Development of Teaching Materials Based on Augmented Reality in Monetary Policy and Central Banking Course at Economics Study Program Universitas Negeri Medan

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Abstract. Teaching materials have an important role in the learning process, one of which is to encourage independent learning: teaching materials provide space for students to learn independently. This course requires Graduate Achievements: Students are able to understand economic problems, applicable monetary policies and central banking steps in overcoming economic problems, especially the implementation of monetary policy carried out by the central bank. The scope of discussion includes: introduction, money supply, money demand theory, Bank Indonesia as a central bank, and monetary policy. To make it easier for students to achieve this goal, innovative teaching materials are needed and provide independent learning spaces for students. The teaching materials developed are in the form of three-dimensional augmented reality. This study adapts the ADDIE development model developed by Robert Maribe Brance in 2009 and consists of five stages (analysis, design, development, implementation, and evaluation). In this study, it was carried out until the formative evaluation stage, summative evaluation was not carried out due to time constraints. This augmented reality based teaching material has been validated by 3 validators and the results show that the teaching material has feasibility but needs to be revised. After the teaching materials were revised, a trial was carried out in a small group consisting of 10 5th semester students which was carried out randomly. Based on the test results, the teaching materials are effective in the learning process.

Keywords: Teaching Materials, Augmented Reality,Monetary Policy and Central Banking

1 Introduction

Developing essential skills for the 21st century requires digital education. Students not only acquire academic knowledge, but they also acquire skills such as problem solving, creativity, communication and digital literacy. Learning in the digital age is different from the learning of previous generations because this generation is a digital immigrant. Digital education has

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expanded access to knowledge worldwide. Students can now access educational resources from anywhere in the world.

Solutions for the transformation of education in the digital age include equitable accessibility of technology, lecturer training and professional development, relevant and responsive curricula, collaborative and interactive learning, technology-based evaluation and feedback, and awareness of digital ethics and security. A teacher must be able to utilise current technological advancements to increase the attractiveness and interest in learning of their students. A student will definitely benefit from engaging and accessible course materials at any time.

Learning using the conventional model, which involves the teacher's entry into the classroom and conducting paper presentations by students reduces their desire to learn; therefore, a teacher must have creative and innovative abilities. One very important learning resource is learning materials and students. Current technological advances allow teaching materials not only to be presented in print, but also non-print versions or electronic teaching materials. The application of graphic images can make teaching materials look more attractive and easy to understand. Since electronic teaching materials allow students to learn independently anytime and anywhere, they can start the lesson without having to carry a book.

Today's rapidly evolving technology has produced some exciting technologies that can be used in conjunction with electronic module teaching materials. Augmented Reality, or AR, is a technology that can integrate 3D objects into the real world using rendering technology. Assistance from a webcam or camera. Developed countries are now widely developing this technology for educational purposes.

This AR-based teaching material is expected to provide a different learning experience because it is able to provide visualisation similar to seeing the original material and can be seen from different perspectives, namely from all directions. The existing teaching materials are in the form of two-dimensional images, so students can only see the surface and cannot see the entire image.

A notable innovation has been the creation of engaging instructional resources, as opposed to the mere provision of conventional reading materials. The creation of educational resources will also be digitally oriented, thereby enabling students and university students to conveniently access instructional materials via their cellphones. Augmented reality (AR) is a technology that merges the physical environment with the virtual world, thus providing interactive and captivating instructional materials.

Research on the development of teaching materials based on argumented reality has been researched before. Hiban, I. (2018) [1], *Pengembangan Bahan Ajar Berbasis Augmented Reality Software dan Smartphone untuk Pencapaian Kompetensi Dasar Matematis Mahasiswa Tunarungu pada Materi Pengubinan* (Doctoral dissertation, Universitas Pendidikan Indonesia), Setiawan, I., & *Martin, N. (2023)* [2]. *PENGEMBANGAN BAHAN AJAR BAHASA INDONESIA BERBASIS AUGMENTED REALITY PADA DOSEN SDN 2 PANCOR. SELAPARANG: Jurnal Pengabdian Masyarakat Berkemajuan*, *7*(2), 898-905.

