reality-based Planetarium Glass learning media makes the subjects of the solar system look more real regarding images of the sun, planets, and their orbits and keep up with the times.

The benefits of this research are; (a) for students, it can increase basic knowledge of scientific literacy, especially solar system material, which is more effective and interactive, (b) for researchers, it can be used as a reference library for further research, (c) for educators, it can be used as technology-based learning media to overcome the low scientific literacy of the solar system material in elementary schools.

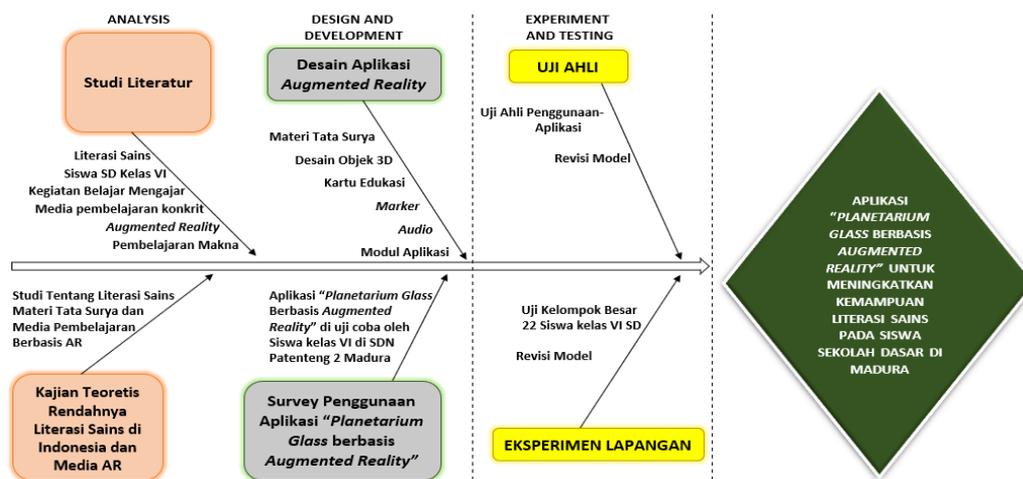
**B. Methodology**

This study uses the ADDIE type Research and Development (R&D) method starting from analysis, design, development, implementation and evaluating. Research and development is a research method used to validate or produce products such as learning media used in education (Hanafi, 2017). One of the products is the Planetarium Glass learning media based on Augmented Reality. The following is the process of the ADDIE type Research and Development (R&D) method.



**Figure 1. ADDIE type Research and Development (R&D) Method**  
(Budoya, Kissaka dan Mtebe, 2019)

The research phase of the ADDIE type Research and Development (R&D) method begins by analyzing teachers, students and Teaching and Learning Activities (KBM) (Mustaqim, Pd and Kurniawan, 2016).



**Figure 2. ADDIE type Research and Development (R&D) Implementation of Planetarium Glass**

The thing that was analyzed was the teacher's difficulty in delivering material to students concretely and effectively. The results of this analysis can be used as a reference in designing and developing an Augmented Reality-based Planetarium Glass application. Making the Planetarium Glass application based on Augmented Reality starts from collecting field information to identify potential problems, then reviewing it with literature studies by the theory developed into a science literacy learning model for elementary school solar system subjects.

Then, make media designs, namely what ideas will be designed, including materials, three-dimensional object designs, educational cards, markers, audio, and application modules. At the design stage, it is evaluated so that it becomes an application that is suitable for problem analysis. The next stage is the development stage, and this stage is considered until it becomes an application design under the design that has been carried out. Then the implementation stage is a step to implement the application that has been made. The Planetarium Glass application based on Augmented Reality will be tested on VI-grade students of SDN Patengteng 2 as users. This test is carried out to adjust the desired product quality and then evaluated. In this ADDIE model, the evaluation stage is carried out at each stage.

