

Research article

Design of a Mathematics Augmented Reality-Based Textbook

Lusi Rachmiazasi Masduki^{1*}, N Nurmawati¹, Eem Kurniasih²

¹Department of Mathematics Education, Universitas Terbuka, Indonesia

²Department of Early Childhood Education, Universitas Terbuka, Indonesia

Abstract.

The learning media used in the mathematics education study program of UPBJJ UT Semarang are still very simple, as shown by the fact that the majority of lecturers still using PowerPoint and UT textbooks in learning. This means that there is a need for these lecturers to innovate, and one way to do so is by making augmented reality-based textbooks (BUBAR) which allow the user to see the reality of the world augmented into 3D. It is hoped that UT lecturers will be interested in developing more innovative textbooks like these. This was research and development research which used the ADDIE approach (analysis, design, develop, implementation and evaluation). In this research, textbooks from various publishers were analyzed for ordinary differential equations, which resulted in the finding that there are no national publishers that have made ordinary differential equations textbooks based on augmented reality. Then a BUBAR augmented reality-based product for the ordinary differential equation course was developed which has 5 chapters and was validated by learning material experts and learning media experts with scores of 87 and 89, respectively. This indicated that this augmented reality-based textbook product is suitable for limited testing.

Keywords: design, textbooks, augmented reality, smart pedagogy, differential equations

Corresponding Author: Lusi Rachmiazasi Masduki; email: lusi@ecampus.ut.ac.id

Published: 28 September 2022

Publishing services provided by Knowledge E

© Lusi Rachmiazasi Masduki et al. This article is distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use and redistribution provided that the original author and source are credited.

Selection and Peer-review under the responsibility of the ICESRE 2021 Conference Committee.

1. Introduction

The development of augmented reality technology in making AR-based textbooks is still very little in Indonesia, even though textbooks require innovation to attract students' attention, at the Open University, AR-based textbooks have not been made, so it is necessary to innovate for mathematics lecturers themselves, to increase lecturer enthusiasm. and students in being creative, it is necessary to innovate in teaching differential equations courses

In this case AR-based media has advantages and disadvantages, Augmented Reality is a technology that allows a person to perform a simulation of a real object using a computer that is able to evoke a 3-dimensional atmosphere so that it makes the user seem physically involved. Such systems can usually be used for drug designers, architects, engineers, medical workers, and even ordinary people to perform activities


OPEN ACCESS

that mimic the real world. augmented reality environments generally provide a visual experience, which is displayed on a computer screen or through a stereoscopic viewer, but some simulations include additional sensory information, such as sound through speakers or headphones [1].

Augmented reality itself has nothing like VR which has a negative effect, namely Cybersickness. Cybersickness is a disorder that is often experienced in the use of virtual reality. Patients will feel eye strain and even be accompanied by dizziness [2]. Sometimes the patient is psychologically still carried away in a pseudo atmosphere even though the patient has actually returned to the real world [3]. So, this disorder should not be taken lightly because sufferers usually find it difficult to return to the real world and are always dreaming in a pseudo-world [4]. The learning conditions in the UT laboratory for the differential equation course are only looking at modules and lecturers have not used mobile applications in learning, thus making students bored in learning, based on interviews students need innovation from lecturers in packaging material for differential equations based on renewable media, one of which is based on augmented reality that is able to see the augmented reality of the real world based on AR, so that simple products can appear in stunning 3D [5].

According to the results of observations made by researchers at the Mathematics Study Program of UPBJJ UT Semarang, the learning process of differential equations is less active and less interesting, this is due to the absence of learning media used by lecturers so that students become bored quickly. Teaching and learning interactions in the classroom cannot be separated from the influence of the media used by lecturers in delivering teaching materials. What is growing rapidly at this time is a smartphone/smartphone. The existence of technology, especially smartphones, which are now growing, must be addressed wisely. The phenomenon of the high number of smartphone users is certainly a challenge and opportunity in the world of education [6]. The challenge is abuse for negative things. Besides being a challenge, the existence of smartphones also brings great opportunities to develop useful technology in the field of education. One of the benefits that can be taken from the existence of this technology is to use it as an effective, creative, and educative learning medium [7], So that educational application media can continue to be developed, one of which is Augmented Reality (AR) technology.

