Design of Web-based Lightweight Interactive Multimedia for Distance Learning

Didik Dwi Prasetya*, Aji Prasetya Wibawa¹, Ansari Saleh Ahmar³

¹,² Department of Electrical Engineering, Universitas Negeri Malang, Malang 65145, Indonesia
³Department of Statistics, Universitas Negeri Makassar, Makassar, 90222, Indonesia

aji.prasetya.ft@um.ac.id

Abstract—Electronic learning based on Information and Communication Technology is one of the backbone behind the success of distance learning because it is actually able to save cost, time, and resources. To optimize the quality of this learning, more variety and interactive content with the support of multimedia elements (such as text, images, animations, sounds and video) is required. This research proposes a design of web-based lightweight interactive multimedia application combined with a game approach to support distance learning. This design employs web technologies based on pure HTML5, CSS3, and AJAX scripting that offer rich interactivity and lightweight performance. This research produces an interesting and fun learning application design that able to motivate students to self-learning.

1. Introduction

In today's digital age, Information and Communication Technology (ICT) becomes an integral part of human life. ICT components have an important role to link and integrate elements in smart city planning [1]. We can see, all human activities today are dominated by the use of ICT, both software and hardware. One of the fields that utilize the features and services of this technology is education. Various educational models, both formal and non-formal use ICT thoroughly, for example, electronic learning (e-learning). ICT with all its related components proved very useful to support electronic learning process [2]. E-learning presents an entirely new learning environment for students, thus requiring a different skill set to be successful [3]. According to Ivleva [4], electronic learning is considered appropriately to be one of the most prospective solution in education development among countries in the world. Electronic learning is one of the backbone behind the success of distance learning because it is actually able to save cost, time, and resources.

There are many different definitions of the distance learning and many researchers have been applied interchangeably. Distance learning could be said as an evolving field, and advances in its pedagogy may well help students learn more online [5]. Distance learning or distance education defined as a planned and structured teaching process that uses one or more support technologies as a conduit for learning [6]. In this learning model, the interaction between teacher and student can be either synchronous (real-time) or asynchronous (delayed). Distance education is a systematic and a unique process of interaction between teacher and learner that allows interactive two-way communication in a virtual environment based on information and communication technology [7].
can be concluded that distance learning is a structured learning approach by utilizing ICT and its components as an appropriate solution to overcome the problem of learners from various locations who cannot attend the class for work or family reasons.

Distance learning is very appropriate implemented in a country with a large population and consists of islands, for example in Indonesia. However, if only relying on classical learning, it is necessary to add an extraordinary amount of infrastructure to support. In general, this education model is usually driven by special needs related to general education, training, professional development or group needs. Distance learning can be organized on all levels and types of education. Online learning model based on ICT is widely applied to distance education because it offers more flexibility. However, this exciting potential must be supported with good infrastructure, including the availability of interesting content. The existence of this learning content is very important to support the success of distance learning based on ICT. To optimize the quality of distance learning, it is necessary an interactive learning media approach with the support of multimedia elements (such as text, images, animation, sound, and video). The learning system approach based on multimedia contents can achieve resource sharing effectively [8]. According to Ni [9], teaching approach with the utilize of multimedia contents can provide various learning information and make language practice learning more effectively. Interactive learning media support has strategic potential to motivate learners. The fact in the class shows that students are less motivated to learn because the approach used is still in a conventional manner.

Multimedia-based learning solutions are already widely applied and with varied approaches. Yavner [10] developed web-based multimedia instruction (WBMI) to provide self-learning environment with video and animation features. In his research, Hwang [11] also shows the implementation of interactive storytelling that utilizes the effects of multimedia and the results show that most students have a very positive attitude and perceptions. However, the use of single-element multimedia, like a video demonstration, tends to form a passive learner so that more suitable representation is required which utilizes all the multimedia elements [12]. In this paper, a learning application will be developed that utilizes multimedia elements to produce interesting content. In addition, application development also emphasizes lightweight performance, in which we use pure HTML technology without Adobe Flash support.

2. System Design

2.1. Research Design
Development of software applications design is done by referring to the rules of software engineering. The specifications of this design of application has been well identified, including the necessary supporting technologies. Thus, this study would be very appropriate if adopted waterfall software process model proposed by Pressman [13]. The underlying reason for choosing this model is because the software requirement specification to be developed is very clear.

