

# Development Of Supplements Print Teaching Materials Based Augmented Reality In Open University

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**Abstract**— *One of the challenges faced in the 4.0 industrial revolution is human resource development. Talking about human resources, it cannot be separated from the education sector, and even this sector is the most dominant in educating the nation's life. There are nine updates related to education, including learning at different times and places, individual learning, students' choices about learning, project-based learning, field experiences, data interpretation, various assessments, student involvement, and mentoring. One of the higher education institutions that have implemented learning in the face of the industrial revolution 4.0 era is the Open University. The principle used by the Open University is independent learning accompanied by printed teaching materials. However, these printed teaching materials require additional supplements in other media technologies so that readers of the teaching materials become more familiar with the material presented. This study adds accessories to printed teaching materials at the Universitas Terbuka with augmented reality technology using the waterfall method. The results showed that the application runs well 90%. Of the ten cellphone devices tested, only one was unable to display supplements. This is because the cellphone specifications are below standard. With this research, it is hoped that it can help readers understand printed teaching materials at the Open University.*

**Keywords**— printed teaching materials, augmented reality, waterfall, Open University.

## I. PRELIMINARY

The advancement of technology information at the time felt very fast. It is driven by the revolution of industrial 4.0, which can challenge the whole race of man. Revolution Industrial 4.0 modify all things in man's life without any limitations as supported by technology development and network the Internet as bone back between humans and machines [1]. Some of the benefits of the revolution of industrial 4.0 influence the production sector, service to customers, and increase revenues [2]. At the same time, the challenges that will be faced is the need for their creation and innovation in the face of the era of industrial 4.0 [3].

One of the challenges most significant in the face of industry 4.0 is the development of a source of power for humans [4]. Speaking about the development of sources of energy of man, it is not separated from the sector of education. Even sectors have become the most dominant sector in the nation's intellectual life to answer the challenges in an era of revolution of the industry 4.0 [5]. Therefore, there should be a creative and innovative process in generating the participant students [6]. The method of learning the creative and innovative one is wearing tool aids in the learning used by the participant students [7].

In the era of revolution industrial 4.0, These are nine freshness associated with education such as learning at a time and place that is different, learning individually, students can determine the choice of how to learn, learning-based projects, experience field, interpretation of data, ratings vary, the involvement of students and mentoring [8]. In the face of this industrial 4.0 era, higher education must be able to apply the updates that have been mentioned. One of the higher education institutions that have implemented learning in the face of the industrial revolution 4.0 era is the Open University. The Open University principle is to learn independently, which is accompanied by the material of teaching print. However, materials of teaching pattern that require supplementation explanation extra in other media so that the reader material resource becomes more familiar with the submitted materials.

Printed teaching materials in this 4.0 industrial revolution era must have more value by adding a touch of technology [9]. One of the technological developments in the period of the industrial revolution 4.0 is augmented reality. Augmented reality can combine the virtual world with the world with two- dimensional and three-dimensional forms [10]. Technology is the latest technology in industrial 4.0 that can help the world of education [11].

In line with the supplement of printed teaching materials at the Open University, it is necessary to add augmented reality technology to have more benefits and attractiveness than the previous ones. Therefore, this study supplements printed teaching materials at the Open University with augmented reality technology. With this technology, the reader can scan using a cellphone on the printed teaching material. An explanation will appear on the cellphone screen so that the reader can better understand the contents of the printed teaching material.

## II. METHOD

The stages of research in developing a supplement for augmented reality-based print teaching materials at the Open University can be seen in Figure 1 as follows:

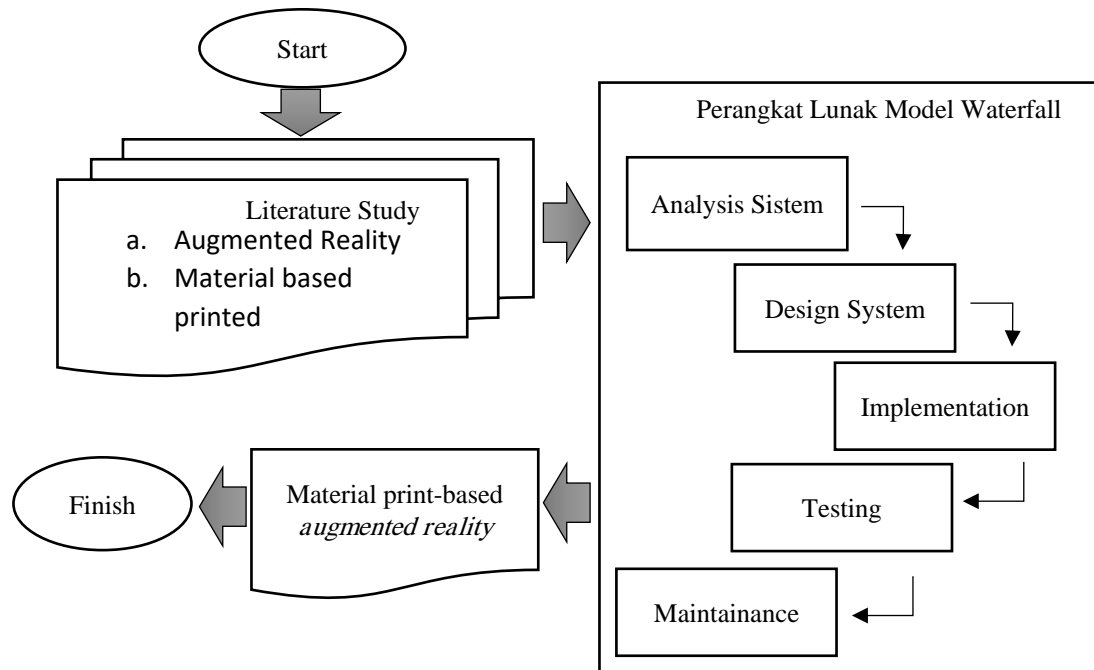


Figure 1. Research Stages

The stages of research that have been described in Figure 1 can be explained as follows:

1. Study of literature

The first stage in this research is the literature study. In this literature study, there are two stages: *augmented reality* and printed teaching materials at the Open University.

2. Waterfall Method Software

a. System Design/Analysis

System design or analysis is the first step in the waterfall method. This stage gathers information related to printed teaching materials, objectives, scope, and solutions to be made, for example, printed teaching materials for management information systems in which there are nine modules. One module was selected from the nine modules, namely module 1, which will be used to develop this application. After selecting module 1, one page is set again as an application *marker*, as an example of the *marker* chosen in Figure 2. *The marker* will function as a *trigger* captured by the *cellphone* camera, which later, the supplements that have been made will appear on the *cellphone* screen. In addition, this stage will analyze the application's functional requirements, such as the function of the button, the screen display, the *cellphone* to be used, etc.

b. System Design

At this stage, we will create a design of the system using object-based modeling. Modeling is done using UML ( *Unified Modeling Language* ), which consists of the *use case diagram* that illustrates several actors involved, *the class diagram* shows the structure of a static class in the system, *state diagrams* describe all conditions by class, *activity diagram* showed classroom activities and added to the design of application display on the *mobile* screen.

c. Implementation

The next stage is implementation or coding. The beginning of this stage is the creation of development applications for printed teaching materials supplements. Then the next *step* is making *markers* from printed teaching materials for management information systems. After the *marker* has been created, it will be stored in *vuforia*. Next, *Vuforia* is used to enter *marker* objects into an online database, later called into *unity*. At the same time, *unity* is an application that will combine *markers* with 3D objects.

d. Test

In this stage, the application will be tested using *black-box* testing. This *black box* test will be tested in terms of the function of the application. For example, one test procedure is when the camera is pointed at the *marker*, the 3D object will appear, and so on—then based on a predetermined process, the application will be tested on several types of *mobile phones* so that the results of this test produce a reliable application.

e. Maintenance

The last stage is maintenance. This maintenance stage is running the application and checking back if there are deficiencies in making the application. For example, if there is a change in content or an error in the content, the application must be *updated* periodically to adjust the range.