The findings of the research indicate that the creation of instructional materials based on augmented reality is an effective method for enhancing student learning outcomes. Moreover, it fosters students' enthusiasm for learning by equipping them with up-to-date and pragmatic knowledge through the utilisation of their mobile devices. The creation of educational resources in the form of augmented reality represents a significant innovation. This approach represents a radical innovation in the field of education, particularly in the context of the digital age. Augmented reality-based learning is an educational approach that incorporates subject matter content into an engaging medium, thereby fostering interest and motivation in the learning process. The objective of this work is to enhance students' comprehension of the subject matter, particularly in the fields of Monetary Policy and Bankruptcy. Augmented reality is used as an educational tool with two primary aims. The primary objective is to captivate the attention of children. *Augmented reality* provides space for lecturers to express teaching materials in this case showing monetary economic phenomena with a more attractive appearance.

2 Theory Review

2.1 Teaching Materials

Teaching materials are defined as systematically organised resources or subject matter that lecturers and students utilise throughout the learning process [3]. The term "teaching materials" is used to describe a collection of educational resources, including learning materials, teaching methods, constraints, and assessment strategies. These materials are meticulously designed and presented in an engaging manner to facilitate the attainment of specific learning objectives, such as acquiring competence or subcompetence in a particular subject or skill [4]. This definition elucidates that a teaching material must be meticulously crafted and composed in accordance with instructional principles, since it will be used by educators to facilitate and enhance the process of learning. Learning materials, also known as curriculum content, refer to the disciplines or areas of study that comprise the curriculum. They consist of themes, subtopics, and detailed information [5].

Educational resources are defined as a collection of items, comprising content or learning material, that has been specifically created with the intention of achieving educational objectives. In contrast, according to various expert opinions, teaching materials are defined as the essential knowledge, tools, and texts that educators require for the purpose of organising and evaluating the learning process. Pannen, corroborates these perspectives by stating that teaching materials are systematically organised resources or subject matter utilised by lecturers and students throughout the learning process [6].

2.2 Functions of Teaching Materials

Teaching materials serve the purpose of teaching and influence the learning process. The quality of teaching materials can also affect learning outcomes. As a result, educational materials have learning objectives, have a very strategic role, and determine the achievement of educational goals. In his book, Teaching materials serve the following functions: firstly, they provide guidance for teachers, who are responsible for overseeing the learning process and determining the content of the competencies to be taught to students. Secondly, they offer guidance to students, who are expected to engage with the learning process and acquire the competencies

outlined in the curriculum. Thirdly, they facilitate the analysis and integration of educational outcomes [7].

2.3 Learning Media

The success of the teaching and learning process is heavily influenced by the choice of learning methods and the appropriateness of the learning media used. Learning methods play a crucial role in determining the atmosphere of the classroom and the engagement levels of students. A well-chosen method not only makes the subject matter more accessible but also stimulates student participation and critical thinking, ultimately fostering a deeper understanding of the material. In addition to learning methods, the success of the learning process can also be seen in terms of the learning media used, both gesture media, print media, or electronic media.

Gagne defines learning media as a type of component in the student's environment that can stimulate them to learn [8]. Similarly, Briggs posits that media constitutes a tool in the form of a physical entity that is typically employed for the conveyance of material content [9]. Additionally, Briggs posited that the aforementioned tools could encompass tape recorders, video recorders, images, cameras, television, graphics, and computers. Briggs identified three categories of media that can be utilized in the teaching and learning process: objects, models, live sound, audio recordings, print media, programmed lessons, blackboards, transparency media, frame films, string films, motion pictures, and television.

Moreover, Gerlach & Ely suggest that the scope of learning media is inherently complex, covering not only materials and tools that aid student comprehension but also human elements that provide guidance and instruction [10]. Learning media is defined as any entity that can channel messages from a learning source in a planned manner, creating a conducive environment in which students can engage in the learning process effectively and efficiently [11]. In this context, media serves as an intermediary or messenger.

2.4 Dimensions

3D or Three-Dimensional technology is a technology that allows us to see objects or images in three dimensions: length, width, and height. With this technology, we can experience more realism, see more interesting effects, enhance understanding, support planning and design, and provide a more impressive entertainment experience.