The stages of waterfall model process can be described as follows: 1) Communication stage is the initiation of the project and aims to explore the web-based lightweight interactive multimedia application requirements specification. At this stage, we collect all the project initiation and requirements gathering; 2) Planning phase includes estimation, project scheduling, and trace activities. In this phase, we also plan product evaluation activity; 3) Modeling consists of two main activities, called analyze and design of products. In this activity, all requirement gathered in the previous phase are broken down into logical units so that they will become easy for implementation. 4) Construction is to translate the results of the modeling stage to a form of product applications and at the same time product testing results. The coding phase begins with defining supporting technologies, such as the environment and the programming language used; 5) Deployment stage aims to broadly distribute products that can be used by the target users of the product.
The phases of the waterfall model of software development carried out systematically and sequentially. Each stage in this model is related, the next stage requires the previous stages as input, and so on until all the stages completed [14].

2.2. Architecture Design
The proposed solution is a design of software application to help improve the quality of distance education services. This application is built using pure web technologies and then they are distributed over the Internet network. More detailed information about the proposed system development architecture is shown in Figure 1.

![Figure 1. Architecture Design](image)

This application works exactly the same as web applications in general, which is uploaded on the internet and accessed by the user. Thus, learners and teachers can access applications together even though they are in different locations. The use of web technologies enables applications to be developed to be widely accessible, whenever and wherever unlimited by space or time. It is expected that this application will be utilized by various users, such as schools/institutions, learners, teachers, and other communities.

2.3. Product Design
To illustrate the functional behavior of the system from the user point of view we use the use case diagram. Actors or users who will interact with the app consist of two categories, learners and teachers as shown in Figure 2.
Learners are user who have a role to access public services from the system. While the teacher is a dedicated user who is tasked with managing the content of the learning application. To access the content, both learners and teacher must log in first. After that, they will be redirected to each page according to user type. The topic of learning materials discussed is the introduction of computer networks.

Design of learning content consists of 3 categories, basic material, exercises/simulation, and interactive quiz.

a. Basic Material
   This material presents the theory or concept that underlies the subject matter of basic computer network.

b. Simulation/Exercises
   Present the exercises in the form of simulations, such as the preparation of computer network topology. This content is designed to be interesting and practical with drag and drop object concept.

c. Interactive Quiz
   This content provides the lightweight interactive multiple choices quiz to evaluate learner’s knowledge.

This paper takes a case study of material at the vocational high school level, especially for students who are performing an internship in industries. Generally, these students undertake an internship program outside the city or island, so there is no face-to-face or synchronous lesson in the class. Therefore, to support these activities, it is necessary learning services that is able to facilitate them, one of which is a distance learning model like this. This study provides restrictions on material content only written in Bahasa Indonesia.

2.4. Testing Design
This stage is done as a verification and validation that the developed software application can meet the system specification and run in accordance with the scenario that has been described. The main purpose of the testing phase is to find unidentified errors. In software engineering, software testing technique plays an important role [15]. It can even be said that most activity in software development is testing and testing.
In this paper, application testing is done using the black-box method, that is by paying attention to the output of interactive multimedia learning application software based on the inputs given. In this black-box model testing, the tester only knows about the system architecture without needing to know the internal design. To support the implementation of this test, descriptions of test procedures and test cases are required.

3. Results

The main activities that are interrelated to one another at the construction or generation stage are the realization of results and testing.

3.1. Implementation Results

Implementation (code generation) is the stage to translate the design results to a machine-readable form. The system implementation stage describes the real-world manifestations of the processing of functions and information structures. In this stage, aspects related to the behavior and structure of the system are represented as they will be built. This stage describes the detailed implementation for each operation expressed through a message.

Development of application emphasizes the interface design with a simple and clear visual impression. The main page implementation view form is shown in Figure 3.

![Figure 3. Main Page View](image)

One of the features provided in this learning app is full screen display. This feature provides convenience for users to focus on the wide view of learning applications without interruption of other application windows.

Learning content is the first main component of the developed system. This content will be the content of this interactive multimedia-based learning application. As mentioned, the material content used in this application concerns the introduction of computer networks. This material is tailored to the vocational high school curriculum for elementary level students.

In basic computer network material contents, there are three topics of discussion:

1. Introduction to Computer Network

   This material is a basic material about computer networks, such as understanding and types of computer networks.

2. Network Equipment

   The discussion on this material emphasizes the introduction of the tools used to build computer networks.
3. Network Topology

This material specifically explains the topology of computer networks and the types of basic topologies used on computer networks.