### III. RESULT

#### 3.1 Analysis

##### a. Analysis of Printed Teaching Materials

Step first analysis of material taught printing is to know the achievements of the learning eye college introductory system information in Program Study System Information Open University. It is then compared with the learning outcomes of module 1. If the achievement of learning on module 1 already meet the achievement of memorizing the eyes of college introductory system information about the material supplements that will be made to explain what that exist in module 1, but if not yet meet the material supplements add material that has not been described based on the achievement of learning the eyes of college introductory system information. See the comparison is presented in the form of table 1 below:

**Table 1 Comparison table of learning achievement**

The achievement of learning eye college introductory system information	Module learning achievements
<ol style="list-style-type: none"> <li>1. Explain the basic concepts of information systems;</li> <li>2. Explain how organizations can use information systems for competitive purposes.</li> </ol>	<ol style="list-style-type: none"> <li>1. Explain the definition of a system;</li> <li>2. Explaining the difference the system of physical and system procedural;</li> <li>3. Describe the characteristics of a system;</li> <li>4. Explain system classification;</li> <li>5. Explain system control;</li> <li>6. Understanding preventive control;</li> <li>7. Understanding the control feedback;</li> <li>8. Understanding feedforward control ;</li> <li>9. Explain the definition of information;</li> <li>10. Knowing the quality of information;</li> <li>11. Knowing the importance of information for the organization;</li> <li>12. Describe the types of information systems and subsystems;</li> <li>13. Explain the control in the system;</li> <li>14. Learning the assessment of an information</li> </ol>

Table 1 can be seen comparing the achievements of the learning eye study and achievement of learning modules 1. On learning the eyes of college, two learning outcomes explain the concept of the basic system information and describe how organizations can use the system information to benefit from competition. Meanwhile, in module 1 learning outcomes, there are 14 components of learning outcomes. The comparison outcomes learning above that memorizing the eyes of a college No. 1 explain the concept of the primary system information is met by learning no 1,2,3,4,5,6,7,8,9,10,12,13,14. While the achievement of memorizing the eyes of a college No. 2 describes how organizations can use the system information for the benefit of competitive, partly fulfilled by the achievement of learning modules No. 11. The accomplishment of learning modules 1 No. 11 only to explain the importance of information for the organization while learning no two eyes lecture is using information systems for the organization's benefit. This means that the material supplement that will be made is related to information systems to benefit the organization.

In module 1, several images can be used as markers, including the following:

1. System characteristic marker
2. Subsystem, System, and Supersystem Markers
3. Inventory Control Open System Marker
4. Inventory Control Relatively Closed System Marker
5. Basic Form Marker of a System
6. System Marker with Feedback Control System
7. Feedback Control System Marker

From the markers above, two markers were selected to be used in this study. These markers are system characteristics and information cycles. The following is a marker image of the system characteristics:

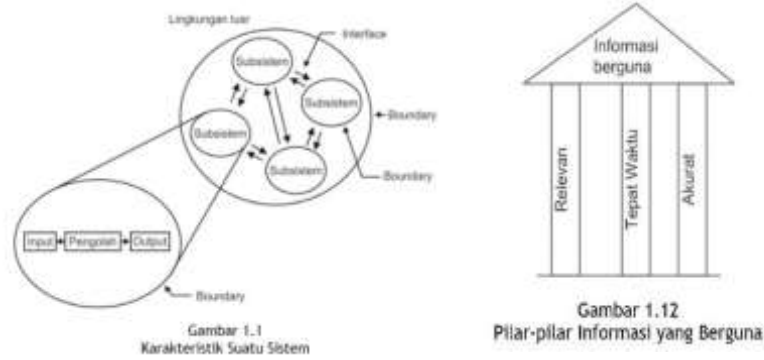


Figure 2. Marker

If the marker above was captured by a camera application that will appear in the form of the material supplement, learning subjects' eyes were submitted.