This research aims to apply Augmented Reality-based Planetarium Glass learning media on the material of the solar system in elementary schools. The data source of this research is the validity assessment score given by 22 students of class VI SDN Patengteng 2. The validator validates and assesses the learning media application as a whole then completes a validation questionnaire adapted to the criteria for developing learning media such as the media used that is easy to understand, use and fit the purpose of learning to be achieved (Nasir, 2014).

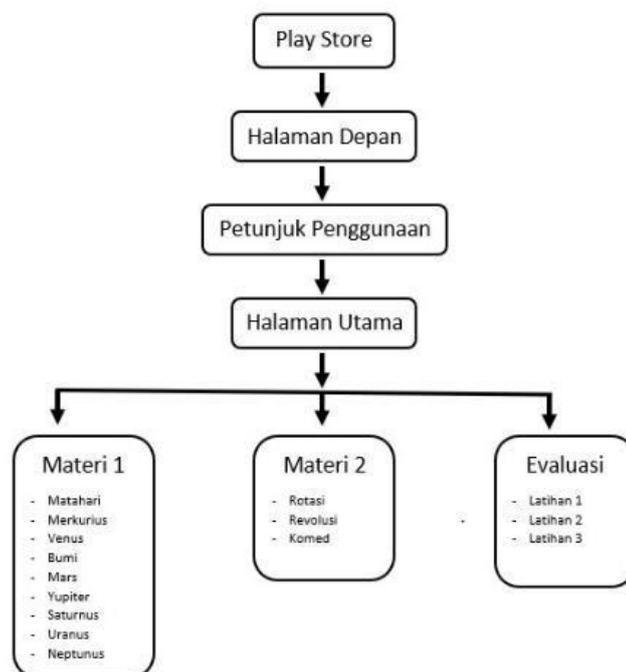
The final goal of R&D in the scope of education is the birth of new products to increase the science literacy knowledge of elementary school students on the material of the solar system. Thus, through the results of R&D, it is hoped that the educational process will be more effective and in line with the needs of the times.

The development of education science is getting faster along with the development of technology. There are 3 literacy abilities in education: language literacy, scientific literacy, and mathematical literacy (Afni and Rokhimawan, 2018). The focus of this research is on scientific literacy. Scientific literacy has two main competencies. First, lifelong learning competencies (lifelong education), and second, competence in using the knowledge they have, which developments can influence in science and technology.

One technology development that can be used in science learning is Planetarium Glass based on Augmented Reality. Planetarium Glass based on Augmented Reality has advantages that deserve to be used as educational media, namely this media is an interactive media that can be used on every smartphone. This media is also equipped with 3-dimensional animation to support students' imagination in understanding the material of the solar system. In addition, the Augmented Reality-based Planetarium Glass media is provided with audio explanations so that students can see, listen and practice more concretely. In addition, with the application of the Planetarium Glass media, elementary school science learning, especially in the material of the solar system, can also be done more meaningfully by revealing various natural phenomena. Thus the learning process experienced by students in school can provide authentic experiences and convince them that what they learn in school is something important and meaningful in life.

### Planetarium Glass Application Design based on Augmented Reality

The design of the Augmented Reality based Planetarium Glass learning media application is carried out to provide alternative solutions in learning science in abstract solar system material.