According to Nalwan (1998) [12], 3D modelling is the process of creating 3D models. This process forms part of the procedure of creating the shape of a 3D model, which can represent the entire object under study. 3D model is created from the process of connecting points in 3D space with various geometric data, including lines, planes and curved planes, which form a 3D model.

2.4.1 Augmented Reality

Augmented Reality is one of the innovative advances in today's modern transformation. *Augmented Reality* is an application that connects the current reality with the virtual world, both two and three dimensions that task images in the original climate. Virtual items that are added have the nature of adding, not replacing real objects. *Augmented Reality* intends to enhance real objects by bringing virtual objects so that data is not only for the user directly, but for each user

aims to simplify real objects by bringing virtual objects so that information is not only for the user directly, but for each user connected to the user of the real object. *Augmented Reality* can be applied to computers and mobile phones. *Augmented Reality* is commonly used by mobile navigation, medicine, robot planning, and learning media.

AR technology will be very useful in delivering data to users, it has almost the same rules as computer-generated virtual reality as 3D, but something contrary to computer-generated reality that incorporates real objects into virtual objects, *Augmented Reality* incorporates virtual objects on real environments.

2.5 Learning Outcomes of Monetary Policy and Banking

Student learning outcomes are influenced by a number of factors, both internal and external, which can be classified as learning circumstances. Internal factors pertain to the variables that are intrinsic to the organism, and are henceforth referred to as individual factors. The key characteristics are maturity or development, intellect, practice and repetition, motivation, and personality qualities. Furthermore, external factors include family dynamics, educators, resources and physical structures, as well as the surrounding environment [13]. One of the factors that affects learning outcomes is the manner in which lecturers design instructional materials, which will be the focus of this research.

The learning outcomes under discussion in this research relate to the knowledge and skills that students are expected to acquire in the course on Monetary Policy and Bankruptcy. In order to facilitate engagement and motivation among students with respect to the subject matter covered in this course, it is necessary to present the ideas, principles, and methods in an engaging and motivating manner. To this end, a novel format for educational content is presented in the form of argumented reality. This information is meticulously organised into visually engaging animations that follow a coherent plot. Furthermore, this content may be conveniently accessed from any location and at any time../

2.6 Development of Teaching Materials for Monetary Policy and Augmented Reality-Based Banking

The utilisation of 3D augmented reality in the development of educational resources enables the transformation of the learning process into a digital format, encompassing both content and system. The incorporation of 3D augmented reality in learning materials represents a pioneering innovation that profoundly influences the learning process. It is not merely an extension of the conventional approach of passively listening to educators elucidate the subject matter; instead, students are encouraged to engage in activities such as observation, performance, and demonstration. Digital-based learning media are gaining popularity due to their flexibility and efficacy, as observed by Surjono [14]. The transmission of learning materials via the Internet allows access at any time [14].

Digital learning platforms and adequate resources enable educational materials to be accessible at any time and from any location. These platforms can be accessed via student cellphones, allowing smartphones to meet everyday requirements without geographical limitations. This can be achieved through a wireless infrastructure network with broad coverage for data transmission or digital audio and video communication.

3 Research Methods

3.1 Research Approach

This study adapts the ADDIE development model developed by Robert Maribe Brance in 2009 and consists of five stages *(analysis, design, development, implementation, and evaluation*) [15]. This research was conducted up to the formative evaluation stage, summative evaluation was not conducted due to time constraints. The ADDIE model is used to describe a systematic approach to learning development. ADDIE makes students the centre of learning, innovative and inspiring for students [14].

3.2 Time and Place of Research

This research was conducted for 6 months at the Economics Study Programme of FE Unimed in the 2023/2024 academic year.

3.3 Research Subjects

The research subjects as a source of data in this study were lecturers and economics students in semester v of the monetary policy and bankruptcy course in the 2023/2024 academic year.

3.4 Data Collection Technique

The research employs a questionnaire as the primary data collection instrument. The questionnaire is designed to assess the quality of the learning media from various perspectives, including feedback from material experts, media experts, users (educators or instructors), and students.

3.5 Research Instruments

This study employs a range of research tools, including expert validation questionnaires and student response questionnaires, to collect data. The questionnaire utilises a checklist format, incorporating a scoring assessment for each dimension, with evaluation conducted using the Likert scale.