In general, the target of learning in this application is the wider community so that the subject of the material is also arranged concisely and clearly. Thus, users who in this case beginners can easily understand the presentation of the material. For example, in the discussion of computer network topology described common types of topology that is often used. Descriptions of this material are also brief and direct on the subject.

An example of the view of the computer network learning content of the network topology is shown in Figure 4.

![Figure 4. Basic Network Topology](image4.jpg)

One of the interesting main features of this learning application is the exercise content. This learning content provides a variety of exercises to evaluate learners' understanding of computer networks. In order for this exercise not to be boring, it is presented as attractive as possible with interactive multimedia elements. In Figure 5, we can see the practice of building a network topology with drag and drop game concepts.

![Figure 5. View of Exercise Content](image5.jpg)
The content of the exercise provides a chance for the learner to interact directly with the application. Here learner will be presented various problems that will be solved interestingly with semi-game approach.

After the learners solve the problem as shown in Figure 6, the system will provide feedback in the form of evaluation results. If the answer is correct, the system will give reward appreciation, while if not correct, then system will give motivation and reinforcement.

![Figure 6. View of The Completion of Exercise](image)

The approach used for all exercise and simulation content is direct interactivity through drag and drop action. As a complement to the entire study material presentation, the quiz page provides randomly selected multiple-choice questions as shown in Figure 7. At the end of the quiz process, the user will get the summary and the results or the quiz score.

![Figure 7. Interactive Quiz](image)

3.2. Testing

Once we successfully get the product application, the next step is to make sure that the product is meeting with the requirements specification through a series of tests. To support the implementation of this test, descriptions of test procedures and test cases are required. Testing is done by testing the main functions contained in the interactive multimedia learning application software that has been
developed. The main functions referred to here are represented by subsystems defined in the analysis phase. The hardware environment used to perform this test is the same as the implementation environment.

Preparation of the test plan is based on a scenario that has been created for each subsystem, specifically testing a normal scenario. There are five subsystems involved, basic material content, exercise and simulation, interactive quiz, login system, and manage content. The test procedure is performed sequentially from the smallest unit until the finish. The complete testing plan is shown in Table 1.

| No | Sub-system          | Testing Scenario | Methods  | Results |
|----|---------------------|------------------|----------|---------|
| 1  | Material contents   | Normal           | Black-box| Accepted|
| 2  | Simulation          | Normal           | Black-box| Accepted|
| 3  | Interactive Quiz    | Normal           | Black-box| Accepted|
| 4  | Login system        | Normal           | Black-box| Accepted|
| 5  | Manage content      | Normal           | Black-box| Accepted|

To test the interactive multimedia learning application software, a test procedure is established that reflects the overall software functionality. The technique of testing procedure is to run the main unit or module, then give input and observe the given output. For example, in the interactive quiz sub-system, when the page is open then the testers will fill in the given problem, and the application will respond to the answer option. If the flow is already running properly, then it can be said that the module functionality is declared acceptable. Conversely, if there are still modules that have not functioned, will be repaired and retested until the module is declared accepted.

Based on test results with a defined test case, it can be deduced that the software is free of syntax errors, and functionally release the results as expected. Thus, in general, interactive multimedia learning applications have been able to meet the requirements specifications that have been defined.

4. Discussion

The design of this application takes advantage of HTML5 features as the main technology. HTML5 is a standard markup language and can run stable on all browsers. According to World Wide Web Consortium (W3C), web applications are “light-weight” in the sense that it is easy to create small applications with them [16]. They are more like a “script” than a “program”. So, it is with the design of web-based applications (“webapps”) that are very small, platform-independent programs that are downloaded on demand and execute inside a client program, such as a browser. They have a clearly separated user interface that allows webapps to be easily adapted to different devices.

Representation of multimedia content can be seen in the components of varied content which is composed of text, images, animation, sound, and video. To provide a fun and friendly look, an animated balloon insert is moved by writing down the relevant information. Content of multimedia is presented proportionally and naturally to create a fun learning environment.

Meanwhile, the interactive representation is clearly visible on the application's interactive capabilities allowing users to construct computer network topologies by drag and drop components through the mouse cursor. This practice approach with the concept of interactive games like this will involve the user directly so as to motivate the attraction. Konten interactive lain yang disediakan pada desain aplikasi ini adalah evaluasi multiple choice. Here the learner can use it for practice and will get a return value that describes the mastery or understanding of the material.
5. Conclusion and Recommendations

From this research findings, it is seen that design of applications that run online on the computer network can be accessed widely thus greatly support the improvement of distance learning services. The application product can be run on various devices (desktop or mobile) and can be easily distributed. It supports the geographic condition and various economic characteristics of the society in Indonesia.