2. Research Methods

This type of research is research and development. The population in this study were graduate students of mathematics Education programme Open University. Data collection techniques used are tests validation expert judgment, questionnaires and documentation [8]. The material in this learning media is differential material, Data analysis techniques in this study were analysis questionare. The development model used is the ADDIE model which includes analysis, design, development, implementation, and evaluation. **The ADDIE model can be shown in Figure 1.**

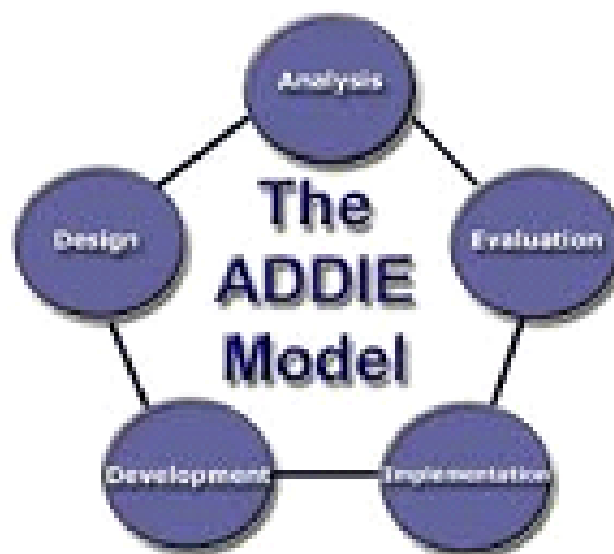


Figure 1: ADDIE Model [8].

3. Results and Discussion

3.1. Analysis

The analysis step consists of two stages, namely performance analysis and needs analysis. The first stage, namely performance analysis, is carried out to find out and clarify whether the performance problems faced requiring solutions in the form of program implementation or management improvements. In the performance analysis, an in-depth study has been carried out on the performance of lecturers at UPBJJ UT Semarang who teach ordinary differential equations courses which shows that so far

there have been no UT lecturers who have used AR-based textbooks during the covid-19 pandemic, so it is very necessary to have media. This textbook is to help students practice AR in understanding differential material and its types.

In the second stage, the needs analysis is a necessary step to determine the abilities or competencies that students need to learn to improve learning achievement [9], What is clear is that learning media is needed that is able to produce ordinary differential equations that are packaged in augmented reality and make students able to practice recognizing other differentials in an interesting and systematic way.

3.2. Design

This step requires a clarification of the learning program designed so that the program can achieve the learning objectives as expected. In product design, what is done is the next stage of the ADDIE model, namely design. At this step, it is necessary to clarify the learning program designed so that the program can achieve the learning objectives as expected [10].

In making augmented reality-based textbook products, the material for ordinary differential equations has been made in a team by the UT research team and assisted by IT experts outside UT so that there is good collaboration with the UT research team to create a material framework and design that is expected in making ordinary differential equations based on AR, then executed by IT experts who are competent in their fields, after the design of the AR-based textbook is approximately 3 months according to expert judgment advice, the product is continued in the third stage, namely development.

3.3. Development

This development step includes creating, buying, and modifying learning media to achieve predetermined learning objectives. The development step, in other words, includes the activity of selecting and determining the appropriate methods, media and learning strategies used in delivering personal material [11]. In this development stage, the framework that has been designed will be realized so as to produce a product that can be implemented. In this development stage, AR-based thematic textbook products for differential equations are usually validated first to experts, namely material experts and media experts, so that augmented reality-based textbook products are feasible to be used before being tested limitedly at UPBJJ UT Semarang and PGRI University Semarang. . At the development stage, AR-based textbooks will be made according



Figure 2: Design of AR-based textbooks for ordinary differential equations after revision.

to the material, after the print-based and AR-based media are complete, they will be validated by media experts and material experts by the validator to get input and evaluate according to the input given by the validator [12]. Furthermore, the android-based media is revised according to the input given by the validator to improve the product.

Based on 2 validators who are experts in the field of primary school children’s education, namely Dr. Imam Kusmaryono, M.Pd. (Lecturer of Mathematics Education Unissula Semarang) and learning media expert, namely Dr. Achmad Buchori, M.Pd. as a learning technology expert at PGRI Semarang University, the following data were obtained:

TABLE 1: Validation of learning media experts.

Media expert	Application aspect	Creativity aspect	Innovation aspect	Visual communication aspect
Score validation	84%	85%	90%	87%