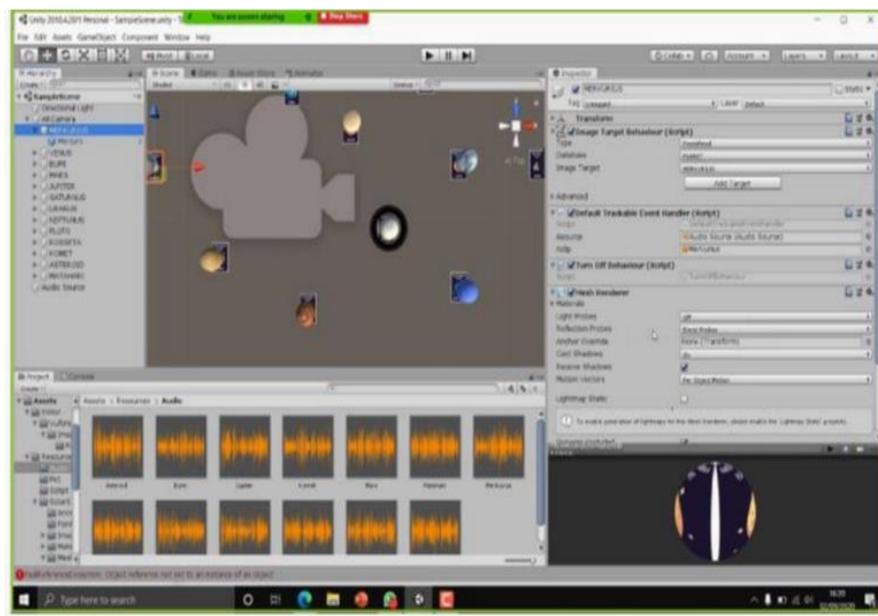


**Figure 3. Augmented Reality based Planetarium Glass Application Design Chart**

The design of this learning media uses Augmented Reality Technology based on the 2013 curriculum for elementary schools. The development of this material is made 3D (3 dimensional) and can move like a planet in real form, both when moving around itself and when moving in its orbit. This media is equipped with audio explanations that resemble human voices (artificial computers), educational cards, and completed with question exercises (evaluations). The following process is making markers used to identify applications in scanning educational cards using the System Development Kit (SDK), which combines the Vuforia and Unity software. The design results are evaluated before proceeding to the development stage.

### Making a Planetarium Glass Application Based on Augmented Reality

Making planetarium glass media based on augmented reality begins with the technology developed in Vuforia Unity 5.59, a camera technology that can convert images into three dimensions, commonly known as Augmented Reality, then upload them to the official website without coding. Then Vuforia Unity 9.3.3 was developed again. The advantage in developing this program is to update the existing features so that they look more perfect.



**Figure 4. Making an Augmented Reality based Planetarium Glass application using Vuforia Unity 9.3.3**

### C. Result and Discussion

The final result of the Augmented Reality-based Planetarium Glass application media is an application format that can be used with an Android-based smartphone. This media provides information about the material of the solar system in the form of 3D virtual animation (3 dimensions) accompanied by an explanation of each object in audio form and is equipped with an application usage module. This application can run on smartphone devices offline (without the internet). Smartphone devices that can support this application use a minimum Android OS 7.0 (Nougat). And has a size of 150 megabytes.

There is a concrete way to improve scientific literacy skills in elementary school students in Madura, namely, Augment Reality-based Planetarium Glass learning media that can be used in the solar system subject. Planetarium Glass based on Augment Reality is a learning medium that utilizes broken glass, styrofoam, and used lamps to be used as learning media in understanding the solar system that is concrete and effective and unique, and environmentally friendly. In addition, the Planetarium Glass based on Augment Reality is also equipped with the use of electric electronics derived from the dynamo on the used lamp as the sun in the middle of the planets that students can observe concretely. So that in using Planetarium Glass learning media can combine visual learning models, auditory or kinesthetic, so that students understand more quickly the material presented. Planetarium Glass is based on Augmented Reality with a 3-dimensional design so that the learning media becomes more concrete and honest about the sun, its orbit, and orbits.

The following is an overview of science literacy learning media in the form of an Augmented Reality-based Planetarium Glass application for elementary school students in Madura:



Figure 6. Visualization of the advantages of Augmented Reality based Planetarium glass media

The media design of the Planetarium Glass application based on augmented reality was tested by a validator, namely 22 students of SDN Patengteng 2. In this study, instrument answers are classified into five choices with a scale score of 1-5. A score of 5 is very feasible, 4 is possible, 3 is not possible, 2 is not possible, and 1 is very inappropriate. The next step is to assess the Augmented Reality-based Planetarium Glass application media by distributing questionnaires to users. The formula for calculating the weight of each respondent is as follows:

Information:

$x^1$  : average score

$n$  : number of appraisers

$x$  : the total score of each

After knowing the average score then calculating the percentage of the results using the following formula:

$$x^1 = \frac{x}{n}$$

$$\text{Result} = \frac{\text{the total score obtained}}{\text{Maximun Score}} \times 100\%$$