This application design employs web technology, specifically pure HTML5, which is able to produce standard applications that are light and reliable. Variations of content consisting of multimedia elements (text, images, audio, animation, and video) are able to present interesting and content-rich learning applications. Meanwhile, the support of interactive features that allows users to interact directly make this application solution more attractive.

Development of interactive multimedia-based learning applications that optimize ICT services is very potential to improve the quality of learning. Utilization of ICT technologies has great potential in broadening educational services broadly as they can be accessed anytime and anywhere through the Internet network. The development of learning content by utilizing the elements of multimedia capable of producing interactive, inspirational, fun, and motivational learning media. However, computer-assisted learning should be used as a supplement, not to substitute the conventional or classical learning.

Based on test results with a defined test case, it can be deduced that the software is free from syntax errors, and functionally release the results as expected. Thus, in general, interactive multimedia learning applications have been able to meet the requirements specifications that have been defined earlier. However, to find a more valid and optimal result, it is necessary to conduct field testing broadly. Therefore, this paper still needs to be continued and developed again in order to conclude the usefulness of the design that has been developed.

References

[1] Virtudes, A and Sá, J, 2017, October Approach of ICT Application to Governance in Urban Planning In IOP Conference Series: Materials Science and Engineering (Vol 245, No 5, p 052086) IOP Publishing
[2] Vallo Hult, H, Byström, K and Gellerstedt, M, 2016 ICT and learning usability at work challenges and opportunities for physicians in everyday practice In Lecture Notes in Business Information Processing (Vol 259, pp 176-190)
[3] A Romiszowski, 2004 "How's the E-learning Baby? Factors Leading to Success or Failure of an Educational Technology Innovation," Educational Technology, vol 44, pp 5–27
[4] Ivleva, NV and Fibikh, EV, 2016, April Experience of e-learning implementation through massive open online courses In IOP Conference Series: Materials Science and Engineering (Vol 122, No 1, p 012008) IOP Publishing
[5] Gordon, N, 2017 Comments In Education, Skills, and Technical Change: Implications for Future US GDP Growth University of Chicago Press
[6] Griffiths, B, 2016 A Faculty's Approach to Distance Learning Standardization Teaching and Learning in Nursing, 11(4), pp157-162
[7] Tutt, A, 2017 about them and what specifically made them" a-ha!" moments
[8] Wang, Y, Qi, A and Cui, F, 2016 Application of the Multimedia Teaching System Based on Real-time Shooting and Production in Martial Art Course International Journal of Emerging Technologies in Learning, 11(3)
[9] Ni, D, 2017 Design and Research on English Listening Teaching Assisted by Computer Multimedia International Journal of Emerging Technologies in Learning, 12(1)
[10] Yavner, SD, Pusic, MV, Kalet, AL, Song, HS, Hopkins, MA, Nick, MW and Ellaway, RH, 2015 Twelve tips for improving the effectiveness of web-based multimedia instruction for clinical learners Medical teacher, 37(3), pp239-244
[11] Hwang, WY, Shadiev, R, Hsu, JL, Huang, YM, Hsu, GL and Lin, YC, 2016 Effects of
storytelling to facilitate EFL speaking using Web-based multimedia system Computer Assisted Language Learning, 29(2), pp215-241

[12] Kirstein, J and Nordmeier, V, 2007 Multimedia representation of experiments in physics European Journal of Physics, 28(3), pS115

[13] Pressman, Roger S 2015 Software Engineering: A Practitioner's Approach 8th international edition New York: McGraw-Hill

[14] Prasetya, D D, Widiyaningtyas, T, Arifin, M Z, & I, W S G 2017 Design reflowable digital book template In AIP Conference Proceedings (Vol 1887, No 1, p 020023) AIP Publishing

[15] Jan, SR, Shah, ST, Johar, ZU, Shah, Y and Khan, F, 2016 An Innovative Approach to Investigate Various Software Testing Techniques and Strategies International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Print ISSN, pp2395-1990

[16] https://www3org/People/Bos/webappshtml Setting the scope for light-weight Web-based applications (online) Retrieved on September 2017