**b. System requirements analysis**

The system requirements analysis is divided into two parts, namely the requirements based on functional and *non*-functional. Needs functional is needed based on the processes that occur in a system while the needs of *non*-functional, namely the condition that the system was running. Needs of functional and non-functional can be seen as follows:

1. Functional requirements
  - a. Applications have started to be opened with four menus: menu start, menu developers, and menu exit.
  - b. Menu start function to start the application.
  - c. The developer menu contains the identity of the developer of this application.
  - d. User manual Menu
  - e. Menu exit, which is an exit from the application.
  - f. When the menu starts clicked, the application will begin looking for markers on teaching print material. Then, if the *markers* are found, the application can display the supplements in video materials instructional photos.
  - g. The video that appears is following the design that has been made.
2. Needs of *non*-functional.
  - a. The application can only be used on *mobile* devices with the Android operating system.
  - b. Applications can run on android ranging from version 4.4 (Kit Kat) to the top.
  - c. The system uses *tools* that can support android and *augmented reality*.

**3.2 Design System**

The system design in this study uses UML ( *Unified Modeling Language* ), which is described in *use cases*, *activity diagrams*, and interface designs.

**a. use case**

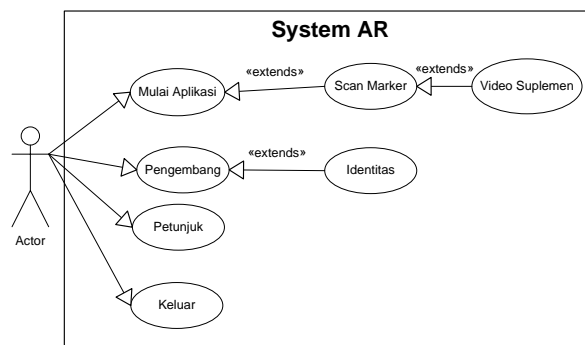


Figure 3. Usecase diagram

This use case diagram will explain the interaction between users (actors) and the system being built. Some of the actor's functions that will be carried out on this system are use cases from applications, developers: hint and exit. The supplemented video has an extended relationship with the scan marker, meaning that the augmented video will not run if the marker scan is not performed.

Likewise, it is the same with scanning markers by starting the application. A marker scan cannot be achieved if it is not performed beginning the application.

**b. Activity diagram**

Activity diagrams describe the workflow of a system. The system created can be seen in Figure 4 below. You can see the workflow starting from initial initiation and starting the application on the user side in the picture. Then enter the system to select the application start menu, developer, and exit. If the user selects the application start menu, it will be continued by looking for a marker. Next, the camera will be ready to capture the marker, and if a marker is found, it will be displayed in the form of supplementary video material. If the user selects a developer, the application developer data and instructions for use will appear. If the user has instructions, instructions for using the application will appear, and if the user chooses to exit, he will leave the application. The following is an image of the AR activity diagram:

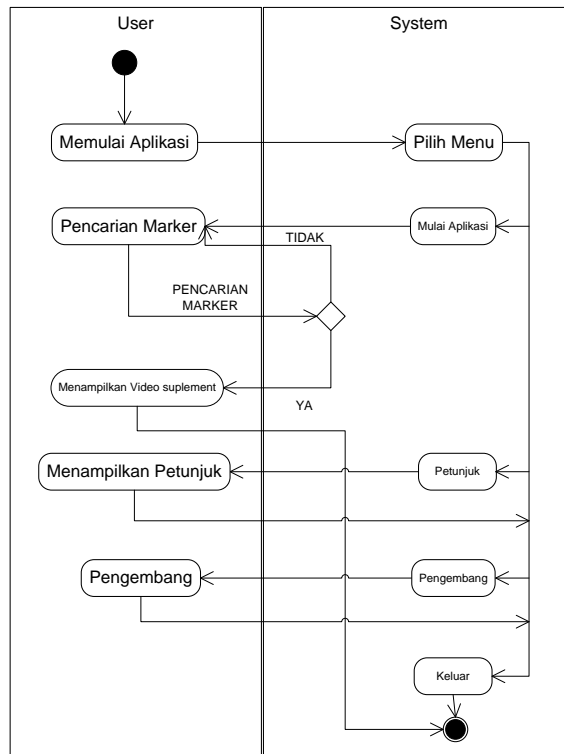


Figure 4. Activity diagram

**c. Interface Design**

The last stage in the design is the interface design. The method of this interface will be made in the form of a sketch/mockup. The tools used in this interface design use Balsamiq version 3.5.17. The following interface design has been made:

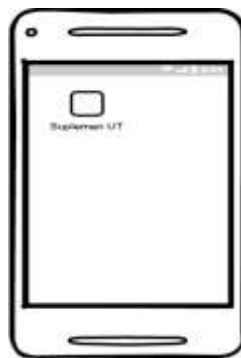
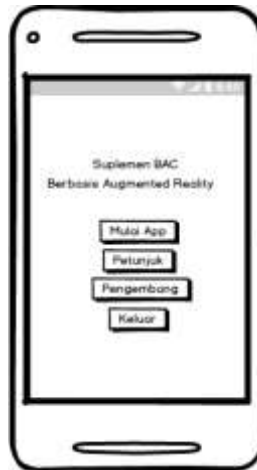


Figure 5. Application interface

Figure 5 shows the display of the application on the Android phone screen. The screen shows an application icon that is ready to be used by the user with the name UT supplement. Furthermore, the application menu display after the icon is clicked on android is as follows:



**Gambar 6. Application menu display**

The user will use four menus in the application menu, namely start the app, instructions, developer, and exit. At the start of the application, the user will start the application and look for markers on teaching materials. The marker search display can be seen in the following example image. Then the instructions menu contains instructions for using the application. Finally, the developer menu is the identity of the application developer and exits the application.



**Gambar 7. Marker search process**

After the user presses the start button, the application will start looking for markers in teaching materials. An example of the display in figure 7 is the display in the marker search. If a marker is found, the video supplement that has been created will be displayed.

### 3.3 Implementation

The next stage is the implementation stage. This implementation stage is the conversion stage of the design made into an application using programming language tools. Supplemental content and markers that have been created will be entered into an augmented reality-based application. For more details, the following view of the application that has been made.



**Figure 8. The application has been successfully installed on the android phone**

Figure 8 is a display of the application that has been installed on the android hand tree. On display, you can see a supplement icon that is ready for use by the user. If you want to use the application, just select it and if you want to delete it, delete it.



**Figure 9. The appearance of the BAC supplement application**

Next is the menu display in Figure 9. If the supplement application has been used. In this menu display, there are four menus, namely start, researcher, instructions, and exit. The start menu is to create the marker search so that supplements can be studied. The researcher menu is a menu to view research members. The instructions menu is to see how to use this application, and the exit menu is to exit this application. Next is to press the start button. If you have pressed the start button, it will look for markers on the introductory information system teaching materials, in this case, using management information system teaching materials. Here's what the marker search looks like:



**Figure 10. Display when selected start and search marker**

In Figure 10, the mobile screen marker search display will look for where the marker is located. If a marker is found, the supplementary material provided will appear, as shown in Figure 11. However, if the marker has not been found, the cellphone screen will continue to search until found. A back menu is also provided on the marker search screen if the user wants to return to the previous main menu.



Figure 11. The display runs when the marker is found

Furthermore, the researcher menu in Figure 12 can be seen in the following figure:



Figure 12. Display when selected by researchers

Figure 12 shows the researcher's menu display. In this research menu, there are two research members, namely Dra. In addition, on the menu of this researcher are members who do supplement research using augmented reality. Dyah Paminta Rahayum, M.Si. and Andri Suryadi, M. Kom.



Figure 13. Display when a hint is selected

Next in Figure 13, which is the display of instructions. This display is a display of technical education to users in running this application. In general, the implementation stage is making applications by the system design that has been done previously.

After the implementation process or application termination is complete, the next step is the testing phase. The testing stages will be discussed in the next point to test whether the application can run on various Android phones.

### 3.4 Testing / Pengujian

At the testing stage, the application will be tested using ten different handphone android. It was mentioned to prove that the application that was made for walking by the desired. At the testing stage, this using a method of testing the black box is a method of testing based on the function of the passage of the application. While the scenario of this test is as follows :

Table 2. Blackbox Testing Scenario

No	Scenario	Hasil Testing berjalan
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	Spesifikasi Handphone Android		Yes	No
1		Installed application (APK)		
2		open application		
3		pull button start and search marker		
4		Supplement video running for marker 1		
5		Supplement video running for marker 2		
6		Pull button researched		
7		Pull button hint		
8		Pull button exit		

From the table above, there are eight scenario testing installed the application (APK) on the phone android, open the app, press the tomb o l to begin and looking for a marker, trying to look for the marker 1, try looking for a marker 2, press the button researcher, pressing the button guide, press the button exit. The scenario that would result in how much an application can be used on ten mobile androids. To find out more, here are the results of tests carried out on ten android phones.