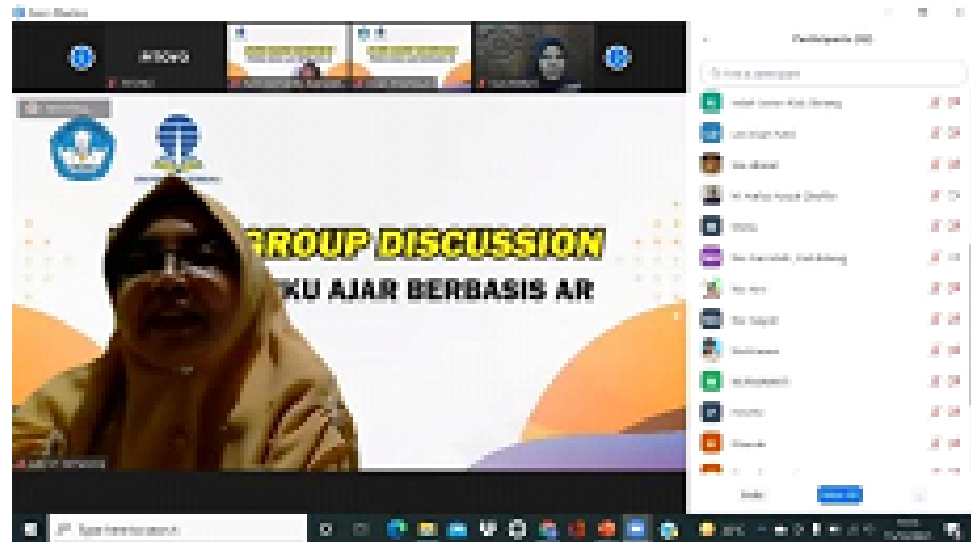


Figure 3: Product validation of AR-based elementary thematic textbooks by experts.

From the table above, an average score of 87% means that this augmented reality-based textbook is very suitable to be used in learning ordinary differential equations courses at UPBJJ UT Semarang and partner campuses.

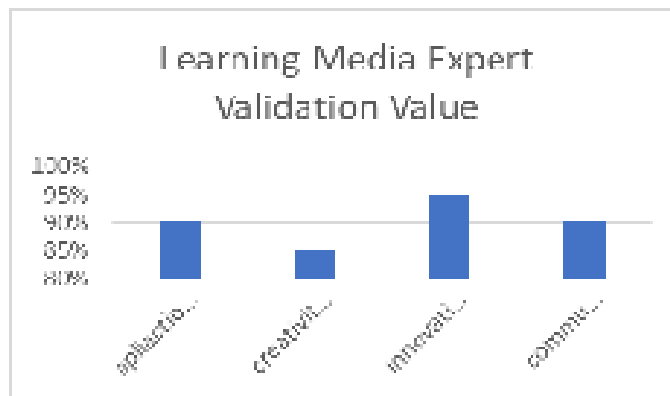


Figure 4: Validation of learning media experts.

Then continued with the validation of learning media experts, it was obtained data that AR-based textbook media was feasible to use, so that AR-based textbook media products in ordinary differential equations courses could be used optimally.

TABLE 2: Validation of learning material experts.

Material expert	Material substantiation aspect	Language aspect
Score validation	90%	88%

From the table above, an average score of 89% means that the material in the AR-based textbook media in the ordinary differential equation course is very suitable for use in learning in universities, especially the Mathematics Education study program.

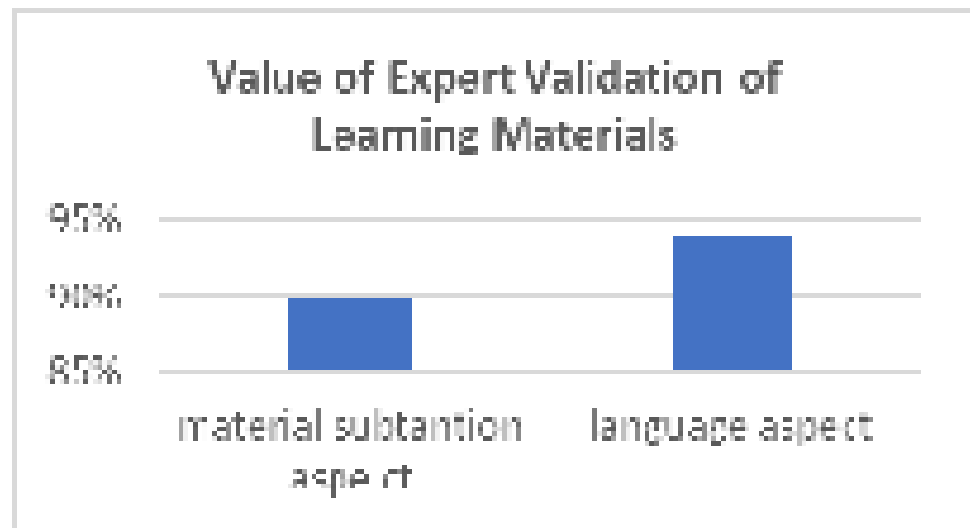


Figure 5: Validation of learning material experts.

Then continued with material expert validation so that the suitability of the material content can be accounted for so that AR-based textbook media products can materially be used. It was confirmed that the Design of Electronic Books in Augmented Reality-Based Elementary School Mathematics Lessons was able to improve the spatial abilities of elementary school students comprehensively [13], then in the development of MAR (Augmented Reality Mathematics) exploration by strengthening the character in elementary school spatial building materials, they were able to strengthen students' personalities, especially being able to explore students' visual abilities [14], then strengthened by the Application of Augmented Reality for Product Marketing Using Unity 3D and Vuforia Software which makes product marketing more attractive to customers [15].

