

# Physics Textbook Enriched Augmented Reality: Easy Way to Understand The Physical Concept

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**Abstract.** Physics textbooks presented in multiple representations in the form of images, tables, graphs, exposures, sample problems still cause misconceptions. The addition of 3D animations and videos through augmented reality technology in textbooks is expected to reduce misconceptions in understanding physics concepts. This research was conducted by the research and development method of the Dick and Carey model. The instrument used was a Likert scale questionnaire. The assessment of the feasibility of the book by material experts, media experts, physics teachers gives a very decent interpretation. Trials limited to students who use books independently give a normalized gain value of 0.35. It was concluded that the physics textbook enriched with augmented reality technology was worthy of being used as a learning resource in learning physics in high school.

**Keywords:** Textbook, Multiple Representations, Augmented Reality, Learning Physics

## 1 Introduction

In understanding subject matter students are assisted with appropriate learning media. Learning media can improve the learning process of students in learning that can affect the achievement of learning outcomes [1]. Science teachers always use books to support learning [2], [3]. Classroom learning requires 75% of textbooks and homework needs to be supported with 90% of textbooks [4]. Textbooks are one of the causes of misconceptions for students [5]. There are five causes of misconceptions among students, namely the students themselves, the teacher, the textbook, the learning media, and the teacher's teaching method [6]. The material presented in multiple representations such as concept maps, pictures, videos, tables of experimental results, graphs of data tables, verbal exposures, mathematical equations, example problems, and application forms, can improve understanding and reduce students' misconceptions about physics concepts [7]

One technology that can enrich representation in books is augmented reality (AR) technology. With AR technology, book media can be enriched with video and 3D animation media. Augmented reality is defined as the expansion of physical reality by adding layers of information generated by the computer to the actual environment [8]. Augmented reality is more than just a simple viewer technology, but also a new type of real-time natural user interface for human interaction with objects and digital devices [9]. Augmented reality can improve the efficiency of the educational process [10] [11] Augmented reality allows each student to have a unique discovery pathway through the symbiosis of real-life between technology and learning [12,13].

Based on this, this research focuses on the development of physics textbook models enriched with 3D media through augmented reality technology. This book can display multiple concepts of physics representation of science-supported by 3D media from augmented reality technology.

## 2 Method

The operational objective of this research is to produce physics textbooks enriched with 3D media with Augmented Reality technology that is feasible to be used by odd semester X High-School students. This research was conducted at the Physics Education Digital Media Laboratory, Physics Education Study Program, Faculty of Mathematics and Natural Sciences, Jakarta State University. The research instrument consisted of a Likert scale questionnaire to test the feasibility of the material and media of textbooks, as well as a test instrument to measure students' knowledge improvement after using physics textbooks enriched with 3D media with Augmented Reality technology. The product trial was conducted at SMA Negeri 6 Bekasi and SMA Negeri 1 Bekasi. The research was conducted by the research and development method of Dick and Carey's model. This research was conducted from November 2017 to August 2019.

## 3 Result and Discussion

The product of this research is a physics textbook enriched by Augmented Reality technology. The use of Augmented Reality is assisted by smartphone devices with the Android operating system, with marker detection using the camera on the device in real-time. Then other content will appear in the form of 3D animation or video on the device's screen. The development of textbooks begins with the preparation of textbook material. Next, determine the illustrations that will be used and create 3D animations and videos. Next, create an APK extension to be installed on a smartphone.

The next stage is formative evaluation in the form of validation tests and user trials. The results of validation by material experts get an average percentage of 91,17% as shown on Table 1, with a very worthy interpretation for each subject matter.

**Table 1.** The results of validation by material experts.

Subject	Scores (%)
Nature of physics and measurement	89,03%
Vectors	94,19%
Linear motion kinematics	93,54%
two-dimensional motion (parabolic motion)	90,32%
Circular motion	88,76%
Average	91,17%

Next is the validation test by media experts who gets an average percentage of 91,17% with a very worthy interpretation (Table 2).

**Table 2.** The results of validation by media experts.

Components	Score (%)
Textbook Components	84%
Size of Textbooks	100%
Book Leather Pages Design	87,5%
Book Content Layout	95,7%
Book Content Typography	90%
Illustration of Book Content	80%
Augmented Reality Media	80%
Average	88,51%

Next is the trial product for use by physics teachers and students. Product trials by the teacher showed a percentage of achievements of 92.86% with a very worthy interpretation as can be seen on Table 3.

**Table 3.** Test Results by Teachers.

Indicator	Score (%)
Materials suitability	92,36%
Material Presentation Techniques	99,01%
Writing Grammar	91,6%
Augmented Reality Media	94,3%
Average	92,86%

While the results of product trials by students show a percentage of achievements of 90% so that the interpretation of the assessment is very worthy as shown on Table 4.