3.6 Data Analysis

The research included a series of data analysis procedures, which were validated by experts in the fields of materials and media, as well as by users. Additionally, the responses of students were examined. To determine the level of validity of *Augmented Reality-based* interactive teaching materials, quantitative data analysis techniques are used, as follows:

a. Validity/Eligibility

Data analysis of validation results aims to determine the level of validity of teaching material products developed in the form of *Augmented Reality-based* interactive teaching materials. Determine the percentage value (%) of validation criteria using the following formula:

$$Vah = \frac{Tse}{Tsh \times 100\%} \quad (1)$$

Description:

Vah: Expert Validation (Percentage Value)

Tse: Total empirical score

Tsh: Total expected score

Subsequently, the mean value is transformed in accordance with the adjusted Likert scale, which has been calibrated to the instrument in question.

Table 3.1 Validation Criteria

Validation Criteria	Validation Level
85,01 - 100,00%	Very valid or can be used without revision
70,01 - 85,00%	Quite valid or can be used but needs minor revisions
50,01 - 70,00%	Not valid, not recommended used because it needs major revision
01,00 - 50,00%	Not valid, or should not be used

B. User Test

Data analysis and student response results aim to determine student responses to *Augmented Reality-based* interactive teaching materials developed. The percentage value (%) of validity criteria can be calculated using the following formula:

$$Vah = \frac{Tse}{Tsh \times 100\%} \quad (1)$$

Description:
Vah: Expert validation (Percentage Value)
Tse: Total empirical score
Tsh: Total maximum expected score

The following is a table of student response criteria to *Augmented Reality-based* interactive teaching materials developed as follows:

Table 3.2 Student Response Criteria

Validation Criteria	Validation Level
81% - 100%	Very valid or can be used without revision
61% - 80%	Fairly valid or usable but needs minor revisions
41% - 60%	Less valid, recommended not to be used because it needs major revision
21% - 40%	Invalid, or should not be used
0% - 20%	Very invalid or should not be used

C. Test effectiveness

In order to assess the efficacy of this pedagogical resource, a preliminary investigation will be conducted on a restricted cohort utilising a before-after (one-to-one) experimental design with a paired sample t-test. The efficacy of argument-based teaching materials was previously

evaluated on a modest sample of 10 students enrolled in the V semester of the Monetary Policy and Central Banking course.

The design of this before after experiment tests the effectiveness of augmented reality-based teaching materials on learning outcomes before and after treatment using teaching materials based argumented reality, so that a research hypothesis test is carried out using a t-test [16].

$$t = \frac{\bar{X}_2 - \overline{X_1}}{n} \quad (2)$$

4. Results and Discussion

The research and development procedures for this learning media adopt a development model that includes the following elements:

4.1 Analysis

a. Performance Analysis

In the performance analysis, interviews were conducted with lecturers teaching monetary policy and bankruptcy courses and interviews with students of the economics study programme in semester v of Medan State University. In interviews with lecturers teaching monetary policy and bankruptcy courses, the results showed that so far many difficulties have been encountered by both lecturers and students. Furthermore, the results of interviews with 15 out of 30 students in the economics study programme in semester v of the economics faculty of Medan State University found that learning is difficult and on material that is abstract, there is a need for media or other supporting teaching materials that make it easier for students to understand the material.

b. Needs Analysis

In the needs analysis, a needs analysis questionnaire was distributed to 30 students in the economics study programme in semester v of the economics faculty of Medan State University.

c. CPMK analysis

This CPMK analysis aims to compile the material that will be contained in the *Augmented Reality-based* interactive teaching materials. CPMK is compiled based on the Merdeka Belajar curriculum in accordance with the applicable curriculum at Medan State University. The material to be compiled in *Augmented Reality* interactive teaching materials is an introduction, money supply, money demand theory, Bank Indonesia as a semtral bank, monetary policy.

4.2 Design

The second stage of this development aims to make the teaching materials developed can increase student interest so as to generate interest in learning with the teaching materials.