Table 1. Results of Application Validation Assessment by Users

Purpose of Questions											
A	1	2	3	4	5	6	7	8	9	10	Total
A1	3	2	3	5	4	4	4	5	3	5	41
A2	4	5	4	3	3	5	3	5	3	3	37
A3	4	4	4	3	3	3	4	5	4	3	36
A4	5	3	3	5	4	4	5	4	3	5	41
A5	5	3	5	5	5	5	5	5	5	5	50
A6	4	5	3	3	3	4	5	5	5	5	41
A7	5	4	3	3	3	3	5	5	4	4	40
A8	5	5	5	3	3	4	5	5	4	4	43
A9	4	5	4	3	3	3	5	5	4	4	39
A10	5	4	5	3	3	4	4	5	3	3	40
A11	3	5	3	4	4	4	5	5	3	3	37
A12	3	3	5	5	3	3	5	4	4	3	38
A13	5	3	5	5	5	5	5	5	5	5	50
A14	3	5	4	3	3	4	5	3	4	4	37
A15	3	4	4	4	5	5	4	3	3	4	38
A16	3	3	4	5	5	3	3	3	3	4	36
A17	3	3	4	4	3	5	4	4	4	3	37
A18	3	3	4	5	3	4	5	4	4	4	37
A19	3	3	3	5	4	4	5	5	4	3	39
A20	4	4	5	4	4	4	4	4	5	4	42
A21	4	4	5	3	3	5	5	5	4	4	42
A22	3	5	5	4	3	3	4	4	5	5	41
<b>amount</b>											<b>882</b>
<b>Average</b>											<b>40</b>
<b>Presentase</b>											<b>80%</b>

The table above shows the overall rating by users, which contains 10 questionnaires. The highest score was 5, and the lowest was 3 with an average of 40 and 80%. According to (Ananda and Rafida, 2017), there are the following eligibility category criteria:

Table 2. Media Eligibility Criteria

No	Score Percentage	Eligibility Category
1	< 20 %	Very unworthy
2	21 – 40 %	Not feasible
3	41 – 60 %	Decent enough
4	61 – 80 %	Well worth it
5	81 – 100%	Very Worth it

So based on the results of the validation test of 22 grade VI students of SDN Pantengteng 2, it shows that the Planetarium Glass application based on augmented reality, the percentage score reaches 80% in the "WORTH" category used as a learning medium to improve science literacy in elementary schools in Madura. This learning media was created for elementary school students in Madura with the hope that:

- 1) So that students can understand and comprehend the material of the solar system scientific literacy method.

- 2) This learning media is easier to understand and fun because it is the material that is emphasized and combined with technology in Augmented Reality. Students are expected to apply it in their lives.
- 3) This media is faster to understand because students can apply Planetarium Glass directly with this media.

With the existence of learning media in the form of the Augmented Reality-based Planetarium Glass application, it can foster student interest in Madura towards scientific literacy and can improve the quality of learning with innovative media, as well as helping to prepare the Generation of the Nation's Children in facing challenges in this growing Millennial Era. In addition, the implementation of this media might also be helpful to make children aware of the greatness of God's creation from an early age so that it can increase their spirituality (Fitriyah *et al.*, 2020).

#### **D. Conclusion**

Augmented Reality-based Planetarium Glass application learning media is an interactive learning media designed in 3 dimensions and combines abstract learning into concrete. This media is designed to facilitate students' understanding in understanding the material of the solar system effectively and efficiently because students can see directly the material conveyed via the smartphone they use.

Another advantage is that students can see how the planets in the solar system form in a concrete way to increase students' interest and motivation to learn and no longer think abstractly. This study aims to develop the level of scientific literacy of elementary school students using media in Augmented Reality-based Planetarium Glass.

It is hoped that this research can further test and develop the effectiveness of Augmented Reality-based Planetarium Glass more broadly and can improve the quality of elementary school learning that is more interactive and innovative.

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