Figure 14. Test Results on software

From the results of tests that have been carried out on ten android devices, as can be seen in Figure 14, the results of the test can be seen in Table 3 below:

Table 3 Test results

No	Perangkat Android	Keterangan
1	Oppo F7	Good
2	Oppo A5 2020	Good
3	Infinix Hotplay 9	Good
4	Oppo A3S	Good
5	Samsung Galaxy Tab 2.0 P3100	Not Good
6	Alldocube m5x	Good
7	Asus Zenfone 4 max pro	Good
8	Samsung A30	Good
9	Asus Zenfone max pro M1	Good
10	Asus Zenfone Max M2	Good

The application can run well except on the Samsung Galaxy Tab 2.0 P3100 with 3 MP Camera specifications, 1GB RAM Memory, and Android 4.0.3 (Ice Cream Sandwich). However, the application can still be installed on the Samsung Galaxy Tab 2.0 P3100, but Augmented Reality cannot run.

#### 4.5 Maintainance

The application is ready for download and use at the maintenance stage of these applications installed on the Google Play Store. On the play store app by name Supplements BAC UT accordance with studies that do this. More details can be seen in Figure 15 below:

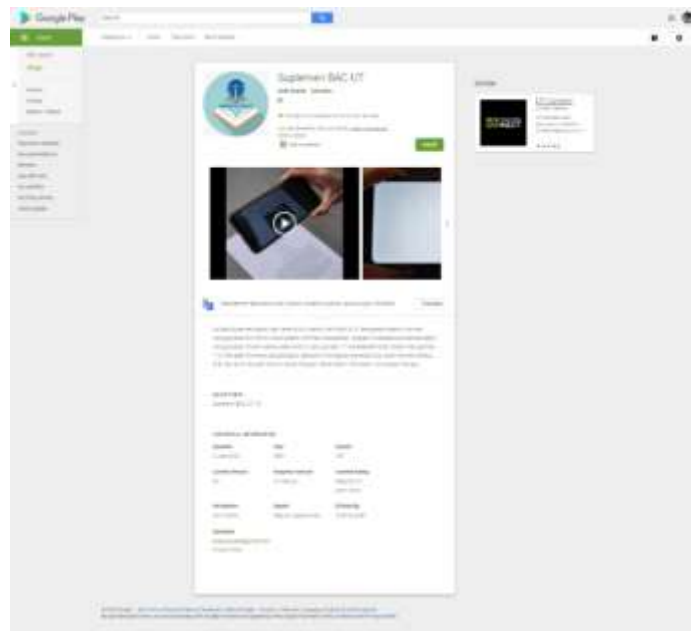


Figure 15. Image of the BAC UT supplement application on the play store

The maintenance process is carried out by releasing the latest version. If there is a change associated with the application or content, then the application in the play store can be updated according to the needs. The initial version of this application is 1.0. According to the image above.

#### IV. CONCLUSIONS AND SUGGESTIONS

##### A. Conclusion

From the research results, it can be concluded that the application runs with both the specifications of the phone, a minimum of system operation android 4, 4 MP camera and a memory of 1GB. On the results of the testing that has been done, the application runs with both types of mobile phones over the minimum has been set. It is seen in testing using a Samsung Galaxy Tab 2.0 P3100 with specifications Camera 3 MP, Memory 1GB RAM, and Android 4.0.3 (Ice Cream Sandwich). On the Samsung Galaxy Tab 2 P3100, The application can be - installed with either, but supplements do not appear when the quest marker. Besides that application runs very well.

##### B. Suggestion

Suggestion for further research is to try several supplements on the same application. Then, more devices are tested so that the minimum specifications are truly measurable. In addition, it did assess the feasibility of the parties related to such students, faculty, and stakeholders' interests of others.

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