At this stage includes the preparation of learning materials, media selection, and initial design. The entire manuscript design in the form of image, script and sound design can be accessed via google drive and you tube links
https://drive.google.com/drive/folders/15106Lki6qt4WzQaYJEfeQXEgbe4dRAeS,
https://youtu.be/jdEtqCXLhqc?si=GUrgAhvh9XyXRT5U

Fig. 1. Augmented reality display script chapter 2

Fig. 2. Augmented reality display script chapter 2

Fig. 3. Augmented reality display script chapter 3

Fig. 4. Augmented reality display script chapter 4

Fig. 5. Augmented reality display script chapter 5

4.3 Development

In this development stage, several things were done, including the following:

a. Material Expert Validation

Assessment of *Augmented Reality-based* interactive teaching materials against material experts has the aim of knowing the validity, from the aspect of content feasibility, presentation feasibility aspects, and language aspects. The material expert assessment was carried out by FE Unimed lecturer Dr Dede Ruslan, M.Si.

The results of the material expert assessment are described in the table as follows:

Table 4.1 Data on Material Validation Results

No.	Aspects	Score Validation	Percentage	Criteria
1.	Aspects of Content Appropriateness	33	94%	Very Valid
2.	Aspects of Feasibility Presentation	10	100%	Very Valid
3.	Language Aspect	14	93%	Very Valid
Total		**57**	**95%**	**Very Valid**

The final percentage results show a value of 95%, based on Sa "dun Akbar table 3.3, the criteria for the feasibility level of the material presented are very valid.

b. Media Expert Validation

Assessment of *Augmented Reality-based* interactive teaching materials against media experts has the aim of knowing the value of feasibility of graphics. Media expert assessors are conducted by FE Unimed lecturers, namely Dr. Arwansyah, M.Si. The results of the material expert assessment are described in the following table:

Table 4.2 Data on Media Validation Results

No.	Aspects	Score Validation	Percentage	Criteria
1.	Aspects of Feasibility Graphics	103	97%	Very Valid
Total		**103**	**97%**	**Very Valid**

The final percentage results show a value of 97%, based on Sa "dun Akbar, the criteria for the feasibility level of the media presented are very valid.

c. User Validation

Assessment of *Augmented Reality-based* interactive teaching materials to users has the aim of knowing the value of *Augmented Reality-based* interactive teaching materials in terms of material, namely based on the material and design of teaching materials. User assessment was carried out by Revita Yuni, S.Pd., M.Pd. as a lecturer in the course of Monetary Policy and Central Bank, Faculty of Economics, Unimed economics study programme. The user validation instrument includes aspects of content feasibility, presentation feasibility aspects, language aspects and graphical aspects.

The results of user validation are described in the following table:

Table 4.3 User Validation Result Data

No.	Aspects	Score Validation	Percentage	Criteria
1.	Aspects of Feasibility Contents	32	91%	Very Valid

2.	Aspects of Feasibility Presentation	15	100%	Very Valid
3.	Aspects of Feasibility Language	13	87%	Very Valid
4.	Aspects of Feasibility Graphics	15	100%	Very Valid
Total		**75**	**94%**	**Very Valid**

The final percentage results show a value of 94%, based on Sa "dun Akbar, the criteria for the feasibility level of the material and media presented are very valid.

d. Test effectiveness

In order to assess the efficacy of this pedagogical resource, a preliminary investigation will be conducted on a restricted cohort utilising a before-after (one-to-one) experimental design with a paired sample t-test.[1] The efficacy of argument-based teaching materials was previously evaluated on a modest sample of 10 students enrolled in the V semester of the Monetary Policy and Central Banking course.

$$t = \frac{91-70.7}{10} = 2.03$$

By using the t-test table for the significance level α = 5% = 0.05 and df=9, then t is obtained in the table, namely ttab = 1.833. Comparing thit with ttab:thit > ttab → 2.03 > 1.833.[2] The value of thit > ttab, so it is said that there are argumented realty-based teaching materials in the course of effective monetary policy and central banking.

4.4 Implementation

Expert validation of *argumented reality-based* materials was carried out by Dr Dede Ruslan M.Si. This stage is a continuation of the development stage. At this stage all teaching material designs that have been developed are then validated by experts consisting of material experts, media experts and users, after going through further revisions are tested on students.[3] The trials were carried out as follows:

a. Small Scale Product Trial

The first product trial is a small-scale trial, this is done with the aim of knowing the readability of teaching materials developed in the form of *Augmented Reality-based* interactive teaching materials. This trial was reviewed from three aspects, namely aspects of attractiveness, material aspects, and language aspects, to 10 FE students of the Economics Study Programme semester v.