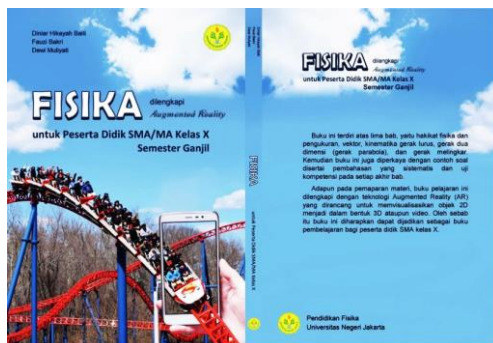
**Table 4.** Test Results by Students.

Indicator	Score (%)
Textbook display	89%
Presentation of material in textbooks	89,89%
Augmented Reality Media	90%
Average	90%

Furthermore, pre-test and post-test were conducted to see the effect of the use of physics textbooks enriched by Augmented Reality on students' cognitive knowledge. The result of pre-test and post-test by students obtained an average pre-test value of 25,12 and a post-test value of 50,49 so that the N-gain obtained was 0,35 with moderate interpretation as can be seen on Table 5. **Figure 1** and **Figure 2** below is a display of the book and the Augmented Reality application that has been developed

Table 5. The result of Pre-test and Post-test.

Subject	Score		
	Pre-test	Post-test	N-Gain
Nature of physics and measurement	40	66,25	0,437
Vectors	25	48,1	0,308
Linear motion kinematics	13,1	40,62	0,316
two-dimensional motion (parabolic motion)	28,1	50	0,304
Circular motion	19,4	47,5	0,4
Average	25.12	50.49	0.35



(a)



(b)

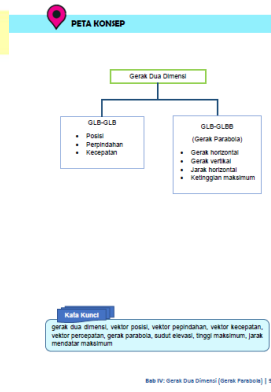
**IV GERAK DUA DIMENSI (GERAK PARABOLA)**

Sumber: [https://id.wikipedia.org/wiki/Gerak\\_parabola](https://id.wikipedia.org/wiki/Gerak_parabola)

Pernahkah kalian menikmati permainan Angry Birds? Dalam permainan Angry Birds kita harus mengantarkan seekor babi hutan untuk menghancurkan tugu yang dibuat oleh sekelompok babi hutan. Dalam permainan kita tahu bahwa untuk memenangkan permainan kita harus meluncurkan burung menggunakan ketepatan dengan maksud untuk memukul babi hutan. Untuk itu, kita harus memahami gerak parabola yang akan kita gunakan untuk menghancurkan tugu. Permainan Angry Birds merupakan permainan yang memanfaatkan gerak parabola yang akan kita gunakan pada saat ini. Dengan mempelajari materi dalam bab ini, kita akan mengetahui hal-hal yang dapat mempengaruhi jarak lemparan burung pada permainan tersebut.

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(c)



(d)

**B. Gerak Parabola (GLB-GLBB)**

Konsep parabola merupakan salah satu konsep penting dalam fisika. Gerak parabola terjadi ketika arah vektor kecepatan dan vektor percepatan membentuk sudut yang tidak tegak lurus. Vektor kecepatan mempunyai nilai dan arah yang selalu berubah terhadap waktu, sehingga gerak benda yang akan membentuk lintasan berbentuk parabola. Perhatikan simulasi berikut:

Gambar 4.8 Perbandingan GLB, GLB, dan gerak parabola

Pada simulasi tersebut, bola hijau bergerak secara GLB dalam sumbu-X horizontal, bola biru bergerak secara GLBB dalam sumbu-Y vertikal dan bola merah bergerak secara parabola. Terlihat bahwa pada gerak parabola, pergerakan benda pada sumbu-X horizontal sama dengan GLB dan pada sumbu-Y sama dengan GLBB. Sehingga dapat disimpulkan bahwa gerak parabola merupakan gabungan antara GLB dan GLBB.

Gerak parabola banyak ditemukan dalam kehidupan sehari-hari, contohnya gerakan bola ketika ditendang dengan ketinggian dan kecepatan awal tertentu, gerakan bola basket, gerakan rusa balistik, dan lain sebagainya.