4. Conclusion

This research showed Augmented reality-based textbook products have been produced that can be used on public and private campuses, especially in the Semarang city area, so the product has been validated by experts and received a very good response from users including lecturers, media experts and learning material experts

5. Authors' Contributions

The author hopes that the results of this study can be an alternative for lecturer to using AR Book or BUBAR media with different materials. So it is expected to improve motivation college student learning outcomes.

Acknowledgments

Thank you to those who were involved and helped, namely mathematics education open university and the ministry of education, culture and technology research

References

- [1] Y. Soepriyanto, S. Sulthoni, and S. Ulfa, "Pengembangan Augmented Reality Sebagai Electronic Performance Support System dalam Pembelajaran.," *Edcomtech: Jurnal Kajian Teknologi Pendidikan*. vol. 2, no. 1, pp. 1–10, 2017
- [2] Hapsari TP, Wulandari A. Analisis kelayakan buku ajar milenial berbasis augmented reality (AR) sebagai media pembelajaran teks prosedur di magelang. *Diglosia: Jurnal Kajian Bahasa, Sastra, dan Pengajarannya*. 2020;3(4):351-364.
- [3] Amir I. Pengembangan buku ajar dan augmented reality pada konsep sistem pencernaan di sekolah menengah atas [Doctoral dissertation]. Universitas Negeri Makassar, Makassar, 2017.
- [4] J. Kajian dan Riset Dalam Teknologi Pembelajaran, A. Faiq Abdillah, I. Nyoman Sudana Degeng, and A. Husna, "Pengembangan Buku Suplemen dengan Teknologi 3D Augmented Reality sebagai Bahan Belajar Tematik untuk Siswa Kelas 4 SD.," *JINOTEP (Jurnal Inovasi dan Teknologi Pembelajaran): Kajian dan Riset Dalam Teknologi Pembelajaran*. vol. 6, no. 2, pp. 111–118, 2020
- [5] Marsono M, Mulyanto M, Isfarudi I. Pengaruh pembelajaran menggunakan augmented reality smartbook terhadap minat dan hasil belajar IPA pada siswa SDN 2 waluyo kecamatan buluspesantren. *Jurnal Pendidikan Tambusai*. 2021;5(2):3463-3469.
- [6] Atmajaya D. Implementasi augmented reality untuk pembelajaran interaktif. *ILKOM Jurnal Ilmiah*. 2017;9(2):227-232.
- [7] Buchori A, Prasetyowati DW. Evaluation of the magic book math media based on augmented reality in UPGRIS laboratorium senior high school. *Solid State Technology*. 2021;64(2):7683-7697
- [8] Setyosari HP. Metode penelitian pendidikan & pengembangan. Prenada Media, Jakarta; 2016.
- [9] Marsono M, Mulyanto M, Isfarudi I. Pengaruh pembelajaran menggunakan augmented reality smartbook terhadap minat dan hasil belajar IPA pada Siswa SDN 2 waluyo kecamatan buluspesantren. *Jurnal Pendidikan Tambusai*. 2021;5(2):3463-3469.

- [10] Hidayatullah AA. Penggunaan smart book digital interactive dalam meningkatkan motivasi belajar siswa di SMPN 3 karangtengah cianjur [Doctoral dissertation]. Universitas Pendidikan Indonesia, Bandung, 2015
- [11] Utami RE, Nugroho AA, Dwijayanti I, Sukarno A. Pengembangan e-modul berbasis etnomatematika untuk meningkatkan kemampuan pemecahan masalah. *JNPM (Jurnal Nasional Pendidikan Matematika)*. 2018;2(2):268-283.
- [12] Sugiyono., *Metode penelitian pendidikan: (pendekatan kuantitatif, kualitatif dan R & D)*. Alfabeta, 2008.
- [13] Adrian QJ, Ambarwari A, Lubis M. Perancangan buku elektronik pada pelajaran matematika bangun ruang sekolah dasar berbasis augmented reality. *Simetris: Jurnal Teknik Mesin, Elektro dan Ilmu Komputer*. 2020;11(1):171-176.
- [14] R. Rachmawati, R. Wijayanti, and A. Putri Anugraini, "Pengembangan eksplorasi MAR (Matematika Augmented Reality) dengan penguatan karakter pada materi bangun ruang sekolah dasar.," *Delta-Pi: Jurnal Matematika dan Pendidikan Matematika*. vol. 9, no. 2, pp. 92–1
- [15] Maulana GG. Penerapan augmented reality untuk pemasaran produk menggunakan software unity 3D dan vuforia. *Jurnal Teknik Mesin Mercu Buana*. 2017;6(2):74-78.