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[1] A one-to-one experimental design with a paired sample t-test is used to measure the difference before and after the intervention on a single group of participants.

[2] The t-value greater than the critical value (t-tab) indicates that the statistical test result is significant at a 95% confidence level.

[3] Validation by experts involves assessing the quality of content (material), the media used, and feedback from end-users such as students.

The results of the small-scale trial are described in the following table:

Table 4.4 Data from Small Scale Trial Results

No.	Aspects	Score	Percentage	Criteria
1.	Aspects of Attractiveness	185	92%	Very Valid
2.	Material Aspect	268	89%	Very Valid
3.	Language Aspect	135	90%	Very Valid
Average Score		**588**	**90%**	**Very Valid**

Based on table 4.6 shows the results of small-scale trials with 10 students at 90%, based on Sa "dun Akbar, the criteria for the level of attractiveness are very interesting.

4.5 Evaluation

The evaluation stage is the final stage of the ADDIE model. In this research only until the limited trial, the evaluation referred to in this stage is formative evaluation. By being carried out by the researchers themselves (*self-evaluation*), *expert evaluation (expert review*), small-scale trials (*one-to-one evaluation*), and large-scale trials (*group evaluation*) that have been carried out by the researchers.

4.6 Data Analysis

In the initial stage, namely analysis, data were obtained from three activities including: performance analysis, needs analysis and CPMK analysis. In the performance analysis, interviews were conducted with lecturers of FE Economics Study Program Unimed and the results obtained that the learning of Monetary Policy and Bankruptcy had encountered many difficulties.

Learning delivered using printed book media and PPT is still considered unable to convey material to students optimally. Furthermore, interviews were conducted with 15 FE Economics Study Programmes in semester v. Unimed and obtained the results that learning Monetary Policy and Bankruptcy is considered difficult and as in abstract material there is a need for media or other supporting teaching materials that make it easier for students to understand the material.

The next analysis activity is the analysis of student needs which is carried out by distributing a needs analysis questionnaire to 25 FE Economics Study Programmes in semester v Unimed.

The results of data from the needs analysis questionnaire obtained by 90% of students need supporting media in learning Monetary Policy and Bankentrality by looking at the existing media on campus, the media that is expected to be developed can involve students directly so that it makes it easier for students to understand the concept of a material.[4] As many as 87% of students expect learning media or teaching materials such as teaching materials accompanied by 3D / Augmented *Reality* content, where students are presented with teaching materials that

[4] Students expressed that traditional learning media, such as books and slides, often fail to engage them effectively, resulting in a demand for more interactive materials.

can be used independently with clear material descriptions and attractive designs coupled with 3D content that helps students get their own concepts in learning. As many as 30% of students expect learning media such as images or videos, in this case it can be seen the lack of student interest in image and video learning media. 83% of students expect technology-based learning media, this is interrelated with learning media in the form of 3D-based teaching materials or Augmented Reality content can be accessed by mobile phones and more freely to learn. As well as 90% of students agree if developed learning support media in the form of interactive teaching materials based on *Augmented Reality* aided by Artstep. The results of the validation of the final percentage of material experts show a value of 95%, based on Sa "dun Akbar table 3.3, the criteria for the feasibility level of the material presented are very valid. The final percentage media expert validation results show a value of 97%, based on Sa "dun Akbar, the criteria for the feasibility level of the media presented are very valid. The final percentage user validation results show a value of 94%, based on Sa "dun Akbar, the criteria for the feasibility level of the material and media presented are very valid. The results of the small-scale trial with 10 students were 90%, based on Sa "dun Akbar, the criteria for the level of attractiveness are very interesting.

5. Conclusion

The results of this research and development project comprise instructional resources pertaining to monetary policy and bankruptcy. The validity test conducted by experts indicates that the construction of these teaching materials is indeed viable. Similarly, the results of the user evaluation conducted by the instructor are highly reliable.

The small-scale test evaluation yielded intriguing findings from the student responder data. This demonstrates that the instructional resources that were created have been shown to be practical, reliable, and engaging in enhancing student learning achievements.

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