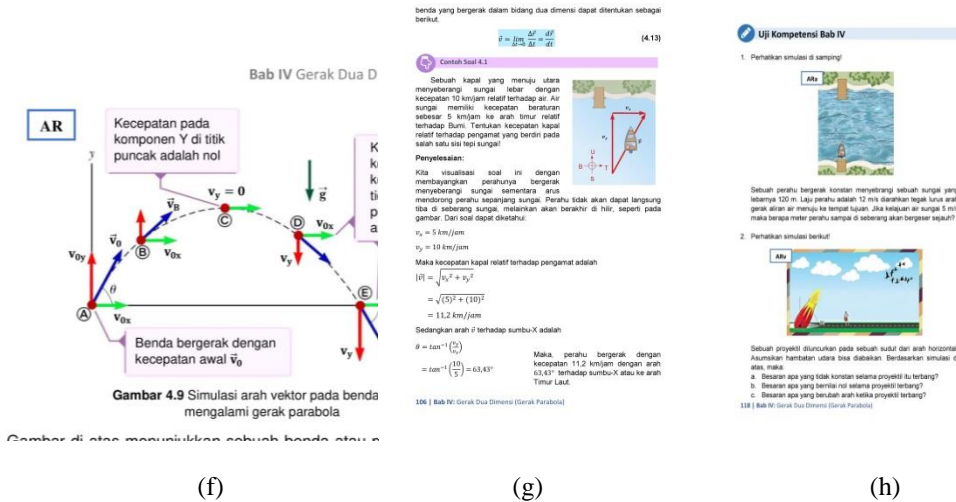
Dalam pembelajaran kali ini gerak parabola suatu benda jatuh untuk ditinjau jika kita membiarkannya jatuh bebas.

(1) benda yang bergerak parabola mengalami percepatan gravitasi  $g$  yang konstan dan arahnya menuju ke bawah (positif bumi).  
(2) pengaruh gangguan atau hambatan udara terhadap benda yang bergerak parabola diabaikan.

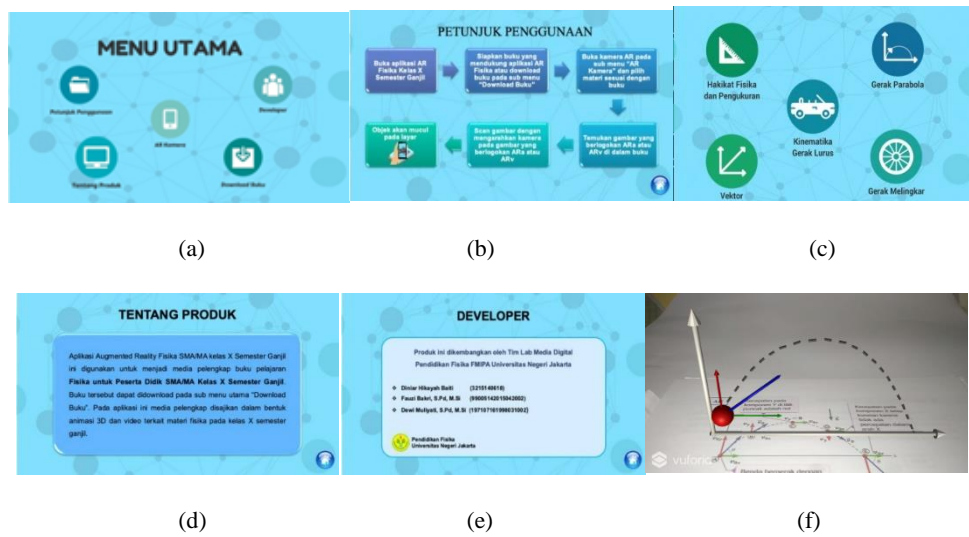
Dengan menggunakan basis simulasi tersebut, maka intonas sebuah benda yang mengalami gerak parabola dapat digambarkan sebagai berikut.

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(e)



**Fig 1.** Example of an AR enriched book display; (a) book cover; (b) review of the contents of the book; (c) the initial introduction to the chapter; (d) concept maps; (e) description of material; (f) AR markers on the marker image; (g) example problems; (h) competency test at the end of the chapter.



**Fig 2.** Display Augmented Reality application; (a) main menu; (b) instructions for use; (c) cameras for each chapter of material; (d) about the product; (e) developer; (f) AR maker when scanned.

## 4 Conclusion

Has produced high school physics textbooks that are displayed in multiple representations of science. The book presents material in a variety of representations, starting with video or animation as a stimulus, presentation of material begins with phenomena, assessment of concepts from observations, data tables and graphs, formulation of mathematical equations, study of material, examples of questions and practice questions and application videos that are displayed with augmented reality technology.

Based on the results of a formative evaluation of physics textbooks enriched with 3D media through augmented reality technology, it is appropriate to be used as a source of learning for high school class X students in an odd semester.

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